FIRST SEMESTER B E PROGRAM 2016-17
Electrical Science Stream Syllabi Content

Program: UG		
Course Code: 16EEEF101	Course Title: Basic Electrical Engineering	
L-T-P-SS: 3-0-0	Credits:4	Contact Hrs: 50
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 3		Exam Duration: 3 hours

Unit I	
Chapter No. 1: Overview of Electrical Engineering Specialization, scope & role, impact of Electrical Engineering on national economy, environment, Sources of generation, sustainability, challenges and opportunities for electrical engineers, electrical engineering marvels, future challenges.	02 hrs
Chapter No. 2 : D.C. and Magnetic Circuits Ohm's law, Kirchhoff's laws, network analysis by Maxwell's circulating currents, constant current and voltage source, nodal analysis, series magnetic circuits, mmf, reluctance and inductance, simple problems and analogy	08 hrs
Chapter No. 3. Actuators Electromagnetic principles, classification of Electric motors, DC motors-shunt, series, PMDC motors – Speed Control, Stepper Motors, BLDC motors, Characteristics and applications, selection of motors for various applications	05 hrs
Unit II	
Chapter No. 4 : Single phase AC Circuits Introduction to AC circuits and theory of generation of sinusoidal alternating voltage, concept of average and effective (rms) values, form factor, peak factor of sinusoidally varying voltage and current, phasor representation of alternating quantities, analysis with phasor diagrams of RLC circuits, power and power factor in AC circuits, parallel RLC Circuits and numerical. Introduction to Transformers (no-load phasor diagram).	10 hrs
Chapter No. 5: Three Phase Systems Necessity and advantages of three phase systems, generation of three phase e.m.f.s, relationship between line and phase values of balanced star and delta connections,	5 hrs

power in balanced three phase circuits and power measurement using two watt meters, three phase induction motor, numericals	
Unit III	
Chapter No. 6. Batteries: Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing.	05 hrs
Chapter No. 7: Electrical Wiring, Safety and protection Types of wires and cables for internal wiring, Types of switches and Circuits, Types of wiring, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Importance of grounding and earthing, Methods for earthing, Fuses, MCB, ELCB and Relays	05 hrs

Text Books

1. Hughes , Electrical & Electronic Technology, 8th edition, Pearson Education
2. David G Alciatore and Michel B Histand, Introduciton to Mechatronics and Measurement Systems, 3rd edition 2005, Tata McGraw Hill Education Private Limited, New Delhi.
3. Gilbert M Masters, Renewable and efficient Electrical Power systems, Published by John Wiley & Sons 2004 edition

Reference Books

1. D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications
2. Vincent Del Toro, Electrical Engineering Fundamentals, 2nd edition Prentice Hall India

Course Content (Electrical Sciences)

Course Code : 15EEEF101 **L-T-P: 3-0-0**
Course Title : Basic Electrical Engineering **CIE : 50**
Teaching Hours : 40 **SEE : 50**

Unit I	
Chapter No. 1: Overview of Electrical Engineering Specialization, scope & role, impact of Electrical Engineering on national economy, environment, Sources of generation, sustainability, challenges and opportunities for electrical engineers, electrical engineering marvels, future challenges.	02 hrs
Chapter No. 2 : D.C. Circuits Ohm's law, Kirchhoff's laws, Analysis of series, parallel and series- parallel circuits excited by independent voltage sources, network analysis by Maxwell's circulating currents, constant current and voltage source, nodal analysis.	05 hrs
Chapter No. 3 : Single phase AC Circuits Introduction to AC circuits and theory of generation of sinusoidal alternating voltage, concept of average and effective (rms) values, form factor, peak factor of sinusoidally varying voltage and current, phasor representation of alternating quantities, analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits, power in an AC circuits, and simple numerical problems	08 hrs
Unit II	
Chapter No. 4: Three Phase Systems Necessity and advantages of three phase systems, generation of three phase e.m.f.s, relationship between line and phase values of balanced star and delta connections, power in balanced three phase circuits, numerical problems	7 hrs
Chapter No. 5: Electrical Wiring, Safety and protection Service mains, Meter board and distribution board, types of wires and cables, Types of wiring, Types of connectors and switches, two and three way control of lamp, control circuit in domestic installation. Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, importance of grounding and earthing, methods for earthing, Fuses, MCB and Relays.	8 hrs
Unit III	
Chapter No. 6 : Introduction to Electrical Machines Principles of DC Motors: PMDC Motor, stepper motor, single phase transformer, Three phase induction Motors, applications, Simple Numericals on transformers and three phase induction motors.	05 hrs
Chapter No. 7: Illumination Types of lamps, fixtures and reflectors, Illumination schemes for domestic, industrial and commercial premises, lumen requirement for different categories	05 hrs

Text Books

1. Hughes , Electrical & Electronic Technology, 8th edition, Pearson Education
2. P C Sen, Principals of Electrical Machines and Power Electronics, 2nd edition, Wiley Publications
3. Vincent Del Toro, Electrical Engineering Fundamentals, 2nd edition Prentice Hall India
4. Robert Helm, Illumination Engg for energy efficient luminous environments

Reference Books

1. D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications
2. David G Alciatore and Michel B Histand, Introduciton to Mechatronics and Measurement Systems, 3rd edition 2005, Tata McGraw Hill Education Private Limited, New Delhi.

FIRST SEMESTER B E PROGRAM 2016-17
Electrical Science Stream Syllabi Content

<table>
<tr><td colspan="2">Course Code: 16EPHP101</td><td colspan="3">Course Title: Engineering Physics lab</td></tr>
<tr><td colspan="2">L-T-P: 0-0-1</td><td>Credits : 1</td><td colspan="2">Contact Hrs.: 02 Hrs./Week</td></tr>
<tr><td colspan="2">CIE Marks: 80</td><td colspan="2">SEE Marks: 20</td><td>Total Marks: 100</td></tr>
<tr><td colspan="3">Teaching Hrs.: 24</td><td colspan="2">Examination Duration: 3 Hrs.</td></tr>
<tr><td colspan="5">Experiments</td></tr>
<tr><td>1.</td><td colspan="4">Four probe method</td></tr>
<tr><td>2.</td><td colspan="4">V-I characteristics of p-n junction diode</td></tr>
<tr><td>3.</td><td colspan="4">Zener diode characteristics</td></tr>
<tr><td>4.</td><td colspan="4">Hysteresis loss</td></tr>
<tr><td>5.</td><td colspan="4">Transistor characteristics</td></tr>
<tr><td>6.</td><td colspan="4">Measurement of dielectric constant</td></tr>
<tr><td>7.</td><td colspan="4">Resonance frequency of LCR circuits</td></tr>
<tr><td>8.</td><td colspan="4">Study of frequency response of passive components</td></tr>
<tr><td>9.</td><td colspan="4">Calibration of thermocouple</td></tr>
<tr><td>10.</td><td colspan="4">Calibration of electrical meters</td></tr>
</table>

Course Code: **15EPHP101**	Course Title: **Engineering Physics lab (Electrical Sciences)**			
L-T-P-SS:**0-0-1-0**	Credits : **1**	Contact Hrs: **02 Hrs/Week**		
CIE Marks: **80**	SEE Marks: **20**		Total Marks: **100**	
Teaching Hrs: **24 Hrs**		Examination Duration: **3 Hrs**		

Experiments

1.	Study of Lissajous figuires using Cathode ray Oscilloscope
2.	Self inductance and resistance of a coil
3.	Hysteresis Loop for a ferromagnetic material (M-B curve)
4.	Electromagnetic induction
5.	Magnetic field along the axis of a coil (Biot-Savart Law) Study of Hall effect (Lorentz Force)
6.	Charging and discharging of a capacitor
7.	Four probe method to determine the energy gap and electrical restivity of given semiconductor material.
8.	V-I characteristics of p-n junction diode
9.	V-I characteristics of zener diode
10.	Rectifier circuits with and without filter (Half wave, Full wave &Bridge)
11.	Zener diode as voltage regulator
12.	V-I characteristics of BJT.
13.	Resonance in LCR circuit

FIRST SEMESTER B E PROGRAM 2016-17
Mechanical Science Stream Syllabi Content

Course Content

Course Code: 15ECRP101	Course Title: Engineering Exploration	
L-T-P: **0-0-3**	Credits: 3	Contact Hrs: 78
CIE Marks: 80	SEE Marks: 20	Total Marks: 100
Teaching Hrs: 78		SEE Exam Duration: 3 hrs

No	Content	Sessions
1	Introduction to Engineering and Engineering Study	1
2	Role of Analysis in Engineering, Analysis Methodology	2
3	Data Analysis Graphing	2
4	Basics of Engineering Design, Multidisciplinary Nature of Engineering Design	5
5	Project Management	1
6	Sustainability in Engineering	2
7	Ethics	1
8	Modeling, Simulation and Data Acquisition using Software Tool	1
9	Platform based development : Arduino	3
9	Course Project	3

Reference Books:

1. Engineering Fundamentals & Problem Solving by Arvid Eide, Roland Jenison, Larry Northup, Steven, Mc GrawHill Higher Education, 6th Edition (2011)
2. Engineering Exploration (Edited Book, 2008) by Pearson Publication

Evaluation Scheme

Chapter No	Name	Weightage in percentage
1	Introduction to Engineering and Engineering Study	-
2	Role of Analysis in Engineering	10
3	Analysis Methodology	
4	Data Analysis Graphing	10

5	Basics of Engineering Design	
	Multidisciplinary Nature of Engineering Design	20
6	Project Management	5
7	Sustainability in Engineering	10
8	Ethics	5
9	Modelling, Simulation and Data Acquisition using Software Tool	-
10	Platform Based Development: Arduino	-
10	Course Project	40

FIRST SEMESTER B E PROGRAM 2016-17
Electrical Science Stream Syllabi Content

Program: UG		
Course Code: 15EHSP101	**Course Title: Social Innovation**	
L-T-P-SS: 0-1-1	**Credits:2**	**Contact Hrs: 40**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hrs: 3		**Exam Duration: 1.5 hours**

Module	Topics	Assignments	Tools
KNOWLEDGE & TOOLS	1. Induction to Social Innovation: • Awakening social consciousness • Engineering& Social innovation • Site Visits • Course Overview	• Read the handout on “The Process of Social Innovation” by Geoff Mulgan • Submit report on field visit	• Special Lectures • Field visit • Review course objectives and syllabus through PPT • Behavioral Blocks to Innovation Questionnaire • Case review
	2. Social Innovation and Leadership	• Report on two social innovations created by engineers/social innovators	• Video session & discussion on applications of engineering in social field
	3. Idea Generation	• One page write up on idea generated about social issues through literatures and observation	• Literature survey • Field visits
	4.Identifying Local Issues & work team formation	• One page report on literature review • Justification Campus activity	• Focused Group Discussions on local challenges observed & Idea pitching • Experience sharing by senior students

KNOWLEDGE & TOOLS	5.Issues Based Problem Solving Tree	• Designing Issue Based Problem Solving Tree for issue identified	• Case study
	6. Project Proposals	• Present the project proposal	• Case study • Report template
	7.Team Analysis	• Carryout & present SWOT analysis for individual & the team	• Case study/ Videos
	8.Stakeholder Analysis	• Prepare & present stakeholder analysis for group project	• Stakeholder engagement activity
	9. Innovative Budgeting and Fundraising	• Preparing budget and fundraising report for group project	• Presentation on fundraising techniques applied for the project
DEVELOPMENT	10. Experiential Sessions	• Brief write up	• Special lecture
	11.Experiential Sessions	• Brief write up	• Special lecture
	12. Innovative Resource Management	• Classroom Activity	• Structure building games
	13. Calculative Risk Management	• Classroom Activity	• Risk Management games
IT SESSIONS	14.Exposure to IT Skills- session 1 and session 2	• IT assignments	• PPT • Movie Maker • Web Designing & Hosting • Internet Basics

(2015-16)

Engineering Exploration 15ECRP101

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Exercise		Total Weightage: 80		No. of lab sessions: 16
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	Introduction to Engineering and Engineering Study	2		
	Learning Outcomes: The students should be able to: 1. Explain the importance of engineering profession in the world 2. List the roles of an engineer in the engineering workplace 3. Describe common engineering disciplines and their Specialisations 4. Differentiate between learning at school and learning in college			
2 a	Role of Analysis in Engineering.	1		
	Learning Outcomes: The students should be able to: 1. Explain the importance of analysis in engineering 2. Characterize an engineering problem by defining the inputs, output, stating assumptions and uncertainties 3. Prioritize the identified attributes for analysis			
2 b	Analysis Methodology	1	10	
	Learning Outcomes: The students should be able to: 1. Write a mathematical model of a system in terms of applicability and required accuracy 2. Interpret the model of the system using scientific and engineering principles			
3	Data Analysis and Graphing	2	10	
	Learning Outcomes: The students should be able to: 1. Explain the significance of Data Analysis 2. Choose appropriate procedures, tools and techniques to represent a dataset 3. Interpret and analyse data quantitatively and/or graphically 4. Establish the relationship between the physical parameters of raw data to reach appropriate conclusions			
4 a	Basics of Engineering Design	2	10	

	Learning Outcomes: The students should be able to: 1. Explain engineering design process 2. Formulate problem definition for the need statement 3. Generate possible design alternatives/ solutions			
4 b	Multidisciplinary Nature of Engineering Design	3	10	
	Learning Outcomes: The students should be able to: 1. Identify multi-disciplinary facet of design 2. Construct proposed simple mechanical / mechatronic systems			
5	Project Management	1	5	
	Learning Outcomes: The students should be able to: 1. Illustrate the importance of team work in managing project 2. Plan project using relevant project management tools like checklist, timeline and Gantt chart 3. Prepare project report for the chosen project following the given standards			
6	Sustainability in Engineering	2	10	
	Learning Outcomes: The students should be able to: 1. Explain that role of engineers is vital in sustainable Engineering Design 2. Analyse an engineering situation based on the three main pillars of sustainable development: Society, Environment and Economy 3. Discriminate engineered products based on their life cycle assessment 4. Draw inferences out of carbon footprint calculations in day to day life			
7	Ethics	1	5	
	Learning Outcomes: The students should be able to: 1. Define the terms: etiquette, law, morals and ethics 2. Explain the need for ethics in engineering profession 3. Explain moral theories 4. Analyse the situation for ethical dilemma and make decision			
8	Modelling, Simulation, Data Acquisition & Analysis using Software Tool	4	20	
	Learning Outcomes: The students should be able to: 1. Describe the significance of Modelling, Simulation, Data			

	Acquisition & Analysis 2. Build Virtual Instrument for an application 3. Use looping, timing and formula node concepts appropriately for an application 4. Build a system by interfacing a sensor/transducer	

References:

1. Engineering Fundamentals & Problem Solving by Arvid Eide, Roland Jenison, Larry Northup, Steven, Mc GrawHill Higher Education, 6th Edition (2011)
2. Engineering Exploration (Edited Book, 2008) by Pearson custom Publishing

Evaluation Scheme

Chapter No	Name	Sessions	Weightage in percentage
1	Introduction to Engineering and Engineering Study	3 hrs	
2	Role of Analysis in Engineering	3 hrs	10
3	Analysis Methodology	3 hrs	
4	Data Analysis Graphing	6 hrs	10
5	Basics of Engineering Design	6 hrs	20
	Multidisciplinary Nature of Engineering Design	6 hrs	
	Review	3hrs	
6	Project Management	3 hrs	5
7	Sustainability in Engineering	3 hrs	10
8	Ethics	6 hrs	5
9	Modelling, Simulation, Data Acquisition & Analysis using Software Tool	12 hrs	20
10	Course Project	24 hrs	20

CEER Director

Date: 7-1-15

KLE Technological University
KLE TECH.
Creating Value
Leveraging Knowledge

Earlier known as
B. V. B. College of Engineering & Technology

FIRST SEMESTER B E PROGRAM 2016-17
Electrical Science Stream Syllabi Content

Common Course

Program: UG		
Course Code: 15EHSP101	**Course Title: Social Innovation**	
L-T-P-SS: 0-1-1	**Credits:2**	**Contact Hrs: 40**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hrs: 3		**Exam Duration: 1.5 hours**

Module	Topics	Assignments	Tools
KNOWLEDGE & TOOLS	1. Induction to Social Innovation: • Awakening social consciousness • Engineering& Social innovation • Site Visits • Course Overview	• Read the handout on "The Process of Social Innovation" by Geoff Mulgan • Submit report on field visit	• Special Lectures • Field visit • Review course objectives and syllabus through PPT • Behavioral Blocks to Innovation Questionnaire • Case review
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	4.Identifying Local Issues & work team formation	• One page report on literature review • Justification Campus activity	• Focused Group Discussions on local challenges observed & Idea pitching • Experience sharing by senior students
	5.Issues Based Problem Solving Tree	• Designing Issue Based Problem Solving Tree for issue identified	• Case study

KNOWLEDGE & TOOLS	6. Project Proposals	• Present the project proposal	• Case study • Report template
	7.Team Analysis	• Carryout & present SWOT analysis for individual & the team	• Case study/ Videos
	8.Stakeholder Analysis	• Prepare & present stakeholder analysis for group project	• Stakeholder engagement activity
	9. Innovative Budgeting and Fundraising	• Preparing budget and fundraising report for group project	• Presentation on fundraising techniques applied for the project
DEVELOPMENT	10. Experiential Sessions	• Brief write up	• Special lecture
	11.Experiential Sessions	• Brief write up	• Special lecture
	12. Innovative Resource Management	• Classroom Activity	• Structure building games
	13. Calculative Risk Management	• Classroom Activity	• Risk Management games
IT SESSIONS	14.Exposure to IT Skills-session 1 and session 2	• IT assignments	• PPT • Movie Maker • Web Designing & Hosting • Internet Basics

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Leveraging Knowledge

2015-16

Course Code: 15EHSP101 | Course Title: Social Innovation
L-T-P: 0-1-1 | Credits: 2 | Contact Hrs: 3 hrs/week

Module	Topics	Assignments	Tools
KNOWLEDGE & TOOLS	1. Induction to Social Innovation: • Awakening social consciousness • Engineering& Social innovation • Site Visits • Course Overview	• Read the handout on "The Process of Social Innovation" by Geoff Mulgan • Submit report on field visit	• Special Lectures • Field visit • Review course objectives and syllabus through PPT • Behavioral Blocks to Innovation Questionnaire • Case review
	2. Social Innovation and Leadership	• Report on two social innovations created by engineers/social innovators	• Video session & discussion on applications of engineering in social field
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	6. Project Proposals	• Present the project proposal	• Case study • Report template
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DEVELOPMENT	10. Experiential Sessions	• Brief write up	• Special lecture
	11.Experiential Sessions	• Brief write up	• Special lecture
	12. Innovative Resource Management	• Classroom Activity	• Structure building games
	13. Calculative Risk Management	• Classroom Activity	• Risk Management games

IT SESSIONS	14.Exposure to IT Skills-session 1 and session 2	• IT assignments	• Presentation Skills • Movie Maker • Web Designing & Hosting • Internet Basics

Monitoring: Faculty will maintain individual student dairy and assess the performance on weekly basis.

FIRST SEMESTER B E PROGRAM 2018-19

Syllabi Content **(New Title) (Common course)**

Program: UG		
Course Title: Single Variable Calculus		Course Code: 18EMAB101
L-T-P: 4-1-0	Credits: 05	Contact Hours: 72
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 06	Examination Duration: 3hrs	

Unit I

1. Functions, Graphs and Models **07 hours**

Functions, types of functions, transformations and models (Linear, exponential, trigonometric).

MATLAB: Graphing functions, Domain-Range and Interpreting the models

2. Calculus of functions and models **13 hours**

Limit of a function, Infinite limits- graph, Continuity and discontinuity, Intermediate value theorem statement, Roots of the equation using Bisection Method and Newton- Raphson Method

Interpretation of derivative as a rate of change, All the rules of derivatives (List only), Maxima, Minima and optimization problems. Curvature and Radius of Curvature, Indeterminate forms, L- Hospital's rule-Examples

MATLAB: optimization problems. Curvature problems

Unit II

3. Infinite Series **06 hours**

Definition, Convergence of series, Tests of convergence – p-series, Alternating series. Power series, radius of convergence, Taylor's and Maclaurin's series, Applications of Taylor's and Maclaurin's series

MATLAB: Convergence of series

4. Integral calculus 14 hours

Tracing of standard curves in Cartesian form ,Parametric form and Polar form; Beta and gamma function, relation between them, evaluation of integrals using Beta and gamma functions; Applications to find arc length, Area, Volume and surface area (Cartesian, parametric and polar curves). Approximate integration- Trapezoidal rule, Simpson's 1/3 rule

MATLAB: problems on arc length, area, volume and surface area

Unit III

5. Ordinary differential equations of first order 10 hours

(a) Introduction to Initial Value problems. Linear and Bernoulli's equations, Exact equations and reducible to exact form, Numerical solution to Initial Value problems-Euler's method, Modified Euler's method and Runge-Kutta method

(b) Applications of first order differential equations-Orthogonal trajectories growth and decay problems, mixture problems, Electrical circuits, falling bodies.

MATLAB: Solve differential equations

Text Books

1. Early Transcendentals Calculus- James Stewart, Thomson Books, 7ed 2010.

Reference Books:

1. Calculus Single and Multivariable, Hughues-Hallett Gleason, Wiley India Ed, 4ed, 2009.
2. Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010

FIRST SEMESTER B E PROGRAM 2017-18

Syllabi Content

(Old Title) (Common course)

Program: UG		
Course Title: Analytical Geometry and Calculus		Course Code: 15EMAB101
L-T-P: 5-0-0	Credits: 05	Contact Hours: 60
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 05	Examination Duration: 3hrs	

Unit I

2. **Functions and Graphs** **05 hours**
   Trigonometric Functions, Exponential Functions and Logarithmic Functions
3. **Limits and continuity**
   10 hours Limit of a function, Infinite limits- graph, Continuity and discontinuity, Intermediate value theorem statement, Roots of the equation using Bisection Method and Newton- Raphson Method
4. **Derivatives and applications** **10 hours**
   Definition and Interpretation of derivates as a rate of change, All the rules of derivatives (List only**)**, Maxima, Minima, What does f' and f'' say about f, Curvature and Radius of Curvature, Indeterminate forms – L'Hospital's rule

Unit II

5. **Infinite Series** **10 hours** Definition, Convergence of series, Tests of convergence – p-series, comparison test, ratio test Representation of a function as a power series, radius of convergence, Taylor's and Maclaurin's series, Applications of Taylor's and Maclaurin's series
6. **Integral calculus** **15 hours** Tracing of standard curves in Cartesian form ,Parametric form and Polar form; Beta and gamma function, relation between them, evaluation of integrals using Beta and gamma functions; Applications to find arc length, Area, Volume and surface area (Cartesian, parametric and polar curves). Approximate integration- Trapezoidal rule, Simpson's 1/3 rule.

Unit III
7. **Vectors and Geometry of space** **(5+5) hours** (a) Three dimensional Coordinate system, Vectors in space, position vector, Direction cosines, Direction angles and planes, angle between planes. (b) Equations of line, coplanar lines, skew lines, surfaces. Cylindrical and spherical coordinates, curves in 3-d spaces
Text Books **1.** Early Transcendental Calculus- James Stewart, Thomson Books, 5e 2007
Reference Books: **3.** Calculus Single and Multivariable, Hughues- Hallett Gleason, Wiley India Ed, 4ed, 2009. **4.** Calculus I, Jerrold Marsden and Alan Weinstein, Springer-Verlag,2e,1986. **5.** Calculus II, Jerrold Marsden and Alan Weinstein, Springer-Verlag, 2e,1986. **6.** Calculus III, Jerrold Marsden and Alan Weinstein, Springer-Verlag, 2e,1986.

SECOND SEMESTER B E PROGRAM 2018-19

Syllabi Content

(New Title) (Common course)

Program: UG		
Course Title: Multivariable calculus		Course Code: 18EMAB102
L-T-P: 4-1-0	Credits: 05	Contact Hours: 72
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 06	Examination Duration: 3hrs.	

Unit I

1. **Partial differentiation** **12 hour s**
   Function of several variables, Partial derivatives, Level curves, Chain rule, Errors and Approximations. Extreme value problems. Lagrange's multipliers.
2. **Double integrals** **08 hours**
   Double integrals- Rectangular and polar coordinates, Change the order of integration. Change of variables, Jacobian. Application of double integrals
   MATLAB: optimization problems, application of double integrals

Unit II

3. **Triple integrals** **07 hours**
   Triple integrals, Cartesian, change to Cylindrical and Spherical coordinates Application of Triple integrals
4. **Calculus of Vector Fields** **13 hours**
   Vector fields, Gradient and directional derivatives. Line and Surface integrals. Independence of path and potential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem.
   MATLAB: application of Triple integrals, Vector calculus problems

Unit III

5. **Differential equations of higher orders** **(5+5) hours**
   (a) Linear differential equations of second and higher order with constant coeffiISAnts The method of Variation of parameters. Initial and boundary value problems.
   (b) Applications of second order differential equations-Newton's 2^{nd} law, electrical circuits, Simple Harmonic motion. Series solution of differential equations. Validity of Series solution of Differential equations.

MATLAB: application of differential equations

Text Books : **1.** Early Transcendental Calculus- James Stewart, Thomson Books, 7ed 2010
Reference Books: **1.** Calculus Single and Multivariable, Hughues-Hallett Gleason, Wiley India Ed, 4ed, 2009. **2.** Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010

SECOND SEMESTER B E PROGRAM 2017-18

Syllabi Content (Common course)

Program: UG		
Course Title: Multivariate calculus and differential equations		**Course Code: 15EMAB102**
L-T-P: 5-0-0	**Credits: 05**	**Contact Hours: 60**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 05	**Examination Duration: 3hrs**	

Unit I

6. **Partial differentiation** **12 hours** Function of several variables, Partial derivatives, Level curves, Chain rule, Errors and Approximations. Extreme value problems. Lagrange's multipliers.
7. **Multiple integrals** **13 hours** Double integrals- Rectangular and polar coordinates, Change the order of integration. Change of variables, Jacobian. Triple integrals- Cartesian, Cylindrical and Spherical coordinates Application of multiple integrals

Unit II

8. **Calculus of Vector Fields** **13 hours** Vector fields, Gradient and directional derivatives. Line and Surface integrals. Independence of path and potential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem.
9. **Differential equations of first order** **12 hours** Introduction to Initial Value problems. Linear and Bernoulli's equations, Exact equations and reducible to exact form, Applications of first order differential equations- Orthogonal trajectories, growth and decay problems, mixture problems, Electrical circuits, falling bodies. Approximate solution to Initial Value problems-Euler's method, Modified Euler's method and Runge-Kutta method.

Unit III

10. **Differential equations of higher orders** **(5+5) hours** (a) Linear differential equations of second and higher order with constant coefficients The method of Variation of parameters. Initial and boundary value problems. (b) Applications of second order differential equations-Newton's 2nd law, electrical circuits, Simple Harmonic motion.

Series solution of differential equations. Validity of Series solution of Differential equations.
Text Books : **1.** Early Transcendental Calculus- James Stewart, Thomson Books, 5e 2007
Reference Books: **3.** Calculus Single and Multivariable, Hughues-Hallett Gleason, Wiley India Ed, 4ed, 2009. **4.** Calculus I, Jerrold Marsden and Alan Weinstein, Springer-Verlag,2e,1986. **5.** Calculus II, Jerrold Marsden and Alan Weinstein, Springer-Verlag, 2e,1986. **6.** Calculus III, Jerrold Marsden and Alan Weinstein, Springer-Verlag, 2e,1986.

FIRST SEMESTER B E PROGRAM 2018-19
Electrical Science Stream Syllabi Content

Program: UG		
Course Code: 18EEEF101	Course Title: Basic Electrical Engineering	
L-T-P: 3-0-0	Credits: 3	Contact: 40 Hrs.
CIA Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching : 40 Hrs.		Exam Duration: 3 Hrs.

Chapter No.	Unit-I	Hours
1	**Overview of Electrical Engineering** Specialization, scope & role, impact of Electrical Engineering on national economy, environment, Sources of generation, sustainability, challenges and opportunities for electrical engineers, electrical engineering marvels, future challenges.	**02**
2	**DC Circuits** Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Time-domain analysis of first-order RL and RC circuits.	**05**
3	**AC Circuits** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. power measurement using two watt meters	**08**
	Unit-II	
4	**Electrical Actuators** Electromagnetic principles, Solenoid, Relays, classification of Electric motors, DC motors-shunt, series, compound, separately excited, PMDC motors –Speed Control, Stepper Motors, BLDC motors, three phase induction motor, Characteristics and applications, selection of motors for various applications.	**9**
5	**Power Electronics** (Text1, chapter 45) Introductory, Thyristor, Some thyristor circuits, Limitations to thyristor operation, The thyristor in practice, The fully controlled AC/DC converter,	**6**

	AC/DC inversion, Switching devices in inverters, Three-phase rectifier networks, The three-phase fully controlled converter, Inverter-fed induction motors, Soft-starting induction motors, DC to DC conversion switched-mode power	
	Unit-III	
6	**Electrical Wiring, Safety and protection(Ref :Text3-page 1 to 10)** Types of wires and cables for internal wiring, Types of switches and Circuits, Types of wiring, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Importance of grounding and earthing, Methods for earthing, Fuses, MCB, ELCB and Relays, Lockout and Tagout, Electrical Codes and Standards.	**05**
7	**Batteries:** Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing. Numericals.	**05**

Text Books	
1	Hughes, Electrical & Electronic Technology, 8th , Pearson Education, 2001
2	P C Sen, Principals of Electrical Machines and Power Electronics, 2nd, Wiley Publications
3	Gilbert M Masters, Renewable and efficient Electrical Power systems, Published by John Wiley & Sons 2004 edition
4	Frank D. Petruzella, Electric Motors and Control Systems, McGraw Hill Education Private Limited 2009 Edition
Reference Books:	
1	D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications
2	David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005
3	Vincent Del Toro, Electrical Engineering Fundamentals, 2nd edition Prentice Hall India

FIRST SEMESTER B E PROGRAM 2017-18

Electrical Science Stream Syllabi Content

CONTENT

Program: UG		
Course Code: 16EEEF101	**Course Title: Basic Electrical Engineering**	
L-T-P-SS: 3-0-0	**Credits:4**	**Contact Hrs: 50**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hrs: 3		**Exam Duration: 3 hours**

Unit I	
Chapter No. 1: Overview of Electrical Engineering Specialization, scope & role, impact of Electrical Engineering on national economy, environment, Sources of generation, sustainability, challenges and opportunities for electrical engineers, electrical engineering marvels, future challenges.	02 hrs
Chapter No. 2 : D.C. and Magnetic Circuits Ohm's law, Kirchhoff's laws, network analysis by Maxwell's circulating currents, constant current and voltage source, nodal analysis, series magnetic circuits, mmf, reluctance and inductance, simple problems and analogy	08 hrs
Chapter No. 3. Actuators Electromagnetic principles, classification of Electric motors, DC motors-shunt, series, PMDC motors – Speed Control, Stepper Motors, BLDC motors, Characteristics and applications, selection of motors for various applications	05 hrs
Unit II	
Chapter No. 4 : Single phase AC Circuits Introduction to AC circuits and theory of generation of sinusoidal alternating voltage, concept of average and effective (rms) values, form factor, peak factor of sinusoidally varying voltage and current, phasor representation of alternating quantities, analysis with phasor diagrams of RLC circuits, power and power factor in AC circuits, parallel RLC Circuits and numerical. Introduction to Transformers (no-load phasor diagram).	10 hrs
Chapter No. 5: Three Phase Systems Necessity and advantages of three phase systems, generation of three phase e.m.f.s, relationship between line and phase values of balanced star and delta connections,	5 hrs

power in balanced three phase circuits and power measurement using two watt meters, three phase induction motor, numericals	
Unit III	
Chapter No. 6. Batteries: Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing.	05 hrs
Chapter No. 7: Electrical Wiring, Safety and protection Types of wires and cables for internal wiring, Types of switches and Circuits, Types of wiring, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Importance of grounding and earthing, Methods for earthing, Fuses, MCB, ELCB and Relays	05 hrs

Text Books

1. Hughes , Electrical & Electronic Technology, 8th edition, Pearson Education
2. David G Alciatore and Michel B Histand, Introduciton to Mechatronics and Measurement Systems, 3rd edition 2005, Tata McGraw Hill Education Private Limited, New Delhi.
3. Gilbert M Masters, Renewable and efficient Electrical Power systems, Published by John Wiley & Sons 2004 edition

Reference Books

1. D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications
2. Vincent Del Toro, Electrical Engineering Fundamentals, 2nd edition Prentice Hall India

SECOND SEMESTER B E PROGRAM 2018-19
Mechanical Science Stream Syllabi Content

Program: UG		
Course Code: 18EEEF102	Course Title: Basic Electrical Engineering	
L-T-P: 3-0-0	Credits: 3	Contact Hrs.: 40
CIA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching:40 Hrs..	Exam Duration: 3 Hrs..	

Chapter No.	Unit-I	Hrs..
1	**Overview of Electrical Engineering** Specialization, scope & role, impact of Electrical Engineering on national economy, environment, Sources of generation, sustainability, challenges and opportunities for electrical engineers, electrical engineering marvels, future challenges.	**02**
2	**DC Circuits** Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Time-domain analysis of first-order RL and RC circuits.	**05**
3	**AC Circuits** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. power measurement using two watt meters	**08**
	Unit-II	
4	**Electrical Actuators** Electromagnetic principles, Solenoid, Relays, classification of Electric motors, DC motors- shunt, series, compound, separately excited, PMDC motors – Speed Control, Stepper Motors, BLDC motors, three phase induction motor, Characteristics and applications, selection of motors for various applications.	**9**
5	**Power Electronics (Text1, chapter 45)** Introductory, Thyristor, Some thyristor circuits, Limitations to thyristor operation, The thyristor in practice, The fully controlled AC/DC converter, AC/DC inversion, Switching devices in inverters, Three-phase rectifier networks, The three-phase fully controlled converter, Inverter-fed induction motors, Soft-starting induction motors, DC to DC conversion switched-mode power	**6**
	Unit-III	

6	**Electrical Wiring, Safety and protection(ref :Text3-page 1 to 10)** Types of wires and cables for internal wiring, Types of switches and Circuits, Types of wiring, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Importance of grounding and earthing, Methods for earthing, Fuses, MCB, ELCB and Relays, Lockout and Tagout, Electrical Codes and Standards.	**05**
7	**Batteries:** Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb effiISAncy, Numerical of high and low charging rates, Battery sizing. Numericals..	**05**

Text Books	
1	Hughes, Electrical & Electronic Technology, 8th , Pearson Education, 2001
2	P C Sen, Principals of Electrical Machines and Power Electronics, 2nd, Wiley Publications
3	Gilbert M Masters, Renewable and effiISAnt Electrical Power systems, Published by John Wiley & Sons 2004 edition
4	Frank D. Petruzella, Electric Motors and Control Systems, McGraw Hill Education Private Limited 2009 Edition
Reference Books:	
1	D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications
2	David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005
3	Vincent Del Toro, Electrical Engineering Fundamentals, 2nd edition Prentice Hall India

SECOND SEMESTER B E PROGRAM 2017-18

Mechanical Science Stream Syllabi Content

Course Code: 16EEEF102	**Course Title: Basic Electrical Engineering**	
L-T-P-SS: 3-0-0	**Credits: 3**	**Contact Hrs/Week: 3**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hrs: 50	**Exam Duration: 3 hours**	

Unit I	
Chapter No. 1: Overview of Electrical Engineering Specialization, scope & role, impact of Electrical Engineering on national economy, environment, Sources of generation, sustainability, challenges and opportunities for electrical engineers, electrical engineering marvels, future challenges.	02 hrs.
Chapter No. 2 : D.C. and Network Theorems Ohm's law, Kirchhoff's laws, Analysis of series, parallel and series- parallel circuits excited by independent voltage sources, network analysis by Maxwell's circulating currents, constant current and voltage source, nodal analysis, Thevenin's Theorem, Norton's Theorem.	8 hrs.
Chapter No. 3. Actuators Electromagnetic principles, classification of Electric motors, DC motors-shunt, series, PMDC motors – Speed Control, Stepper Motors, BLDC motors, Characteristics and applications, selection of motors for various applications	5 hrs.
Unit II	
Chapter No. 5 : Single phase AC Circuits Introduction to AC circuits and theory of generation of sinusoidal alternating voltage, concept of average and effective (rms) values, phasor representation of alternating quantities, analysis with phasor diagrams of RLC circuits, power and power factor in AC circuits, parallel RLC Circuits and numericals, transformers.	10 hrs.
Chapter No. 6. Three Phase Systems Necessity and advantages of three phase systems, generation of three phase e.m.f.s, relationship between line and phase values of balanced star and delta connections, power in balanced three phase circuits, three phase induction motor, numerical	05 hrs.
Unit III	

Chapter No. 6: Batteries Basics of lead acid batteries, Lithium Ion Battery, Battery storage capacity, Coulomb efficiency, high and low charging rates, Battery sizing, numericals.	05 hrs.
Chapter No. 7: Electrical Wiring, Safety and protection Types of wires and cables for internal wiring, Types of switches and Circuits, Types of wiring, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Importance of grounding and earthing, Methods for earthing, Fuses, MCB, ELCB, and Relay	05 hrs.

Text Books

1. Hughes , Electrical & Electronic Technology, 8th edition, Pearson Education
2. David G Alciatore and Michel B Histand, Introduciton to Mechatronics and Measurement Systems, 3rd edition 2005, Tata McGraw Hill Education Private Limited, New Delhi.
3. Gilbert M Masters, Renewable and efficient Electrical Power systems, Published by John Wiley & Sons 2004 edition

Reference Books

1. D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications
2. Vincent Del Toro, Electrical Engineering Fundamentals, 2nd edition Prentice Hall India

FIRST SEMESTER B E PROGRAM 2018-19

Mechanical Science Stream Syllabi Content

Program: UG			
Course Title: Basic Electronics		**Course Code: 18EECF102**	**Teaching Hours**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4Hrs/week**	
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**	
Teaching Hours: 50 Hrs.	**Examination Duration: 3 Hrs.**		
Unit I **Chapter 1: Overview of Electronics in Mechanical Engineering** Definition & overview of Mechatronics, Mechatronics and Design Innovation, Mechatronics and Manufacturing, Mechatronics and Education; Typical Mechatronics Components**;** Sensors and Transducers.			**03**
Chapter 2: Semiconductor Devices and Applications: PN junction diode, characteristics and parameters, diode approximations, half wave rectifier, full wave bridge rectifier, full wave bridge rectifier capacitor filter, Zener diode, Voltage regulator design, BJT, Darlington Pair, JFET, MOSFET, UJT, SCR.			**10**
Chapter 3: Operational Amplifiers: Ideal op-amp characteristics, op-amp applications: Comparator, Inverting amplifier, Non-inverting amplifier, Voltage follower, Integration, Differentiation, Adder, Subtractor and numerical as applicable.			**08**
Unit II **Chapter 4: Digital Logic:** Digital Number system: Binary & Hexadecimal number systems, Conversion, BCD Number system, Gray code, Data word representation , Binary Arithmetic, Boolean Algebra, Logic gates, Combinational & Sequential circuits, Adders, Flip-Flops, Registers, Counters, Multiplexer. **Introduction to Digital Electronics (Text-2):** Introduction, Switching and Logic Levels using circuits, Digital Waveform (Sections 9.1to 9.3).Number system: Binary, Octal Decimal and Hexadecimal, Inter Conversion, BCD Number system, Gray code, Data word representation , Binary Arithmetic, Boolean Algebra: Laws, rules & theorems of Boolean algebra, Sum of products form (SOP), products of sum form (POS) of Boolean functions. Study of Karnaugh Maps (K-maps) for 2, 3 & 4 variables only. Logic gates, Adders, Encoder, Decoder, Multiplexer and Demultiplexer. Combinational & Sequential circuits, Latches and Flip-Flops(SR, JK, D, T),			**13**

Chapter 5: Sensors and Transducers : Introduction, Classification of sensors and transducers, Contact type – Mechanical switches, Non-contact type - proximity sensors & Hall sensors, principle of working of light sensors,Future Challenges	**06**
Unit – III **Chapter 6: Signal Conditioning:** Analog & Digital signals, Digital to Analog Conversion, R-2R DAC, Analog to Digital Conversion, SAR ADC, Data Acquisition.	**06**
Chapter 7: Case Studies of Mechatronic Systems: Automatic Camera, Drilling Machine, Bar code reader.	**04**

Text Book

1. David A Bell, "Electronic devices and Circuits" , PHI New Delhi, 2004.
2. Morris Mano, "Digital logic and Computer design" 21st Indian print Prentice Hall India, 2000.
3. W.Bolton, "Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering", 3rd edition Pearson Education, 2005.
4. David Bradley and David W., "Mechatronics in Action", 2nd edition, Springer, 2010

References

1. David G Alciatore, Michael B Histand, "Introduction to Mechatronics and Measurement Systems", TMH 3rd edition, 2007.
2. K.A Krishnamurthy and M.R.Raghuveer, "Electrical, Electronics and Computer Engineering for Scientist and Engineers", Second Edition New Age International Publishers, Wiley Eastern, 2001.
3. P. Malvino, "Electronic Principles" Sixth edition Tata McGraw Hill, 1999.
4. Floyd, "Digital fundamentals" Third Edition Prentice Hall India, 2001
5. BoylesteadNashelsky, "Electronic devices & Circuit theory" Sixth Edition Prentice Hall India, 2000.
6. RamakantGayekawad "Operational Amplifiers & applications" 3rd Edition, PHI, 2000.

KLE Technological University
Creating Value
Leveraging Knowledge

Earlier known as
B. V. B. College of Engineering & Technology

FIRST SEMESTER B E PROGRAM 2017-18
Mechanical Science Stream Syllabi Content

Course code: 15EECF101	**Course Title: Basic Electronics**	
L-T-P: 4-0-0	**Credits: 4**	**Contact Hrs.: 4**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hrs: 50	**Exam Duration: 3 hrs**	

1. Introduction to Mechatronics: Definition & overview of Mechatronics, Introduction to microprocessor based control. Mechatronics approach, examples of Mechatronics systems.	**03 Hrs**
2. Semiconductor Devices and Applications: PN junction diode, characteristics and parameters, diode approximations, Half wave rectifier, full wave bridge rectifier, full wave bridge rectifier capacitor filter, Zener diode, Voltage regulator design. BJT, Darlington Pair, JFET, MOSFET, UJT, SCR, Triac, IGBT.	**10 Hrs**
3. Operational Amplifiers: Ideal op-amp characteristics, op-amp applications: Comparator, Inverting amplifier, Non inverting amplifier, Voltage follower, Integration, Differentiation, Adder, Subtractor and numerical as applicable.	**08 Hrs**

Unit – II

4. Digital Logic: Digital Number system -- Binary & Hexadecimal number systems, Conversion, BCD Number system, Gray code, Data word representation , Binary Arithmetic, Boolean Algebra, Logic gates, Combinational & Sequential circuits, Adders, Flip-Flops, Registers, Counters, Multiplexer.	**13 Hrs**
5. Sensors and Transducers : Introduction, Classification of sensors and transducers, Contact type – Mechanical switches, Non-contact type - proximity sensors & Hall sensors, principle of working of light sensors.	**06 Hrs**

Unit – III

6. Signal Conditioning: Analog & Digital signals, Digital to Analog Conversion, R-2R DAC, Analog to Digital Conversion, SAR ADC, Data Acquisition.	**06 Hrs**
7. Case Studies of Mechatronics Systems: Automatic Camera, Drilling Machine, Bar code reader.	**04 Hrs**

Text Book

1. David G Alciatore, Michael B Histand, “Introduction to Mechatronics and Measurement Systems”, TMH 3rd edition, 2007.
2. David A Bell, “Electronic devices and Circuits” , PHI New Delhi, 2004.

3. W.Bolton, "Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering", 3rd edition Pearson Education, 2005.

References

1. N.P.Mahalik, "Mechatronics - Principles, Concepts and Applications", Tata McGraw-Hill, 2011.

2. K.A Krishnamurthy and M.R.Raghuveer, "Electrical, Electronics and Computer Engineering for Scientist and Engineers", Second Edition New Age International Publishers, Wiley Eastern, 2001.

3. P. Malvino, "Electronic Principles" Sixth edition Tata McGraw Hill, 1999.

4. George Kennedy, "Electronic Communication Systems" Fourth Edition Tata McGraw Hill, 2000.

5. Morris Mano, "Digital logic and Computer design" 21st Indian print Prentice Hall India, 2000.

6. Floyd, "Digital fundamentals" Third Edition Prentice Hall India, 2001.

7. Boylestead Nashelsky, "Electronic devices & Circuit theory" Sixth Edition Prentice Hall India, 2000.

8. Ramakant Gayekawad "Operational Amplifiers & applications" 3rd Edition, PHI, 2000.

SECOND SEMESTER B E PROGRAM 2018-19
Electrical Science Stream Syllabi Content

Program: UG			
Course Title: Basic Electronics		**Course Code: 18EECF101**	
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs./week**	
ISA Marks: 50		**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50Hrs.		**Examination Duration: 3 Hrs..**	

Unit 1	**Hours**
Chapter 1: Trends in Electronic Industries: Introduction, Roadmap of electronic sector, scope and opportunities in various segments of electronics (i.e., Consumer, Telecom, IT, Defense, Industrial, Medical and Automobiles), Government and private sectors, Growth profile of Electronic industries, Standards and PoliISAs, Electronic System Components.	**03**
Chapter 2: Basic Components, Devices and Applications: Diode: PN junction characteristics; modeling as a circuit element, ideal and practical diode. AC to DC converter: Half wave and full wave rectifier (centre tap and bridge), capacitor filter and its analysis, numerical examples. Zener diode and its applications (Voltage reference and voltage regulator). Realization of simple logic gates like AND and OR gates.	**10**
Chapter 3: Transistor: BJT, transistor voltages and currents, Signal amplifier (Fixed bias, Collector base bias, Voltage divider bias, CE configuration). DC load line. Voltage, current and power gains. Transistor as a switch: NOT Gate, Basic (DTL) NAND gate. Transistor as a Small Signal Amplifier (Single Stage and Two Stage RC-coupled Amplifier).	**07**
Unit 2	
Chapter 4: Digital Logic: Number systems: Decimal, Binary, Octal and Hexadecimal number systems, Conversions, Binary Operations-Addition and subtraction in binary number systems. Logic gates: Realization of simple logic functions using basic gates (AND, OR, NOT), Realization using universal gates (NAND, NOR). Boolean algebra: Theorems and postulates, DeMorgan's Theorems , simplification of logical expressions, Karnaugh Maps, Use of Karnaugh Maps to Minimize Boolean Expressions (2 Variables, 3 Variables and 4 Variables), Design of Half Adder and Full Adder, Parallel Adder using full adders.	**14**
Chapter 5: Operational Amplifier: OPAMP characteristics (ideal and practical), Linear and non-linear applications: Inverting amplifier, Non inverting amplifier, Voltage follower, Integration, Differentiation, Adder, Subtractor, ZCD and Comparator.	**06**

Unit 3	
Chapter 6: Communication Systems: Basic block diagram of communication system, types of modulation. Amplitude modulation: Time-Domain description, Frequency-Domain description. Generation of AM wave: square law modulator. Detection of AM waves: envelope detector. Double side band suppressed carrier modulation (DSBSC), Generation of DSBSC wave : balanced modulator, Super heterodyne principle.	**07**
Chapter 7: Linear Power Supply, UPS & CRO: Working principle of linear power supply, UPS and CRO. Measurement of amplitude, frequency and phase of a given signal.	**03**

Text Book

1. David A Bell, Electronic devices and Circuits, PHI New Delhi, 2004
2. K.A Krishnamurthy and M.R.Raghuveer, Electrical, Electronics and Computer Engineering for SISAntist and Engineers, 2, New Age International Publishers, 2001
3. A.P. Malvino, Electronic Principles, Tata McGraw Hill, 1999

References

1. George Kennedy, Electronic Communication Systems, Tata McGraw Hill, 2000
2. Morris Mano, Digital logic and Computer design , 21st Indian print Prentice Hall India, 2000
3. Floyd, Digital fundamentals, 3, Prentice Hall India, 2001
4. BoylesteadNashelsky, Electronic devices & Circuit theory, Prentice Hall India, 2000
5. RamakantGaikawad , Operational Amplifiers & applications, PHI, 2000

SECOND SEMESTER B E PROGRAM 2017-18
Electrical Science Stream Syllabi Content

Course Code: 15EECF102	Course Title: Basic Electronics	
L-T-P: 0-0-3	Credits: 3	Contact Hrs.: 6
CIE Marks: 80	SEE Marks: 20	Total Marks: 100
Teaching Hrs: 78	Exam Duration: 3 hrs	

Unit - I	
1. **Trends in Electronic Industries:**Introduction, Roadmap of electronic sector, scope and opportunities in various segments of electronics (i.e., Consumer, Telecom, IT, Defense, Industrial, Medical and Automobiles), Government and private sectors, Growth profile of Electronic industries, Standards and Policies, Electronic System Components.	**3 hours**
2. **Basic components, devices and Applications:** Diode: PN junction characteristics; forward conduction, reverse breakdown, temperature dependence, modeling as a circuit element, approximations. AC to DC converter: Half wave and full wave rectifier (centre tap and bridge), capacitor filter and its approximate analysis, numerical examples as applicable. Zener diode and its applications (Voltage reference and voltage regulator). Common anode and common cathode connections, Simple logic gates : AND , OR	**11 hours**
3. **Transistor:** BJT, transistor voltages and currents, Signal amplifier (Fixed bias, CE configuration). DC load line. Voltage, current and power gains. Transistor asa switch: NOT Gate, Basic (DTL) NAND gate	**6 hours**
Unit-II	
4. **Digital Logic:** Number systems: Decimal, Binary, Octal and Hexadecimal number systems, Conversions, Addition and subtraction in binary number systems. Logic gates: Realization of simple logic functions using basic gates (AND, OR, NOT), Realization using universal gates (NAND, NOR) . Boolean algebra: Theorems and postulates, DeMorgan's Theorems, simplification of logical expressions, Design of Half Adder and Full Adder,Parallel Adder using full adders.	**10 Hrs**
5. **Operational Amplifier:** OPAMP characteristics (ideal and practical). Concept of positive and negative feedback (At zero frequency). Linear and non-linear	**8 hours**

applications: Inverting amplifier, Non inverting amplifier, Voltage follower, Integration, Differentiation, Adder, Subtractor, ZCD and Comparator.	
Unit-III	
6. **Communication Systems:** Basic block diagram of communication system, concept of multiplexing, modulation. Different modulation techniques: AM, FM, their comparison	**6 hours**
7. **Receivers & CRO:** Super heterodyne receivers (block schematic) Block diagramof CRO, Block diagram of CRT, measurement of amplitude, frequency and phase of a given signal.	**6 hours**

Text Books:

- David A Bell, “Electronic devices and Circuits”, PHI New Delhi, 2004.
- K.A Krishnamurthy and M.R.Raghuveer, “Electrical, Electronics and Computer Engineering for Scientist and Engineers”, Second Edition New Age International Publishers, Wiley Eastern, 2001.
- A. P. Malvino, “Electronic Principles” Sixth edition Tata McGraw Hill, 1999.

Reference Books:

- George Kennedy, “Electronic Communication Systems” Fourth Edition Tata McGraw Hill, 2000.
- Morris Mano, “Digital logic and Computer design” 21st Indian print Prentice HallIndia, 2000.
- Floyd, “Digital fundamentals” Third Edition Prentice HallIndia, 2001.
- BoylesteadNashelsky, “Electronic devices & Circuit theory” Sixth Edition Prentice HallIndia, 2000.
- RamakantGaikawad “Operational Amplifiers & applications” 3rd Edition, PHI, 2000.

SECOND SEMESTER B E PROGRAM 2018-19
Electrical Science Stream Syllabi Content
(New Course)

Program: **UG**		
Course Title: **Problem Solving with Data Structures**		**Course Code: 18ECSP102**
L-T-P: **0-0-3**	Credits: **3**	Contact : **6 Hrs../week**
ISA Marks: 8**0**	ESA Marks: **20**	Total Marks: **100**
Teaching : **78 Hrs..**	Exam Duration: **3** Hrs..	

1	**Pointers, Structures and Files** Recap of basics: Pointers ,Structures; Self-referential structures, dynamic memory management Files – File manipulation programs	**12 hrs.**
2	**Stacks and Recursion** Stack: Definition, Operations, Stack ADT Implementation of stack operations. Applications of stack. Recursion- Need for Recursion and problems on Recursion.	**16 hrs.**
3	**Queues** Queue: Definitions of Linear, Circular queues, Queue ADT Linear and circular queue operations Definition and working of Priority queue, Double ended queue; Applications of queues.	**16 hrs.**
4	**Lists** Concept of lists and dynamic memory management lists, definitions and representations: singly, doubly, circular lists. Dynamic Implementation of lists and its operations, Applications of linked lists	**18 hrs.**
5	**Binary trees**	**16 hrs.**

	Binary Tree: Definition, Terminology and representation, Tree Traversals both recursive and iterative. Binary Search Tree and its applications.	

Text Books

1. Data Structures with C -- Seymour Lipschutz, Schaum's Outline Series
2. Data Structures Using C and C++ -- Langsam and Tanenbaum, PHI Publication
3. Data Structures Through C -- Yashavant P Kanetkar, BPB Publication

Reference Books:

1. Data Structures, Algorithms and Applications In C++ -- Satraj Sahani
2. Data Structures and Algorithms Made Easy – Narshiman Karumunchi, Career Monk

Program: Bachelor of Engineering		
Course Title: **Data Structures and Algorithms**		Course Code: **17ECSC204**
L-T-P: **4-1-0**	Credits: **5**	Contact Hrs: **5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **62 hrs**	Exam Duration: **3 hrs**	

Unit –I		
1	**Introduction to Data Structures and Algorithm Analysis** Primitive Data structures in C, Custom Data Types, Arrays, Recursive Definitions, Recursive Functions, Towers of Hanoi, Backtracking, Recursion Vs. Iteration, Model, Running Time Calculations, Space and Time Complexities, Order of an Algorithm	**10 hrs**
2	**Lists, Stacks, Queues** Abstract Data Types, Lists, Stacks, Queues, Applications	**10 hrs**
3	**Hashing** General Idea, Hash Function, Collision Resolution Techniques, Applications in Number Theory	**05 hrs**
Unit –II		
4	**Trees** Introduction to graphs, Trees, Binary Search trees, AVL Trees, Tree Traversals, Applications	**08 hrs**
5	**Sorting** Sorting, Bubble sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort, Heap Sort.	**08 hrs**
6	**Graphs and Graph Algorithms** Graphs, Topological sort, Shortest Path Algorithms, Minimum Spanning Tree	**09 hrs**
Unit –III		
7	**Graph Algorithms Continued** Greedy algorithms, DFS, BFS, Application of Graph algorithms	**06 hrs**
8	**File Structures and Storage Management** Files, Random and Direct access, Storage Management with Fixed and Variable Blocks	**06 hrs**

Text Books:

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 2010

Reference Books:

1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", 1st Edition, Addison Wesley Publication, 1983.

1. Aron M. Tenenbaum, et. al, "Data Structures using C", PHI, 2006.

2. Levitin A., "Introduction to the Design and Analysis of Algorithms", 2nd Edition, Pearson

Education, 2008.

Scheme for Semester End Examination (SEE)

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2,3	Solve Any **2** out of **3**
II	Q.No.-4, Q.No.-5, Q.No.-6	4,5,6	Solve Any **2** out of **3**
III	Q.No.-7	7	Solve Any **1** out of **2**
	Q.No.-8	8	

Program: Bachelor of Engineering		
Course Title: **Engineering Design Practice [Part B] [Part A – Central Level]**		Course Code: **17ECSP202**
L-T-P: **0-0-1.5**	Credits: **1.5**	Contact Hrs: **3 hrs/week**
ISA Marks: **40**	ESA Marks: **0**	Total Marks: **40**
Teaching Hrs: **39 hrs**	Exam Duration: **3 hrs**	

Experiments	Lab assignments/experiment
Phase 1 (Plannig)	Introduction to Eclipse –IDE Requirement modeling : • Identifying use cases and actors • Apply UML notations to draw use case diagram
Phase 2 (Conceptual Design)	Behaviour Modeling using DFD • List behavior of system/sub-system • List states, tasks and their dependencies Illustrate DFD : • Identify data flow and processes of a system • Draw data flow diagrams for system/sub-system • Draw system diagram to show interaction of all domain components (Draw state and sequence diagram for identified tasks)
Phase 3(System Design)	Software Architectures: • List components of architecture • List type of architectures Choose appropriate architecture for given system
Phase 4 (Detail Design)	UI Design using GUI wireframe: • Design function prototyping for event diagrams(DFD) • Identify user interface components • Choose appropriate property of component • Use wireframe to design a user interface

Text books:

1. Ian Somerville, Software Engineering, 9th, Pearson Ed, 2015
2. Clive L Dym and Patrick Little, "Engineering Design: A Project Based Introduction", John Wiley & Sons

Reference books:

1. Roger S. Pressman, Software Engineering: A Practitioners Approach, 7th, McGraw, 2007
2. Shari Lawrence Pfleeger and Joanne M. Atlee, Software Engineering Theory and Practice, 3rd, Pearson Ed, 2006
3. Jalote, P, An Integrated Approach to Software Engineering, 3rd, Narosa Pub, 2005

Program: **Bachelor of Engineering**		
Course Title: **Data Structure and Algorithms Lab**		Course Code: **17ECSP201**
L-T-P: **0-0-2**	Credits: **2**	Contact Hrs: **4 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Teaching Hrs:**56 hrs**	Exam Duration: **3 Hrs**	

Tentative plan of lab implementation

Week No	**Lab Assignments**
1	03 Programming Assignments on C language Features
2	
3	
4	01 Assignment on List and Stack
5	01 Assignment on List and Queue
6	02 Assignments on Applications of List
7	
8	01 Assignment on Trees
9	01 Assignment on Introduction to Algorithms
10	01 Assignment on Sorting technique and efficiency analysis
11	03 Assignments on Search or Graph algorithms
12	
13	
14	Open Ended Experiment

Program: **Bachelor of Engineering**		
Course Title: **Data Structure and Algorithms Lab**		Course Code: **17ECSP201**
L-T-P: **0-0-2**	Credits: **2**	Contact Hrs: **4 hrs/week**
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Tentative plan of lab implementation

Week No	Lab Assignments
1	03 Programming Assignments on C language Features
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9	01 Assignment on Introduction to Algorithms
10	01 Assignment on Sorting technique and efficiency analysis
11	03 Assignments on Search or Graph algorithms
12	
13	
14	Open Ended Experiment

Department of Computer Science & Engineering	

Program: Bachelor of Engineering		
Course Title: **Engineering Design Practice [Part B] [Part A – Central Level]**		Course Code: **17ECSP202**
L-T-P: **0-0-1.5**	Credits: **1.5**	Contact Hrs: **3 hrs/week**
ISA Marks: **40**	ESA Marks: **0**	Total Marks: **40**
Teaching Hrs: **39 hrs**	Exam Duration: **3 hrs**	

Experiments	Lab assignments/experiment
Phase 1 (Plannig)	Introduction to Eclipse –IDE Requirement modeling : • Identifying use cases and actors • Apply UML notations to draw use case diagram
Phase 2 (Conceptual Design)	Behaviour Modeling using DFD • List behavior of system/sub-system • List states, tasks and their dependencies Illustrate DFD : • Identify data flow and processes of a system • Draw data flow diagrams for system/sub-system • Draw system diagram to show interaction of all domain components (Draw state and sequence diagram for identified tasks)
Phase 3(System Design)	Software Architectures: • List components of architecture • List type of architectures Choose appropriate architecture for given system
Phase 4 (Detail Design)	UI Design using GUI wireframe: • Design function prototyping for event diagrams(DFD) • Identify user interface components • Choose appropriate property of component • Use wireframe to design a user interface

Text books:

3. Ian Somerville, Software Engineering, 9th, Pearson Ed, 2015
4. Clive L Dym and Patrick Little, "Engineering Design: A Project Based Introduction", John Wiley & Sons

Reference books:

4. Roger S. Pressman, Software Engineering: A Practitioners Approach, 7th, McGraw, 2007
5. Shari Lawrence Pfleeger and Joanne M. Atlee, Software Engineering Theory and Practice, 3rd, Pearson Ed, 2006
6. Jalote, P, An Integrated Approach to Software Engineering, 3rd, Narosa Pub, 2005

Program: Bachelor of Engineering		
Course Title: **Data Mining & Analysis**		Course Code: **18ECSC301**
L-T-P: **3-0-1**	Credits: **4**	Contact Hrs: **5 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Teaching Hrs: **40**	Exam Duration: **3hrs**	

Unit –I		
1	**Data Pre-Preprocessing** Introduction to data mining, Data Warehouse and OLAP Technology for Data mining: Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Major tasks in data preprocessing- data reduction, data transformation and data Discretization, data cleaning and data integration.	**08 hrs**
2	**Frequent Pattern Mining** Frequent item sets and association rules; Item set mining algorithms; Generating association rules; Summarizing item sets: maximal and closed frequent item sets; Interesting patterns: pattern evaluation methods;	**08 hrs**
Unit –II		
3	**Classification Techniques** Probabilistic classification: naïve Bayes classifier, K-nearest neighbours; Decision tree classifier: decision tree induction, tree pruning; Model evaluation and selection: metrics, cross validation, random sampling, ROC curves;	**08 hrs**
4	**Cluster Analysis** Cluster Analysis- Partitioning methods, Hierarchical Methods, Density based methods, Outlier Detection.	**08 hrs**
Unit –III		
5	**Advanced Mining Techniques** Popular data pre-processing techniques: One hot encoding, stacking; Techniques to improve classification accuracy: ensemble methods, random forests, XGBoosting; Bias-variance trade-off; Post processing: Visualization and Interpretation;	**08 hrs**

Text Books:

1. Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, 3rd edition, Morgan Kaufmann, 2012.

Reference Books:

1. Ian H. Witten, Eibe Frank, Mark A. Hall and Christopher J. Pal, Data Mining:

Practical Machine Learning Tools and Techniques, Morgan Kaufmann; 4th edition, 2016.

2. Pang-Ning, Michael Steinbach and Vipin Kumar, Introduction to Data Mining, Pearson, International edition, 2013.
3. Mohammed J. Zaki and Wagner Meira, Jr., Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014.
4. M. H. Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education, 1st edition, 2006.

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2	Solve Any **3** out of **4**
II	Q.No.-4, Q.No.-5, Q.No.-6	3, 4,5	Solve Any **3** out of **4**
III	Lab exam	6	Lab exam evaluation

Program: **Bachelor of Engineering**		
Course Title: **Embedded Intelligent Systems**		Course Code: **18ECSE302**
L-T-P: 0-0-3	Credits: 3	Contact Hrs: **6hrs/week**
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 60	Exam Duration: 3 hrs	

1	**Basics of embedded systems** Linux Application Programming, System V IPC, . Linux Kernel Internals and Architecture , Kernel Core , Linux Device Driver Programming, Interrupts & Timers , Sample shell script, application program, driver source build and execute	**10 hrs**
2	**Heterogeneous computing** Basics of heterogeneous computing with various hardware architectures designed for specific type of tasks, Advanced heterogeneous computing with a. Introduction to Parallel programming b.GPU programming (OpenCL) c. Open standards for heterogeneous computing (Openvx) , Basic OpenCL examples - Coding, compilation and execution	**12 hrs**
3	**ML Frameworks lab with the target device** Caffe, tensorflow, TF Lite machine learning frameworks & architecture ,Model parsing, feature support and flexibility ,Supported layers , advantages and disadvantages with each of these frameworks, Android NN architecture overview , Full stack compilation and execution on embedded device	**16 hrs**
4	**Model Development and Optimization** Significance of on device AI ,Quantization , pruning, weight sharing, Distillation ,Various pre-trained networks and design considerations to choose a particular pre-trained model ,Federated Learning , Flexible Inferencing	**8 hrs**
6	**Android Anatomy** Android Architecture ,Linux Kernel , Binder , HAL Native Libraries , Android Runtime, Dalvik Application framework , Applications, IPC	**8 hrs**

Program: **Bachelor of Engineering**		
Course Title: **Algorithmic Problem Solving**		Course Code: **17ECSE309**
L-T-P: **0-0-6**	Credits: **6**	Contact Hrs: 74
ISA Marks: **70**	ESA Marks: 30	Total Marks: **100**
Teaching Hrs: 74	Exam Duration: 2 to 3 days	

Course Content

Unit – 1	
Chapter 0: Building Blocks Understanding coding platforms and tools, Data Structures and Algorithms revisited	**06 hrs**
Chapter 1: Strategies and Performance Warm up problems, Parsing and Formatting text, Code performance analysis and tools	**06 hrs**
Chapter 2: Advanced Data Structures Matrix, Grids, Trees and variants, Lists, Skip lists, Hash, Trie and variants	**10 hrs**
Chapter 3: Dynamic Programming Memory functions, Optimization problems	**08 hrs**
Unit – 2	
Chapter 4: Graph algorithms Traversal Algorithms, Shortest Path Algorithms, Spanning Tree Algorithms and variants	**25 hrs**
Chapter 5: Introduction to Computational Geometry Points, Line Segments, Polygons and Basics of Geometric Problems	**05 hrs**
Unit – 3	
Chapter 6: Problem Solving Assortment of problems and techniques.	**14 hrs**

Text Book

1. Levitin A., "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education, 2017.
2. Levitin A, Levitin M, "Algorithmic Puzzles", First Edition, Oxford University Press, 2011.
3. Online Coding Platforms

References

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, MIT Press, 2010.

Program: **Bachelor of Engineering**		
Course Title: **Natural Language Processing**		Course Code: **18ECSE403**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **04 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **30**	Exam Duration: **3 hrs**	

	Unit –I	
1	**Introduction to NLP and Deep Learning** Introduction to Natural Language Processing, Applications of Natural Language Processing, Word2vec introduction, Word2vec objective function gradients	**05 hrs**
2	**Dependency Parsing, Recurrent Neural Networks** Dependency Grammar , Neural dependency parsing, Recurrent Neural Networks and Language Models, Vanishing Gradients, Fancy RNNs	**07 hrs**
	Unit –II	
3	**Machine Translation, Seq2Seq and Attention** Machine Translation, Seq2Seq and Attention, Advanced Attention	**06 hrs**
4	**Transformer Networks , Coreference Resolution, Memory Networks** Transformer Networks and CNNs, Tree Recursive Neural Networks and Constituency Parsing , Advanced Architectures and Memory Networks	**06 hrs**
	Unit –III	
5	**Reinforcement Learning** Reinforcement Learning for NLP, Semi-supervised Learning for NLP, Future of NLP Models, Multi-task Learning and QA Systems	**06 hrs**

Text Books:

1. Yoav Goldberg. A Primer on Neural Network Models for Natural Language Processing , 2016.

Reference Books:

Dan Jurafsky and James H. Martin. Speech and Language Processing (3rd ed. draft).

Ian Goodfellow, YoshuaBengio, and Aaron Courville. *Deep Learning*. MIT Press.

Scheme for End Semester Assessment(ESA)

UNIT	**8 Questions to be set of 20 Marks Each**	**Chapter Numbers**	**Instructions**
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2	Solve Any **2** out of **3**
II	Q.No.-4, Q.No.-5, Q.No.-6	4,5	Solve Any **2** out of **3**
III	Q.No.-7	6	Solve Any **1** out of **2**
	Q.No.-8		

KLE TECH.	Department of Computer Science & Engineering

Program: **Bachelor of Engineering**		
Course Title: **Fuzzy Set Theory**		Course Code: **19ECSE402**
L-T-P: **3-0-0**	Credits: 3	Contact Hrs: 3**hrs/week**
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hrs: 40	Exam Duration: 3hrs	

Unit –I		
1	**Introduction** : Introduction to Fuzzy Logic, Fuzzy Membership Functions, Operations on Fuzzy Sets	8hrs
2	**Fuzzy Measures:** Fuzzy Relations,Fuzzy Proposition,Fuzzy Implications,Fuzzy Inferences	8hrs
Unit –II		
3	**Fuzzy Relations and Fuzzy Graphs**: Fuzzy Relations, Compositions of Fuzzy Relations, Properties of the Min-Max Composition, DefuzzificatinTechniques,Lambda-cut method, Weighted average method, Maxima methods, Centroid methods, Output of a Fuzzy System	8 hrs
4	**Uncertainty Modeling:** Application-oriented Modeling of Uncertainty, Causes of Uncertainty, Uncertainty Methods, Possibility Theory	8hrs
Unit –III		
5	**Fuzzy Data Bases and Queries:** Introduction, Fuzzy Relational Databases, Fuzzy Queries in Crisp Databases	4 hrs
6	**Fuzzy Sets and Expert Systems:** Introduction to Expert Systems, Uncertainty Modeling in Expert Systems, Applications	4 hrs

Text Books:

1. H. J. Zimmermann ., Fuzzy Set Theory-and Its Applications, Fourth Edition, 4th Ed., Springer Science Business Media, LLC , 2001
2. Chander Mohan, An Introduction to Fuzzy Set Theory and Fuzzy Logic,2nd ed. Vivo Books pvt ltd , 2015

Reference Books:

1. Timothy J. Ross, Fuzzy Logic With Engineering Applications, 3ed., 2010, A John Wiley and Sons, Ltd., Publication
2. Kumar S. Ray,Soft Computing and Its Applications: Fuzzy Reasoning and Fuzzy Control, 1st Edition, Apple Academic Press 2014
3. Ahmed M. Ibrahim, Fuzzy Logic for Embedded Systems Applications, Elesvier Press, 2004.

Scheme for End Semester Assessment (ESA)

UNIT	**8 Questions to be set of 20 Marks Each**	**Chapter Numbers**	**Instructions**
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2	Solve Any **2**
II	Q.No.-4, Q.No.-5, Q.No.-6	3,4	Solve Any **2**

III	Q.No.-7	5	Solve Any **1**
	Q.No.-8	6	

Program: Bachelor of Engineering		
Course Title: **Wireless Ad Hoc and Sensor Networks**		Course Code: **18ECSE406**
L-T-P: **3-0-0**	Credits: **3**	Contact Hrs: **3hrs/week**
CIE Marks: **50**	SEE Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**	Exam Duration: **3 hrs**	

Unit –I		
1	**Introduction:** Fundamentals of wireless communication technology, Characteristics of wireless channel, Multiple Access Techniques, IEEE802.11 Standards, Bluetooth, Cellular Concept, Cellular Architecture.	**07 hrs**
2	**Ad hoc Networks:** Introduction, Issues in Ad hoc wireless networks, Ad hoc wireless internet.	**04 hrs**
3	**MAC Protocols:** Introduction, Issues in Designing MAC protocol, Design goals, Classification, Contention Based Protocols with Reservation Mechanisms. Contention-Based MAC Protocols with Scheduling Mechanism.	**05 hrs**
Unit –II		
4	**Routing Protocols:** Introduction, Issues in designing a routing protocol, classification, Table drive routing protocol, On-demand routing protocol, Hybrid routing protocol, Hierarchical routing protocols, Power aware routing protocols.	**06 hrs**
5	**Energy Management:** Introduction, Need for Energy Management, Classification, Battery Management Scheme, Transmission Power Management Schemes, System Management Scheme.	**05 hrs**
6	**Sensor Networks:** Introduction, Architecture, Data Dissemination, Data Gathering, MAC Protocols (schedule based protocols).	**05 hrs**
Unit –III		
7	**Routing Protocols for Sensor Networks:** Routing Characteristics, Routing Strategies, LEACH, SPIN.	**04 hrs**
8	**Sensor Network Applications:** Case Study: Traffic Control, Health Care, Green House Monitoring.	**04 hrs**

Text Books:

1. C. Siva Ram Murthy and B. S. Manoj, “Ad hoc Wireless Networks”,2nd Edition, Pearson Education, 2006.
2. KazemSohraby, Daniel Minoli, TaiebZnati, “Wireless Sensor Networks: Technology, Protocols, and Applications”, John Wiley and Sons, 2007.

Reference Books:

1. Ozan K. Tonguz and Gianguigi Ferrari, “Ad hoc Wireless Networks”,John Wiley, 2006.
2. C.K. Toh, “Adhoc Mobile Wireless Networks”,Protocols and Systems, Prentice-Hall PTR, 2002.

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2,3	Solve Any **2** out of **3**
II	Q.No.-4, Q.No.-5, Q.No.-6	4,5,6	Solve Any **2** out of **3**
III	Q.No.-7	7	Solve Any **1** out of **2**
	Q.No.-8	8	

Program: **Bachelor of Engineering**		
Course Title: **Advanced Parallel Computing**		Course Code:**18ECSE408**
L-T-P:**3-0-0**	Credits: **3**	Contact Hrs: **03 hrs/week**
CIE Marks**: 50**	SEE Marks: **50**	Total Marks: **100**
Teaching Hrs: **40**	Exam Duration: **3 hrs**	

Unit –I		
1	**Introduction and History** GPUs as Parallel Computers; Architecture of a Modem GPU; Parallel Programming Languages and Models; Overarching Goals; Evolution of Graphics Pipelines; The Era of Fixed- Function ; Graphics Pipelines; Evolution of Programmable Real-Time Graphics; Unified Graphics and Computing Processors; GPGPU; An Intermediate Step; GPU Computing; Scalable GPUs Recent Developments; Future Trends.	**07 hrs**
2	**Introduction to CUDA** Data Parallelism; CUDA Program Structure; A Matrix-Matrix Multiplication Example; Device Memories and Data Transfer; Kernel Functions and Threading; Function declarations; Kernel launch; Predefined variables; Runtime API.CUDA Thread Organization; Using b1ock Id x and thread Id x ; Synchronization and Transparent Scalability; Thread Assignment ; Thread Scheduling and Latency Tolerance.	**09 hrs**
Unit –II		
3	**CUDA Memories** Importance of Memory Access Efficiency; CUDA Device Memory Types; A Strategy for Reducing Global Memory Traffic; Memory as a Limiting Factor to Parallelism; Global Memory Bandwidth; Dynamic Partitioning of SM Resources; Data Perfetching; Instruction Mix; Thread Granularity; Measured Performance.	**07 hrs**
4	**Introduction to OPENCL** Introduction to OPENCL; Background; Data Parallelism Model; Device Architecture; Kernel Functions; Device Management and Kernel Launch; Electrostatic Potential Map in OpenCL.	**09 hrs**
Unit –III		
5.	**Case Study** Concepts of Game Design, Applications like Matrix multiplication, MRI reconstruction Molecular Visualization and Gaming.	**04 hrs**
6.	**Parallel Programming and Computational Thinking** Goals of Parallel Programming, Problem Decomposition, Algorithm Selection, Computational Thinking.	**04 hrs**

Text Books:

2. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors: A Hands on Approach", Morgan Kaufmann/Elsevier India reprint, 2010.

Reference Books:

1. Benedict R Gaster, Lee Howes, David Kaeli, Perhaad Mistry and Dana Schaa, "Heterogeneous Computing with OpenCl", Morgan Kaufmann/Elsevier reprint, 2012.

Scheme for End Semester Assessment(ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2	Solve Any **2** out of **3**
II	Q.No.-4, Q.No.-5, Q.No.-6	3,4	Solve Any **2** out of **3**
III	Q.No.-7	5	Solve Any **1** out of **2**
	Q.No.-8	6	

Program: **Bachelor of Engineering**		
Course Title: **Software Architecture and Design Thinking**		Course Code:**18ECSE410**
L-T-P:**3-0-0**	Credits: **3**	Contact Hrs: 3**hrs/week**
CIE Marks**: 50**	SEE Marks: **50**	Total Marks: **100**
Teaching Hrs: **40**	Exam Duration: **3 hrs**	

Unit –I		
1	**Chapter No. 1 What Is Software Architecture?** What Software Architecture Is and What It Isn't ,Architectural Structures and Views, Architectural Patterns, What Makes a "Good" Architecture?	**5 hrs**
2	**Chapter No. 2 Why Is Software Architecture Important?** Inhibiting or Enabling a System's Quality Attributes, Reasoning About and Managing Change, Predicting System Qualities, Enhancing Communication among Stakeholders, Carrying Early Design Decisions, Defining Constraints on an Implementation, Influencing the Organizational Structure, Enabling Evolutionary Prototyping, Improving Cost and Schedule Estimates, Supplying a Transferable, Reusable Model, Allowing Incorporation of Independently Developed Components, Restricting the Vocabulary of Design Alternatives, Providing a Basis for Training	**6hrs**
3	**Chapter No. 3 The Many Contexts of Software Architecture** Architecture in a Technical Context, Architecture in a Project Life-Cycle Context, Architecture in a Business Context, Architecture in a Professional Context, Stakeholders, How Is Architecture Influenced?,What Do Architectures Influence?	**5 hrs**
Unit –II		
4	**Chapter No. 4. Understanding Quality Attributes** Architecture and Requirements, Functionality, Quality Attribute Considerations, Specifying Quality Attribute Requirements, Achieving Quality Attributes through Tactics, Guiding Quality Design Decisions	**5 hrs**
5	**Chapter No. 5. Quality Attributes** Tactics for Availability, Tactics for Interoperability, Tactics for Modifiability, Tactics for Performance, Tactics for Security, Tactics for Testability, Tactics for Usability,	**6hrs**
6	**Chapter No. 6. Architectural Tactics and Patterns** Architectural Patterns, Overview of the Patterns Catalog, Relationships between Tactics and Patterns, Using Tactics Together	**5 hrs**
Unit –III		
5.	**Chapter No. 7 Architecture and Requirements** Gathering ASRs from Requirements Documents, Gathering ASRs by Interviewing Stakeholders, Gathering ASRs by Understanding the Business Goals, Capturing ASRs in a Utility Tree, Tying the Methods Together	**4 hrs**
6.	**Chapter No. 8 Designing an Architecture, Implementation, Testing and EvaluationDesigning:**	**4 hrs**

	Design Strategy, The Attribute-Driven Design Method, The Steps of ADD, Implementation, and Testing:Architecture and Implementation, Architecture and Testing, Evaluation:Evaluation Factors, The Architecture Tradeoff Analysis Method, Lightweight Architecture Evaluation	

Text Books:

1. Len Bass, Paul Clements, Rick Kazman, Software Architecture in Practice (3rd Edition), Addison-Wesley Professional; 3 edition

Reference Books:

Scheme for End Semester Assessment(ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2	Solve Any **2** out of **3**
II	Q.No.-4, Q.No.-5, Q.No.-6	3,4	Solve Any **2** out of **3**
III	Q.No.-7	5	Solve Any **1** out of **2**
	Q.No.-8	6	

Course Title: **Model Thinking**	Course Code: **18ECSE411**	
L-T-P: **3-0-0**	Credits: **3**	Contact Hrs: **30**
CIA Marks: **50**	SEE Marks: 50	Total Marks: **100**
Teaching Hrs: **40**		Exam Duration: **3 hrs**

Content	40 Hrs
Unit – 1	
1. **Why Model** Model Thinking - The need, Advantages and disadvantages, Segregation/Peer Effects, Case study	4 hrs
2.**Modeling People, Tipping Points & Economic Growth** Rational models, Behavioral models, Rule based models, Percolation Models, Growth and its kinds	6 hrs
3. **Special Topics** Standing ovation model, Game of Life, Lyapunov Functions: Equilibrium, A cycle, Randomness or complexity, Coordination and culture. Urn models, Polya process, paths and networks, Prisoners' Dilemma, Collective Action & Mechanism Design	6 hrs
Unit – 2	
4. **Randomness and Learning Models** Luck as randomness, Random Walks & Colonel Blotto, Replicator Dynamics, Fisher's fundamental theorem, Prediction and the Many Model Thinker	8 hrs
5**. Model Checking and Modelling Concurrent Systems** Model Checking, Characteristics of Model Checking, Transition Systems, Parallelism and Communication, The State Space Explosion	8 hrs
Unit – 3	
6**. Linear-Time Properties** Linear-Time behavior, Safety Properties and Invariants, Liveness Properties, Fairness	4 hrs
7. **Regular Properties** Automata on Finite Words, Model-Checking Regular Safety Properties, Automata on Infinite Words, Model Checking with omega-regular properties	4 hrs

Text Books

1. Scott E Page, The Model Thinker, Basic Books Publication, 2018
2. ChristelBaier and Joost-Pieter Katoen, Principles of Model Checking (Representation and Mind Series), The MIT Press, 2008

References

1. Model Thinking Coursera online course from Michigan University.

Program: **Bachelor of Engineering**		
Course Title **Scripting Languages Lab**		Course Code: **18ECSP201**
L-T-P: **0-0-2**	Credits: **2**	Contact Hrs: **4hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Teaching Hrs: **30**	Exam Duration: **3 hrs**	

1	**Introduction to UNIX Utilities** Architecture, Commands, File Attributes, vi Editor, Process, Simple Filter, File System, Handling Files and Basic File Attributes.	**06hrs**
2	**UNIX shell Scripting** Shell Basics, Shell Environment, Shell Script Programming Concepts, Decision Structures, Looping Structures, and Command line arguments, Functions and Arrays, Regular Expression & Filters, Processes.	**06hrs**
3	**Python Scripting** Python: Types, Variables, and Simple I/O, Branching and Looping, String Manipulation,Numbers, Lists and Dictionaries, Regular Expressions, Functions, Files and Exceptions, Programming using numpy and scipy libraries.	**12hrs**
4	**System Administration** Common administrative tasks, creating and mounting file system, File system management, managing users and group accounts, monitoring system performance, accessing system information, backup and restore files, reconfiguration hardware with kudzu, installing and removing packages.	**06 hrs**

Tentative plan of lab implementation

Expt./ Job No.	Lab assignments/experiment	No. of Lab. Slots per batch (estimate)
1-2	Introduction to UNIX Utilities	02
3-4	Shell Script	03
5-10	Python programming	05
11-12	System Administration	02

Text Books

1. Sumitabha Das, UNIX Concepts and Applications", 4th Edition, McGraw-Hill, 2017.
2. Mark Lutz, "Programming Python", 4th Edition, O'Reilly, 2010.

Reference Books

1. Noah Gift, Jeremy Jones, Python for Unix and Linux System Administration, 2008.
2. RytisSileikam, Pro Python System Administration, 2nd Edition, 2014
3. Michael Dawson, Python Programing for the Absolute Beginner, Premier Press, 3rd Edition 2010.

Program: Bachelor of Engineering		
Course Title: **Computer Organization and Architecture**		Course Code: **18ECSC201**
L-T-P: **4-0-0**	Credits: **4**	Contact Hrs: **04 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50**	Exam Duration: **3hrs**	

	Unit –I	
1	**Fundamentals of Digital Logic** Combinational Circuits: Adders, Mux, De-Mux, Sequential Circuits : Flip-Flops (SR, JK & D), Counters : Synchronous and Asynchronous Counter, Addition and Subtraction of Signed Numbers. Design of Fast Adders. Multiplication of Signed and Unsigned Numbers. Fast Multiplication. Integer Division. Floating-Point Numbers and Operations	**12hrs**
2	**Computer System** Basic operational concepts. Bus structures. Fundamental concepts: Instruction Execution, Hardware Components Control Signals. Hardwired Control CISC-Style Processors. Accessing i/o devices. Interrupts. Bus Structure/Operation, Arbitration.	**08hrs**
	Unit –II	
4	**The Memory System** Basic Concepts. Semiconductor RAM Memories. Read-only Memories. Direct Memory Access. Memory Hierarchy. Cache Memories. Virtual Memory.	**08 hrs**
5	**Architecture** The State of Computing, Elements of Modern Computers, Evolution of computing Architecture, System Attributes to Performance. Multiprocessors and Multi computer: Shared-Memory Multiprocessor, Distributed-Memory Multicomputer. Multi vector and SIMD computers: Vector Supercomputers, SIMD Supercomputers, CISC Scalar Processor, RISC Scalar Processor, SPARC processor, Superscalar and Vector Processor, VLIW Architecture.	**12 hrs**
	Unit –III	
7	**Introduction to Pipelining** Basic Concepts. Pipeline Organization. Pipelining Issues: Data Dependencies, Memory Delays, And Branch Delays: Unconditional branches and Resource Limitations.	**05 hrs**
8	**Advanced features in Pipelining** Performance Evaluation: Effects of stalls and penalties, Number of pipeline stages. Superscalar Operation: Branch and data dependency, out-of- order execution , execution completion, dispatch operation,	**05 hrs**

Text Books:

1. Donald D. Givone “Digital Principles and Design” Tata McGraw Hill edition 2003.
2. Hamacher C., Vranesic Z., and Zaky S., Computer Organization, 5ed., McGraw Hill,2002
3. Kai Hwang .Advanced Computer Architecture, McGraw Hill, 2001

Reference Books:

1. John P. Hayes. Computer Architecture and Organization,3rd Edition, McGraw Hill
2. V Rajaraman, C Murthy. Parallel Computers Architecture and programming, PHI 2000.
3. M. Morris Mano and C. R. Kime "Logic and Computer Design Fundamentals" 2nd Edition, Updated Publishers Pearson Education 2005.
4. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, "Digital Systems Principles and Applications" 10th Edition, PHI/Pearson Education, 2007.

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2	Solve Any **2** out of **3**
II	Q.No.-4, Q.No.-5, Q.No.-6	3, 4	Solve Any **2** out of **3**
III	Q.No.-7	5	Solve Any **1** out of **2**
	Q.No.-8	6	

Program: Bachelor of Engineering		
Course Title: Object Oriented Programming with C++		Course Code: 18ECSC207
L-T-P: **3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40**	Exam Duration: **3hrs**	

Unit –I		
1	**Chapter No. 1: Introduction:** Introduction to object oriented programming. Characteristics of object oriented languages, Programming Basics, arrays, Functions in C++ (parameter passing techniques.)	**4 hrs**
2	**Chapter No. 2:Classes and Objects:** Introduction to Classes and Objects, encapsulation visibility modifiers, constructor and its types, nested classes, String class. UML diagrams to describe classes and relationships.	**6 hrs**
3	**Chapter No. 3:Inheritance:** Introduction, types of Inheritance, constructors, Abstract class,Aggregation: classes within classes	**6 hrs**
Unit –II		
4	**Chapter No. 4:Virtual Functions and Polymorphism:** Virtual functions, Friend functions, static functions, The 'this' pointer	**6 hrs**
5	**Chapter No. 5:Templates and Exception Handling:** Function and class templates.Introduction to exceptions, Throwing an Exception, Try Block, Exception Handler (Catching an Exception), Multiple exceptions. Exceptions with arguments	**6hrs**
6	**Chapter No. 6:Design Patterns:** Creational, Structural and Behavioural design patterns.	**4 hrs**
Unit –III		
7	**Chapter No. 7:Streams and Files:** Stream classes, File I/O with streams.	**4 hrs**
8	**Chapter No. 8:Standard Template Library:** container classes**:** Sequence and Associative Containers	**4 hrs**

Textbooks

1. Robert Lafore, "Object oriented programming in C++", 4th Edition, Pearson education,

Reference Books

1. Lippman S B, Lajorie J, Moo B E, C++ Primer, 5ed, Addison Wesley, 2013.
2. Herbert Schildt: The Complete Reference C++, 4th Edition, Tata McGraw Hill

Program: Bachelor of Engineering		
Course Title: **Operating System Principles and Programming**		Course Code: **18ECSC202**
L-T-P: **4-0-1**	Credits: **5**	Contact Hrs: 4+2**hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **74**	Exam Duration: **3 hrs**	

Unit –I		
1	**Chapter No. 1. Introduction and Systems structures** Operating system definition; Operating System operations; Modules of OS **,**Overview of UNIX Operating System,UNIX APIs	04 hrs + 02 hrs (lab)
2	**Chapter No. 2. Process Management** Process concept; Process scheduling; Operations on processes; Inter-process communication (Pipes and FIFOs). Threads, Process Scheduling: Basic concepts; Scheduling criteria; Scheduling algorithms. Process management using UNIX APIs**:** Process Management Functions, User IDs and Group IDs, Creating process, parent child relationship.	10 hrs + 08 hrs (lab)
3	**Chapter No. 3. Process Synchronization** Synchronization: The Critical section problem; Peterson's solution; Semaphores, Classical problems of synchronization, Process synchronization UNIX APIs.	06 hrs + 02 hrs (lab)
Unit –II		
4	**Chapter No. 4. Deadlocks** Deadlocks: System model; Deadlock characterization; Methods	06 hrs + 02

	for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.	hrs (lab)
5	**Chapter 5 : File management** File concepts, Directory structure, File Types , File systems , File Attributes, Inodes in UNIX , UNIX Kernel Support for Files, Directory Files, Hard and symbolic names. General File APIs: File and record lock API, Symbolic file API	07 hrs + 04 hrs (lab)
6	**Chapter No. 6. Memory Management** Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Segmentation. Virtual Memory Management: Background; Demand paging; Page replacement.	07 hrs + 02 hrs (lab)
Unit –III		
7	**Chapter No. 7. Secondary Storage Management** Mass storage structures; Disk structure; Disk attachment; Disk scheduling; Disk management.	5hrs
8	**Chapter No. 8. Case study** Architecture of Mobile OS - Introduction. .Overall Architecture, Linux Kernel, various components, Network OS, Applications.	5hrs

Text Books

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne: Operating System Principles, 9th edition, Wiley-India, 2006.
2. W. Richard Stevens, Stephen A. Rago, “Advanced Programming in the UNIX Environment”, 3rd Edition, Addison Wesley Professional, 2013

References

1. William Stallings,"Operating System Internals and Design Principles", 5th edition, Pearson Education, Asia, 2005
2. Gary Nutt," Operating System"3rd edition, Pearson Education,2004
3. Terrence Chan, "Unix System Programming Using C++", 1 ed., Prentice Hall India, 2007
4. Marc J. Rochkind, "Advanced Unix Programming", 2nd Edition, Pearson Education, 2005.

Course Code: 18ECSC206	**Course Title: Microcontroller Programming& Interfacing**	
L-T-P-SS: 3-0-1	**Credits: 4**	**Contact Hrs: 3+2 hrs**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hrs: 40		**Exam Duration: 3 hrs**

Content	**Hrs**
Unit – I	
Chapter No. 1.The 8051 Architecture Introduction, 8051 Microcontroller hardware, input/output pins, ports & circuits, External memory,	04 hrs
Chapter No. 2. Assembly Programming Introduction, addressing modes, External Data Moves, Code Memory Read Only Data Moves / Indexed Addressing mode, PUSH and POP opcodes, Data exchanges, assembler directives, example programs. Byte level logical Operations, Bit level Logical Operations, Rotate and Swap Operations, Example Programs. Arithmetic Operations: Flags, Incrementing and Decrementing, Addition, Subtraction, Multiplication and Division, Decimal Arithmetic, Example Programs. The JUMP and CALL Program range, Jumps, Call and Subroutines, Example programs	12hrs +08 hrs (Lab)
Unit – II	
Chapter No. 3. Timer/Counter & Serial Port Programming. C Data Types and Time delay computation in 8051 Counters and Timers, Programming 8051 Timers/counters in different modes, Basics of Serial Communication, RS232 standards, 8051 connection to RS232, 8051 serial port Programming.	12 hrs
Chapter No. 4. Interrupts Programming 8051 Interrupts, Programming Timer Interrupts, Programming external hardware interrupts, Programming the Serial Communication Interrupts, Interrupt Priority in the 8051, Interrupt programming.	04 hrs
	4 hrs
Unit – III	
Chapter No. 5. Interfacing to Peripheral Devices Interfacing 8051 to LEDs, DIP switches, BCD Decoder display, 7 Segment Display, LCD, Keypad, DAC, ADC, Stepper Motor and DC Motor	08hrs +12 Hrs (Lab)

Text Books (List of books as mentioned in the approved syllabus)

3. Ayala.K.J, “The 8051 Microcontroller”, 3rd.,CENGAGELearning, 2007.
4. Mazidi.M.A, Mazidi.J.G and McKinlay.R.D, “The 8051 Microcontroller and Embedded Systems-using Assembly and C”, 2ed, PHI 2006/Pearson, 2006.

References

1. Ayala.K.J., Gadre D.V., “The 8051 Microcontroller & Embedded Systems using Assembly and C”, 1ed., CENGAGE Learning, 2010
2. V. Udayashankara, M.S. Mallikarajunaswamy, ”8051 Microcontroller Hardware, Software and Applications”, 1ed., Tata McGraw Hill, 2009.

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1 & 2	Solve Any **2** out of **3**
II	Q.No.-4, Q.No.-5, Q.No.-6	3 &4	Solve Any **2** out of **3**
III	Q.No.-7	5	Solve Any **1** out of **2**
	Q.No.-8	5	

	Q.No.-8	5	

Program: Bachelor of Engineering		
Course Title: **Object Oriented Programming with C++ Lab**		Course Code: **18ECSP203**
L-T-P: **0-0-1.5**	Credits: **1.5**	Contact Hrs: **3 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Teaching Hrs: **39**	Exam Duration: **3hrs**	

UNIT	**8 Questions to be set of 20 Marks Each**	**Chapter Numbers**	**Instructions**
I	Q.No.-1, Q.No.-2, Q.No.-3	1 & 2	Solve Any **2** out of **3**
II	Q.No.-4, Q.No.-5, Q.No.-6	3 &4	Solve Any **2** out of **3**
III	Q.No.-7	5	Solve Any **1** out of **2**
	Q.No.-8	5	

Program: Bachelor of Engineering		
Course Title: **Object Oriented Programming with C++ Lab**		Course Code: **18ECSP203**
L-T-P: **0-0-1.5**	Credits: **1.5**	Contact Hrs: **3 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Teaching Hrs: **39**	Exam Duration: **3hrs**	

Experiments	**Lab assignments/experiment**
2-Demonstration	Introduction to Code Blocks IDE (Integrated Development Environment), C++ programming basics.
4–Exercise	Classes and objects, Inheritance, Polymorphism, Templates and Exceptions Handling
2-Structured Enquiry	Classes and objects, Inheritance, Polymorphism, Templates and Exceptions Handling
1-Open Ended	Data types, Classes and Objects, Inheritance polymorphism, Exception Handling. Design patterns

Text Book:

1. Robert Lafore, “Object oriented programming in C++”, 4th Edition, Pearson education.

Reference Books:

1. Lippman S B, Lajorie J, Moo B E, C++ Primer, 5ed, Addison Wesley, 2013.
2. Herbert Schildt: The Complete Reference C++, 4th Edition, Tata McGraw Hill

1.

Evaluation :

Students Assessment Through CIE (80%) + SEE (20%)

	Assessment	**Weightage in Marks**
Continuous Internal Evaluation (80%)	Exercises	40
	Structured Enquiry	20
	Open Ended Experiment	20
Semester End Examination (20%)	Structured Enquiry	**20**
	Total	**100**

Program: **Bachelor of Engineering**		
Course Title: **Computer Networks - I**		Course Code: **19ECSC302**
L-T-P: **3-1-0**	Credits: **4**	Contact Hrs: 5**hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40**	Exam Duration: **3 hrs.**	

	Unit –I	
1	**Introduction** Internet, The Network Edge and Core, Protocol Layer and Service Models: OSI and TCP/IP, Networks Attacks, History of Computer Network and Internet.	8 hrs
2	**Application Layer** Principles of Network Applications , HTTP , SMTP, DNS,DHCP	8 hrs
	Unit –II	
3	**Transport-Layer Services** Introduction, Connectionless Transport, Principles of Reliable Data Transfer Protocol, Connection-Oriented and Connectionless Transport, Principle of Congestion Control, TCP Congestion Control.	8 hrs
4	**Network Layer: Data plane** Introduction to Data and Control Plane, Virtual Circuit and Datagram Networks, Internet Protocol: Datagram Format, Fragmentation, IP Addressing	8 hrs
	Unit –III	
5	**Network Layer: Data plane** NAT, IPv6, Software Defined Network(SDN)	4 hrs
6	**Network Layer: Control Plane and Network Management** SDN Control Plane, Network Management and SNMP	4 hrs

Text Books

1. J. F. Kurose, K. W. Ross, Computer Networking: A Top-Down Approach, 7th Edition, Pearson Education, 2017.

Reference Books:

1. Peterson, Larry L, Computer networks : A Systems Approach, 5th Edition, The Morgan Kaufmann series in networking, 2012
2. Behrouz A. Forouzan , TCP/IP protocol suite, 4th , McGraw Hill, 2010.

Computer Networks-I Tutorial

Sl. No	Exercise	No of Slots (2 hrs)
1	Demonstration of n/w commands and tools.	2
2	Demonstration of socket programming- Connection oriented/Connectionless.	2
3	Application layer protocol implementation - FTP, Mail server, HTTP.	3
4	Demonstration of NS3 / Qualnet tools.	1
5	Performance analysis of TCP, UDP and SCTP.	1
6	Exercise on congestion control techniques.	1

7	Exercise on flow control techniques.	1
8	Design of network topology with IP addressing scheme.	2

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1,2	Solve Any **2**
II	Q.No.-4, Q.No.-5, Q.No.-6	3,4	Solve Any **2**
III	Q.No.-7	5	Solve Any **1**
	Q.No.-8	6	

Program: Bachelor of Engineering			
Course Title: **JAVA Programming**		Course Code: 19ECSP301	
L-T-P:**1-0-1.5**	Credits: **2.5**	Contact Hrs: 4 Hrs/week	
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**	
Teaching Hrs: **52**	Exam Duration: **3hrs**		
Unit –I			
1	**JAVA Language Fundamentals:** Java Features, Programming basics, Arrays and Strings, classes and objects		**4 Hrs**
2	**Inheritance**: Introduction, types of inheritance, static and dynamic polymorphism.		**2 Hrs**
Unit –II			
3	**Interfaces and Exception Handling:** Introduction,Create and implement interfaces, Exception handling,		**2 Hrs**
4	**Generics and Collections Frame work:** Introduction to generic programming, Collections: Interfaces: List, Set, Queue Classes: ArrayList, LinkedList and HashSet, Map		**2 Hrs**
Unit –III			
5	**Lambda Expressions:** Functional programming, Functional interface, Bulk operations on collections		**2hrs**
6	**Java Database Connectivity (JDBC):** Introduction, Drivers, Interfaces and classes to develop data base applications, case study		**2 Hrs**

Text Books:

1. JAVA The Complete Reference, Herbert Schildt, 10th Ed, 2017, McGraw-Hill

Reference Book

1. Kathy Sierra and Bert Bates, Head First Java: A Brain-Friendly Guide, 2nd Edition, O'Reilly Media
2. Introduction to Java Programming, Liang Y D, Pearson, 11^{th} Edition

Program: **Bachelor of Engineering**		
Course Title: **Computer Networks-II**		Course Code: **19ECSC303**
L-T-P: **2-0-1.5**	Credits: **3.5**	Contact Hrs: **5hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **30**	Exam Duration: **3 hrs**	

	Unit –I	
1	**Network Layer** Address Mapping, Error Reporting, Multicasting: IGMP Group Management, IGMP Messages, Message Format, and IGMP Operation.	06hrs
2	**Network Layer- Routing** Delivery, Forwarding Techniques and Process, Routing Table, Unicast Routing Protocols, Intra and Inter-domain Routing, Distance Vector Routing, Link State Routing, Path Vector Routing, Routing protocols: Unicast, Multicast, and Broadcast Applications.	06hrs
	Unit –II	
3	**Data Link Layer** Error Detection and Correction, Forward Error Correction Versus Retransmission, Coding, Modular Arithmetic, Block coding: Error Detection, Error Correction, Hamming Distance, Minimum Hamming Distance, Cyclic Redundancy Check,Checksum, Framing.	06hrs
4	**Switched Local Area Networks** Ethernet, Link-Layer Switches, Virtual Local Area Networks (VLANs),Multiprotocol Label Switching (MPLS), Data Center Networking, Multiple Access: Aloha , Slotted Aloha, CSMA, CSMA/CD, CSMA/CA.	06hrs
	Unit –III	
5	**Wireless Networks** Wireless Links and Network Characteristics, 802.11 Wireless LANs, Architecture, MAC Protocol, Frame, Mobility, Personal Area Networks: Bluetooth and Zigbee.	03hrs
6	**Cellular Networks and Mobility Management** Cellular Networks and Internet Access, Mobility, Mobile IP, Managing Mobility in Cellular Network.	03hrs

Text Books

1. J. F. Kurose, K. W. Ross, Computer Networking: A Top-Down Approach, 7th Edition, Pearson Education, 2017.
2. Behrouz A. Forouzan , TCP/IP protocol suite, 4th , McGraw Hill, 2010.

Reference Books:

1. Peterson, Larry L, Computer Networks: A Systems Approach, 5th Edition, The Morgan Kaufmann series in networking, 2012.
2. Dimitri P. Bertsekas and Robert G. Gallager, Data Networks (2nd Edition),PHI,2009.

List of Experiments

S.No	Experiments	Number of lab Slots (3 hrs)
1.	Demonstration of SDN testbed.	1
2.	Traffic measurement and traffic volume control using the POX controller.	1
3.	Implementation of load balancing/routing technique.	1
4.	Demonstration of Junos.	1
5.	Configuration and analysis of VLAN.	1
6.	Configuration and analysis of STP, MPLS and VPN.	1
7.	Configuration and analysis of OSPF and BGP routing protocols.	2
8.	Performance analysis of routing metrics.	1
9.	Experimental analysis of the Handover Procedure in a WiFi Network.	1
10	Performance analysis of IEEE 802.11 MAC protocols.	1
1	Network application development using Mojo access points.	2

Scheme for End Semester Assessment (ESA)

UNIT	**8 Questions to be set of 20 Marks Each**	**Chapter Numbers**	**Instructions**
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2	Solve Any **2**
II	Q.No.-4, Q.No.-5, Q.No.-6	3,4	Solve Any **2**
III	Q.No.-7	5	Solve Any **1**
	Q.No.-8	6	

Program: **Bachelor of Engineering**		
Course Title: **Semantic Web**		Course Code:**19ECSE303**
L-T-P: **3-0-0**	Credits: **3**	Contact Hrs: **3hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40**	Exam Duration: **03 hrs**	

Unit –I		
1	**Introduction to Semantics** History of the Web, Limitations, Vision of Semantic Web, Principles, Data Integration Across Web, Data Modeling Methods, Semantic Relationships, Metadata, Perpetual Data	**4 hrs**
2	**Expressing Meaning** Triple Store, Merging Graphs, Querying: Case Study	**4 hrs**
3	**Using Semantic Data** Query Language, Feed Forward Inference, Searching for Connections, Linked Data, Freebase	**8 hrs**
Unit –II		
4	**Working with Semantics** RDF—The Basis of the Semantic Web, OWL, Metadata with RDF, Metadata Taxonomies, Ontology	**8 hrs**
5	**Reasoning and Social Web** Reasoning types: Approximate Reasoning and Bounded Reasoning, Social Semantic Web, Semantic Crawlers	**8 hrs**
Unit –III		
6	**Semantic Modeling** Semantic Modeling, Semantic Web Applications, Logic for Semantic Web, Case Studies: Dr. Watson, Yahoo! SearchMonkey	**8 hrs**

Text Books

1. Grigoris Antoniou, Paul Groth, Frank van Harmelen and Rinke Hoekstra, A Semantic Web Primer, MIT Press; 3rd edition, 2012.
2. Toby Segaran, Colin Evans, and Jamie Taylor, Programming the Semantic Web: Build Flexible Applications with Graph Data, O'Reilly Media; 2 edition, July 2009.

Reference Books:

1. Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, Foundations of Semantic Web Technologies, Chapman and Hall; 1st edition, 2009.
2. Dean Allemang, and James Hendler, Semantic Web for the Working Ontologist, Effective Modeling in RDFS and OWL, Morgan Kaufmann; 2nd edition, 2011.
3. John Hebeler, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, and Mike Dean (Foreword), Semantic Web Programming, Wiley Publishers, 1 edition 2009.

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions

I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2,3	Solve Any **2**
II	Q.No.-4, Q.No.-5, Q.No.-6	4,5	Solve Any **2**
III	Q.No.-7	6	Solve Any **1**
	Q.No.-8	6	

Course Title: Block Chain Technology		Course ode:19ECSE301
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **3hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40**	Exam Duration: **3 hrs**	

	Unit –I	
1	**Introduction** Overview of Blockchain, History: Digital Money to Distributed Ledgers, Design Primitives: Protocols, Security, Consensus, Permissions, Privacy	**08 hrs**
2	**Blockchain Architecture and Design** Crypto primitives- Hash, Signature, Hashchain to Blockchain, basic consensus mechanisms, Requirements for the consensus protocols, Proof of Work, Proof of State, Scalability issues of consensus protocols	**08 hrs**
	Unit –II	
3	**Blockchain Contracts** Financial Services, Crowdfunding, Bitcoin Prediction Markets, Smart Property, Smart Contracts, Blockchain Development Platforms and APIs, Blockchain Ecosystem: Decentralized Storage, Communication, and Computation	**08 hrs**
4	**Etherium** Etherium transactions, accounts, smart contracts, smart contract development, Solidity basics, basic contracts, distributed storage, Etherium scaling	**08 hrs**
	Unit –III	
5	**Blockchain Applications** Blockchain in Financial Software and Systems: Settlements, KYC, InsuranceBlockchain for Government: Digital identity, land records and other kinds of record keeping between government entities, public distribution system social welfare systems	**08hrs**

Text Books:

1. Melanie Swan, "Blockchain: Blueprint for New Economy", 1st Edition, O'Reilly Media, 2014.

Reference Books:

1. ArshdeepBhaga, Vijay Madisetti, "Blockchain Applications: A Hands-On Approach", Paperback– January 31, 2017

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1,2	Solve Any **2**
II	Q.No.-4, Q.No.-5, Q.No.-6	3,4	Solve Any **2**
III	Q.No.-7, 8	5	Solve Any **1**

Course Title: The ARM Architecture		Coursecode:19ECSE302
L-T-P: 2-1-0	Credits: 3	Contact Hrs: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 30	Exam Duration: 3 hrs	

	Unit –I	
1	**ARM Embedded Systems and Processor Fundamentals** The RISC Design Philosophy , The ARM Design Philosophy, Embedded System Hardware, Embedded System Software, Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table, Core Extensions, Architecture Revisions, ARM Processor Families	06 hrs
2	**Introduction to the ARM Instruction Set & Assembly Programming** Data Processing Instructions, Branch Instructions, Load-Store Instructions, Software Interrupt Instruction, Program Status Register Instructions, Loading Constants, ARMv5E Extensions, Conditional Execution, Thumb instruction set.	06 hrs
	Unit –II	
3	**Efficient C Programming** Overview of C Compilers and Optimization, Basic C Data Types, C Looping Structures, Register Allocation, Function Calls, Pointer Aliasing, Structure Arrangement, Bit-fields, Unaligned Data and Endianness, Division.	06 hrs
4	**Writing and Optimizing ARM Assembly Code** Writing Assembly Code, Profiling and Cycle Counting, Instruction Scheduling, Register Allocation, Conditional Execution, Looping Constructs, Bit Manipulation, Efficient Switches, Handling Unaligned Data.	06 hrs
	Unit –III	
5	**Introduction to LPC-2148 controller** Input output Ports, Pin select registers, Input output select registers, direction control and control registers, Introduction to interfacing standards	03 hrs
6	**ARM Interfacing** ARM interfacing to peripherals like LED, LCD, Seven segments, Motors, Converters, Keypad.	03 hrs

Text Books

1. Andrew N.Sloss et al, ARM System Developer's Guide- Designing and Optimizing System Software

Reference Books:

1.Marilyn Wolf, Computers as Components: Principles of embedded computing system design, Morgan Ka, 2012

2.Steve Furber, ARM System-on-chip Architecture, 2, Pearson, 2000

Tutorial Plan

Expt./ Job No.	assignments/experiment	No. of Lab. Slots per batch (estimate)
1	ALP on arithmetic instructions set	*01*
2	ALP on logical instructions set	01
3	ALP on loop and branch instructions	01
4	Interface LED and Seven segments to ARM for displaying message.	01
5	Interface LCD to ARM for displaying message.	01
6	Interface Keypad to read the characters	01
7	Rotate DC and stepper motor for variable speed and direction	01
8	Interface DAC to ARM controller	01

Scheme for End Semester Assessment (ESA)

UNIT	**8 Questions to be set of 20 Marks Each**	**Chapter Numbers**	**Instructions**
I	Q.No.-1, Q.No.-2, Q.No.-3	1,2	Solve Any **2** out of **3**
II	Q.No.-4, Q.No.-5, Q.No.-6	3,4	Solve Any **2** out of **3**
III	Q.No.-7, 8	5	Solve Any **1** out of **2**

Program: Bachelor of Engineering		
Course Title: **Discrete Mathematical Structures**		Course Code:**19ECSC202**
L-T-P:**3-1-0**	Credits: **3**	Contact Hrs: **3hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40**	Exam Duration: **3 hrs**	

Unit –I		
1	**Logic and Proofs**: Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Rules of Inference. Introduction to Proofs, Mathematical Induction and Well-Ordering	**8hrs**
2	**Functions and Relations:** Types of sets, Functions, Relations, Equivalence relations partial ordering (Poset), HasseDiagram, Counting	**8hrs**
Unit –II		
3	**Recurrence Relations:** Introduction, Applications of Recurrence Relations, Solving Recurrence Relations, Formulating Recurrence relations, Generating Functions, Inclusion–Exclusion, Applications of Inclusion–Exclusion	**8 hrs**
4	**Groups:** Binary Operations, Semi groups, Products and Quotients of Semi Groups, Groups, Product and Quotients of Groups	**8 hrs**
Unit –III		
5	**Cryptography:** Cryptography and Modular Arithmetic, Introduction to Cryptography, Private Key Cryptography, Public-key Cryptosystems. Arithmetic modulo n, Cryptography using multiplication mod n	**4hrs**
6	**RSA Cryptosystem:** The RSA Cryptosystem; RSA Encryption, RSA Decryption, RSA as a Public Key System, Cryptographic Protocols	**4 hrs**

Text Books:

1. Rosen K.H., Discrete Mathematics and its Applications with Combinatorics and graph theory, 7th Ed, Tata Mc-GrawHill Publications, 2012

Reference Books:

1. Kolman, Busby and Ross, Discrete Mathematical Structures, 5Ed., PHI, 2004
2. Grimaldi R.P. and Ramana B.V, Discrete and Combinatorial Mathematics- An Applied Introduction, 5Ed., Pearson Education, 2007

Tentative tutorial Plan

Sl.No	Topic	Number of slots
1	Logic and Proofs	3
2	Functions and Relations	2
3	Recurrence Relations	3
4	Group	2
5	Cryptography	2

6	RSA Cryptosystem	1

Scheme for Semester End Examination (ESA)

UNIT	**8 Questions to be set of 20 Marks Each**	**Chapter Numbers**	**Instructions**
I	Q.No.-1, Q.No.-2, Q.No.-3	1,2	Solve Any **2**
II	Q.No.-4, Q.No.-5, Q.No.-6	3,4	Solve Any **2**
III	Q.No.-7	5	Solve Any **1**
	Q.No.-8	6	

Program: Bachelor of Engineering		
Course Title: **Principles of Compiler Design**		Course Code:**19ECSC203**
L-T-P:**3-1-0**	Credits: **3**	Contact Hrs: **03 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40**	Exam Duration: **03 hrs**	

Unit –I		
1	**Introduction to compilers:** Brief History Of Compilers, Translation Process, Major Data Structures In Compilers, Chomsky Hierarchy, Lexical Analysis: Scanning Process, Regular Expressions For Tokens, Lexical Errors, ApplicationsOf Regular Expressions.	**06hrs**
2	**Finite Automata:** Introduction: Language, Automata, From Regular Expressions To Deterministic Finite Automata (DFA): Є-Nondeterministic Finite Automata (Є-NFA), NFA, DFA, DFA Optimization, Finite Automata As Recognizer, Implementation Of Finite Automata	**06hrs**
3	**Introduction to Syntax Analysis:** Introduction To Grammars, Context-Free Grammars (Cfgs), Ambiguity In Grammars And Languages, Role Of Parsing.	**04 hrs**
Unit –II		
4	**Top Down Parsing:** Introduction, Left Recursion, Left Factoring, LL (1) Parsing, FIRST And FOLLOW Sets, Error Recovery In Top Down Parsing.	**08 hrs**
5	**Bottom up Parsing:** Introduction, SLR (1) Parsing, General LR (1) And LALR (1) Parsing, Error Recovery In Bottom Up Parsing.	**08 hrs**
Unit –III		
6	**Semantic Analysis:** Attributes And Attributes Grammars, Algorithm For Attribute Computation, Symbol Table, Data Types And Data Checking.	**04 hrs**
7	**Intermediate Code Generation:** Intermediate Code And Data Structure For Code Generation, Code Generation Of Data Structure References, Code Generation Of Control Statements.	**04 hrs**

Text Book:

1. Alfred V Aho, Monica S. Lam, Ravi Sethi, Jeffrey D Ullman, Compilers - Principles, Techniques and Tools, 2nd Edition, Pearson, 2011.
2. Kenneth C Louden: Compiler Construction Principles & Practice, Cengage Learning, 1997.

References:

1. Andrew W Apple, Modern Compiler Implementation in C, Cambridge University Press, 1999.
2. Charles N. Fischer, Richard J. leBlanc, Jr, Crafting a Compiler with C, Pearson, 2011.
3. Peter Linz, An Introduction to formal languages and Automata, IV edition, Narosa, 2016.
4. Basavaraj S Anami, Karibasappa K.G, Formal Languages and Automata Theory, First, Wiley India, 2011.

Tutorial tentative plan

Expt/Job No	Brief description of experiments	No of slots 1 slot = 2hrs
1	Regular expressions.	01
2	NFA, DFA and DFA optimization.	02
3	Regular and Context free grammars.	01
4	Top down parsing.	01
5	Bottom up parsing.	02
6	Implementation of lexical & syntax analyzer using LEX and YACC tools.	02
7	Design of CFG for validating Natural languages and implement the same.	02

Scheme for End Semester Assessment (ESA)

	8 Questions to be set of 20 Marks Each	Chapter Numbers	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2 ,3	Solve Any **2**
II	Q.No.-4, Q.No.-5, Q.No.-6	4 ,5	Solve Any **2**
III	Q.No.-7	6	Solve Any **1**
	Q.No.-8	7	

Course Content

Program: **Bachelor of Engineering**		
Course Title: **Senior Design Project**		Course Code: 20ECSW401
L-T-P: **0-0-6**	Credits: **6**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **39**	Exam Duration: **3hrs**	

Seventh semester senior design project theme: Usage of Design Principles in building the solution.

SDP aims to design and develop a solution using software design principles:- design patterns (creational, behavioral & structural) , User experience (UX) design and API (application programming interface) that are generally followed in industries.

Project domains:

Networking	**Data Engineering**	**System Engineering**
• Internet of Things • Cloud Computing • SDN(Software Defined Network) • SNA(Social Network Analysis)	• Data Analytics *Data Processing:* • Image and video processing • Computer Vision and Graphics • NLP(Natural Language Processing)	• Parallel Computing • HPC(High Performance Computing) • Parallel system design

Student Evaluation Matrix:
Project will have 3 internal reviews as follows:

Continuous internal Evaluation	Review Expectation
Review-1	Literature Survey, Problem Analysis and Problem formulation
Review-2	Requirements, Design, design principles adopted in modules/components and Algorithms.
Review-3	Implementation and Testing.

Scheme for End Semester Assessment (ESA)

Sl.No	Expectation	Marks

1	Write up 1. Problem Statement and Objectives. 2. System design with brief description. 3. Concluding remarks.	05
2	Presentation: Prepare minimum of 15-18 slides of presentation with consultation of your respective guides.	05
3	Demo (Complete execution of the project with results) and Viva voce.	30
4.	Project Report.	10

Course Code: **16ECSE705**	Course Title: **Compiler Design**	
L-T-P: **3-1-0**	Credits:4	Contact Hrs: 5hrs/week
ISA Marks: 50	ESA Marks: 100	Total Marks: 100
Teaching Hrs: 42		Exam Duration: 03

No	Content	Hrs
1	**Introduction** Why compilers, Programs Related to compilers, Translation process, Major Data structure in compiler, Bootstrapping and porting.	**06**
2	Lexical analysis :Scanning process, Regular Expressions, Finite Automata, From regular expressions to DFA, Specifications of Tokens, Recognition of Tokens	**06**
3	**Syntax Analysis:** Parsing process, context free grammars, parse tree ,ambiguity. Top-down Parsing: Recursive descent parsing, LL(1) parsing	**07**
4	**Bottom-up Parsing** Overview of Bottom-up Parsing, Simple LR Parser(SLR(1),	**06**
5	**More powerful parsers:** LR(1),LALR(1) parsing	**06**
6	**Semantic Analysis** Attributes and Attributes grammars, Algorithm for attribute computation, Symbol table, data types and Data checking	**06**
7	**Code Generation** Intermediate Code and data structure for code generation, Code generation of data structure references, code generation of control statements and expressions.	**05**

Text Book:

1. Kenneth C Louden: Compiler Construction Principles & Practice, Cengage Learning, 1997
2. Alfred V Aho, Monica S. Lam, Ravi Sethi, Jeffrey D Ullman: Compilers - Principles, Techniques and Tools, 2nd Edition, Pearson, 2007.

References:

1. Andrew W Apple: Modern Compiler Implementation in C, Cambridge University Press, 1997
2. Charles N. Fischer, Richard J. leBlanc, Jr.: Crafting a Compiler with C, Pearson, 1991.
3. Peter Linz: An Introduction to formal languages and Automata, IV edn, Narosa,2009.

Course Code: **16ECSE707**	Course Title: **Cryptography and Network Security**	
L-T-P: **3-0-0**	Credits: 3	Contact Hrs: 42
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 3		Exam Duration: 3 hrs

Ch. No	Content	Hrs
1	**Network Security Overview** **Common Attacks and Defense Mechanisms:** Eavesdropping, Cryptanalysis Password Pilfering, Identity Spoofing, Buffer-Overflow Exploitations, Repudiation, Intrusion, Traffic Analysis, Denial of Service Attacks, Marvelous Software. **Attacker Profiles:** Hackers, Script Kiddies, Cyber Spies, VICIOUS Employees, Cyber Terrorists, Hypothetical Attackers. **Basic Security Model.**	**05**
2	**Data Encryption Algorithms** **Data Encryption Algorithm Design Criteria:** ASCII Code, XOR Encryption, Criteria of Data Encryptions, implementation Criteria. **Data Encryption Standard :** Feistel's Cipher Scheme , DES Subkeys, DES Substitution Boxes , DES Encryption , DES Decryption and Correctness Proof., DES Security Strength. **Multiple DES**. **Advanced Encryption Standard:** AES Basic Structures., AES S-Boxes 60, AES-128 Round Keys , Add Round Keys Substitute-Byt, Shift-Ro, Mix-Colum, AES-128 Encryption, AES-128 Decryption and Correctness Proof, Galois Fields, Construction of the AES S-Box and Its Inverse , AES Security Strength. **Standard Block-Cipher Modes of Operations:** Electronic-Codebook Mode, Cipher-Block-Chaining Mode, Cipher-Feedback Mode Output-Feedback Mode, Counter Mode. **Stream Ciphers:** RC4 Stream Cipher, RC4 Security Weaknesses. **Key Generations**.	**07**
3	**Public-Key Cryptography and Key Management** **Concepts of Public-Key Cryptography, Elementary Concepts and Theorems In Number Theory**: Modular Arithmetic and Congruence Re1attons, Modular Inverse. **Diffie-Hellman Key Exchange**, Key Exchange Protocol , Man-in-the-Middle Attacks , Elgamal PKC. **RSA Cryptosystem :** RSA Key Pairs, Encryptions, and Decryptions , RSA Parameter Attacks RSA Challenge Numbers. **Key Distributions and Management**: Master Keys and Session Keys , Public-Key Certificates CA Networks, Key Rings.	**05**
4	**Data Authentication** **Cryptographic Hash Functions:** Design Criteria of Cryptographic Hash F Unctions , Quest for Cryptographic Hash Functions, Basic Structure of Standard Hash Functions , SHA-512 , WHIRLPOOL , **Cryptographic Checksums**: Exclusive-OR Cryptographic Checksums , Design Criteria of MAC Algorithms , Data Authentication Algorithm. **HMAC :** Design Criteria	**07**

	of HMAC , HMAC Algorithm, **Offset Codebook Mode of Operations**: Basic Operations , OCB Encryption and Tag Generation , OCB Decryption and Tag Verification. **Birthday Attacks**: Complexity Upper Bound of Breaking Strong Collision, Resistance, Set Intersection Attack. **Digital Signature Standard, Dual Signatures and Electronic Transactions:** Dual Signature Applications, Dual Signatures and Electronic Transactions, **Blind Signatures and Electronic Cash:** RSA Blind Signatures , Electronic Cash .	
5	**Network Security Protocols in Practice** **Crypto Placements in Networks:** Crypto Placement at the Application Layer , Crypto Placement at the Transport Layer , Crypto Placement at the Network Layer , Crypto Placement at the Data-Link Layer , Hardware versus Software Implementations of, Cryptographic Algorithms. **Public-Key Infrastructure**: X.509 Public-Key Infrastructure , X.509 Certificate Formats **, IPsec: A Security Protocol at the Network Layer:** Security Association, Application Modes and Security Associations , AH Format , ESP Format Secret Key Determination and Distribution.	**06**
6	**Security Protocols at Transport and Application Layers** SSL Handshake Protocol , SSL Record Protocol. **PGP and SIMIME**: **Email Security Protocols**: Basic Email Security Mechanisms. PGP, S/MIME. **Kerberos' An Authentication Protocol:** Basic Ideas , Smgle-Realm Kerberos , Multiple-Realm Kerberos , **SSH: Security Protocols for Remote Logins .**	**04**
7	**Wireless Network Security -1:** **Wireless Communications and 802 11 WLAN Standards:** WLAN Architecture, 802.11 Essentials Wireless Security Vulnerabilities. **WEP**: Device Authentication and Access Control, Data Integrity Check LLC Frame Encryption, Security Flaws of WEP. **WPA:** Device Authentication and Access Controls, TKIP Key Generations, TKIP Message Integrity Code , TKIP Key Mixing , WPA Encryption and Decryption , WPA Security Strength and Weaknesses.	**04**
8	**Wireless Network Security -2 :** **IEEE 802.11i/WPA2:** Key Generations 230, CCMP Encryptions and MIC 802.11i Security Strength and Weaknesses , **Bluetooth Security:** Piconets , Secure Pairings SAFER+ Block Ciphers, Bluetooth Algorithms E_1, E_{2l}, and E_{22}, Bluetooth Authentication, A PIN Cracking Attack , Bluetooth Secure Simple Pairing. **Wireless Mesh Network Security.**	**04**

Text Book:

1. Jiewang, "Network Security Theory and Practices", Springer Higher Higher Education, 2009

References:

1. William Stallings, Cryptography and Network Security Principles And Practices, 5th Edition, Pearson Publication, 2011.
2. Mark Stamp And Richard M Low, Applied Cryptanalysis, John Wiley & Sons, 2007

Course Code: 16ECSC711	Course Title: Distributed and Cloud Computing	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 55		Exam Duration: 3 hrs

Content	Hrs
Chapter No. 1: Distributed System Models and Enabling Technologies Scalable Computing over the Internet, Technologies for Network-Based Systems, System Models for Distributed and Cloud Computing, Software Environments for Distributed Systems and Clouds.	6 hrs
Chapter No. 2: Virtual Machines and Virtualization of Clusters and Data Centers Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resources Management, Virtualization for Data-center Automation.	8 hrs
Chapter No. 3: Cloud Platform Architecture over Virtualized Data Centers Cloud Computing and Service Models, Architectural Design of Compute and Storage Clouds, Public Cloud Platforms.	8 hrs
Chapter No. 4: Cloud Programming and Software Environments Features of Cloud and Grid Platforms, Parallel and Distributed Programming Paradigms, Programming Support of Google App Engine, Emerging Cloud Software Environments.	10 hrs
Chapter No. 5: Cloud Resource Management and Scheduling PoliISAs and mechanisms for resource management, Applications of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based web services. Resource bundling; combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds. Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic application scaling.	12 hrs
Chapter No. 6: Cloud Security Cloud security risks, Security; the top concern for cloud users, Privacy; privacy impact assessment, Trust, Operating system security, Security of virtualization. Security risks posed by shared images, Security risks posed by a management OS, Xoar - breaking the monolithic design of the TCB, A trusted virtual machine monitor.	11 hrs

Text Books:

1. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, "Distributed and Cloud Computing from Parallel Processing to the Internet of Things", Morgan Kaufman, Elsevier- 2012.
2. Dan C. Marinescu "Cloud Computing Theory and Practice", Morgan Kaufman, Elsevier-2013.

Reference Books:

1. Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi "Mastering Cloud Computing", McGraw Hill Education (India) Pvt. Limited, 2013.
2. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter: Cloud Computing, A Practical Approach, McGraw Hill, 2010.

Course Code: 16ECSC713	Course Title: Software Testing	
L-T-P :3-0-0	Credits: 4	Contact Hrs: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 42		Exam Duration: 3 hrs

Content	Hrs
Chapter No. 1. Principles of Testing Context of testing in producing software: About the chapter, The incomplete Car, Dijkstra's Doctrine, A test time , The cat and the saint, Test the test first, The pesticide paradox, The convoy and the rags, The police man on the bridge, The Ends of Pendulum, Men in black, Automation syndrome, Putting it all together.	3 hrs
Chapter No. 2. Software Development Life Cycle Models Phases of Software Project: Requirements gathering and analysis, Planning, Design, Development or coding, Testing, Development and Maintenance, Quality, Quality assurance, and Quality Control, Testing, Verification and validation, Process model to represent different phases: Life cycle Models, Waterfall model, Prototyping and Rapid Application Development models, Spiral or Iterative model, The V model, Comparison of various life cycle models, References.	5 hrs
Chapter No. 3. Defect Testing White Box Testing: What is white box testing, Static testing, Static testing by humans, Static analysis tools: Structural testing, Unit /code fundamental testing, Code coverage testing, Code complexity testing, Black Box Testing: What is black box testing?, Why black box testing?, When to do black box testing?, How to do black box testing?, Requirement based testing, Positive and negative testing, Boundary value analysis, Decision tables, Equivalence participating , State based or graphic based testing, Compatibility testing, User documentation testing, Domain testing.	5 hrs
Chapter No. 4. Regression Testing What is regression testing?, Types of regression testing, When to do regression testing?, How to do regression testing?, Performing an initial "smoke" or "sanity" test, Understanding the criteria for selecting the test cases, Classifying the test cases, Methodology for selecting test cases, Resetting the test cases for regression testing, Concludes the results of regression testing, Best practices in regression testing.	4 hrs
Chapter No. 5. Unit Testing & Integration Testing What is integration testing?, Types of integration testing, Top-down integration, Bottom– up integration, Bi-directional integration, System integration, Choosing integration method, Integration testing as a phase of testing, Scenario testing, System scenarios, Use case scenarios, Defect bash, Choosing the frequency and duration of defect bash, Selecting right product build, Communicating the object of defect bash, Setting up monitoring lab, Taking action and Fixing issues, Optimizing the effort involved in defect bash.	5 hrs
Chapter No. 6. System and Acceptance Testing System Testing overview: Why is System testing done?, Functional versus Non-Functional testing, Functional system testing, Design/Architecture verification, Business vertical testing, Development testing, Beta testing, Certification, Standards and testing compliance, Non – Function testing, Setting up the configuration, Coming up with entry/exit criteria, Balancing key resources, Scalability testing, Reliability testing, Stress testing, Interoperability testing, Acceptance testing, Acceptance criteria, Selecting test cases for acceptance testing, Executing acceptance tests, Summary of testing phases, Multiphase testing model.	5 hrs
Chapter No. 7. Performance Testing Introduction, Factors governing performance testing, Methodology for performance testing, Collecting requirements, Writing test cases, Automating performance test cases, Executing performance test cases, Analyzing the performance test results, Performance tuning,	5 hrs

Performance bench marking, Capacity planning, Tools for performance testing, Processes for performance testing, Challenges, Problems and Exercises.	
Chapter No. 8. Test Planning, Management and Execution Introduction, Test planning, Preparing a test plan, Scope management – deciding features to be tested / not tested, Deciding test approach/strategy, Setting up criteria for testing, Identifying responsibilities, Staffing, and Training needs, Identifying resource requirements, Identifying test deliverables, Testing tasks – Size and effort estimation, Activity breakdown and scheduling, Communication management, Risk management: Test management, Choice of standards, Test infrastructure management, Test people management, Integration with product release, Test process, Putting together and base lining a test plan, Test case specifications, Update of traceability matrix, Identifying possible candidates for automation, Developing and base lining test cases. Executing test cases and keeping traceability matrix current, Collecting and analyzing matrix	5 hrs
Chapter No. 9. Reporting and Software Test Automation Preparing test summary report, Recommending product release criteria: Test reporting, Recommending product release, Best practices, Process related best practices, People related best practices, Technology related best practices, What is Test automation?, Terms used in automation, Skills needed for automation, What to automate?, Scope of automation-Identifying the types of testing amenable to automation, Automating areas less prone to change, Automate tests that pertain to standards, Management aspects in automation, Design and architecture for automation.	5 hrs
Text Book: 1. Desikan Srinivasan and Gopalswamy, Ramesh, Software Testing- Principles and Practices, Published by Person Education, 2nd edition, Pearson Education, 2007. ***References:*** 1. Edward Kit, Software Testing in the Real World Improving the Process, Published by Person Education, 1995. 2. Ron, Patton, Software Testing, 2nd edition Person Education, 2004. 3. Marnie, Hutcheson L., Software Testing Fundamentals, Wiley India, 2003. **4.** Roger S. Pressman, Software Engineering A Practitioners Approach, 5th edition McGraw Hill.	

School of Computer Science and Engineering

Course Code: 16ECSE715	Course Title: **Applied Parallel Computing**	
L-T-P: **3-1-0**	Credits: **4**	Contact Hrs:**5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42 hrs**		Exam Duration: **3 hrs**

1	**Introduction and History** GPUs as Parallel Computers; Architecture of a Modem GPU; Parallel Programming Languages and Models; Overarching Goals; Evolution of Graphics Pipelines; The Era of Fixed- Function; Graphics Pipelines; Evolution of Programmable Real-Time Graphics; Unified Graphics and Computing Processors; GPGPU; An Intermediate Step; GPU Computing; Scalable GPUs Recent Developments; Future Trends	**05 Hrs**
2	**Introduction to CUDA** Data Parallelism; CUDA Program Structure; A Matrix-Matrix Multiplication Example; Device Memories and Data Transfer; Kernel Functions and Threading; Function declarations; Kernel launch; Predefined variables; Runtime API.CUDA Thread Organization; Using b1ock Id x and thread Id x ; Synchronization and Transparent Scalability; Thread Assignment ; Thread Scheduling and Latency Tolerance	**07 Hrs**
3	**CUDA Memories, Performance Considerations and Floating Point Considerations** Importance of Memory Access EffiISAncy; CUDA Device Memory Types; A Strategy for Reducing Global Memory Traffic; Memory as a Limiting Factor to Parallelism; Global Memory Bandwidth; Dynamic Partitioning of SM Resources; Data Prefetching; Instruction Mix; Thread Granularity; Measured Performance; More on thread execution, Global memory bandwidth, dynamic partitioning of SM resources, Floating point format, Arithmetic Accuracy and rounding	**07 Hrs**
4	**Floating Point Considerations** Floating-Point Format, Normalized Representation of M, Excess Encoding of E, Representable Numbers, Special Bit Patterns and Precision, Arithmetic Accuracy and Rounding, Algorithm Considerations	**05 Hrs**
5	**Introduction to OPENCL** Introduction to OPENCL; Background; Data Parallelism Model; Device Architecture; Kernel Functions; Device Management and Kernel Launch; Electrostatic Potential Map in OpenCL;	**05 Hrs**
6	**Parallel Programming and Computational Thinking** Goals of Parallel Programming, Problem Decomposition, Algorithm Selection, Computational Thinking	**03 Hrs**
7	**Introduction to Embedded GPU Computing** Architecture, Programming Model, Programs, Configuration etc.	**05 Hrs**
8	**Case Study /Projects** Concepts of Game Design, Applications like Matrix multiplication, MRI reconstruction Molecular Visualization and Gaming	**05 Hrs**

Text book:

1. Programming Massively Parallel Processors: A Hands on Approach; David B. Kirk, Wen-mei W. Hwu; Morgan Kaufmann /Elsevier India reprint 2010

Reference Books:

1. *Heterogeneous Computing with OpenCL, by Benedict R. Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry & Dana Schaa*; Morgan Kaufmann 2011

Course Code: 16ECSE716	Course Title: Internet of Things	
L-T-P-SS: 3-1-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 42		Exam Duration: 3 hrs

Content	Hrs
Chapter No 1. Introduction to Internet of Things (IoT) Definition & Characteristics of IoT, Physical Design of IoT: IoT protocols, Logical Design of IoT: IoT functional blocks, communication models and APIs.	4 hrs
Chapter No 2. IoT Enabling Technologies Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, IoT Levels and Deployment Templates.	6 hrs
Chapter No 3. Domain specific IoTs Home Automation ,Cities, Environment ,Energy, Retail, Logistics, Agriculture, Industry ,Health and Lifestyle	6 hrs
Chapter No 4. IoT Platforms Design Methodology IoT Design Methodology, Case Study on IoT System for Weather Monitoring.	4 hrs
Chapter No 5. IoT systems – Logical design using Python Introduction to Python, Data types, data structures, Control of flow, functions modules, packages, file handling, data/time operations, classes, Python packages - JSON, XML, HTTPLib, URLLib, SMTPLib.	6 hrs
Chapter No 6. IoT Physical Devices and Endpoints Basic building blocks of an IoT device, Exemplary device: Rasyberry Pi, interface (serial, SPI, I2C), Programming Rasyberry Pi with Python. Tutorial: • Programming Inputs and Outputs with Python: Reading a Button • Working with Webcams: Testing Webcams, Displaying an Image,Modifying an Image, Accessing the Webcam • Python and The Internet: Serving Pi (Be a Web Server) Connecting the Web to the Real World	6 hrs
Chapter No 7. IoT Physical Servers & Cloud Offerings Introduction to Cloud Storage models and communication APIs ,Webserver – Web server for IoT, Cloud for IoT, Python web application framework, Designing a RESTful web API	5 hrs
Chapter No 8. Case Studies Illustrating IoT Design: Home Automation-smart lighting, home intrusion detection, Cities-smart parking.	5 hrs

Text Book (List of books as mentioned in the approved syllabus) 1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547 References 1. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759	

Course Code: 16ECSC801	Course Title: **Data Mining and Business Analytics**	
L-T-P: **4-0-0**	Credits: **4**	Contact Hrs:**4 hrs/week**
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

1	**Introduction to Data Mining** Fundamentals of data mining, Data mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining, Data Warehouse and OLAP Technology for Data mining: Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture.	**06 hrs**
2	**Association Rule Mining** Mining Frequent Patterns, Associations: Basic Concepts, EffiISAnt and Scalable Frequent Itemset Mining methods (Apriori Algoithm, improving effiISAncy of Apriori, Mining frequent Itemsets without Candidate generation, using vertical data formats). Mining various kinds of association rules, from association analysis to Correlation analysis.	**06hrs**
3	**Analytical Characterization & Statistical Measures:** Analytical Characterization: Analysis of Attribute Relevance, Mining Descriptive Statistical Measures in Large Databases	**04 hrs**
4.	**Classification and Prediction** Classification, Prediction, Classification by Decision tree Induction, Bayesian classification, Associative classification, Prediction: Linear Regression, non-linear regression.	**08 hrs**
5	**Cluster Analysis** Types of data in cluster analysis, Categorization of major clustering methods, Classical Partitioning methods : k-Means and k-Medoids.	**08 hrs**
6	**Graph Mining & Social Network Analysis** Graph mining: Methods for Mining Frequent Subgraphs, Mining Variant and Constrained substructure patterns, Social Network Analysis: Social networks, Characteristics of Social Networks,Link Mining, Mining on Social networks	**08 hrs**
7	**Business Analytical Modeling** Analytical Modeling by Factor and Cluster Analysis, Analytical Modeling by Logistics Regression and Discriminant Analysis.	**05 hrs**
8	**Segmentation of Target Market** Segmentation of primary target market by Heuristic Modeling such as RFM (Recency, Frequency, Monetary) analysis, Segmentation of target market based on large databases using Decision Tree approaches such as CHAID (Chi-square Automatic Interaction Detection) and other Classification and Regression Trees.	**05hrs**

Text Book

1. Jiawei Han and MichelineKamber, Data Mining: Concepts and Techniques, Second Edition, Elsevier.
2. Purba Halady Rao, Business Analytics: An Application Focus, PHI, New Delhi, 2013.

References

1. Michael Berry and Gordon Linoff, *Data Mining Techniques,*Wiley Publishing, 2004.
2. Kimball and Ross, The Data Warehouse Toolkit, Second Edition, John Wiley & Sons, 2002.
3. T. Davenport, “Competing on Analytics,” Harvard Business Review (Decision Making), January 2006.

Course Code: 16ECSE803	Course Title: **Image and Video Processing**	
L-T-P: **3-1-0**	Credits: **4**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42 hrs**		Exam Duration: **3 hrs**

1	**Introduction:** 2D systems, Mathematical preliminaries – Fourier Transform, Z Transform, Optical & Modulation transfer function, Matrix theory, Random signals, Discrete Random fields, Spectral density function.	**05 hrs**
2	**Image Perception:** Light, Luminance, Brightness, Contrast, MTF of the visual system, Visibility function, Monochrome vision models, Fidelity criteria, Color representation, Chromaticity diagram, Color coordinate systems, Color difference measures, Color vision model, Temporal properties of vision.	**05 hrs**
3	**Image Sampling and Quantization:** Introduction, 2D sampling theory, Limitations in sampling &reconstruction, Quantization, Optimal quantizer, Compander, Visual quantization.	**05 hrs**
4	**Image Transforms:** Introduction, 2D orthogonal & unitary transforms, Properties of unitary transforms, DFT, DCT, DST, Hadamard, Haar, Slant, KLT, SVD transform.	**05 hrs**
5	**Image Enhancement:** Point operations, Histogram modeling, spatial operations, Transform operations, Multi-spectral image enhancement, false color and Pseudo-color, Color Image enhancement. **Image Filtering & Restoration:** Image observation models, Inverse & Wiener filtering, Fourier Domain filters, Smoothing splines and interpolation, Least squares filters, generalized inverse, SVD and Iterative methods, Maximum entropy restoration, Bayesian methods, Coordinate transformation & geometric correction, Blind de-convolution.	**07 hrs**
6	**Image Analysis & Computer Vision:** Spatial feature extraction, Transform features, Edge detection, Boundary Extraction, Boundary representation, Region representation, Moment representation, Structure, Shape features, Texture, Scene matching & detection, Image segmentation, Classification Techniques.	**05 hrs**
7	**Video Processing:** Fundamental Concepts in Video – Types of video signals, Analog video, Digital video, Color models in video, Video Compression Techniques – H.261, H.263, MPEG I, MPEG 2, MPEG 4, MPEG 7 and beyond, .	**05 hrs**

8	**Video Segmentation and Tracking :** Scene change detection, Spatiotemporal change detection, Motion segmentation, Motion tracking , Motion tracking in video : Rigid object tracking and articulated object tracking	**05 hrs**

Text Book

1. A. K. Jain, "Fundamentals of Digital Image Processing," Pearson Education (Asia) Pte. Ltd./Prentice Hall of India, 2004.

2. Alan C Bovik " Essential Guide to Video Processing", AP Elsevier publication, 2009

References:

1. Z. Li and M.S. Drew, "Fundamentals of Multimedia," Pearson Education (Asia) Pte. Ltd., 2004.
2. R. C. Gonzalez and R. E. Woods, "Digital Image Processing," 2nd edition, Pearson Education(Asia) Pte. Ltd/Prentice Hall of India, 2004.
3. M. Tekalp, "Digital Video Processing," Prentice Hall, USA, 1995.

Course Code: 16ECSE804	Course Title: **Wireless Networks**	
L-T-P: 3-1-0	Credits: 4	Contact Hrs: 3
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 42		Exam Duration: 3 hrs

Content	Hrs
Chapter No.1 Introduction. Fundamentals of Wireless Communication Technology. Characteristics of the Wireless Channel. Modulation Techniques. Multiple Access Techniques. Voice Coding. Error Control. Fundamentals of WLANs. IEEE 802.11 Standards. HIPERLAN Standard. Bluetooth. HomeRF.	6 hrs
Chapter No. 2: Wireless WANS AND MANS. Introduction. The Cellular Concept. Cellular Architecture. 1G,2G and 3G Cellular Systems. Wireless in Local Loop. Wireless ATM. IEEE 802.16 Standard. HIPERACCESS. Wireless Internet, Mobile IP. TCP in Wireless Domain. WAP. Optimizing Web Over Wireless. Ad Hoc Wireless Networks. Issues in Ad Hoc Wireless Networks.	8 hrs
Chapter No. 3: MAC Protocols for Ad Hoc Wireless Networks. Introduction. Issues in Designing a MAC Protocol for Ad Hoc Wireless Networks. Design Goals of a MAC Protocol for Ad Hoc Wireless Networks. Classifications of MAC Protocols. Contention-Based Protocols. Contention-Based Protocols with Reservation Mechanisms. Contention-Based MAC Protocols with Scheduling Mechanisms.	8 hrs
Chapter No. 4: Routing Protocols for Ad Hoc Wireless Networks. Introduction. Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks. Classifications of Routing Protocols. Table-Driven Routing Protocols. On-Demand Routing Protocols. Hybrid Routing Protocols. Routing Protocols with EffiISAnt Flooding Mechanisms. Hierarchical Routing Protocols. Power-Aware Routing Protocols.	8hrs
Chapter No.5: Transport Layer and Security Protocols for Ad Hoc Wireless Networks. Introduction. Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks. Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks. Classification of Transport Layer Solutions. TCP Over Ad Hoc Wireless Networks. Other Transport Layer Protocols for Ad Hoc Wireless Networks. Security in Ad Hoc Wireless Networks. Network Security Requirements. Issues and Challenges in Security Provisioning. Network Security Attacks. Key Management. Secure Routing in Ad Hoc Wireless Networks.	8 hrs
Chapter No. 6. Quality of Service in Ad Hoc Wireless Networks. Introduction. Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks. Classifications of QoS Solutions. MAC Layer Solutions. Network Layer Solutions. QoS	4 hrs

Frameworks for Ad Hoc Wireless Networks.	

Text Book:

C. Siva Ram Murthy,B.S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall. 2012.

References:

1. Clint smith, Daniel Collins, “Wireless networks”, 3rd Edition, Mc Graw Hill Publication 2014.
2. Jim Geier, "Designing and Deploying 802.11n Wireless Networks" Cisco Press.2010.

Program: Master of Technology		
Course Title: **Applied Mathematics**		Course Code: **18ECSC701**
L-T-P: **3-0-1**	Credits: **4**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Introduction to Statistics** Statistical Thinking, Collecting data, Statistical Modeling Framework, Measure of Central Tendency and Variance, Importance of Data symmetry and Display, Graphical and Tabular Display.	**04 hrs**
2	**Discrete Random Variables and Probability Distribution** Discrete Random variables, Probability distributions and Probability mass function, Cumulative distribution function, Mean and Variance of a discrete random variable, Discrete Uniform distribution, Binomial distribution, Geometric distribution, Poisson distribution, Applications.	**07 hrs**
3	**Continuous Random Variables and Probability Distributions** Continuous random variables, Probability distributions and probability density functions, cumulative distribution functions, Mean and Variance of a continuous random variable, Uniform distribution, Normal Distribution, Normal approximation to Binomial and Poisson distribution, Exponential distribution.	**07 hrs**
4	**Testing of Hypothesis** Estimation theory, Hypothesis testing, Inference on the mean of population (variance known and unknown) Inference on the variance of a normal population, Inference on a population proportion, Testing for Goodness of fit, Inference for a difference in Means(variances known), Inference for a difference in means of two normal distributions (variances unknown), Inference on the Variances of two normal populations, Inference on two population proportions.	**08 hrs**
5	**Simple Linear Regression and Correlation** Simple Linear Regression, Properties of Least square Estimators and Estimation of Variances, Transformations to a Straight line, Correlation, Multiple linear regression model, Least square Estimation of parameters, Matrix approach to multiple linear regression, Properties of least square estimators and estimation of variance.	**06 hrs**
6	**Queuing Theory 1 :** Basics of queuing models, Model I (M /M/ 1): (∞/FIFO), Single Server with Infinite Capacity, Model II (M/M/s): (∞/FIFO), Multiple Server with Infinite Capacity	**05 hrs**
7	**Queuing Theory 2:** Model III (M/M/1): (k/FIFO), Single Server with Finite Capacity, Model IV (M/M/s): (k/FIFO), Multiple Server with Finite Capacity.	**05 hrs**

Text Books:

References:

1. Douglas C Montgomery, George C Runger, Applied Statistics for Engineers, 2nd Edition,John Wiley and Sons, ISBN-0-471-170027-5.
2. Richard I Levin, David S Rubin, Statistics for Management, 6th Edition, Prentice Hall India.
3. Willian W Hines, Douglas C Montgomery, Probability and Statistics in Engineering, 2nd Edition, John Wiley and Sons.
4. V. Sundarapandian, Probability, Statistics and Queuing theory, PHI, 2009.
5. Arnold Oral Allen, Probability, statistics, and queuing theory: with computer science applications, Gulf Professional Publishing, Edition: 2 ,28-Aug-1990

Program: Master of Technology		
Course Title: **Internet Of Things**		Course Code: **18ECSC702**
L-T-P: **3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Introduction to Internet of Things (IoT):** Definition & Characteristics of IoT, Physical Design of IoT: IoT protocols, Logical Design of IoT: IoT functional blocks, communication models and APIs.	**04 hrs**
2	**IoT Enabling Technologies:** Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, IoT Levels and Deployment Templates.	**06 hrs**
3	**Domain specific IoTs:** Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and Lifestyle.	**06 hrs**
4	**IoT Platforms Design Methodology:** IoT Design Methodology, Case Study on IoT System for Weather Monitoring.	**04 hrs**
5	**IoT systems – Logical design using Python:** Introduction to Python, Data types, data structures, Control of flow, functions modules, packages, file handling, data/time operations, classes, Python packages - JSON, XML, HTTPLib, URLLib, SMTPLib.	**06 hrs**
6	**IoT Physical Devices and Endpoints:** Basic building blocks of an IoT device, Exemplary device: Rasyberry Pi, interface (serial, SPI, I2C), Programming Rasyberry Pi with Python.	**06 hrs**
7	**IoT Physical Servers & Cloud Offerings:** Introduction to Cloud Storage models and communication APIs ,Webserver – Web server for IoT, Cloud for IoT, Python web application framework, Designing a RESTful web API	**05 hrs**
8	**Case Studies Illustrating IoT Design:** Home Automation-smart lighting, home intrusion detection, Cities-smart parking.	**05 hrs**

Text Books:

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547

References:

1. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759

Program: Master of Technology		
Course Title: **Computer Networks**		Course Code: **18ECSC704**
L-T-P: **3-0-1**	Credits: **4**	Contact Hrs: **5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Fundamental Concepts of computer Networks** Basic Definitions in Data Networks, Applications, Requirements, Network Architecture, Packet Size and Optimizations, Performance.	**04 hrs**
2	**Data Link Layer** Perspectives on Connecting, Encoding (NRZ, NRZI,Manchester, 4B/5B), Framing, Error Detection, Reliable Transmission, Ethernet and Multiple Access Networks	**08 hrs**
3	**The Network Layer: Data Plane** Overview of Network Layer, Router Architecture, The Internet Protocol (IP): IPv4, Addressing, IPv6, Generalized Forwarding and SDN	**08 hrs**
4	**The Network Layer: Control Plane** Introduction, Routing Algorithms, Intra-AS Routing in the Internet: OSPF, Routing Among the ISPs: BGP, The SDN Control Plane, ICMP: The Internet Control Message Protocol, Multicast, Multiprotocol Label Switching (MPLS)	**08 hrs**
5	**Transport Layer** Introduction and Transport-Layer Services, Multiplexing and De-multiplexing, connectionless Transport: UDP, Connection-Oriented Transport: TCP , Principles of Congestion Control, TCP Congestion Control	**08 hrs**
6	**Application Layer** Principles of Network Applications, The Web and HTTP, Electronic Mail in the Internet, DNS—The Internet's Directory Service, Peer-to-Peer Applications, Video Streaming and Content Distribution Networks	**06 hrs**

Text Books:

1. J. F. Kurose and K. W. Ross, , Computer Networking, A Top-Down Approach, 7th Ed, , Pearson , 2017
2. Larry L Peterson & Bruce S Davien, Computer Networks A System Approach, 5th Ed , Morgan Kaufmann (Elsevier),, 2011

References:

1. Nader F. Mir, Computer and Communication Networks, 2nd Edition, Pearson Prentice-Hall, 2015
2. Behrouz Forouzan, Data Communications and Networking, 5th Ed, McGraw Hill, 2012.
3. A S Tanenbaum, D J Wetherall, Computer Networks, 5th Ed., Prentice-Hall, 2010.

School of Computer Science and Engineering

Program: Master of Technology		
Course Title: **Distributed and Cloud Computing**		Course Code: **18ECSC710**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Distributed System Models and Enabling Technologies** Scalable Computing over the Internet, Technologies for Network-Based Systems, System Models for Distributed and Cloud Computing	**04 hrs**
2	**Virtual Machines and Virtualization of Clusters** Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resources Management.	**06 hrs**
3	**Cloud Platform Architecture over Virtualized Data Centers** Cloud Computing and Service Models, Architectural Design of Compute and Storage Clouds, Public Cloud Platforms.	**06 hrs**
4	**Cloud Programming and Software Environments** Challenges and Opportunities in cloud application, architectural styles, workflows: co-ordination of multiple activities, MapReduce programming model.	**06 hrs**
5	**Cloud Resource Management** Policies and mechanisms for resource management, Applications of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers.	**08 hrs**
6	**Cloud Resource Scheduling** Resource bundling; combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds. Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling Map Reduce applications subject to deadlines.	**06 hrs**
7	**Cloud Security** Cloud security risks, Security; the top concern for cloud users, Privacy; privacy impact assessment, Trust, Operating system security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, Xoar - breaking the monolithic design of the TCB, A trusted virtual machine monitor.	**06 hrs**

Text Books:

1. 1. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, Distributed and Cloud Computing from Parallel Processing to the Internet of Things, 1, Elsevier, 2012
2. Dan C. Marinescu , Cloud Computing Theory and Practice, 1, Elsevier, 2013

References:

1. RajkumarBuyya, Christian Vecchiola, S.ThamaraiSelvi , Mastering Cloud Computing, 1, McGraw Hil, 2013
2. 2. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach, 1, McGraw Hil, 2010

Program: Master of Technology		
Course Title: **Machine Learning**		Course Code: **18ECSC711**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Introduction & Data Pre-Preprocessing** Introduction to data mining, Introduction to Machine Learning, Applications of Machine Learning, Major tasks in data preprocessing - data reduction, data transformation and data Discretization, data cleaning and data integration.	**08 hrs**
2	**Mining Frequent Patterns, Associations and Correlations: Concepts and Methods** Basic Concepts, Efficient and Scalable Frequent Item set Mining Methods, finding interesting Patterns, Pattern Evaluation Methods, Applications of frequent pattern and associations, Advanced Frequent Pattern Mining- Frequent Pattern and Association Mining: A Road Map, Mining Various Kinds of Association Rules. Pattern Mining in Multilevel, Multidimensional Space.	**07 hrs**
3	**Supervised Learning: Classification** Model Evaluation and Selection, Techniques to Improve Classification Accuracy: ensemble Methods; Bayesian belief networks, Introduction to perceptron learning, Back propagation algorithm.	**08 hrs**
4	**Unsupervised Learning: Cluster Analysis** Partitioning methods, Hierarchical Methods, Density based methods, Outlier Detection.	**07 hrs**
5	**Regression Analysis** ANOVA, Linear Discriminant Analysis, Support Vector Machines	**06 hrs**
6	**Reinforcement Learning** Introduction to Reinforcement Learning (RL), Sequential Decision Problems, Passive RL, Active RL, Generalization in RL, Applications of RL	**06 hrs**

Text Books:

1. Jiawei Han, MichelineKamber, and Jian Pei, Data Mining: Concepts and Techniques, 3rd, Morgan Kaufmann, 2011

2. Pang-Ning, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Education, 2007

References:

1. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining - Practical Machine Learning Tools and Techniques, 3rd, Elsevier Inc, 2011.
2. M. H. Dunham, “Data Mining: Introductory and Advanced Topics”, Pearson Education. 2008.

Program: Master of Technology		
Course Title: **Software Engineering**		Course Code: **18ECSC712**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

	Content	Hrs
1	**Introduction to Software Engineering** Introduction to Software Engineering and A Generic view of process	4 hrs
2	**Process Models** Prescriptive Models, The waterfall model, Incremental process models, Evolutionary process models, Specialized process models, The Unified process. Agile view of process.	6 hrs
3	**Requirements engineering :**Requirements Engineering tasks, Initiating Requirements Engineering Process Eliciting Requirements, Elicitation Work Products ,Developing Use-Cases , Analysis Model, Negotiating Requirements and Validating requirements.	5 hrs
4	**Design Engineering** Design within the context of SE, Design process and design quality, Design concepts, The design Model, Pattern based software design, Architectural design: Software Architecture, Data design, Architectural styles and patterns, Architectural design,	4 hrs
5	**Overview of object-oriented concepts** Unified Modeling Language (UML). Class Model, State Model and Interaction Models: Use case, sequence and activity diagrams.	6 hrs
6	**Object Oriented System Design** Reuse Plan, Breaking a system into sub-systems and organizing. Allocation of sub-systems to hardware and software. High Level Class Design: Design Optimization, Adjustment of Inheritance and Organizing a class design.	7 hrs
7	**Testing Strategies:** A strategic approach to software testing, Test strategies for conventional software, validation testing, system testing. Testing tactics: White box testing, basis path testing, control structure testing, black box testing, testing for specialized environments, architectures and applications.	5 hrs
8	**Project Management and Metrics:** Management spectrum, The people, product, process , metrics in the process and project domains, soft ware measurements, metrics for software quality. Project Estimation: Observations on estimation, the project planning process , software scope and feasibility , resources, software project estimation, Decomposition techniques, empirical estimation models	5 hrs

References:

1. Roger S Pressman, Software Engineering A practitioner Approach, Seventh Edition, McGrawHill International Edition, 2009
2. Blaha M, Rumbaugh, Object Oriented Modeling and Design with UML, Second, Pearson, 2008
3. Ian Sommerville, Software Engineering, Seventh Edition, Pearson education, 2004.
   Ali Bahrami, Object Oriented System Development using U M Languages, Mc-Grawhill, 2008

Program: Master of Technology		
Course Title: **Image and Video Processing**		Course Code: **18ECSC713**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Fundamentals of Image processing and Image Transforms:** Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels. Image Transforms: 2 D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms.	**07 hrs**
2	**Image Enhancement:** Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters. Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering.	**08 hrs**
3	**Image Analysis:** Spatial feature extraction, Transform features, Edge detection Boundary Extraction, Boundary representation, Region representation, Moment representation, Structure, Shape features, Texture, Scene matching & detection, Image segmentation and Classification Techniques.	**08 hrs**
4	**Basics of Video Processing**: Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation, Photometric Image formation, sampling of video signals, filtering operations	**07 hrs**
5	**2-D Motion Estimation:** Optical flow, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation.	**06 hrs**
6	**Video Segmentation and Tracking :** Change detection, Spatiotemporal change detection, Motion segmentation, Motion tracking in video : Rigid object tracking and articulated object tracking	**06 hrs**

Text Books:

1. R. C. Gonzalez and R. E. Woods, "Digital Image Processing," 3rd edition, Pearson Education(Asia) Pte. Ltd/Prentice Hall of India, 2009.
2. M. Tekalp, "Digital Video Processing", 2nd edition, Prentice Hall, USA, 2015.

References:

1. Anil K. Jain, "Fundamentals of Digital Image Processing," Pearson Education (Asia) Pte. Ltd./Prentice Hall of India, 2004.
2. Alan C Bovik " Essential Guide to Video Processing", AP Elsevier publication, 2009
3. Z. Li and M.S. Drew, "Fundamentals of Multimedia," Pearson Education (Asia) Pte. Ltd., 2004.

Program: Master of Technology		
Course Title: **Cryptography and Network Security**		Course Code: **18ECSC714**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Network Security Overview** Computer Security Principles, The OSI Security architecture: Security attacks, services and mechanisms, A model for Network Security, Classical Encryption techniques: Substitution ciphers- Caesar, Monoalphabetic, Playfair and Hill ciphers, Substitution ciphers, Taxonomy of Cryptography and Cryptanalysis.	**08 hrs**
2	**Data Encryption Algorithms** Traditional block cipher structure, Data Encryption Standard, DES example, strength of DES, Multiple DES, block cipher design prinicples, Advanced Encryption Standard, block-cipher modes of operation, Stream Ciphers: RC4 and A5/1.	**08 hrs**
3	**Public-Key Cryptography and Key Management** Elementary Concepts and Theorems In Number Theory, principles of public-key cryptosystems, The RSA algorithm, Diffie-Hellman Key Exchange, Elliptic curve arithmetic, Elliptic key cryptography, Key Distributions and Management, X.509 certificates, public key infrastructure	**08 hrs**
4	**Data Authentication** Cryptographic Hash Functions: applications and requirements, Hash functions based on cipher block chaining, Secure Hash algorithm, SHA3, Message authentication codes: requirements and functions, HMAC, Digital Signatures, and Digital Signature Standard.	**06 hrs**
5	**Application, Transport and Network layer Security** Web security considerations, Pretty Good Privacy and S/MIME,Secure Sockets Layer, HTTPs, Kerberos, SSH, DomainKeys Identified Mail (DKIM), IPSec overview, Encapsulating security payload, combining security associations, Internet key exchange	**06 hrs**
6	**Wireless Network Security** Wireless security threats and measures, mobile device security, IEEE 802.11 WLAN Standard, IEEE 802.11i Wireless Lan Security: Services and phases of operation, WPA and WPA2	**06 hrs**

Text Books:

1. William Stallings, Cryptography and Network Security Principles And Practices, 6th Edition, Pearson, 2014.

References:

2. Behrouz A. Forouzan, "Cryptography and Network Security**",** 6th Edition, Tata McGraw-Hill, 2014.
3. Mark Stamp, "Information Security: Principles and Practices", 2nd Edition, John Wiley and Sons, 2011.

Lab Plan

Expt./Job No.	***Brief description about the experiment/job***	***No. of Lab. Slots***
1.	Demo and practice on Crypto Library	1
2.	Implementation of symmetric key algorithm algorithms	1
3.	Implementation of asymmetric key algorithm algorithms, Hash algorithms	2
4.	Web Security using SSL certificates	1

5.	Secure access to resources to Kerberos	2
6.	Web server security using CAPTCHA	1
7.	Implemenetation of access Control	1
8.	Configuring Firewall, IDS	1

KLE TECH.	School of Computer Science and Engineering

Program: Master of Technology		
Course Title: **Embedded Systems**		Course Code: **18ECSE715**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**The 8051 Architecture** Introduction, 8051 Microcontroller hardware, input/output pins, ports & circuits, External memory.	**06 hrs**
2	**Addressing modes and operations of 8051** Introduction, addressing modes, external data Moves. Code Memory Read Only Data Moves / Indexed Addressing mode, PUSH and POP opcodes, Data exchanges, example programs. Byte level logical Operations, Bit level Logical Operations, Rotate and Swap Operations, Example Programs. Arithmetic Operations: Flags, Incrementing and Decrementing, Addition, Subtraction, Multiplication and Division, Decimal Arithmetic, Example Programs.	**06 hrs**
3	**Jump and Call Instructions** The JUMP and CALL Program range, jump calls and Subroutines, Example programs	**04 hrs**
4	**8051 Programming in C** Data Types and Time delays in 8051C, I/O Programming, Logic operations, Data Conversion programs, Data serialization.	**04 hrs**
5	**8051 Timer/Counter Programming in Assembly and C** Programming 8051 Timers, Counter Programming, Programming Timer 0 and Timer1 in 8051.	**04 hrs**
6	**8051 Serial Port Programming in Assembly and C** Basics of Serial Communication, 8051 connection to RS232, 8051 serial port Programming in Assembly, 8051 serial port Programming in C.	**04 hrs**
7	**8051 Interrupts Programming in Assembly and C** 8051 Interrupts, Programming Timer Interrupts, Programming external hardware interrupts, Programming the Serial Communication Interrupts, Interrupt Priority in the 8051, Interrupt programming in assembly and C.	**04 hrs**
8	**8051 Interfacing techniques using ATMEGA32 microcontroller** Interfacing 8051 to LEDs, DIP switches, BCD Decoder display, 7 Segment Display, Timers hyperterminal (Serial Communication)	**05 hrs**
9	**8051 Interfacing to peripheral devices using ARM microcontroller** Interfacing 8051 to LCD, Keypad, DAC, parallel and serial ADC, Stepper Motor and DC Motor	**05hrs**

Text Books:

3. Ayala.K.J, “The 8051 Microcontroller Architecture, Programming & Applications”, 2ed., Penram International, 2006
4. Mazidi.M.A, Mazidi.J.G and McKinlay.R.D, “The 8051 Microcontroller and Embedded Systems- using Assembly and C”, 2ed, PHI 2006/Pearson, 2006

References:

3. Hall.D.V, “Microprocessors and Interfacing”, Revised 2ed., TMH,2006

Program: Master of Technology		
Course Title: **Computer Graphics and Vision**		Course Code: **18ECSE716**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Basic Raster Graphics Algorithms for Drawing 2d Primitives.** Overview, Scan Converting Lines, Scan Converting Circles, Filling Rectangles. Filling Polygons, Filling Ellipse Arcs, Pattern Filling, Thick Primitives, Line Style and Pen Style.	**08 hrs**
2	**Clipping in a Raster World.** Clipping Lines, Clipping Circles and Ellipses, Clipping Polygons. Antialiasing	**04 hrs**
3	**Texture Mapping: The Basics** Loading Textures, Using the Color Buffer , Updating Textures, Mapping Textures to Geometry ,Texture Matrix , A Simple 2D Example ,Texture Environment ,Texture Parameters, Basic Filtering, Texture Wrap, Mipmapping, Texture Objects: Managing Multiple Textures	**05 hrs**
4	**Geometric Objects and Transformations** Frames in OpenGL. Modeling a Colored Cube, Affine Transformations, Translation, Rotation, and Scaling, Transformations in Homogeneous Coordinates, Concatenation of Transformations, OpenGL Transformation Matrices	**06 hrs**
5	**Viewing** Classical and Computer Viewing, Viewing with a Computer, Positioning of the Camera Simple Projections, Projections in OpenGL, Interactive Mesh Displays, Parallel- Projection Matrices, Perspective-Projection Matrices, Projections and Shadows	**05 hrs**
6	**Representing Curves** Polygon Meshes,Parametric Cubic Curves: Hermit curves,Bezier curves, B-Splines	**04 hrs**
7	**Introduction to Computer Vision** Fundamentals of image formation, camera imaging geometry, feature detection and matching, multiview geometry including stereo, motion estimation and tracking, and classification.	**05 hrs**
8	**Basic methods for applications** Finding known models in images, depth recovery from stereo, camera calibration, image stabilization, automated alignment (e.g. panoramas), tracking and recognition	**05 hrs**

Text Books:

4. Computer Graphics: Principles and Practice, James D. *Foley* , Andries *van Dam* ,Steven K. Feiner, John F. Hughes ,2nd Edition, Pearson Education, 2008
5. Interactive Computer Graphics - A Top-Down Approach Using OpenGL (5/e), Edward Angel , 5th Edition Pearson Education, 2009.
6. Computer Vision: Algorithms and Applications, Richard Szeliski, springer 2010

References:

1. Computer Graphics using OpenGL , F. S. Hill Jr. and S. M. Kelley , 3rd Edition ,Pearson Education, 2009
2. Computer Graphics with OpenGL ,D. D. Hearn and M. P. Baker, 3rd Edition
3. Dictionary of Computer Vision and Image Processing, Fisher,2nd edition,Weily,2014

Program: Master of Technology		
Course Title: **Parallel Computing**		Course Code: **18ECSE802**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Introduction and History** GPUs as Parallel Computers; Architecture of a Modem GPU; Parallel Programming Languages and Models; Overarching Goals; Evolution of Graphics Pipelines; The Era of Fixed- Function; Graphics Pipelines; Evolution of Programmable Real-Time Graphics; Unified Graphics and Computing Processors; GPGPU; An Intermediate Step; GPU Computing; Scalable GPUs Recent Developments; Future Trends	**05 hrs**
2	**Introduction to CUDA** Data Parallelism; CUDA Program Structure; A Matrix-Matrix Multiplication Example; Device Memories and Data Transfer; Kernel Functions and Threading; Function declarations; Kernel launch; Predefined variables; Runtime API.CUDA Thread Organization; Using b1ock Id x and thread Id x ; Synchronization and Transparent Scalability; Thread Assignment ; Thread Scheduling and Latency Tolerance	**07 hrs**
3	**CUDA Memories, Performance Considerations and Floating Point Considerations** Importance of Memory Access Efficiency; CUDA Device Memory Types; A Strategy for Reducing Global Memory Traffic; Memory as a Limiting Factor to Parallelism; Global Memory Bandwidth; Dynamic Partitioning of SM Resources; Data Prefetching; Instruction Mix; Thread Granularity; Measured Performance; More on thread execution, Global memory bandwidth, dynamic partitioning of SM resources, Floating point format, Arithmetic Accuracy and rounding	**07 hrs**
4	**Floating Point Considerations** Floating-Point Format, Normalized Representation of M, Excess Encoding of E, Representable Numbers, Special Bit Patterns and Precision, Arithmetic Accuracy and Rounding, Algorithm Considerations	**06 hrs**
5	**Introduction to OPENCL** Introduction to OPENCL; Background; Data Parallelism, Model; Device, Architecture, Kernel Functions, Device Management and Kernel Launch; Electrostatic Potential Map in OpenCL;	**06 hrs**
6	**Parallel Programming and Computational Thinking** Goals of Parallel Programming, Problem Decomposition, Algorithm Selection, Computational Thinking	**02 hrs**
7	**Introduction to Embedded GPU Computing** Architecture, Programming Model, Programs, Configuration etc.	**04 hrs**
8	**Case Study /Projects** Concepts of Game Design, Applications like Matrix multiplication, MRI reconstruction Molecular Visualization and Gaming	**05 hrs**

Text Books:

1. Programming Massively Parallel Processors: A Hands on Approach; David B. Kirk, Wen- mei W. Hwu; Morgan Kaufmann /Elsevier India reprint 2010

References:

1. *Heterogeneous Computing with OpenCL, by Benedict R. Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry & Dana Schaa*; Morgan Kaufmann 2011

Program: Master of Technology		
Course Title: **Social Network Analysis**		Course Code: **18ECSE803**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Introduction:**Aspects of Networks, Network Datasets: An Overview. Strong and Weak Ties :Triadic Closure , The Strength of Weak Ties , Tie Strength and Network Structure in Large-Scale Data, Tie Strength, Social Media, and Passive Engagement , Closure, Structural Holes, and Social Capital	**06 hrs**
2	**Networks in Surrounding Contexts :**Homophily ,Mechanisms Underlying Homophily: Selection and Social Influence , Tracking Link Formation in On-Line Data, Spatial Model of Segregation	**06 hrs**
3	**Positive and Negative Relationships :**Structural Balance Characterizing the Structure of Balanced Networks , Applications of Structural Balance . . . A Weaker Form of Structural Balance ,Advanced Material: Generalizing the Definition of Structural Balance	**06 hrs**
4	**Link Analysis and Web Search :**Searching the Web: The Problem of Ranking , Link Analysis using Hubs and Authorities , PageRank , Applying Link Analysis in Modern Web Search , Applications beyond the Web , Spectral Analysis, Random Walks, and Web Search .	**06 hrs**
5	**Cascading Behavior in Networks :**Diffusion in Networks , Modeling Diffusion through a Network , Cascades and Clusters , Diffusion, Thresholds, and the Role of Weak Ties , Extensions of the Basic Cascade Model , Knowledge, Thresholds, and Collective Action, The Cascade Capacity .	**06 hrs**
6	**Power Laws and Rich-Get-Richer Phenomena :**Popularity as a Network Phenomenon , Power Laws , Rich-Get-Richer Models , The Unpredictability of Rich-Get-Richer Effects , The Long Tail , The Effect of Search Tools and Recommendation Systems , Advanced Material: Analysis of Rich-Get-Richer Processes .	**06 hrs**
7	**The Small-World Phenomenon :**Six Degrees of Separation , Structure and Randomness , Decentralized Search , Modeling the Process of Decentralized Search , Empirical Analysis and Generalized Models , Core-Periphery Structures and Difficulties in Decentralized Search , Analysis of Decentralized Search	**06 hrs**

Text Books:

1. Networks, Crowds and Markets by David Easley and Jon Kleinberg, Cambridge University Press, 2010
2. Social and Economic Networks by Matthew O. Jackson, Princeton University Press, 2010.

References:

1. Peter R. Monge, Noshir S. Contractor, Theories of communication networks. Oxford University Press, 2003.
2. Duncan Watts. Six degrees: the science of a connected age. Norton, 2004.
3. Stanley Wasserman, Katherine Faust. Social network analysis: methods and applications. Cambridge University Press, 1994.

Program: Master of Technology		
Course Title: **Wireless and Mobile Networks**		Course Code: **18ECSE804**
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **42**	Exam Duration: **3 hrs**	

1	**Introduction:** Characteristics of Cellular Systems, Fundamentals of Cellular Systems, Cellular System Infrastructure, Satellite Systems, Network Protocols, Ad Hoc Networks, Sensor Networks, Wireless LANs, MANs and PANs	**04 hrs**
2	**Mobile Radio Propagation :** Introduction, Types of Radio Waves, Propagation, Mechanisms, Free Space Propagation, Land Propagation, Path Loss , Slow Fading, Fast Fading , Statistical Characteristics of Envelope, Characteristics of Instantaneous Amplitude, Doppler Effect, Delay Spread, Intersymbol Interference, Coherence and width Cochannel Interference	**06 hrs**
3	**Cellular Concept :** Introduction, Cell Area. Signal Strength and Cell Parameters, Capacity of a Cell, Frequency Reuse, How to Form a Cluster, Cochannel interference, Cell Splitting , Cell Sectoring	**07 hrs**
4	**Traffic Channel Allocation :** Introduction , Static Allocation versus Dynamic Allocation , Fixed Channel Allocation (FCA) , Simple Borrowing Schemes, Complex Borrowing Schemes, Dynamic Channel Allocation (DCA) , Centralized Dynamic Channel Allocation Schemes , Distributed Dynamic Channel Allocation Schemes , Hybrid Channel Allocation (HCA), Hybrid Channel Allocation (HCA) Schemes, Flexible Traffic Channel Allocation Schemes, Allocation in Specialized System Structure, Channel Allocation in One-Dimensional Systems , Reuse Partitioning–Based Channel Allocation, Overlapped Cells–Based Channel Allocation	**04 hrs**
5	**Mobile Communication Systems:** Introduction, Cellular System Infrastructure, Registration, Handoff Parameters and Underlying Support, Parameters Influencing Handoff , Handoff Underlying Support, Roaming Support, Home Agents, Foreign Agents, and Mobile IP, Rerouting in Backbone Routers, Multicasting.	**06 hrs**
6	**Mobile network and transport layer:**Mobile IP Packet delivery-Tunneling-Reverse tunneling, IPV6-Dynamic host routing protocol, Traditional TCP-Congestion control-classical TCP-Snooping Mobile TCP, Transaction oriented TCP-TCP over 2.5/3G Wireless Networks,	**07 hrs**
7	**Emerging wireless technologies:** Femtocell Network : Introduction, Technical Features, Challenges Push-to-Talk (PTT) Technology for SMS : PTT Network Technology , PTT in iDEN Cellular Networks, PTT in Non-iDEN Cellular Networks: PoC Multicast in Wireless Networks : Recent Advances in Multicast over Mobile IP , Reliable Wireless Multicast Protocols, Broadcasting, Multicasting, and Geocasting in Ad HocNetworks	**04 hrs**

Text Books:

1. Dharma PrakashAgrawal , Qing –An Zeng , “ Introduction to wireless and mobile systems”, Cengage Learning, 2014.
2. Roy Blake, “Wireless communication technology”,Cengage Learning, sixth Indian reprint 2013.
3. Singal T.L., “Wireless communication”, Tata McGraw Hill Education private limited , 2011.

References:

1. Wireless telecommunications systems and networks by Gray J.Mullet, CengageLearning,Reprint 2014.
2. UpenaDalal, “Wireless communication” Oxford University press, first edition 2009.
3. MartynMallick, “Mobile and Wireless Design Essentials”, Wiley Dreamtech India Pvt. Ltd., 2004.
4. Jochen Schiller, “Mobile Communications”, Addision Wesley, 2nd Edition, 2011.

Change summary between 2015-16 and 2016-17 admitted batches (i.e. 2015 to 19 batch 2016 to 20 batch)

Program: III Semester Bachelor of Engineering (Electronics & Communication Engineering)			**Teaching Hours**
Course Title: Digital Circuits		**Course Code: 17EECC203**	
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3Hrs/week**	
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**	
Teaching Hours: 42 Hrs	**Examination Duration: 3 Hrs**		
Unit-I **Chapter No. 1. Logic Families** Logic levels, output switching times, fan-in and fan-out, comparison of logic families			**03**
Chapter No. 2. Principles of Combinational Logic Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4 variables, Incompletely specified functions(Don't care terms),Simplifying Maxterm equations, Quine-McCluskey minimization technique- Quine-McCluskey using don't care terms, Reduced Prime Implicant Tables.			**07**
Chapter No. 3. Analysis and design of combinational logic General approach, Decoders-BCD decoders, Encoders, Digital multiplexers- Using multiplexers as Boolean function generators. Adders and subtractors-Cascading full adders, Look ahead carry adders, Binary comparators.			**08**
Unit-II **Chapter No. 4.Introduction to Sequential Circuits** Basic Bistable Element, Latches, A SR Latch, Application of SR Latch, A Switch De bouncer, The SR Latch, The gated SR Latch, The gated D Latch, The Master-Slave Flip-Flops (Pulse-Triggered Flip-Flops): The Master-Slave SR Flip-Flops, The Master-Slave JK Flip-Flop, Edge Triggered Flip- Flop: The Positive Edge-Triggered D Flip-Flop, Negative-Edge Triggered D Flip-Flop; Characteristic Equations			**08**
Chapter No. 5. Analysis of Sequential Circuits Registers and Counters, Binary Ripple Counters, Synchronous Binary counters, Ring and Johnson Counters, Design of a Synchronous counters, Design of a Synchronous Mod-n Counter using clocked JK Flip-Flops Design of a Synchronous Mod-n Counter using clocked D, T or SR Flip-Flops.			**08**
Unit-III **Chapter No. 6. Sequential Circuit Design** Introduction to Sequential Circuit Design, Mealy and Moore Models, State Machine notations, Synchronous Sequential Circuit Analysis, Construction of state Diagrams and counter design.			**04**

Chapter No. 7. Introduction to memories Introduction and role of memory in a computer system, memory types and terminology, Read Only memory, MROM, PROM, EPROM, EEPROM, Random access memory, SRAM, DRAM, NVRAM.	04

Text Books

1. Donald D Givone, Digital Principles and Design, Tata McGraw Hill Edition,2002
2. John M Yarbrough, Digital Logic Applications and Design, Thomson Learning,2001
3. A Anand Kumar , Fundamentals of digital circuits, PHI,2003

References

1. Charles H Roth, Fundamentals of Logic Design, Thomson Learning, 2004 2.Zvi Kohavi, Switching and Finite Automata Theory, 2nd, TMH
2. .R.D. Sudhaker Samuel, Logic Design, Sanguine Technical Publishers, 2005
3. .R P Jain, Modern Digital Electronics, 2nd, Tata McGraw Hill , 2000

Program: III Semester Bachelor of Engineering (Electronics & Communication Engineering)			**Teaching Hours**
Course Title: Engineering Design		**Course Code: 17EECF201**	
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours: 03 Hrs/week**	
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**	
Teaching Hours:	**Examination Duration: 2 Hrs**		
PART A			
Planning Introduction to Engineering Design, Problem Definition, Design attributes Gantt Chart, Design Objectives, Design Specifications			**02**
Conceptual Design Functional Analysis, Concept generation, Concept Evaluation			**03**
System Level Design Product Architecture, Configuration Design, Parametric Design			**03**
Detail Design Sub-system Design, Design Verification			**03**
PART B			
OrCAD Functional simulation of basic Analog and Digital application circuits using OrCAD eCAD tool			**01**
Schematic Capture of the reference design using using OrCAD eCAD tool.			**01**
Layout Design of the reference design using using OrCAD eCAD tool.			**01**
Creation of Symbols/Cell/Part			**01**
LabVIEW Introduction to LabVIEW and functional simulation of basic Analog and Digital application circuits in LabVIEW			**01**
Functional Simulation of the circuit for selected problem statement			**01**
Co-simulation of the circuit for selected problem statement.			**01**

Program: IV Semester Bachelor of Engineering (Electronics & Communication Engineering)			**Teachig Hours**
Course Title: Linear Integrated circuits		**Course Code:17EECC205**	
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3Hrs/week**	
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**	
Teaching Hours: 40Hrs	**Examination Duration: 3 Hrs**		**Hrs**
Unit I			
Chapter No 1. OPAMP characteristics Ideal and non-ideal OPAMP terminal characteristics, Input and output impedance, output Offset voltage, Small signal and Large signal bandwidth.			**04**
Chapter No 2. OPAMP with Feedback OPAMP under Positive and Negative feedback, Impact Negative feedback on Bandwidth, Input and Output impedances, Offset voltage under negative feedback, Follower property & Inversion Property under linear mode operation.			**04**
Chapter No 3. Basic OPAMP architecture Basic differential amplifier, Common mode and difference mode gain, CMRR, 5-pack differential amplifier with design, 7-pack operational amplifier, Slew rate limitation, Instability and Compensation, Bandwidth and frequency responsecurve.			**08**
Unit II			
Chapter No 4. Current Mirrors Current Mirror circuits and Modeling, Figures of merit (output impedance, voltage swing), Widlar, Cascode and Wilson current Mirrors, Current source and current sink.			**08**
Chapter No 5. Linear applications of OPAMP DC and AC Amplifier, Summing, Scaling and Averaging amplifiers (Inverting, Non-inverting and Differential configuration), Integrator, Differentiator,Voltage sources, current sources and current sinks, Active Filters –First and second order Low pass & High pass filters. V to I and I to V converters.			**08**
Unit III			
Chapter No 6 . Nonlinear applications of OPAMP Zero Crossing detectors (ZCD. Comparator), Inverting Schmitt trigger circuits, Triangular/rectangular wave generators, Waveform generator, Precision rectifier, Limiting circuits, Clamping circuits, Peak detectors, sample and hold circuits, Phase shift oscillator, Wein bridge oscillator, DAC and ADC			**08**

Text Book

1. Behzad Razavi, Fundamentals of microelectronics , 2nd edition.
2. Phillip E. Allen, Douglas R. Holberg, CMOS Analog CircuitDesign.
3. Ramakant A. Gayakwad, Op - Amps and Linear IntegratedCircuits.

References

1. A.S. Sedra& K.C. Smith, MicroelectronicCircuits,
2. Sergio Franco, Design with Operational Amplifiers and Analog IntegratedCircuits.
3. David A. Bell, Operational Amplifiers and LinearIC's.
4. B. Razavi, Design of Analog CMOS Integrated Circuits McGraw-Hill,2001

Semester: IV

Course Title: **Product Realization**	Course Code: 17EECF203
Total Contact Credits: **2** **(0-0-2)**	Duration of SEE Credits: -
ISA Marks: 80	ESA Marks: 20

Week #	**Particulars**	**Template #**	**Venue**
Week 1 **and** **Week 2**	➢ Introduction to Prototyping ➢ Defining- Specifications, Part Drawings, Assembly Drawings, PCB Layout, Wireframe , Pseudocode, BOM, Process Plan, Fabrication and Test Plan Validation ➢ IOT Workshop		Studio Engagement
Week 3	➢ Identifying sub-assemblies (minimum of 3) ➢ Selection of materials for all the parts and joining techniques		Makers Space/
Week 4	➢ Process plan ➢ Identifying the proper machines and tools required for prototyping. ➢ Preparing of raw materials for prototyping. ➢ Plan and procure the bought out parts.		
Week 5	➢ Fabricate the parts for sub assembly 1		
Week 6	➢ Fabricate the parts for sub assembly 2		
Week 7	➢ Fabricate the parts for sub assembly 3		
Week 8	➢ Assemble the sub assemblies and check for interference and functionality		
Week 9	➢ Test the functional prototype using proper identified test methods.		

Week 10	➢ Analyse the test results ➢ System modification		
Week 11	➢ Final concluding review ➢ Product catalogue		Studio/ Makers Space

References

1. Pahl, G., Beitz, W., Feldhusen, J. and Grote ; "Engineering Design-A Systematic Approach" by, K.-H- Springer; 3rd ed. 2007

KLE TECH. Earlier known as B. V. B. College of Engineering & Technology	School of Electronics & Communication Engineering

Course Title: **Embedded Intelligent Systems**		Course Code: 17EECE310
L-T-P: 0-0-3	Credits: 3	Contact Hrs: **6hrs/week**
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 60	Exam Duration: 3 hrs	

	Unit - I	
1	**Basics of embedded systems** Linux Application Programming, System V IPC, . Linux Kernel Internals and Architecture , Kernel Core , Linux Device Driver Programming, Interrupts & Timers , Sample shell script, application program, driver source build and execute	**10 hrs**
2	**Heterogeneous computing** Basics of heterogeneous computing with various hardware architectures designed for specific type of tasks, Advanced heterogeneous computing with a. Introduction to Parallel programming b.GPU programming (OpenCL). Open standards for heterogeneous computing (Openvx) , Basic OpenCL examples - Coding, compilation and execution	**12 hrs**
	Unit - II	
3	**ML Frameworks with the target device** Caffe, tensorflow, TF Lite machine learning frameworks & architecture ,Model parsing, feature support and flexibility ,Supported layers , advantages and disadvantages with each of these frameworks, Android NN architecture overview , Full stack compilation and execution on embedded device	**16 hrs**
4	**Model Development and Optimization** Significance of on device AI ,Quantization , pruning, weight sharing, Distillation ,Various pre-trained networks and design considerations to choose a particular pre-trained model ,Federated Learning , Flexible Inferencing	**8 hrs**
	Unit - III	
5	**Android Anatomy** Android Architecture ,Linux Kernel , Binder , HAL Native Libraries , Android Runtime, Dalvik Application framework , Applications, IPC	**8 hrs**

Text Books

1. Linux System Programming , by Robert Love , Copyright © 2007 O'Reilly Media
2. Heterogeneous Computing with OpenCL, 2nd Edition by Dana Schaa, Perhaad Mistry, David R. Kaeli, Lee Howes, Benedict Gaster , Publisher: Morgan Kaufmann

Reference Books:

1. Deep Learning , MIT Press book ,Goodfellow, Bengio, and Courville's
2. Beginning Android , by Wei-Meng Lee , Publisher: Wrox , O'Reilly Media

Scheme for End Semester Assessment (ESA)

UNIT	Experiments to be set of 10 Marks Each	Chapter Numbers	Instructions
I	Project Examination	1,2,3,4,5	Project implementation and demonstration 20 marks

Course Code: 19EECE416	Course Title: Biosensor	
L-T-P: 0-0-3	Credits: 3	Contact Hrs: 72
ISA Marks: 00	ESA Marks: 100	Total Marks: 100
Teaching Hrs: 72		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1. Basic Introduction to sensors Introduction to sensors: fundamental characteristics such as Sensitivity, linearity, repeatability, hysteresis, drift. Sensing Principles: optical sensors, electrochemical sensors, micromechanical sensors, surface Plasmon sensors, colorimetric Sensors, acoustic sensors	5 hrs
Chapter No. 2. Active Electrical Transducers Thermoelectric transducers, thermoelectric phenomenon, common thermocouple systems, piezoelectric transducers, piezoelectric phenomenon piezoelectric materials, piezoelectric force transducers, piezoelectric strain, piezoelectric torque transducers, piezoelectric pressure transducers, piezoelectric acceleration transducers. Magnetostrictive transducers Magnetostrictive force transducers, Magnetostrictive acceleration transducers, Magnetostrictive torsion transducers, Hall Effect transducers, and application of Hall transducer. Electromechanical transducers-Tachometers, variable reluctance tachometers Electrodynamic vibration transducers, Electromagnetic pressure electromagnetic flowmeter. Photoelectric transducers- photoelectric phenomenon, photoelectric transducers, Photo volatile transducers, Photo emissive transducers. Electrochemical transducers- basics of electrode potentials, reference electrodes, indicator electrodes, measurement of PH, measurement of bioelectric signals.	10 hrs
Unit - 2	
Chapter No. 3. Passive electrical transducer Introduction, Resistive transducers- resistance thermometers, hot wire resistance transducers, Resistive displacement transducer, Resistive strain transducer, resistive pressure transducer, resistive optical radiation transducers. Inductive transducers-Inductive thickness transducers, Inductive displacement transducers, Movable core-type Inductive transducers, eddy current type Inductive transducers. Capacitive transducers-Capacitive thickness transducers, capacitive displacement transducers, capacitive moisture transducers Substrate and Wafers, Active Substrate Materials, Silicon as Substrate Material, Silicon Compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric Crystals, Polymers, Packaging Materials.	5 hrs
Chapter No. 4. Microfabrication Technology Design of process flow for device fabrication for application in biology and medicine: Introduction to the Clean room and contaminants, Wafer cleaning processes (DI water, RCA, metallic impurities, etc.), Substrate materials: Silicon,	10 hrs

polymer and PCB, Thermal oxidation: Wet and dry oxidation, thin film deposition techniques: PVD- DC and RF Magnetron Sputtering, thermal evaporation, e-beam evaporation, LPCVD, PLD. Types of masks: Hard and soft Lithography, Lithography – UV Photolithography, Soft lithography, additive manufacturing. Mask design and fabrication – Photo resists and mechanical mask such as stencils. Types of etching- Wet etching- anisotropic and Isotropic and dry etching RIE and DRIE. Device fabrication and inspection in the clean room.	
Unit - 3	
Chapter No. 5. Biosensors Introduction: Biosensors and its applications in health care, agriculture, drug discovery and environmental monitoring. Devices for biology and medicine: Microfluidic channels, flow cytometry/ sorting, microchip using electrophoresis, force measurement with cantilevers, micro engineered devices for medical therapeutics, blood pressure sensors, devices for drug delivery, and devices for minimally invasive surgery.	5 hrs
Chapter No. 6. Biological components for detection Enzymes, antigen-antibody reaction, biochemical detection of analysts, organelles, whole cell, receptors, DNA probe, pesticide detection, sensors for pollutant gases. Surface chemistry: Immobilization of biorecognition element, Antigen-Antibody functionalization, and assay labels including radioisotopes, fluorophores, dyes.	5 hrs

Text Books (List of books as mentioned in the approved syllabus):

1. Fundamentals of Microfabrication and Nanotechnology by Marc J. Madou, 3rd edition. Taylor and Francis group.
2. Transducers and Instrumentation – D.V.S. Murthy, 2nd Edn, PHI Ltd, 2010.
3. A.P.F. Turner, I. Karube & G.S. Wilson: Biosensors: Fundamentals & Applications, Oxford University Press, Oxford, 1987.

References:

1. Ernest O. Doeblin : Measurement Systems, Application and Design, McGraw-Hill, 1985.
2. Richard S.C. Cobbold : Transducers for Biomedical Measurements: Principles and Applications, John Wiley & Sons, 1974
3. John G. Webster (ed.) : Medical Instrumentation - Application and Design; Houghton Mifflin Co., Boston, 1992.
4. Stephen D. Senturia : "Micro system Design", Kluwer Academic Publishers, 2001

Course Code: 19EECE402	Course Title: Information Theory and Coding	
L-T-P-SS: 2-0-1	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. Chapter 1:Information Theory: Information Theory: Introduction, Measure of information, Average information content of symbols in long independent sequences, Average information content of symbols in long dependent sequences. Mark-off statistical model for information source, Entropy and information rate of mark-off source	7 hrs
Chapter No. Chapter 2: Source Coding: Encoding of the source output, Shannon's encoding algorithm. Communication Channels, Discrete communication channels, Continuous channels. Source coding theorem,, Huffman coding	8 hrs
Unit - 2	
Chapter No. Chapter 3: Channel coding Discrete memory less Channels, Mutual information, Channel Capacity Channel coding theorem, Differential entropy and mutual information for continuous ensembles, Channel capacity Theorem.	4 hrs
Chapter No. Chapter 4: Introduction to Error Control Coding: Introduction, Types of errors, examples, Types of codes Linear Block Codes: Matrix description, Error detection and correction, Standard arrays and table look up for decoding.	7 hrs
Chapter No. Chapter 5: Binary Cycle Codes Algebraic structures of cyclic codes, Encoding using an (n-k) bit shift register, Syndrome calculation.	4 hrs
Unit - 3	
Chapter No. Chapter 6: BCH codes RS codes Golay codes, Shortened cyclic codes, Burst error correcting codes. Burst and Random Error correcting codes. Convolution Codes, Time domain approach. Transform domain approach. Systematic Convolution codes	10 hrs

Text Book (List of books as mentioned in the approved syllabus)

1. K. Sam Shanmugam, Digital and analog communication systems, John Wiley, 1996

2. Simon Haykin, Digital communication, John Wiley, 2003

References

1. Ranjan Bose, ITC and Cryptography, TMH(reprint 2007), 2002

2. Glover and Grant, Digital Communications , 2, Pearson, 2008
3. D Ganesh Rao, K N Haribhat, Digital Communications, Sanguine, 2009

Course Title: **CMOS ASIC Design**	Course code: 18EECE420	
L-T- P: 0-0-3	Credits: 03	Contact Hrs: 06hrs/week
CIE Marks: 100	SEE Marks: 00	Total Marks: 100
Teaching Hrs: 16hrs Lab Hrs: 24 hrs		

Chapter No. 1. Introduction: Design of combinational and sequential logic gates in CMOS. Layout and characterization of standard cells. Verilog for representing gate level netlists.	8 hrs
Chapter No. 2. Timing Analysis: Sequential circuit timing and static timing analysis. Cell and net delays and cross-talk. Rationale and implementation of scan chains for testing standard-cell based logic circuits. Timing Verification: Setup Timing Check, Hold Timing Check, Timing across Clock Domains	10hrs
Chapter No. 3: Physical design Physical design of standard-cell based CMOS ASICs: scan insertion, placement, and clock tree synthesis and routing. Netlist transformations at each step of the physical design process. Net parasitic and parasitic extraction. Use of PLLs for clock generation and de-skew.	12 hrs
Chapter No. 4. Standard Data formats: Standard data formats for representing technology and design: LEF, Liberty, SDC, DEF and SPEF. Clock gating and power gating for reduction of device power consumption. Design for reliability: electro- migration, wire self heat and ESD checks and fixes.	6 hrs
Chapter No. 5. Packaging An overview of package design and implementation and system level timing.	4 hrs

Reference Books:

1. The Design & Analysis of VLSI Circuits, L. A. Glassey & D. W. Dobbepahl, Addison Wesley Pub Co. 1985.
2. H. Bhatnagar, Advanced ASIC Chip Synthesis Using Synopsys Design Compiler Physical Compiler and PrimeTime, 2nd edition, 2001.
3. Static Timing Analysis for Nanometer Designs A Practical Approach, J. Bhasker • Rakesh Chadha, Springer Science+Business Media, LLC 2009

Tools: Cadence Innovous, Encounter

Course Title: **Physical Design-Analog**	Course code: 18EECE419	
L-T- P: 0-0-3	Credits: 03	Contact Hrs: 06hrs/week
CIE Marks: 100	SEE Marks: 00	Total Marks: 100
Teaching Hrs: 16hrs Lab Hrs: 24 hrs		

Chapter No 1. Standard cell Layout creation Layout Practice Sessions (DRC/LVS Dirty layout), Understanding verification errors, Error debugging skills, Hands on experience of using layout editor, Quality of the layout, Half DRC rules, Mega module creation.	8 hrs
Chapter No 2. Analog layout Importance of performance in Analog layout, Importance of floor planning and placement, Attributes need to be taken care during routing stage, Introduction to DRC, LVS, Density and RCX.	8 hrs
Chapter No 3. Matching and Guard rings, Matching: Introduction to mismatch concepts, Causes for mismatch, Types of mismatch, Rules for matching, Activities. Guard ring : What is guard ring, Usage of guard ring	6 hrs
Chapter No 4. Reliability issues Introduction to failure mechanism, Causes of reliability issues, Process enhancement techniques and Layout considerations to reduce reliability issues	8 hrs
Chapter No 5. Physical design of amplifier and buffer Applying the studied concepts and doing layout, Prioritising the constraints given, Quality checks, Buddy reviews and implementations, Documentation	10 hrs

Reference:

The Art of Analog Layout – Alan Hastings

CMOS IC layout – Dan Clien

IC Layout Basics – Chris saint and Judy saint

Course Code: **19EECE322** / **19EECE422**	Course Title: **Introduction to Deep Learning**		
L-T-P: **2-0-1**	Credits: **3**	Contact Hrs: **4**	
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**	
Teaching Hrs: **42**		Exam Duration: **3 hrs**	
Content			**Hrs**
Unit - 1			
Chapter 1: Introduction to Deep Learning: What is Deep Learning?, Applications of deep learning, Differences between machine learningand deep learning, Basics of Neural Networks, Supervised Learning with Neural Networks, Logistic regression as a neural network, Computation graph, shallow neural networks, Deep neural networks. Introduction to metric tensors and tensorflow, Basic programs in tensorflow.			8 hrs
Chapter 2: Hyper-Parameter Tuning, Regularization and Optimization: Basics of Hyper-parameters, Regularization, Need for regularization, dropout regularization, gradient checking, mini-batch gradient descent, exponentially weighted averages and its biascorrection, Gradient descent with decay, Adam's optimization algorithm, The problem of localminima, weight initialization in neural networks, Normalizing activations in a network, Fitting Batch norm into a network, Softmax regression, Softmax classifier.			8 hrs
Unit - 2			
Chapter 3: Convolutional Neural Networks Introduction to Computer Vision and Image Processing, 2D Convolutions, Strided convolution,convolution over volume, One layer of a convolution network, ReLu and pooling, Example of aConvNet, Classic CNN Networks, ResNet architecture, Inception Networks, Transfer learning,Data Augmentation, Residual networks, Object Localization, Landmark and object detection, Convolutional implementation of sliding windows, YOLO algorithm, Car detection algorithm using YOLO, One shot learning, Face recognition algorithm.			12 hrs
Chapter 4: Recurrent Neural Networks Backpropogation through time, RNN model, Types of RNN, Vanishing gradients with RNN,Gated Recurrent Unit, LSTM, Bidirectional RNN, Deep RNN, basics of NLP and Concept ofword embedding, speech recognition.			04 hrs
Unit - 3			
Chapter 5: Unsupervised Deep Learning Concepts of Unsupervised deep learning, RBM (Restricted Boltzman Machine) and auto encoders, structure of Auto encoders, collaborative filtering with RBM, Deep belief networks.			10 hrs

KLE TECH. Earlier known as B. V. B. College of Engineering & Technology	School of Electronics & Communication Engineering

Change summary between 2016-17 and 2018-19 admitted batches
(i.e. 2016 to 20 batch 2017 to 21 batch)

Laboratory Title: **C Programming (for Diploma)**	Lab. Code: 18EECF204
Total Hours: 20	Duration of Exam: 02
ESA Marks: 20	Total ISA. Marks: 80

Experiment wise plan

1. **List of experiments/jobs planned to meet the requirements of the course.**

Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment
1.	Write a C program to perform addition , subtraction , multiplication and division of two numbers .	01	8.00
2.	Write a C program to i) Identify greater number between two numbers using C program. ii) To check a given number is Even or Odd .	01	8.00
3.	Write a C program to i) To find the roots of a quadratic equation. ii) Find the factorial of given number.	01	8.00
4.	Write a C program to i) To find the sum of n natural numbers. ii) Print the sum of 1 + 3 + 5 + 7 + + n	01	8.00
5.	Write a C program to i) Print the pattern . * * * * * * * * * * * * * * * ii) Print the pattern 1 1 2	01	8.00

	1 2 3 1 2 3 4 1 2 3 4 5		
6.	Write a C program to To test whether the given character is Vowel or not. (using switch case)	01	8.00
7.	Write a C program to To accept 10 numbers and make the average of the numbers using one dimensional array.	01	8.00
8.	Write a C program to Find out square of a number using function.	01	8.00
9	Write a C program to To find the summation of three numbers using function.	01	8.00
10	Write a C program to Find out addition of two matrices.	01	8.00

1. **Materials and Resources Required:**

Text Book

1. Programming in ANSI C, E Balagurusamy

Program: IV Semester Bachelor of Engineering (Electronics & Communication Engineering)			Lab+ Teaching Hours
Course Title: Data Structures Application Lab		**Course Code: 18EECC210**	
L-T-P: 0-0-2	**Credits: 2**	**Contact Hours: 4Hrs/week**	
ISA Marks: 80	**ESA Marks:20**	**Total Marks: 100**	
Teaching + Lab. Hours: 48 Hrs	**Examination Duration:2 Hrs**		
1.	**Hashing** Hash, Hash function, Hash Table, Collision resolution techniques, Hashing Applications		12Hrs
2.	**Trees** Computer representation, Tree properties, Binary Tree properties, Binary search trees properties and implementation, Tree traversals, AVL tree, 2-3 Tree		20Hrs
3.	**Graphs** Computer representation, Adjacency List, Adjacency Matrix, Graph properties, Graph traversals		16Hrs

Book

1. Data Structures A Psedocode Approach with C, Richard F. Gilberg & Behrouz A. Forouzan, second edition, CENGAGE Learning.
2. Data Structures Using C. Author, Aaron M. Tenenbaum. Publisher, Pearson Education.

Course Code: **19EECC302**	Course Title: OOPS using C++	
L-T-P: 2-0-1	Credits: 3	Contact Hrs: 42
ISA: Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 42		Exam Duration:

Content	**Hrs**
Unit - 1	
Chapter 1: Fundamental concepts of object oriented programming: Introduction to object oriented programming, Programming Basics (keywords, identifiers, variables, operators, classes, objects),Arrays and Strings Functions/ methods (parameter passing techniques),	04 hrs
Chapter 2: OOPs Concepts: Overview of OOPs Principles, Introduction to classes & objects ,Creation & destruction of objects, Data Members, Member Functions , Constructor & Destructor , Static class member, Friend class and functions, Namespace	08hrs
Unit - 2	
Chapter 3: Inheritance: Introduction and benefits, Abstract class, Aggregation: classes within classes Access Specifier, Base and Derived class Constructors, Types of Inheritance. Function overriding	8 hrs
Chapter 4: Polymorphism: Virtual functions, Friend functions, static functions, this pointer	6 hrs
Unit - 3	
Chapter 5: Exception Handling: Introduction to Exception, Benefits of Exception handling, Try and catch block, Throw statement, Pre-defined exceptions in C++,Writing custom Exception class	8 hrs
Chapter 6: I/O Streams: C++ Class Hierarchy, File Stream, Text File Handling, Binary File Handling Error handling during file operations, Overloading << and >> operators	6 hrs

Books/References: **Text Book** **1. Robert Lafore, "Object oriented programming in C++", 4th Edition, Pearson education, 2009.** **References** **1. Lippman S B, Lajorie J, Moo B E, C++ Primer, 5ed, Addison Wesley, 2013.** **2. Herbert Schildt: The Complete Reference C++, 4th Edition, Tata McGraw Hill**	

Change summary between 2018-19 and 2019-20 admitted batches
(i.e. 2017 to 21 batch 2018 to 22 batch)

Program: III Semester Bachelor of Engineering (Electronics & Communication Engineering)			**Teaching Hours**
Course Title: Signals and Systems		**Course Code: 19EECC202**	
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4Hrs/week**	
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**	
Teaching Hours: 50Hrs	**Examination Duration: 3 Hrs**		
Unit I			
Chapter No. 01: Signal Representation Definition of a signals and systems, classification of signals,(analog and discrete signal, periodic and aperiodic, deterministic and random signals, even and odd signals, energy and power) , basic operation on signals(independent variable, dependent variable , time scaling, multiplication, time reversal), elementary signals (Impulse, step, ramp, sinusoidal, complex exponential), Systems Interconnections(series, parallel and cascade), properties of linear systems. (homogeneity ,superposition, linearity and time invariance, stability, memory, causality)			**10**
Chapter No. 02 : LTI System Representation Impulse response representation and properties, Convolution, convolution sum and convolution integral. Differential and difference equation Representation, Block diagram representation			**10**
Unit II			
Chapter No. 03:Fourier representation for signals Introduction, Discrete time Fourier series(derivation of series excluded) and their properties. Discrete Fourier transform (derivation of transform excluded) and properties			**10**
Chapter No. 04:Applications of Fourier transform Introduction, frequency response of LTI systems, Fourier transform representation of periodic signals, Fourier transform representation of discrete time signals. Sampling of continuous time signals.			**10**
Unit III			
Chapter No. 05: Z-transform Definition of z-transform, Properties of ROC, Properties of Z-transforms: Inverse z-transforms (Partial Fraction method, long division method), Unilateral Z-transform, Transform of LTI.			**10**

Text Book (List of books as mentioned in the approved syllabus)

1. Simon Haykin and Barry Van Veen , Signals and Systems, Second, John Wiley & Sons,2002
2. Alan V Oppenheim ,Alan S Willsky and S. Hamid Nawab , Signals and Systems, Second, PHI public,1997

References

1. H. P Hsu, R. Ranjan, Signals and Systems , TMH,2006

2. GaneshRaoandSatishTunga,,SignalsandSystems,SanguineT,2004
3. M.J.Roberts, Fundamentals of Signals and Systems, first Edition, TMH

Change summary between 2018-19 and 2019-20 admitted batches
(i.e. 2018 to 22 batch 2019 to 23 batch)

Laboratory Title: **Senior Design Project**	Lab. Code:**20EECW401**
Credit : 0-0-6 Total Hours: 70**hours/week**	Duration of exam: **2 hours**
Total Exam Marks: **100**	ISA Marks: **50**

Application Areas are,

- Smart City
- Connected Cars
- Home Automation
- Health care
- Smart energy
- Automation of Agriculture

Guide lines for selection of a project:

- The project needs to encompass the concepts learnt in the previous semesters, so that the student will learn to integrate, the knowledge base acquired to provide a solution to the defined problem statement of the project work.
- Student can select a project which leads to a product or model or prototype.
- Time plan: Effort to do the project should be between 60-70Hrs per team, which includes self-study of an individual member (80-100 Hrs) and team work (40-50hrs).
- Learning overhead should be 20-25% of total project development time.

Criteria for group formation:

- 3-4 students in a team.
- Role of teammates: Team lead and members.

Allocation of Guides and Mentors for the projects:

Every Project batch will be allocated with one faculty.

Details of the project batches:

- Number of faculty - members: 50
- Number of students:3-4 students in a team.

Role of a Guide

The primary responsibility of the guide is to help students to understand the meaning and need of various stages in the implementation of the project. At every stage of the project development, guide should help towards its successful completion as per the predefined standards.

How student should carry out a project:

- Define the problem.
- Specify the requirements.
- Specify the design in the understandable form (Block Diagram, Flowchart,Algorithm,etc).
- Analyze the design and identify hardware and software componentsseparately.
- Select appropriate simulation tool and development board for the design.
- Implement the design.
- Optimize the design and generate the results.
- Result representation and analysis.
- Prepare a document and presentation.

Report Writing

- The format for report writing should be downloaded from ftp://10.3.0.3/projects
- The report needs to be shown to guide and committee for each review.
-

Evaluation Scheme

- Internal semester assessment (ISA)
- Evaluation is done based on the evaluation rubrics given in Table 1
- Project shall be reviewed and evaluated by the concerned Guide for 50% of the marks.
- Project shall be evaluated by the review committeefor 50% of the marks.

KLE Technological University — Creating Value, Leveraging Knowledge	School of Electronics & Communication Engineering **PG – VDES**

Program: VLSI Design & Embedded Systems			
Course Title: Advanced Processor Architectures		**Course Code: 15EVEC704**	
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4**	
CIE Marks: 50	**SEE Marks: 50**	**Self Study : --**	
Teaching Hours: 50	**Examination Duration: 3 hours**	**Total Marks: 100**	
Chapter 1: Recapitulate ARM system: ARM registers, Pipeline, Interrupts Exceptions, Vector table. Text 1 (2.1,2.2,2.3,2.4,9.1,9.2,9.3,9.4),Text 2(chapter 2,chapter 11), Text 3(2.3,4.1,4.2,4.3)			**8 hours**
Chapter 2: ARM instruction set review: Data processing instructions, Branch instructions, Load-Store instructions, Software interrupt instruction, Program Status Register instructions, loading constants. Text 1 (Chapter 3)			**3 Hours**
Chapter 3: Thumb instruction set review: Thumb register usage, ARM-THUMB internetworking, other branch instructions, Data processing instructions, Single register load store instructions, multiple register load store instructions, stack instructions software interrupt instructions. Text 1 (Chapter 4)			**3 hours**
Chapter 4: ARM Caches: The memory hierarchy and Cache memory, Cache architecture, Cache policy, Coprocessor 15 and caches, Flushing cache memory, Cleaning cache memory, Cache lockdown, Caches and software performance. Text 1 (Chapter 12)			**3 hours**
Chapter 5: ARM MPU, MMU: Protected regions, initializing the MPU, Caches and Write buffer, Demonstration of MPU system, Moving from MPU to MMU, How virtual memory works, Details of ARM MMU, Page tables, The translation lookaside buffer, Domains and Memory access permissions, The caches and write buffer, FCSE. Text 1 (13.1,13.2,13.3,14.2,14.3,14.4,14.5,14.6,14.9)			**3 hours**
Chapter 6: AMBA,AHB,APB,AXI: Overview of the AMBA specification, Objectives of the AMBA specification, A typical AMBA-based microcontroller, Terminology, Bus interconnection, Overview of AMBA AHB operation, Basic transfer, Transfer type, Split and retry, Split transfers, AHB bus slave, AHB bus master, AHB arbiter, AHB decoder, AMBA APB, APB specification, APB bridge, APB slave. About the AXI protocol, Architecture, Additional features. Text 3 (8.2)			**3 hours**
Chapter 7: Practical ARM Hardware-Essentials: ARM 7,ARM 9,ARM 11, Cortex M0, Cortex M3, Cortex M4, Memory technology, memory types : Embedded RAM, DRAM technology, SDRAM, Generations of SDRAM, DDR1,DDR2 memories, DDR3 memory, Error correction code, Storage Flash concepts, Power managers, Sequencing.			**8 hours**
Chapter 8: Bootloader Essentials: Boot Mode Selection & PIN Muxing, ARM core configuration for Bootloader, The standard Startup.S overview, U-Boot Architecture, U-Boot vs Redboot vs WinCE Bootloader.			**5 hours**
Chapter 9: Operating System-Key practical concepts, Part 1: Linux OS Boot Flow, Build Systems: LTIB, Open Embedded, Platform Builder.			**4 hours**
Chapter 10: Operating System-Key practical concepts, Part 2: WinCE Boot Flow, Linux vs WinCE Driver Models, Linux: A Simple character driver, Flow of a framebuffer driver, Flow of a network device driver, Common Driver & Kernel API: IOCTLS etc			**6 hours**
Chapter 11: Board bring up concepts: Power system bring up, High speed digital bring up, Low speed digital bring up, Analog section bring up.			**4 hours**
Text Books 1. Andrew N.Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide", Elsevier 2005 2. William Hohl, "ARM Assembly Language fundamentals and Techniques", CRC press 2009. 3. Steve Furber, "ARM System-On-Chip Architecture", LPE second edition.			

KLE Technological University — Creating Value, Leveraging Knowledge	School of Electronics & Communication Engineering **PG – VDES**

Program: VLSI Design & Embedded Systems		
Course Title: Principles and Practices of Engineering Education		**Course Code:** 15ECRC701
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 3**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 hrs**	

1. **Fundamental Principles of Teaching and Learning**	**8 Hours**
2. **Learning Styles and Theories**	**8 Hours**
3. **Instructional Design Models and Technology Enhanced Learning**	**8 Hours**
4. **Assessment and Evaluation**	**8 Hours**
5. **Engineering Learning Modules**	**8 Hours**

Program: VLSI Design & Embedded Systems		
Course Title: Data Structures using C		**Course Code:** 17EVEC701
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 25	**Examination Duration: 3 hrs**	

Chapter 01:C language features Pointers revisited, Strings, Structures – Basics, Structures and functions, Arrays of structures, Pointers to structures, Self Referential Structures, Unions and bit fields, Files.	5 Hrs
Chapter 02:Stacks and Queues Definition, Representation and Applications of stack. Definitions, representation and applications of linear, circular, queues, multiple queues, priority queue. Recursion	5 Hrs
Chapter 03:Lists Linked lists, singly, doubly, circular lists, definitions, representations. Implementation of list operations, applications – polynomial addition, addition of long integers. Linked stacks, Linked Queues	5 Hrs
Chapter 04:Trees Binary trees – Definitions, traversals (recursive and iterative versions), Building and searching, Threaded Binary trees, Trees and their applications	5 Hrs
Exchange sorts, Selection and tree sorts, Merge and radix sorts	5 Hrs
Text Book 1. Aaron M. Tenenbaum, et al, Data Structures using C, II Edition, PHI, 2006 2. Horowitz, Sahani, Anderson-Feed, Fundamentals of Data Structures in C, II Edition, University, 2008 **References** 1. E Balaguruswamy, The ANSI C programming Language, II Edition, PHI, 2010 2. Yashavant Kanetkar, Data Structures through C, II Edition, BPB public, 2010 3. Richard F. Gilberg, Behrouz A. Forouzan , Data Structures: A Pseudocode Approach With C, II Edition, Course Tec, 2009	
Lab: **1.** Programs on Pointer concepts. **2.** Programs on string handling functions, structures union And bit-files. **3.** Programming on files **4.** Programming on stacks data structures **5.** Programs on implementation of different queue data structures. **6.** Programs on implementation of different types of Linked lists **7.** Programs on Implementation of trees **8.** Programs to implement different sorting techniques. **9.** Programming on graph	

10. Programming on hashing tables **11.** Design and implement stack queue data structures **12.** Design and implement linked list data structures **13.** Project	

Program: VLSI Design & Embedded Systems		
Course Title: Analog and Digital Circuits		**Course Code:** 17EVEC702
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 4**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**
Teaching Hours: --	**Examination Duration: 3 hrs**	

Applications of theorems.
RLC Circuits
Combinational circuits and Sequential circuits
Case study — 8 Hrs

Devices: Diodes, MOSFETs. Diode circuits: clipping, clamping, rectifier. Design of BJT and MOSFET single-and multi-stage amplifiers, Feedback amplifier, Oscillator, Op-amp linear & non linear applications.

Digital Circuits — 8 Hrs

Combinational Circuits: Adder, encoder & decoder, MUX& DEMUX, Comparator. Sequential Circuits: Latches, Flip Flops, Shift Registers, Design of Synchronous counters and Asynchronous counters.

Conventional control systems: R-H Stability criterion, Root locus, Bode plots and Nyquist stability criterion. — 8 Hrs

Tools: Simulink, MATLAB, Proteus, Pspics, Cadence, LabView, Microcap, OrCAD

Reference Books:

1. A.S. Sedra & K.C. Smith, Microelectronic Circuits, 5th Edition, Oxford Univ. Press, 1999
2. Jacob Millman and Christos Halkias, Integrated Electronics, McGraw Hill,
3. John M Yarbrough, Digital Logic Applications and Design, Thomson Learning, 2001
4. David A. Bell, Electronic Devices and Circuits, 4th edition, PHI publication, 2007
5. Grey, Hurst, Lewis and Meyer, Analysis and design of analog integrated circuits, 4th edition.
6. Charles H Roth, Jr; Fundamentals of Logic Design, Thomson Learning, 2004.
7. Zvi Kohavi, Switching and Finite Automata Theory, 2ed, TMH
8. Ogata, Modern Control Theory, 4th ed, PHI.

Lab:

Analog Electronics Lab

1. Study & analyze Diode Clipping and Clamping (single/double ended) circuits.
2. Implement the RLC circuit to study the transient response.
3. Design an Amplifier using MOSFET and determine its gain, input & output impedance.
4. To implement an amplifier with negative feedback & show the effect of negative feedback on input impedance; output impedance & gain of the amplifier using MOSFET.
5. Study of transformer-less Class B push pull power amplifier and determination of its conversion efficiency
6. Design an amplifier for an unity gain and high input impedance using MOSFET. Suggest suitable techniques to increase the input impedance and verify the same.

Digital Circuits lab

1. Design and implement BCD adder and Subtractor using 4 bit parallel adder
2. Design and implement n bit magnitude comparator using 4- bit comparators
3. Design and implement Ring and Johnson counter using shift register.
4. Design and implement 8 bit ALU.

Tools: Simulink, Proteus, Pspics, Cadence, LabView, Microcap, OrCAD, MATLAB.

Program: VLSI Design & Embedded Systems		**Teaching Hours**
Course Title: Principle of Embedded Systems	**Course Code: 17EVEC703**	

L-T-P: 0-0-2	**Credits: 2**	**Contact Hours: 4 Hrs/week**	
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**	
Teaching Hours: 42 Hrs	**Examination Duration: 3 hrs**		

1. Introduction to embedded system: Introduction, Classification of Embedded System, Major Application Areas, Purpose of Embedded System. Characteristics and quality attributes of Embedded Systems, Design Metric and Optimizing the metrics.	**06 Hrs**
2. Typical Embedded Systems: Core of Embedded System-processor fundamentals, up vs uc, risc vs cisc, vonneumann vs Harvard, 8051 controller architecture and programmer model, Memory, Sensor and Actuators, Communication Network, Embedded Firmware	**08 Hrs**
3. Low Level programming Concepts: Addressing Modes, Instruction Set and Assembly Language programming(ALP), Developing, Building, and Debugging ALP's	**08 Hrs**
4. Middle Level Programming Concepts: Cross Compiler, Embedded C language implementation, programming, & debugging, Differences from ANSI-C, Memory Models, Use of directives, Functions, Parameter passing and return types	**02 Hrs**
5. On-Chip Peripherals Study, Programming, and Application: Ports: Input/Output, Timers & Counters, UART, Interrupts	**08 Hrs**
6. External Interfaces Study, Programming and Applications : LEDS, Switches(Momentary type, Toggle type), Seven Segment Display: (Normal mode, BCD mode, Internal Multiplexing & External Multiplexing), LCD (8bit, 4bit, Busy flag, custom character generation), Keypad Matrix, Stepper Motor, DC Motor	**10 Hrs**

Text Books

1. Introduction to Embedded Systems 1E by Shibu K V.
2. Kenneth J. Ayala ; "The 8051 Microcontroller Architecture, Programming & Applications" 2e, Penram International, 1996 / Thomson Learning 2005
3. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; "The 8051 Microcontroller and Embedded Systems – using assembly and C "- PHI, 2006 / Pearson, 2006

References

1. Embedded System Design: A Unified Hardware/Software Introduction – Frank Vahid, Tony Givargis, John Wiley & Sons, Inc.2002
2. Predko ; "Programming and Customizing the 8051 Microcontroller" –, TMH
3. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2005

Program: VLSI Design & Embedded Systems			**Teaching Hours**
Course Title: CMOS VLSI Design		**Course Code: 17EVEC704**	
L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 6 Hrs/week**	
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**	
Teaching Hours: 50 Hrs	**Examination Duration: 3 hrs**		
Chapter No. 1. Introduction to VLSI and IC fabrication technology VLSI Design Flow, Semiconductor Technology - An Overview, Czochralski method of growing Silicon, Introduction to Unit Processes (Oxidation, Diffusion, Deposition, Ion-implantation), Basic CMOS technology - Silicon gate process, n-Well process, p-Well process, Twin-tub Process, Oxide isolation. FinFET device, The root cause of short channel effects in twenty-first century MOSFETS, The thin body			15 hrs

MOSFET concept, The FinFET and a new scaling path for MOSFETs, Ultra thin body FET, Recent trends in fabrication technology.	
Chapter No. 2. DC Analysis of CMOS logic gates DC transfer characteristics of CMOS inverter, Beta Ratio Effects, Noise Margin, MOS capacitance models.	05 hrs
Chapter No. 3. Transient Analysis of CMOS logic gates Transient Analysis of CMOS Inverter, NAND, NOR and Complex Logic Gates, Gate Design for Transient Performance, Switch-level RC Delay Models, Delay Estimation, Elmore Delay Model, Power Dissipation of CMOS Inverter, Transmission Gates & Pass Transistors, Tristate Inverter.	08 hrs
Chapter No. 4. Designing High-Speed CMOS Logic Networks Stick Diagrams, Euler Path, Layout design rules, DRC, Circuit extraction, Latch up – Triggering Prevention, Gate Delays, Driving Large Capacitive Loads, Delay Minimization in an Inverter Cascade, Logical effort, BiCMOS Drivers.	12 hrs
Chapter No. 5. Combinational CMOS Circuit Design Pseudo nMOS, Clocked CMOS, Dynamic CMOS Logic Circuits, Dual-rail Logic Networks: CVSL, CPL.	05 hrs
Chapter No. 6. Sequential CMOS Circuit Design Sequencing static circuits, Circuit design of latches and flip-flops, Clocking- clock generation, clock distribution.	05 hrs

Text Books

1. John P. Uyemura, Introduction to VLSI Circuits and Systems, 1, Wiley, 2007
2. Neil Weste, David Harris & Ayan Banerjee, CMOS VLSI Design, 3, Pearson Ed, 2005
3. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, 3, Tata McGraw, 2007

References

1. FinFET Modeling for IC Simulation and Design: Using the BSIM-CMG Standard By Yogesh Singh Chauhan, Darsen Duane Lu, Vanugopalan Sriramkumar, Sourabh Khandelwal, Juan Pablo Duarte, Navid Payvadosi, Ai Niknejad, Chenming Hu, Elsevier Publication, 2015
2. Wayne, Wolf, Modern VLSI design: System on Silicon, 3, Pearson Ed, 2005
3. Douglas A Pucknell and Kamran Eshraghian, Basic VLSI Design, 3, PHI, 2005
4. Phillip. E. Allen, Douglas R. Holberg, CMOS Analog circuit Design, 1, Oxford Uni, 2002

Lab:

1. Introduction to Cadence EDA tool.
2. Static and Dynamic Characteristic of CMOS inverter.
3. Layout of CMOS Inverter (DRC,LVS)
4. Static and Dynamic Characteristic of CMOS NAND2 and NOR2
5. Layout of NAND2, NOR2, XOR2 gates (DRC, LVS).
6. Design a Phase Detector using D-FF
7. Design complex combinational circuits and analyze the performance using Cadence tool.

Program: VLSI Design & Embedded Systems			Teaching Hours
Course Title: RISC Architectures		**Course Code: 17EVEC705**	
L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 3 Hrs/week**	
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**	
Teaching Hours: 46 Hrs	**Examination Duration:**		
1. The 32 bit RISC Architecture: The Acorn RISC machine, Architectural inheritance, Architecture of ARM7TDMI, ARM programmers model, ARM development tools, 3 stage pipeline ARM organization, ARM instruction execution.			**06 Hrs**
2. 32 bit Instruction set: Data processing instruction, Branch instruction, Load store instruction, Software interrupt instruction, Program status register instruction, Conditional execution, Example programs, 16bit Instruction set- The Thumb programmer model, ARM-Thumb interworking, other branch instructions, Data processing instructions, Single/Multiple register load store instruction, Stack operation, Software interrupt instructions, example programs.			**06 Hrs**
3. Exception Handling: Introduction, Interrupts, error conditions, processor exception sequence, the vector table, Exception handlers, Exception priorities, Procedures for handling exceptions.			**04 Hrs**
4. Memory Hierarchy Design: Cache basics, Miss rate and penalty, Cache Hierarchy, Memory Organizations, Memory Hierarchy.			**06 Hrs**
5. Pipelining: Linear pipeline processor, Nonlinear pipeline processor, Instruction pipeline design, Branch handling techniques, Arithmetic pipeline design, Computer arithmetic principles, Static arithmetic pipeline, Multifunctional arithmetic pipeline.			**08 Hrs**
6. Cortex M4 : Functional description, programmer's model, memory protection unit, nested vectored interrupt controller.			**06 Hrs**
7. Multi-Core Architectures : Introduction to Intel Architecture, How an Intel Architecture System works, Basic Components of the Intel Core 2 Duo Processor: The CPU, Memory Controller, I/O Controller.			**07 Hrs**
8. Current Trends in Intel Architectures and Applications : Seminar on current trends in Intel Architectures			**03 Hrs**

Text Books

1. "ARM System- on-Chip Architecture" by 'Steve Furber', LPE, Second Edition.
2. "ARM Assembly Language fundamentals and Techniques" by William Hohl, CRC press, 2009.
3. D. A. Patterson and J. L. Hennessey "Computer Organization and Design", Morgan , Kaufmann,2002
4. H. Jonathan Chao and Bin Liu, "High performance switches & routers", Wiley Interscience, 2007.
5. Kai Hwang, " Advanced Computer Architecture – TMH – 1993
6. Web resources for Example Architectures of INTEL and Texas Instruments: http:/ /download.intel.com/design/intarch/papers/321087.pdf

References

1. Kai Hwang, Faye A. Briggs, Computers Architecture and Parallel Processing – MGH – 1985
2. David E Culler, Jaswinder Pal Singh, Anoop Gupta "Parallel Computer Architecture", Harcourt Asia Pte Ltd 2000
3. Stalling W." Computer Organization and Architecture- Designing for performance" PHI,2005
4. D. Sima,T. Fountain, P.Kasuk," Advanced Computer Architecture-A Design Space Approach" Addisson Wesley,1997.
5. M. J. Flynn,"Computer Architecture, Pipelined And Parallel Processing", Narosa Publications, 1998.

List of Experiments:

1. Write an ALP to verify data transfer w.r.t memory to achieve following
   i. 8 bit data transfer
   ii. 16 bit data transfer
   iii. 32 bit data transfer
2. Write an ALP for Tables and lists to do following:
   i. Add an entry to a list
   ii. Remove an element from the queue
3. Write an ALP to pass parameters to a subroutine.
   i. Ascending order
   ii. Descending order
4. Write a 'C' program & demonstrate an interfacing of Alphanumeric LCD 2X16 panel to LPC2148Microcontroller
5. Write a 'C' program & demonstrate concept of Interrupts interface to LPC2148 Microcontroller.
6. Write a 'C' program & demonstrate an interfacing of DAC to LPC2148 Microcontroller.
7. Write a 'C' program & demonstrate an interfacing of UART to LPC2148 Microcontroller.
8. Write a 'C' program & demonstrate an interfacing of ADC to LPC2148 Microcontroller.
9. Write a 'C' program & demonstrate an interfacing of RTC to LPC2148 and read time, date and year.
10. Write a 'C' program & demonstrate interface I2C to LPC2148
11. Develop a code for college bell system. (Use the following interfaces LCD, RTC and Buzzer).

Reference Books

1. "ARM System- on-Chip Architecture" by 'Steve Furber", LPE, Second Edition.
2. "Embedded Systems- Architecture, Programming and Design" by Raj Kamal, TMH
3. Dr. K.V.K.K. Prasad, "Embedded/Real-time systems: concepts, Design & Programming", published by dreamtech press.

Manual

1. LPC2148 datasheet by NXP.
2. LPC2148 board manual by ALS, Bangalore.

Program: VLSI Design & Embedded Systems		
Course Title: IC Fabrication Technology		**Course Code:** 17EVEC706
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3**

ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 hours	

1. Crystal growth, wafer preparation, epitaxy and oxidation Electronic Grade Silicon, Czochralski crystal growing, Silicon Shaping, processing considerations, Vapor phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation, Growth Mechanism and kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxide properties, Redistribution of Dopants at interface, Oxidation of Poly Silicon, Oxidation inducted Defects.	15 Hrs
2. Lithography and relative plasma etching Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, Feature Size control and Anisotropic Etch mechanism, reactive Plasma Etching techniques and Equipment.	10 Hrs
3. Deposition, Diffusion, Ion implementation and Metallization Deposition process, Poly silicon, plasma assisted Deposition, Models of Diffusion in Solids, Fick's one dimensional Diffusion Equations – Atomic Diffusion Mechanism – Measurement techniques – Range theory-Implant equipment. Annealing Shallow junctions – High energy implantation – Physical vapor deposition – Patterning.	10 Hrs
4. Process simulation and VLSI process integration Ion implantation – Diffusion and oxidation – Epitaxy – Lithography – Etching and Deposition- NMOS IC Technology – CMOS IC Technology – MOS Memory IC technology - Bipolar IC Technology – IC Fabrication.	10Hrs
5. Analytical, Assembly Techniques and Packaging of VLSI Devices Analytical Beams – Beam Specimen interactions - Chemical methods – Package types – packaging design considerations – VLSI assembly technology – Package fabrication technology.	5 Hrs

References:

1. S.M.Sze, "VLSI Technology", McGraw Hill Second Edition. 1998.
2. James D Plummer, Michael D. Deal, Peter B. Griffin, "Silicon VLSI Technology: Fundamentals Practice and Modeling", Prentice Hall India.2000.
3. Wai Kai Chen, "VLSI Technology" CRC Press, 2003.
4. C.Y. Chang and S.M.Sze (Ed), ULSI Technology, McGraw Hill Companies Inc, 1996.
5. S.K. Gandhi, VLSI Fabrication Principles, John Wiley Inc., New York, 1983.

Program: VLSI Design & Embedded Systems			**Teaching Hours**
Course Title: Electronic System Design		**Course Code: 17EDEC707**	
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours:6 Hrs/week**	
ISA Marks: 100	**ESA Marks:**	**Total Marks: 100**	
Teaching Hours: 25 Hrs	**Examination Duration: --**		
To level specifications, Block level specifications, Timing of micro architecture, Verification and test plan, Schematic capture			05 Hrs
Simulation, Advanced simulation, Signal Integrity			05 Hrs
PCB layout- Floor planning, component pre planning, PCB printing- 2 layer			05 Hrs
Functionality and performance check, Failure analysis, Validation and system integration			05 Hrs
System Analysis			05 Hrs

References

1. A. S Sedra and KC Smith, Microelectronic circuits, Oxford, 1998.
2. G.L. Ginsberg, Printed Circuit Design, McGraw Hill, 1991.

Program: VLSI Design & Embedded Systems		
Course Title: Automotive Electronics		**Course Code:** 17EVEC708
L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 5**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**
Teaching Hours: 40	**Examination Duration: 3 hrs**	

Content	Hours
Chapter No. 1. Automotive Fundamentals Overview Introduction to Automotive Industry and Modern Automotive Systems Vehicle classifications and specifications need for electronics in automobiles, Application areas of electronics in the automobiles Four Stroke Cycle, Engine Control, Ignition System, Spark plug, Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System.	8Hrs
Chapter No. 2. Sensors and Actuators Oxygen (O2/EGO) Sensors, Throttle Position Sensor (TPS), Engine Crankshaft Angular Position (CKP) Sensor, Magnetic Reluctance Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Hall effect Position Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure (MAP) Sensor Strain gauge, Engine Coolant Temperature (ECT) Sensor, Knock Sensor, Throttle angle sensor, Fuel Injector Actuator, Ignition Actuator	7Hrs
Chapter No. 3. Electronic Engine Control Engine parameters, variables, Engine Performance terms, Electronic Fuel Control System, Electronic Ignition control, Idle sped control, EGR Control	5Hrs
Chapter No. 4. Vehicle Motion Control and Safety Systems Cruise Control, Antilock Brake System (ABS), Electronic Steering Control, Power Steering, Traction Control, Electronic Stability Program.	6Hrs
Chapter No:5. Automotive communication protocols Overview of Automotive communication protocols : CAN, LIN .	3Hrs
Chapter No. 6. Advanced Driver Assistance Systems (ADAS) Lane Departure Warning, Collision Warning, Automatic Cruise Control, Pedestrian Protection, Headlights Control, Connected Cars technology and trends towards Autonomous vehicles.	5Hrs
Chapter No. 7. Automotive safety standards ISO26262 and Diagnostics Functional Safety: Need for safety standard-ISO 26262, safety concept, safety process for product life cycle, safety by design, validation. Fundamentals of Diagnostics: Basic wiring system and Multiplex wiring system, Preliminary checks and adjustments, Self-diagnostic system. Fault finding and corrective measures, OBD & off board diagnostic.	6Hrs

Text books:

1. Denton.T – Automobile Electrical and Electronic Systems, Edward Arnold publication, 1995.

References:

1. William T.M – Automotive Electronic Systems, Heiemann Ltd., London ,1978.
2. Nicholas Navet – Automotive Embedded System Handbook, CRC Press, 2009.
3. BOSCH Automotive Handbook, Wiley Publications, 8th Edition, 2011.
4. Co-Verification of hardware & software for ARM SoC Design – Jason.R.Andrews, Newnes Publications, 2004.
5. Hardware Software co-design of embedded systems, F.Balarin, Kluwer Academic Oublishers, 1987.

Lab:

1. Demonstration of cut section modules: Engine, Transmission , Steering, Braking, Suspension - Automobile dept.
2. Electronic engine control system: Injection and Ignition control system Transmission trainer modules
3. Modeling an engine Vehicle model simulation with Simulink using PI CONTROLLER
4. Basic gate logic simulation and modeling using Simulink and realization on the hardware platform.
5. Seat belt warning system simulation and modeling using Simulink and realization on the hardware platform. Vehicle speed control based on the gear input simulation and modeling using Simulink and realization on the hardware platform.
6. Throttle control modeling and simulation using Simulink and realization on the hardware platform.
7. Accelerator pedal interfacing software modeling and simulation using Simulink and realization on the hardware platform.
8. Develop matlab code for stepper motor control and convert it to Simulink model and port it to embedded hardware

Program: VLSI Design & Embedded Systems			Teaching Hours
Course Title: Real Time Embedded Systems		**Course Code: 17EVEC709**	
L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 3 Hrs/week**	
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**	
Teaching Hours: 45 Hrs	**Examination Duration:**		
UNIT I			
1. Building blocks: Real Time System, Types, Real Time Computing, Design Issue, Sample Systems, Hardware Requirements- Processor in a system, System Memories, System I/O, De-bouncing, Other Hardware Devices (A/D, D/A, USART, Watchdog Timers, Interrupt Controllers). Device Drivers, Interrupt Servicing Mechanism & Interrupt Latency.			**12 Hrs**
2. Advanced Processors: Automotive Grade Processors: AEC-Q100 qualification, Qorivva 32-bit Microcontrollers, MPC577XK for ADAS, AURIX from Infineon, Tricore Architecture, Renasas RL78/D1x (Automotive Only)			**10 Hrs**
UNIT II			
3. Real Time Operating System: Interrupt driven systems, foreground/background systems, full featured rtos, POSIX, buffering data, mailboxes, critical regions, semaphores, event flags & signals, deadlock, process stack management, dynamic allocation.			**04 Hrs**
4. Case Studies: Mucos/ VX Works Functions – System level, task service, time delay, memory allocation, semaphore, mailbox, queue. Example systems: Coding for Automatic chocolate vending machine using MUCOS & Coding for sending application layer byte streams on a TCP/IP Network using Vx Works.			**06 Hrs**
UNIT III			
5. Process of Embedded System Development: Development process, requirements engineering, design, implementation, integration & testing, packaging, configuration management, managing embedded system development, embedded system fiascos.			**08 Hrs**
6. Current trends, ethical & environmental issues The students shall give seminars on current trends in the field of RTES, ethical, & environmental issues.			**05 Hrs**

Text Books

1. Philip. A. Laplante, “Real-Time Systems Design and Analysis- an Engineer’s Handbook”- Second Edition, PHI Publications.
2. Rajkamal, “Embedded Systems: Architecture, Programming and Design”, Tata McGraw Hill, New Delhi, 2003.
3. Dr. K.V.K K Prasad, “Embedded Real Time Systems: Concepts Design and Programming”, Dreamtech Press New Delhi, 2003.

References

1. Joseph Yiu, “The Definitive guide to ARM CORTEX –M3 & CORTEX-M4 Processors”, Elsevier, Newnes, 2014.
2. Steve Furber “ARM System –on – Chip Architecture” Second Edition, Pearson Education
3. David E. Simon, “An Embedded software primer”, Pearson Education, 1999..
4. David A. Evesham, “Developing real time systems – A practical introduction”, Galgotia Publications, 1990
5. William Hohl, “ARM Assembly Language Fundamentals & Techniques”, CRC Press
6. C. M. Krishna, “Real Time Systems” MGH, 1997
7. Jane W.S. Liu, “Real-Time Systems”, Pearson Education Inc., 2000

Program: VLSI Design & Embedded Systems		
Course Code: 17EVEC710	Course Title: **Advanced Digital Logic Design**	
L-T-P: 1-0-3	Credits: 4	
ISA Marks: 50+100	ESA Marks: 50	
Teaching Hrs: 40		
Chapter No. 1. Digital Integrated Circuits Moore's law, Technology Scaling, Die size growth, Frequency, Power dissipation, Challenges in digital design, Design metrics, Cost of Integrated circuits, ASIC , Evolution of SoC ASIC Flow Vs SoC Flow, SoC Design Challenges. Introduction to CMOS Technology, PMOS & NMOS Operation, CMOS Operation principles, Characteristic curves of CMOS, CMOS Inverter and characteristic curves, Delays in inverters, Buffer Design, Power dissipation in CMOS, CMOS Logic, Stick diagrams and Layout diagrams. Setup time, Hold Time, Timing Concepts.		10 hrs
Chapter No. 2. Digital Building Blocks Basic Gates, Universal Gates, nand & nor Implementations. Decoder, encoder, code converters, Priority encoder, multiplexer, demultiplexer, Comparators, Parity check schemes, Multiplexer, De-multiplexer, Pass Transistor Logic, application of multiplexer as a multi-purpose logical element. Asynchronous and synchronous up-down counters, Shift registers. FSM Design, Mealy and Moore Modelling, Adder & Multiplier concepts, Memory Concept		10 hrs
Chapter No. 3. Logic Design Using Verilog Evolution & importance of HDL, Introduction to Verilog, Levels of Abstraction, Typical Design Flow, Lexical Conventions, Data Types Modules, Nets, Values, Data Types, Comments, arrays in Verilog, Expressions, Operators, Operands, Arrays, memories, Strings , Delays , parameterized designs Procedural blocks, Blocking and Non-Blocking Assignment, looping, flow Control, Task, Function, Synchronization, Event Simulation. Need for Verification, Basic test bench generation and Simulation		12 hrs
Chapter No. 4. Principles of RTL Design Verilog Coding Concepts, Verilog coding guide lines: Combinational, Sequential, FSM. General Guidelines, Synthesizable Verilog Constructs, Sensitivity List, Verilog Events, RTL Design Challenges, Clock Domain Crossing. Verilog modelling of combinational logic and sequential logic		8 hrs
Chapter No. 5. Design and simulation of Architectural building blocks Basic Building blocks design using Verilog HDL: Arithmetic Components – Adder, Subtractor, and Multiplier design, Data Integrity – Parity Generation circuits, Control logic – Arbitration, FSM Design – overlapping and non-overlapping Mealy and Moore state machine design		10 hrs

Reference Books:

1. Digital Design by Morris Mano M, 4th Edition
2. Verilog HDL: A Guide to Digital Design and Synthesis by Samir Palnitkar, 2nd Edition
3. Principles of VLSI RTL Design: A Practical Guide by Sapan Garg, 2011 Tools: 1. NC Verilog, NC Sim, CVER + GTKWave, VCSMX, Modelsim for Verilog 2. Microwind for layout.

Program: VLSI Design & Embedded Systems		
Course Code: 17EVEC711	**Course Title: Testing & IC Characterization**	
L-T-P: 3-0-1	**Credits: 4**	**Contact Hrs: 5 hrs/week**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**
Teaching Hrs: 40		**Exam Duration: 03 hrs**

Content	**Hrs**
CHAPTER NO. 1. VERIFICATION CONCEPTS Concepts of verification, importance of verification, Stimulus vs Verification, functional verification, test bench generation, functional verification approaches, typical verification flow, stimulus generation, direct testing, Coverage: Code and Functional coverage, coverage plan.	10 hrs
CHAPTER NO. 2. SYSTEM VERILOG – LANGUAGE CONSTRUCTS System Verilog constructs - Data types: two-state data, strings, arrays: queues, dynamic and associative arrays, Structs, enumerated types. Program blocks, module, interfaces, clocking blocks, modports.	10 hrs
CHAPTER NO. 3. SYSTEM VERILOG – CLASSES & RANDOMIZATION SV Classes: Language evolution, Classes and objects, Class Variables and Methods, Class instantiation, Inheritance, and encapsulation, Polymorphism. Randomization: Directed Vs Random Testing. Randomization: Constraint Driven Randomization.	12 hrs
CHAPTER NO. 4. SYSTEM VERILOG – ASSERTIONS & COVERAGE Assertions: Introduction to Assertion based verification, Immediate and concurrent assertions. Coverage driven verification : Motivation, Types of coverage, Cover Group, Cover Point, Cross Coverage, Concepts of Binning and event sampling.	8 hrs
CHAPTER NO. 5. BUILDING TESTBENCH LAYERED TESTBENCH ARCHITECTURE. INTRODUCTION TO UNIVERSAL VERIFICATION METHODOLOGY, OVERVIEW OF UVM BASE CLASSES AND SIMULATION PHASES IN UVM AND UVM MACROS. UNIFIED MESSAGING IN UVM, UVM ENVIRONMENT STRUCTURE, CONNECTING DUT- VIRTUAL INTERFACE	10 hrs

REFERENCES:

1. SYSTEM VERILOG LRM
2. CHRIS SPEAR, GREGORY J TUMBUSH - SYSTEMVERILOG FOR VERIFICATION - A GUIDE TO LEARNING THE TESTBENCH LANGUAGE FEATURES - SPRINGER, 2012
3. STEP-BY-STEP FUNCTIONAL VERIFICATION WITH SYSTEMVERILOG AND OVM BY SASAN IMAN SIMANTIS INC. SANTA CLARA, CA SPRING 2008 TOOLS: 1. NC VERILOG, NC SIM, VCSMX FOR SYSTEM.

Program: VLSI Design & Embedded Systems			
Course Code: **17EVEE701**	Course Title: **Image and Video Processing**		Teaching Hrs: **40 Hrs**
L-T-P: **2-0-1**	Credits: **3**		Contact Hrs: **4 Hrs/week**
ISA Marks: **50+100**	Exam Duration: **3Hrs**	ESA Marks: **50**	Total Marks: **200**

1	**Introduction**: 2D systems, Mathematical Preliminaries- FT, Z-transform, Optical and Modulation Transfer Functions (OTF and MTF). Matrix theory, Image perception: Light, Luminance, Brightness, Contrast, MTF of the visual system, Visibility function, Monochrome Vision Models, Fidelity criteria, Color Representation, Color Vision Models, Temporal Properties of Vision.	2 hrs
2	**Image sampling and Quantization:** 2D Sampling theory, Quantization, Optimal Quantizer, Compander and Visual Quantization.	2 hrs
3	**Image Transforms:** 2D orthogonal and unitary transforms, DFT, DCT, Harr, KLT	4hrs
4	**Image Enhancement**: Histograms Modeling, Spatial operations, Transform operations, Multispectral Image Enhancement,	4hrs
5	**Image Filtering and Restoration:** Image Observation Models, Inverse and Weiner filtering , Frequency Domain Filters. Smoothing Splines and Interpolation.	4hrs
6	**Basics of Video:** Analog Video, Digital Video	2 hrs
7	**Two dimensional motion estimation:** Optical flow methods**,** Block based methods, Bayesian methods**.**	7 hrs

Text books

1. Jain, A.K., Fundamentals of Digital Image Processing, 3rd Edision, Pearson Education (Asia) 2013
2. A. Murat Tekalp, Digital Video processing Pearson Education (Asia) Pte. Ltd.
3. Li and, Z. Drew, M.S. Fundamentals of Multimedia, Pearson Education (Asia) Pte. Ltd,. 2010.

References books

1. Gonzalez, Rafael C., Woods, Richard E. and Eddins Steven L., Digital Image Processing Using Matlab, Pearson Education (Asia) Pvt. Ltd.,
2. Al. Bovik, Essential guide to Video Processing, Academic Press

Implementation:

Implementation assignments are designed using opencv/c++ to explore the concepts like

1. Image enhancement techniques
2. Image transforms.
3. Image restoration technique
4. Develop an image processing application to assist
   a. ADAS
   b. Agriculture
   c. Defense
   d. Health Care
   e. Surveillance and Forensics
   f. Remote sensing
5. Track an object in video
6. Optimal use of surveillance video

Program: VLSI Design & Embedded Systems		
Course Title: Digital Control Systems		**Course Code:** 17EVEE702
L-T-P: 2-0-1	**Credits: 4**	**Contact Hours: 5**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**
Teaching Hours: 40	**Examination Duration: 3 hours**	

1. Introduction to digital control: Introduction, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction.	4hrs
2. Modeling discrete-time systems by pulse transfer function: Z-transform, Mapping of Z-plane to z-plane, Pulse transfer function , Pulse transfer function of closed loop system, Sampled signal flow graph.	3hrs
3. Time response of discrete systems: Transient and steady state responses, Time response parameters of a prototype second order system.	5hrs
4. Stability analysis of discrete time systems: Jury stability test, Stability analysis using bi-linear transformation.	5hrs
5. Design of sampled data control systems: Root locus method, Controller design using root locus, Root locus based controller ,design using MATLAB, Nyquist stability criteria, Bode plot.	5hrs
6. Deadbeat response design :Design of digital control systems with deadbeat response, Practical issues with deadbeat response design, Sampled data control systems with deadbeat response.	6hrs
7. Discrete state space model: Introduction to state variable model, Various canonical forms, Characteristic equation, state transition matrix, solution to discrete state equation.	2hrs
8. Controllability, observability and stability of discrete state space models: Controllability and observability, Lyapunov stability theorem.	5hrs
9. State feedback design: Pole placement by state feedback, Set point tracking controller, Full order observer, Reduced order observer.	5hrs

References:

1. B. C. Kuo,Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
2. K. Ogata, Discrete Time Control Systems, Prentice Hall, 2/e, 1995.
3. M. Gopal,Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.
4. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems,

Program: VLSI Design & Embedded Systems	
Course Code: 17EVEE703	Course Title: **Standard Cell Design and Layout**

KLE Technological University Creating Value Leveraging Knowledge	School of Electronics & Communication Engineering **PG – VDES**

L-T-P: 2-0-1	Credits: 3	Contact Hrs:
ISA Marks: 50+100	ESA Marks: 50	Total Marks: 200
Teaching Hrs: 50		Exam Duration: 3 hrs

Chapter No. 1. Introduction IC design flows. Use of standard cell elements vs. custom design and Gate array paradigms. Introduction to memory types and construction of memory elements.	15 hrs
Chapter No. 2. Standard cell library composition and usage Types of standard cell elements. Logical and functional elements, primitives and complex macros. Sequential elements and register files. (Flip flop and latch design). Data path elements. Library size vs. usage in standard flows. Drive strength and cell families. Layout of library elements – single height, double height cells. Power Management cells.	17hrs
Chapter No. 3. Standard cell characterization Usage of standard cells by various tools. Information needed at each stage of design flow. Characterization parameters, setup and runs across PVT corners. Library representation formats. (Gate level simulation, synthesis, timing, layout, timing, LVS, DRC)	18 hrs
References: Standard cell and memory library documentation by Vendors 90nm EDK library	

Program: VLSI Design & Embedded Systems		
Course Title: Low Power VLSI Circuits		**Course Code:** 17EVEE704
L-T-P: 2-0-1	**Credits: 4**	**Contact Hours:4**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**
Teaching Hours: 40	**Examination Duration: 3 hours**	

1: Introduction to low power VLSI design: Need for Low Power VLSI Chips, sources of power dissipation. Device and Technology impact on Low Power, dynamic power dissipation in CMOS. Power Estimation.	6Hrs
2: Power analysis: Simulation Power Analysis, Spice circuits simulator, gate level logic simulator, Probabilistic power analysis	5Hrs
3: A new CMOS driver model for transient analysis and power dissipation analysis, low power design of off-chip drivers and transmission lines: a branch and bound approach.	5Hrs
4: Different levels of power optimization Low Power Design; circuit Level, logic Level, Low Power Architecture.	7Hrs
5: Floor plan design with low power considerations, optimal drivers of high-speed low power ics, retiming sequential circuits for low power	5Hrs
6: Clock Distribution: Low Power Clock distribution, single driver versus distributed buffers. Power management: Power & performance management,switching activity reduction, parallel architecture.	4Hrs
7:Algorithmic level methodologies for power reduction: Algorithm and architectural level methodologies- algorithmic level analysis & optimization, architecture level estimation and synthesis, Current trends	8Hrs

Text Books

1. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, KAP, 2002.
2. Rabaey, Pedram, “Low power design methodologies” Kluwer Academic, 1997.

Reference Books:

1. A. Chandrakasan and R. Brodersen, “Low Power CMOS Design”.
2. Sung - Mo Kang & Yosuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, TMH, 2003

(Third Edition).
3. Laung-Terng Wang, Charles E. Stroud, Nur A. Touba, “System-on-chip Test Architectures”, 2008.
4. Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley, 2000.

Program: VLSI Design & Embedded Systems		
Course Title: Analog and Mixed mode VLSI Circuits		**Course Code: 17EVEE705**
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 6**
ISA Marks: 50	**ESA Marks: 50**	
Teaching Hours: 50	**Examination Duration: 3 hours**	**Total Marks: 100**

1. Introduction to CMOS analog circuits, MOS transistor DC and AC small signal parameters from large signal model, Common source amplifier with resistive load, diode load and current source load, Source follower, Common gate amplifier, Cascode amplifier, Frequency response of amplifiers.	12 hrs
2. Current source/sink/mirror, Matching, Wilson current source, Widlar current source and Regulated Cascode current source, Differential amplifier.	08 hrs
3. Op-Amp: CMOS Op-Amp, Compensation of Op-Amp,Design of two stage Op-Amp.	06 hrs
4. Basic Current reference, and Voltage (Bandgap) reference circuits, OPAMP based references, Current mode bandgap reference.	06 hrs
5. Bidirectional analog switch, Sample and Hold circuit, Basic Comparator architecture, non-idealities (offset error, bandwidth consideration), Dynamic comparator, Sense amplifier, Current Mode Logic(Buffer and Latch)	08 hrs
6. Data Converter Fundamentals, DAC architectures and ADC architectures	10 hrs

Text Books

1. Phillip. E. Allen, Douglas R. Holberg, “CMOS Analog circuit Design” Oxford University Press, 2002.
2. Baker, Li, Boyce, “CMOS: Circuit Design, Layout and Simulation”, Prentice Hall of India, 2000

Reference Books

1. N. Weste and K. Eshranghian, Principles of CMOS VLSI Design, Addison Wesley. 1985.
2. J. Rabaey, Digital Integrated Circuits: A Design Perspective, Prentice Hall India, 1997
3. B Razavi ‘Design of Analog CMOS Integrated Circuits’ First Edition McGraw Hill 2001

Lab:

1. Design and implement Common source MOS amplifier with resistive load, diode load and current source load.
2. Design and implement a Cascode amplifier.
3. Design and implement a Simple current mirror
4. Design and implement a Differential amplifier
5. Design and implement a Operational amplifier
6. Design and implement a basic comparator
7. Design and implement a R-2R DAC

<table>
<tr><td colspan="3">Program: VLSI Design & Embedded Systems</td><td rowspan="5">Teaching Hours</td></tr>
<tr><td colspan="2">Course Title: Embedded Software Design</td><td>Course Code: 17EVEC801</td></tr>
<tr><td>L-T-P: 0-0-3</td><td>Credits: 3</td><td>Contact Hours: 6 Hrs/week</td></tr>
<tr><td>ISA Marks: 80</td><td>ESA Marks: 20</td><td>Total Marks: 100</td></tr>
<tr><td>Teaching Hours: 40 Hrs</td><td>Examination Duration:</td><td></td></tr>
<tr><td colspan="3">1. Introduction To Real-Time Operating Systems:
Introduction to OS, Introduction to real time embedded system- real time systems, characteristics of real time systems, and the future of embedded systems.
Introduction to RTOS, key characteristics of RTOS, its kernel, components in RTOS kernel, objects, scheduler, services, context switch, Scheduling types: Preemptive priority-based scheduling, Round-robin and preemptive scheduling.</td><td>08 Hrs</td></tr>
<tr><td colspan="3">2. Tasks, Semaphores and Message Queues::
A task, its structure, A typical finite state machine, Steps showing the how FSM works. A semaphore, its structure, binary semaphore, mutual exclusion (mutex) semaphore, Synchronization between two tasks and multiple tasks, Single shared-resource-access synchronization, Recursive shared-resource-access synchronization. A message queue, its structure, Message copying and memory use for sending and receiving messages, Sending messages in FIFO or LIFO order, broadcasting messages.</td><td>08 Hrs</td></tr>
<tr><td colspan="3">3. Typical RTOSs:
Study of VX works, RT Linux and Android OS and comparisons. Real time programming using RTX/free RTOS.
Applications and Common Design Problems: Embedded RTOS for Image Processing & Control Systems, and common problems encountered in these applications.</td><td>04 Hrs</td></tr>
<tr><td colspan="3">4. Introduction to embedded linux:
Embedded Linux overview: Development-Kernel architectures and device driver model-Embedded development issues-Tool chains in Embedded Linux-GNU Tool Chain (GCC,GDB, MAKE, GPROF & GCONV)- Linux Boot process</td><td>02 Hrs</td></tr>
<tr><td colspan="3">5. Boot sequence-System loading, sys linux, Lilo, grub-Root file system-Binaries required for system operation-Shared and static Libraries overview-Writing applications in user space-GUI environments for embedded Linux system</td><td>02 Hrs</td></tr>
<tr><td colspan="3">6. File system in Linux:
File system Hierarchy-File system Navigation -Managing the File system –Extended file systems-INODE-Group Descriptor-Directories-Virtual File systems-Performing File system Maintenance -Locating Files –Registering the File systems-Mounting and Un-mounting –Buffer cache-/proc file systems-Device special files</td><td>08 Hrs</td></tr>
<tr><td colspan="3">7. Program design and Analysis :
Components of Embedded system: State machines; stream oriented programming and circular buffers, queues. Models of programs: data flow graph and control flow graphs, Assembly, linking and loading. Basic compilation techniques: Statement translation, procedures, data structures. Program optimization: Expression simplification, dead code elimination, procedure inlining, loop transformations, register allocation, scheduling, instruction selection, interpreters and JIT compilers. Program level performance analysis, software performance optimization, program level energy and power analysis, analysis and optimization of program size. Program validation and testing: Clear box testing, black box testing, evaluating function tests.</td><td>08 Hrs</td></tr>
</table>

Text Books

1. Qing Li with Caroline Yao, “Real-Time Concepts for Embedded Systems”, Published by CMP Books,2011
2. Dr. K.V.K.K. Prasad, “Embedded/Real-time systems: concepts, Design & Programming”, published by dreamtech press .
3. “Embedded Systems- Architecture, Programming and Design” by Raj Kamal, TMH

References

1. Philip.A.Laplante, “Real Time System Design and Analysis”, Prentice Hall of India, 3rd Edition, April 2004.
2. “Programming embedded systems” in C and C++ Micheal Barr orielly

List of Experiments:

1. Write a ‘C’ program & demonstrate concept of Task Scheduling.
2. Write a ‘C’ program & demonstrate concept of Semaphore.
3. Write a ‘C’ program & demonstrate concept of Mailbox.
4. Write a ‘C’ program & demonstrate concept of S/W Interrupts.
5. Write a ‘C’ program & demonstrate concept of interrupts.
6. Write a ‘C’ program & demonstrate concept of Inter Task Communication.

Reference Books

1. Dr. K.V.K.K. Prasad, “Embedded/Real-time systems: concepts, Design & Programming”, published by dreamtech press.

Manual

1. LPC2148 datasheet by NXP.

LPC2148 board manual by ALS, Bangalore.

Program: VLSI Design & Embedded Systems		
Course Code: 17EVEC802	Course Title: **Advanced Digital logic Verification**	
L-T-P: 1-0-3	Credits: 4	Contact Hrs: 6hrs/week
ISA Marks: 50+100	ESA Marks: 50	Total Marks: 200
Teaching Hrs: 50		Exam Duration: 3 hrs

Chapter No. 1. Verification Concepts Concepts of verification, importance of verification, Stimulus vs Verification, functional verification, test bench generation, functional verification approaches, typical verification flow, stimulus generation, direct testing, Coverage: Code and Functional coverage, coverage plan.	10 hrs
Chapter No. 2. System Verilog – Language Constructs System Verilog constructs - Data types: two-state data, strings, arrays: queues, dynamic and associative arrays, Structs, enumerated types. Program blocks, module, interfaces, clocking blocks, modports.	10 hrs
Chapter No. 3. System Verilog – Classes & Randomization SV Classes: Language evolution, Classes and objects, Class Variables and Methods, Class instantiation, Inheritance, and encapsulation, Polymorphism. Randomization: Directed Vs Random Testing. Randomization: Constraint Driven Randomization.	12 hrs
Chapter No. 4. System Verilog – Assertions & Coverage Assertions: Introduction to Assertion based verification, Immediate and concurrent assertions. Coverage driven verification : Motivation, Types of coverage, Cover Group, Cover Point, Cross Coverage, Concepts of Binning and event sampling.	8 hrs

Chapter No. 5. Building Testbench Layered testbench architecture. Introduction to Universal Verification Methodology, Overview of UVM Base Classes and simulation phases in UVM and UVM macros. Unified messaging in UVM, UVM environment structure, Connecting DUT- Virtual Interface	10 hrs
References: 1. System Verilog LRM 2. Chris Spear, Gregory J Tumbush - SystemVerilog for verification - a guide to learning the testbench language features - Springer, 2012 **3.** Step-by-Step Functional Verification with SystemVerilog and OVM by Sasan Iman SiMantis Inc. Santa Clara, CA Spring 2008 Tools: 1. NC Verilog, NC Sim, VCSMX for System.	

Program: VLSI Design & Embedded Systems			**Teaching Hours**
Course Title: Internet of Things		**Course Code: 17EVEE801**	
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 5 Hrs/week**	
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**	
Teaching Hours: 25 Hrs	**Examination Duration:**		

1	**Introduction to Internet of Things (IoT)** Definition & Characteristics of IoT, Things in IoT, IoT protocols, IoT functional blocks, communication models and APIs.	**04 hrs**
2	**IoT Architecture** Enabling technologies: Sensors, Zigbee, Bluetooth, IoT ecosystem, Data Link protocols: IEEE 802.15.4e, IEEE 802.11.ah, DASH7, Low Power Wide Area Network (LoRaWAN).	**04 hrs**
3	**Network protocols** Routing Protocol for Low-Power and Lossy Networks (RPL), cognitive RPL (CORPL), Channel-Aware Routing Protocol (CARP), Low power Wireless Personal Area Networks (LoWPAN).	**04 hrs**
4	**Application and Security protocols** Message Queue Telemetry Transport (MQTT), MQTT for Sensor Networks, Secure MQTT, Advanced Message Queuing Protocol (AMQP), Constrained Application Protocol (CoAP), OPC UA, 6LoWPAN), Routing Protocol for Low-Power and Lossy Networks (RPL).	**04 hrs**
5	**IoT Platforms Design Methodology** IoT Design Methodology, Case Study on IoT System for Weather Monitoring etc., Basic building blocks of an IoT device, Raspberry Pi, interface (serial, SPI, I2C), IoT Operating Systems: Contiki, RIOT.	**04 hrs**
6	**Programming with Raspberry Pi** XML, JSON, SOAP and REST-based approach, WebSocket protocol.	**04 hrs**
7	**IoT prototyping** Business models, example applications: Case studies on Home automation, Cities, Environment, Energy, Agriculture, Health with emphasis on data analytics and security.	**06 hrs**

Text Books:

1. Arshdeep Bahga, Vijay Madisetti “Internet of Things (A Hands-on-Approach)” Universities Press- 2014.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”

John Wiley & Sons – 2012.

Reference Books:

1. Subhas Chandra Mukhopadhyay “Internet of Things Challenges and Opportunities” Springer- 2014.

Lab:

1. Programming with Raspberry Pi
2. Cloud service interface for data storage and retrieval
3. Performance analysis of Data link protocols, routing and application protocols
4. Open Ended Experiment with focus on data analytics and security

Program: VLSI Design & Embedded Systems		
Course Code: 17EDEE802	Course Title: **AUTOSAR**	
L-T-P : 2-0-1	Credits: 3	Contact Hrs: 3 Hours
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3

Content	Hrs
Unit – 1	
Chapter No. 1: AUTOSAR Fundamentals Evolution of AUTOSAR – Motivations and Objectives AUTOSAR consortium – Stake holders – work Packages, AUTOSAR Partnership, Goals of the partnership, Organization of the partnership, AUTOSAR specification, AUTOSAR Current development status, BSW Conformance classes: ICC1, ICC2, ICC3, and Drawbacks of AUTOSAR.	8 hrs
Chapter No. 2: AUTOSAR layered Architecture AUTOSAR Basic software, Details on the various layers , Details on the stacks Virtual Function Bus (VFB) Concept Overview of AUTOSAR Methodology , Tools and Technologies for AUTOSAR AUTOSAR Application Software Component (SW-C) ,Types of SW-components AUTOSAR Run Time Environment (RTE): RTE Generation Process: Contract Phase, Generation Phase, MCAL, IO HW Abstraction Layer, Partial Networking, Multicore, J1939 Overview, AUTOSAR Ethernet, AUTOSAR E2E Overview , AUTOSAR XCP, Metamodel , From the model to the process , Software development process.	7 hrs
Unit – 2	
Chapter No. 3: Methodology of AUTOSAR and Communication in AUTOSAR CAN Communication, CAN FD, CAN in Automation, CANape, Application Layer and RTE, intra and inter ECU communication, Client-Server Communication, Sender-Receiver, Communication, CAN Driver, Communication Manager (ComM), Overview of Diagnostics Event and Communication Manager	10 hrs
Chapter No. 4: BSW Development and Integration BSW Constituents: Memory layer, COM and Services layer, ECU abstraction, AUTOSAR, Operating system, Interfaces: Standard interface, AUTOSAR standardized interface, BSW-RTE interface,(AUTOSAR interface), BSW-ECU hardware interface, Complex device drivers and BSW module configuration, AUTOSAR Integration.	5 hrs
Unit – 3	
Chapter No. Chapter 5: Infotainment Systems in Automobiles Infotainment Systems Fundamentals: Radio, Multimedia, and Navigation: Introduction to In Vehicle Infotainment (IVI) systems, Use of operating systems in IVI , GENIVI Alliance, Tuner: AM/FM, XM/Sirrus, DAB/DMB, Software Defined Radio; Concepts of HD, radio, Ensemble, Traffic Announcements, Spread Spectrum, d. Multimedia: Types of Media; Music, Video, Podcasts, etc. Media management; Playback, Track Control, Metadata, Playlists, Categories, Trick play, Audio/Video Source Management, Navigation: Points of Interests, Routes, Waypoints, Dead Reckoning position, Traffic Info, GLONASS, GNSS, RTK, GPS, and SBAS/GBAS,INS f. Media types: CD, DVD, CDDA, USB, SDCARD, Media Formats:MP3, WMV, RealAudio/Video, QTP, Architecture – Design Patterns - Proxies, Adaptors, Interfaces, Singleton, Factory method	5 hrs
Chapter No. Chapter 6: Communication Systems in Automobiles Automotive & Consumer Electronic Communication Systems: Introduction to Bluetooth – Pairing, HFP, A2DP, PAN, PBAP, DUN, Concepts of MOST network, DLNA, AVB, Concepts of TCP/IP, Ethernet, WiFi, WiFi Direct, MyWiFi and CAN, Mirror link, Tethering	5 hrs

Text Book (List of books as mentioned in the approved syllabus) 1. Ribbens, Understanding of Automotive electronics, 6th Edition, Elsevier, 2003 2. Denton.T, Automobile Electrical and Electronic Systems, Elsevier, 3rd Edition, 2004 3. Denton.T, Advanced automotive fault diagnosis, 2000 **References** 1. Ronald K Jurgen, Automotive Electronics Handbook, 2nd Edition, McGraw-Hill, 1999 2. James D Halderman, Automotive electricity and Electronics, PHI Publication, 2000 3. Allan Bonnick, Automotive Computer Controlled Systems Diagnostic Tools and Techniques, Elsevier Science, 2001 4. Nicholas Navet , Automotive Embedded System Handbook , 2009	

Program: VLSI Design & Embedded Systems		
Course Code: 17EVEE803	Course Title: **ASIC Design**	
L-T-P: 2-0-1	Credits: 4	Contact Hrs: 50
ISA Marks: 50+100	ESA Marks: 50	Total Marks: 200
Teaching Hrs: 50		Exam Duration: 3 hrs

Content	**Hrs**
Chapter No. 1. Introduction to ASIC ASIC types, design flow, economics of ASIC	8 hrs
Chapter No. 2. ASIC design library and Logic cell Transistor as register, transistor parasitic capacitance, Logic Effort, Data Path Elements, Adders, Multiplier, Sequential logic cells, I/O cell.	10 hrs
Chapter No. 3. Logic Synthesis and Simulation Logic synthesis, FSM synthesis, structural simulation, static timing analysis, delay models	10 hrs
Chapter No. 4. ASIC Construction Floor planning and placement and routing Physical Design, System Partitioning, Estimating ASIC size, partitioning methods.	10 hrs
Chapter No. 5. Floor planning and placement and routing Floor planning tools, I/O and power planning, clock planning, placement algorithms, iterative placement improvement, Time driven placement methods. Physical Design flow global Routing, Local Routing, Detail Routing, Special Routing, Circuit Extraction and DRC.	12 hrs

Text Books:

1. M.J.S .Smith, - "Application - Specific Integrated Circuits" – Pearson Education, 2003.
2. Randall L Geiger, Phillip E. Allen, "Noel K.Strader, VLSI Design Techniques for Analog and Digital Circuits", McGraw Hill International Company, 1990.

References:

1. Jose E.France, Yannis Tsividis, "Design of Analog-Digital VLSI Circuits for Telecommunication and signal processing", Prentice Hall, 1994.
2. Andrew Brown, - "VLSI Circuits and Systems in Silicon", McGraw Hill, 1991.
3. S.D. Brown, R.J. Francis, J. Rox, Z.G. Uranesic, "Field Programmable Gate Arrays"- Kluwer Academic Publishers, 1992.
4. Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing ", McGraw Hill, 1994.
5. S. Y. Kung, H. J. Whilo House, T. Kailath, "VLSI and Modern Signal Processing", Prentice Hall, 1985.

Program: VLSI Design & Embedded Systems		
Course Code: **17EVEE804**	Course Title: **MEMS**	
L-T-P: **2-0-1**	Credits: 3	Contact Hrs: 40
ISA Marks: 50+100	ESA Marks: 50	Total Marks: 200
Teaching Hrs: 40		Exam Duration: 3 hrs

No	Content	Hrs
1	**Overview of MEMS and Microsystems** Evolution of Microsystems, Miniaturization, Applications, Working principles of Microsystems: Introduction to Micro-sensors, Micro-actuation, Example of MEMS with Micro-actuators – Airbag	5
2	**Micro-fabrication** Different structures used for MEMS devices (combination of Mechanical, electrical), How to create these structures	2
	Materials for MEMS and Microsystems: Silicon as a preferred material, Silicon compounds, GaAS, Quartz, Polymers, piezo-resistors; Machining processes (Bulk, Surface and LIGA processes). Unit processes in VLSI, Oxidation, Diffusion, Deposition, Etching, Photolithography	8
3	**Sensing Techniques and Examples:** PZR, PZE, and Capacitive sensing techniques, Modeling, Design and Analysis with example for each technique. Numerical problem for each technique.	10
4	**Case studies –** MEMS resonator, PZR accelerometer (Commercial)	5
5	**Scaling laws in miniaturization:** Introduction to scaling, scaling in geometry, electrostatic forces, EM forces, Electricity, Numerical problems.	4
6	**Modeling:** Modeling techniques: Mathematical modeling, Electrical modeling (Lumped modeling), Mechanical Modeling, MEMS CAD tools. MEMS as Inductor, Capacitor, Micro-Characterization.	6

Text Book:

"MEMS and Microsystems – Design and Manufacture", *Tai-Ran Hsu, TMH Edition*

References:

"*Micro system Design*", Stephen D. Senturia, Kluwer Academic Publishers, 2001.

Program: VLSI Design & Embedded Systems			**Teaching Hours**
Course Title: Machine learning		**Course Code: 18EVEC708**	
L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 5 Hrs/week**	
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**	
Teaching Hours: 40 Hrs	**Examination Duration: 3 hrs**		
Chapter No. 1: Introduction Introduction What is Machine Learning? Applications of Machine Learning, Types of Machine Learning: Supervised, Unsupervised and Reinforcement learning, Dataset formats, Basic terminologies.			**05 Hrs**

Chapter No. 2: Supervised Learning Linear Regression, Logistic Regression Linear Regression: Single and Multiple variables, Sum of squares error function, The Gradient descent algorithm, Application, Logistic Regression, The cost function, Classification using logistic regression, one-vs-all classification using logistic regression, Regularization.	**10 Hrs**
Chapter No. 3: Supervised Learning: Neural Network Introduction to perception learning, Implementing simple gates XOR, AND, OR using neural network. Model representation, Gradient checking, Back propagation algorithm, Multi-class classification, Application- classifying digits, SVM.	**10 Hrs**
Chapter No. 4: Unsupervised Learning: Clustering Introduction, K means Clustering, Algorithm, Cost function, Application.	**05Hrs**
Chapter No. 5: Unsupervised Learning: Dimensionality reduction Dimensionality reduction, PCA- Principal Component Analysis. Applications, Clustering data and PCA.	**05Hrs**
Chapter No. 6: Machine Learning System Design Evaluating a hypothesis, Model selection, Bias and variance, error analysis, error metrics for skewed classes. Building a Model.	**05 Hrs**

Text Book (List of books as mentioned in the approved syllabus)

1. Tom Mitchell, Machine Learning, 1, McGraw-Hill. , 1997
2. Christopher Bishop, Pattern Recognition and Machine Learning, 1, Springer, 2007

References

1. Video lectures by : Andrew Ng, Co-founder, Coursera; Adjunct Professor, Stanford University; formerly head of Baidu AI Group/Google Brain https://www.coursera.org/learn/machine-learning#
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning : Data Mining, Inference and Prediction, 2, Springer, 2009

Implementation Assignments:

1. Assignments are designed to explore the concepts like
   - Supervise and unsupervised learning,
   - Clustering,
   - Regression and estimation
2. Motivate students to take up open challenges like Kaggle, walmart, ect
3. To explore different Machine Learning Tools/ Libraries.

Program: VLSI Design & Embedded Systems			**Teaching Hours**
Course Title: Advanced Computer Architecture & Programming		**Course Code: 17EDEC801**	
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 4 Hrs/week**	
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**	
Teaching Hours: 40 Hrs	**Examination Duration: 3 hrs**		
Chapter 1: Instructions: Representing Instructions in the Computer, ARM Addressing for 32-Bit Immediates and more complex addressing modes, Parallelism and Instructions: Synchronization, Translating and Starting a Program.			**05**

Chapter 2: Arithmetic for Computers Addition and Subtraction, Multiplication, Division, Floating Point, Parallelism and Computer Architecture: Associativity.	**05**
Chapter 3: The Processor: Introduction, Logic Design Conventions, Building a Datapath , A Simple Implementation Scheme, An overview of pipelining, Pipelined datapath and control, Data Hazards: Forwarding versus Stalling, Control hazards, Exceptions , Parallelism and advanced instruction level parallelism, Real Stuff: AMD opteron pipeline, Advance Topic: an introduction to describe and model a pipeline and more pipelining illustrations.	**10**
Chapter 4: Large and Fast: Exploiting Memory Hierarchy Introduction, The Basics of Caches , Measuring and Improving Cache Performance, Virtual Memory A Common Framework for Memory Hierarchies, Virtual machines, using a finite state machine to control a simple cache, Parallelism and memory hierarchy: cache coherence ,Advanced material: Implementing cache controllers, Real Stuff: AMD Opteron & Intel Nehalem Memory hierarchies	**10**
Chapter 5: Storage, Networks, and Other Peripherals Introduction , Dependability, Reliability and Availability, Disk Storage, Flash storage, Connecting Processors, Memory, and I/O Devices, Interfacing I/O Devices to the Processor, Memory and Operating System, I/O Performance Measures: Examples from Disk and File Systems, Designing an I/O System, Parallelism and I/O: Redundant arrays of inexpensive disks, Real Stuff: Sun firwe x4150 server, Advanced topics: Networks	**10**
Chapter 6: Multicores, Multiprocessors and Clusters Introduction, Difficulty of creating parallel processing programs, Shared memory multiprocessors Clusters and other message passing multiprocessors,Hardware multithreading,SISD, MIMD, SIMD, SPMD, and vector,Introduction to graphics processing units,Introduction to multiprocessor network topologies, Multiprocessor benchmarks, Roofline : A simple performance model, Real Stuff: Benchmarking four multicores using the roofline model.	**10**

Text Books:

1. Computer Organization and Design, The hardware/Software interface, ARM edition– David A. Patterson, John L.Hennessy. 4th edition,MK publishers,2009

Reference Books:

1. Computer Architecture and Organization- John P. Hayes, 3rd edition, McGraw-Hill, 1998

Program: VLSI Design & Embedded Systems		
Course Title: System Simulation & Modeling		**Course Code: 17EDEE804**
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 4**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 26	**Examination Duration: 3 hours**	

1. **Introduction:** Simulation Examples	2 hrs
2. **Statistical models:** Discrete distribution and continuous distribution and empirical distribution(ch5)	2 hrs
3. **Queuing models:** Characteristics, steady state behavior of finite and infinite population models, network of queues. (ch6)	2 hrs
4. **Random number generation, techniques and tests, random variate generation:** Inverse transform techniques, direct transformation, convolution methods, acceptance and rejection techniques (ch7 and ch8).	5 hrs
5. **Input modeling:** Parameter estimation, goodness fit test, multivariate and time series input models (ch9).	5 hrs
6. **Verification and Validation of Simulation models:** Model building, calibration and validation (ch10).	5 hrs
7. **Output analysis for single model:** Types, stochastic nature of output data, measure of performance of output data and estimation, output analysis for terminating simulations, output analysis of steady state simulation.	5 hrs

Text Books

1. "An .Jerry Banks, John S. Carson II, Barry L Nelson and David M. Nicol, " Discrete event system simulation", PHI, III edition 2005
2. **2.**Averill M. Law and W. David Kelton, "Simulation modelling and Analysis" , Tata McGraw-Hill, **III** edition.2003

Reference books

1. Raj Jain, The Art of Computer Systems Performance Evaluation, John Wiley and Sons, Inc., 1991.
2. Edward Lazowska, John Zahorjan, Scott Graham, and Kenneth Sevcik, Computer Systems Analysis Using Network Models, Prentice-Hall Inc., 1984.
3. Leonard Kleinrock, Queueing Systems Theory- Volume I, John Wiley and Sons, Inc., 1975.
4. Morris H. DeGroot and Mark J. Schervish, Probability and Statistics (Third Edition), Addision-Wesley, 2002

Program: VLSI Design & Embedded Systems		
Course Title: System on Chip		**Course Code: 19EVEE702**
L-T-P-SS: 4-0-0-0	**Credits: 4**	**Contact Hours: 4**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 hours**	

1. **Verification and Technology Options:** Overview of verification, challenges in verification of SOC, Simulation technologies, Static technologies, Formal technologies, Physical verification and analysis, comparing verification options.	10 hrs
2. **Verification Methodology:** Verification plans, Testbench creation, Testbench migration, Verification languages, Verification device test, System level verification, Verification IP Reuse, Verification approaches.	10 hrs
3. **System level Verification:** System design, System verification, Applying the system level testbench, System testbench migration, Bluetooth SOC.	10 hrs
4. **Static Netlist Verification:** Netlist verification, Bluetooth SOC arbiter, Equivalence checking, Equivalence checking methodology, RTL to RTL verification, RTL to Gate level netlist verification, Gate level netlist to Gate level, Static timing verification and analysis.	10 hrs
5. **SOC Testing:** Importance of system on chip testing, SOC test issues, FPGA Testing: Overview of FPGA, Testing approaches, BIST of programmable resources, Embedded processor based testing.	10 hrs

Text Books

1. Prakash Rashinkar, Peter Paterson, Leena Singh, " SOC Verification –Methodology and Techniques",

Springer 2000

2. Laung-Terng Wang, Charles E. Stroud, Nur A. Touba, "System-on-chip Test Architectures", 2008.

Reference books

1. J-M. Berge, O. Levia, J. Rouillard: Hardware/Software Co-Design and Co-Verification, Kluwer, 1997.
2. M. L. Bushnell and V. D. Agrawal, Essential of Electronics Testing for Digital, Memory and Mixed-Signal Circuits, Kluwer Academic Publishers, 2001.
3. Thomas Kropf, "Introduction to Formal Hardware Verification", Springer 1999.

Program: VLSI Design & Embedded Systems		
Course Title: Automotive Electronics and Communication		**Course Code:** 19EVEC701
L-T-P: 4-0-1	**Credits: 5**	**Contact Hours: 5 hrs**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 hrs**	

Chapter No: 1.Automotive Systems, Design cycle and Automotive industry overview Overview of Automotive industry, Vehicle functional domains and their requirements, automotive supply chain, global challenges. Role of technology in Automotive Electronics and interdisciplinary design. Introduction to modern automotive systems and need for electronics in automobiles and application areas of electronic systems in modern automobiles, Introduction to power train, Automotive transmissions system ,Vehicle braking fundamentals, Steering Control, ,Overview of Hybrid Vehicles, ECU Design Cycle : Types of model development cycles(V and A) , Components of ECU, Examples of ECU on Chassis, Infotainment, Body Electronics and cluster.	9 hrs
Chapter No: 2. Embedded system in Automotive Applications & Automotive safety systems Automotive grade microcontrollers: Architectural attributes relevant to automotive applications, Automotive grade processors ex: Renesas, Quorivva, and Infineon. EMS: Engine control functions, Fuel control, Electronic systems in Engines , Development of control algorithm for EMS, Look-up tables and maps, Need of maps, Procedure to generate maps, Fuel maps/tables, Ignition maps/tables, Engine calibration, Torque table, Dynamometer testing Safety Systems in Automobiles: Active and Passive safety systems: ABS, TCS, ESP, Brake assist, Airbag systems etc.	10 hrs
Chapter No: 3. Automotive Sensors and Actuators Sensor characteristics, Sensor response, Sensor error, Redundancy of sensors in ECUs, Avoiding redundancy, Smart Nodes, Examples of sensors: Accelerometer (knock sensors),wheel speed sensors, Engine speed sensor, Vehicle speed sensor, Throttle position sensor, Temperature sensor, Mass air flow (MAF) rate sensor, Exhaust gas oxygen concentration sensor, Throttle plate angular position sensor, Crankshaft angular position/RPM sensor, Manifold Absolute Pressure (MAP) sensor. Actuators: Engine Control Actuators, Solenoid actuator, Exhaust Gas Recirculation Actuator.	9 hrs
Chapter No: 4. Automotive communication protocols Overview of Automotive communication protocols : need for communication in Automotive, overview of vehicle network architecture, need for CAN in Automotive, CAN Bus logic ,CAN frame formats, CAN bus fault confinement, LIN , Flex Ray, MOST.	10 hrs
Chapter No: 5. Advanced Driver Assistance Systems (ADAS) and Functional safety standards Advanced Driver Assistance Systems (ADAS):Examples of assistance applications: Lane Departure Warning, Collision Warning, Automatic Cruise Control, Pedestrian Protection, Headlights Control, Connected Cars technology and trends towards Autonomous vehicles. Functional Safety: Need for safety standard-ISO 26262, safety concept, safety process for product life cycle, safety by design, validation.	7 hrs
Chapter No: 6. Diagnostics Fundamentals of Diagnostics: Basic wiring system and Multiplex wiring system, Preliminary checks	5 hrs

and adjustments, Self-diagnostic system. Fault finding and corrective measures, Electronic transmission checks and Diagnosis, Diagnostic procedures and sequence, On board and off board diagnostics in Automobiles, OBDII, Concept of DTCs, DLC, MIL, Freeze Frames, History memory, Diagnostic tools, Diagnostic protocols: KWP2000 and UDS.	

Text books:

2. William B. Ribbens, Understanding Automotive Electronics, 6, Newnes Publications, 2003
3. Denton.T , Automobile Electrical and Electronic Systems, Edward Arnold , 1995

References:

6. William T.M , Automotive Electronic Systems, Heiemann Ltd., London , 1978
7. Nicholas Navet , Automotive Embedded System Handbook, CRC Press , 2009

Lab:

9. Demonstration of cut section modules: Engine, Transmission , Steering, Braking, Suspension - Automobile dept.
10. Electronic engine control system: Injection and Ignition control system Transmission trainer modules
11. Modeling an engine Vehicle model simulation with Simulink using PI CONTROLLER
12. Basic gate logic simulation and modeling using Simulink and realization on the hardware platform.
13. Seat belt warning system simulation and modeling using Simulink and realization on the hardware platform. Vehicle speed control based on the gear input simulation and modeling using Simulink and realization on the hardware platform.
14. Throttle control modeling and simulation using Simulink and realization on the hardware platform.
15. Accelerator pedal interfacing software modeling and simulation using Simulink and realization on the hardware platform.
16. Develop matlab code for stepper motor control and convert it to Simulink model and port it to embedded hardware

Program: VLSI Design & Embedded Systems		
Course Title: AUTOSAR and Infotainment		Course Code: **19EVEE707**
L-T-P : 2-0-1	Credits: 3	Contact Hrs: 4
CIA Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 24	Exam Duration: 3 hrs	

Chapter No. 1: AUTOSAR Fundamentals Evolution of AUTOSAR – Motivations and Objectives AUTOSAR consortium – Stake holders – work Packages, AUTOSAR Partnership, Goals of the partnership, Organization of the partnership, AUTOSAR specification, AUTOSAR Current development status, BSW Conformance classes: ICC1, ICC2, ICC3, and Drawbacks of AUTOSAR.	4 hrs
Chapter No. 2: AUTOSAR layered Architecture AUTOSAR Basic software, Details on the various layers , Details on the stacks Virtual Function Bus (VFB) Concept Overview of AUTOSAR Methodology , Tools and Technologies for AUTOSAR AUTOSAR Application Software Component (SW-C) ,Types of SW-components AUTOSAR Run Time Environment (RTE): RTE Generation Process: Contract Phase, Generation Phase, MCAL, IO HW Abstraction Layer, Partial Networking, Multicore, J1939 Overview, AUTOSAR Ethernet, AUTOSAR E2E Overview , AUTOSAR XCP, Metamodel , From the model to the process , Software development process.	4 hrs
Unit - 2	
Chapter No. 3: Methodology of AUTOSAR and Communication in AUTOSAR CAN Communication, Application Layer and RTE, intra and inter ECU communication, Client-Server Communication, Sender-Receiver, Communication, CAN Driver, Communication Manager (ComM), Overview of Diagnostics Event and Communication Manager	4 hrs

Chapter No. 4: BSW Development and Integration BSW Constituents: Memory layer, COM and Services layer, ECU abstraction, AUTOSAR, Operating system, Interfaces: Standard interface, AUTOSAR standardized interface, BSW-RTE interface,(AUTOSAR interface), BSW-ECU hardware interface, Complex device drivers and BSW module configuration, AUTOSAR Integration.	4 hrs
Chapter No. Chapter 5: Infotainment Systems in Automobiles Infotainment Systems Fundamentals: Radio, Multimedia, and Navigation: Introduction to In Vehicle Infotainment (IVI) systems, Use of operating systems in IVI , GENIVI Alliance, Tuner: AM/FM, XM/Sirrus, DAB/DMB, Software Defined Radio; Concepts of HD, radio, Ensemble, Traffic Announcements, Spread Spectrum, d. Multimedia: Types of Media; Music, Video, Podcasts, etc. Media management; Playback, Track Control, Metadata, Playlists, Categories, Trick play, Audio/Video Source Management, Navigation: Points of Interests, Routes, Waypoints, Dead Reckoning position, Traffic Info, GLONASS, GNSS, RTK, GPS, and SBAS/GBAS,INS f. Media types: CD, DVD, CDDA, USB, SDCARD, Media Formats:MP3, WMV, RealAudio/Video, QTP, Architecture – Design Patterns - Proxies, Adaptors, Interfaces, Singleton, Factory method	4 hrs
Chapter No. Chapter 6: Communication Systems in Automobiles Automotive & Consumer Electronic Communication Systems: Introduction to Bluetooth – Pairing, HFP, A2DP, PAN, PBAP, DUN, Concepts of MOST network, DLNA, AVB, Concepts of TCP/IP, Ethernet, WiFi, WiFi Direct, MyWiFi and CAN, Mirror link, Tethering	4 hrs

Text Books (List of books as mentioned in the approved syllabus)

Ronald K. Jurgen, Infotainment systems, 2007, SAE International, 2007

Program: Digital Electronics		
Course Title: Principles and Practices of Engineering Education		**Course Code:** 15ECRC701
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 3**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 hrs**	

1. **Fundamental Principles of Teaching and Learning**	**8 Hours**
2. **Learning Styles and Theories**	**8 Hours**
3. **Instructional Design Models and Technology Enhanced Learning**	**8 Hours**
4. **Assessment and Evaluation**	**8 Hours**
5. **Engineering Learning Modules**	**8 Hours**

Program: Digital Electronics		
Course Title: Fault diagnoses and testing for VLSI circuits		**Course Code:** 15EDEC708
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 hours**	

1. Threshold Logic: Introduction, Synthesis of threshold networks.	5 hrs
2. Reliable Design And Fault Diagnosis: Different types of Faults, Fault Detection in Combinational Circuits, Fault Location Experiments, Different approaches used in fault diagnosis of Combinational Circuits, Failure Tolerant Design, Quadded Logic.	15 hrs
3. Capabilities, Minimization and Transformation of Sequential Machines: Finite State Model (FSM) used in Machine design, Capabilities & Limitations of finite state machines, State equivalence and machine minimization, Simplification of incompletely specified machines.	10hrs
4. Structure of Sequential Machines: State Assignments Using Partitions, The Lattice of Closed Partitions, Reduction of the Output Dependency, Input Independence and Autonomous Clocks, Covers and Generation of Closed Partitions by State Splitting, Information Flow in Sequential Machines, Machine Decomposition.	10 hrs
5. State-Identification And Fault-Detection Fault detection / location Experiments, Machine Identification, Fault-Detection Experiments, Design of Diagnosable Machines, Second Algorithm for the Design of Fault-Detection Experiments, Fault-Detection Experiments for Machines, Which have no Distinguishing Sequences.	10 hrs

Text Books

1. Khohavi ZVI Switching and Finite Automata Theory, 2ed., TMH, 1999,

Reference Books:

2. Samuel Lee Digital Circuits & Logic Design, PHI, 1990

Program: Digital Electronics		
Course Title: Real Time Embedded System lab		**Course Code:** 15EDEP706
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2**
CIE Marks: 80	**SEE Marks: 20**	**Total Marks: 100**
Lab Hours: 20	**Examination Duration: 3 hours**	

Experiments

I Advanced Embedded Systems

1. Use any EDA (Electronic Design Automation) tool to learn the Embedded Hardware Design and for PCB design.
2. Familiarize the different entities for the circuit diagram design.
3. Familiarize with the layout design tool, building blocks, component placement, routings, design rule checking etc.

II Embedded Programming Concepts (RTOS)

4. Create „n" number of child threads. Each thread prints the message " I"m in thread number …" and sleeps for 50 ms and then quits. The main thread waits for complete execution of all the child threads and then quits. Compile and execute in Linux.
5. Implement the multithread application satisfying the following :

   i.Two child threads are crated with normal priority.

   ii.Thread 1 receives and prints its priority and sleeps for 50ms and then quits.

   iii.Thread 2 prints the priority of the thread 1 and rises its priority to above normal and retrieves the new priority of thread 1, prints it and then quits.

   iv The main thread waits for the child thread to complete its job and quits.
6. Implement the usage of anonymous pipe with 512 bytes for data sharing between parent and child processes using handle inheritance mechanism.
7. Test the program below using multithread application-

   i.The main thread creates a child thread with default stack size and name Child_Thread".

   ii. The main thread sends user defined messages and the message „WM_QUIT" randomly to the child thread.

   iii. The child thread processes the message posted by the main thread and quits when it receives the „WM_QUIT" message.

   iv. The main thread checks the termination of the child thread and quits when the child thread complete its execution.

   v. The main thread continues sending the random messages to the child thread till the „WM_QUIT" message is sent to child thread.

   vi. The messaging mechanism between the main thread and child thread is synchronous.

Program: Digital Electronics		
Course Title: Data Structure using C		**Course Code:** 17EDEC701
L-T-P: 0-0-1	**Credits: Audit**	**Contact Hours: 2**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 25	**Examination Duration: -**	

Chapter 01:C language features Pointers revisited, Strings, Structures – Basics, Structures and functions, Arrays of structures, Pointers to structures, Self Referential Structures, Unions and bit fields, Files.	5 Hrs
Chapter 02:Stacks and Queues Definition, Representation and Applications of stack. Definitions, representation and applications of linear, circular, queues, multiple queues, priority queue. Recursion	5 Hrs
Chapter 03:Lists Linked lists, singly, doubly, circular lists, definitions, representations. Implementation of list operations, applications – polynomial addition, addition of long integers. Linked stacks, Linked Queues	5 Hrs

Chapter 04:Trees Binary trees – Definitions, traversals (recursive and iterative versions), Building and searching, Threaded Binary trees, Trees and their applications Exchange sorts, Selection and tree sorts, Merge and radix sorts	5 Hrs 5 Hrs
Text Book 1. Aaron M. Tenenbaum, et al, Data Structures using C, II Edition, PHI, 2006 2. Horowitz, Sahani, Anderson-Feed, Fundamentals of Data Structures in C, II Edition, University, 2008 **References** 1. E Balaguruswamy, The ANSI C programming Language, II Edition, PHI, 2010 2. Yashavant Kanetkar, Data Structures through C, II Edition, BPB public, 2010 3. Richard F. Gilberg, Behrouz A. Forouzan , Data Structures: A Pseudocode Approach With C, II Edition, Course Tec, 2009	
Lab: **1.** Programs on Pointer concepts. **2.** Programs on string handling functions, structures union And bit-files. **3.** Programming on files **4.** Programming on stacks data structures **5.** Programs on implementation of different queue data structures. **6.** Programs on implementation of different types of Linked lists **7.** Programs on Implementation of trees **8.** Programs to implement different sorting techniques. **9.** Programming on graph **10.** Programming on hashing tables **11.** Design and implement stack queue data structures **12.** Design and implement linked list data structures **13.** project	

Program: Digital Electronics		
Course Title: Analog and Digital Circuits		**Course Code:** 17EDEC702
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 4**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**
Teaching Hours: 24	**Examination Duration: -**	

Applications of theorems. RLC Circuits Combinational circuits and Sequential circuits Case study Devices: Diodes, MOSFETs. Diode circuits: clipping, clamping, rectifier. Design of BJT and MOSFET single-and multi-stage amplifiers, Feedback amplifier, Oscillator, Op-amp linear & non linear applications.	8 Hrs
Digital Circuits Combinational Circuits: Adder, encoder & decoder, MUX& DEMUX, Comparator. Sequential Circuits: Latches, Flip Flops, Shift Registers, Design of Synchronous counters and Asynchronous counters.	8 Hrs
Conventional control systems: R-H Stability criterion, Root locus, Bode plots and Nyquist stability criterion. **Tools: Simulink, MATLAB, Proteus, Pspics, Cadence, LabView, Microcap, OrCAD**	8 Hrs

Reference Books:	
1. A.S. Sedra & K.C. Smith, Microelectronic Circuits, 5th Edition, Oxford Univ. Press, 1999 2. Jacob Millman and Christos Halkias, Integrated Electronics, McGraw Hill, 3. John M Yarbrough, Digital Logic Applications and Design, Thomson Learning, 2001 4. David A. Bell, Electronic Devices and Circuits, 4th edition, PHI publication, 2007 5. Grey, Hurst, Lewis and Meyer, Analysis and design of analog integrated circuits, 4th edition. 6. Charles H Roth, Jr; Fundamentals of Logic Design, Thomson Learning, 2004. 7. Zvi Kohavi, Switching and Finite Automata Theory, 2ed, TMH 8. Ogata, Modern Control Theory, 4th ed, PHI.	
Lab: **Analog Electronics Lab** 1. Study & analyze Diode Clipping and Clamping (single/double ended) circuits. 2. Implement the RLC circuit to study the transient response. 3. Design an Amplifier using MOSFET and determine its gain, input & output impedance. 4. To implement an amplifier with negative feedback & show the effect of negative feedback on input impedance; output impedance & gain of the amplifier using MOSFET. 5. Study of transformer-less Class B push pull power amplifier and determination of its conversion efficiency 6. Design an amplifier for an unity gain and high input impedance using MOSFET. Suggest suitable techniques to increase the input impedance and verify the same. **Digital Circuits lab** 1. Design and implement BCD adder and Subtractor using 4 bit parallel adder 2. Design and implement n bit magnitude comparator using 4- bit comparators 3. Design and implement Ring and Johnson counter using shift register. 4. Design and implement 8 bit ALU. **Tools: Simulink, Proteus, Pspics, Cadence, LabView, Microcap, OrCAD, MATLAB.**	

Program: I Semester Master of Technology (Digital Electronics)			**Teaching Hours**
Course Title: Principles of Embedded Systems		**Course Code: 17EDEC703**	
L-T-P: 0-0-2	**Credits: 2**	**Contact Hours: 4 Hrs/week**	
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**	
Teaching Hours: 42 Hrs	**Examination Duration:**		
1. Introduction to embedded system: Introduction, Classification of Embedded System, Major Application Areas, Purpose of Embedded System. Characteristics and quality attributes of Embedded Systems, Design Metric and Optimizing the metrics.			**06 Hrs**
2. Typical Embedded Systems: Core of Embedded System-processor fundamentals, up vs uc, risc vs cisc, vonneumann vs Harvard, 8051 controller architecture and programmer model, Memory, Sensor and Actuators, Communication Network, Embedded Firmware			**08 Hrs**
3. Low Level programming Concepts: Addressing Modes, Instruction Set and Assembly Language programming(ALP), Developing, Building, and Debugging ALP's			**08 Hrs**
4. Middle Level Programming Concepts: Cross Compiler, Embedded C language implementation, programming, & debugging, Differences from ANSI-C, Memory Models, Use of directives, Functions, Parameter passing and return types			**02 Hrs**

5. On-Chip Peripherals Study, Programming, and Application: Ports: Input/Output, Timers & Counters, UART, Interrupts	**08 Hrs**
6. External Interfaces Study, Programming and Applications : LEDS, Switches(Momentary type, Toggle type), Seven Segment Display: (Normal mode, BCD mode, Internal Multiplexing & External Multiplexing), LCD (8bit, 4bit, Busy flag, custom character generation), Keypad Matrix, Stepper Motor, DC Motor	**10 Hrs**

Text Books

1. Introduction to Embedded Systems 1E by Shibu K V.
2. Kenneth J. Ayala ; "The 8051 Microcontroller Architecture, Programming & Applications" 2e, Penram International, 1996 / Thomson Learning 2005
3. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; "The 8051 Microcontroller and Embedded Systems – using assembly and C "- PHI, 2006 / Pearson, 2006

References

1. Embedded System Design: A Unified Hardware/Software Introduction – Frank Vahid, Tony Givargis, John Wiley & Sons, Inc.2002
2. Predko ; "Programming and Customizing the 8051 Microcontroller" –, TMH
3. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2005

Program: Digital Electronics			**Teaching Hours**
Course Title: Fundamentals of signal processing		**Course Code: 17EDEC704**	
L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 5 Hrs/week**	
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**	
Teaching Hours: 40 Hrs	**Examination Duration: 3 hrs**		
Chapter No. 1. Introduction Definition of a signals and systems, classification of signals, basic operation on signals, elementary signals, Systems viewed as Interconnection of operation, properties of systems.			**08 Hrs**
Chapter No. 2. Time-Domain representation for LTI systems Convolution, Impulse response representation, convolution sum and convolution integral. Properties of impulse response representation.			**08 Hrs**
Chapter No. 3. Discrete Fourier Transforms Discrete Fourier Transforms (DFT): Frequency domain sampling and reconstruction of discrete time signals. DFT as a linear transformation, its relationship with other transforms. use of DFT in linear filtering, overlap-save and overlap-add method. Fast-Fourier-Transform (FFT) need for efficient computation of the DFT (i.e. FFT algorithms). Radix-2 FFT algorithm for the computation of DFT and IDFT: decimation-in-time and decimation-in-frequency algorithms. Composite FFT.			**08 Hrs**
Chapter No. 4. Design of digital filters Design of digital filters: Considerations and Characteristics of practical digital filters. Design of digital filters: symmetric and anti symmetric FIR filters, design of linear phase FIR filters using windowing method- Rectangular, Hamming, Hanning, Bartlet and Kaiser windows. Design of linear phase FIR filters using frequency sampling technique.			**08Hrs**
Chapter No. 5. Design of IIR filters from analog filters Design of IIR filters from analog filters: Approximation of derivative, Impulse invariance method, bilinear transformation. Characteristics of commonly used Analog Filters: Butterworth and Chebyshev			**08Hrs**

filters. Frequency transformation in the digital domain	

Text Books

1. Simon Haykin and Barry Van Veen, Signals and Systems, second, John Wiley & Sons, 2002
2. Proakis & Monalakis, Digital signal processing Principles Algorithms & Applications, 4th Edition, PHI, New Delhi, 2007

References

1. Alan V. Oppenheim, Alan S Willsky and S. Hamid Nawab, Signals and Systems, second, Pearson Education Asia, 1997

Implementation Assignments:

1. Implementation assignments are designed using Python. Ex:
   - Generate different elementary signals and perform mathematical operations on them.
   - Calculate N point DFT and find the cost of computation, justify the use of FFT algorithms to calculate DFT.
   - Design Filters (FIR/IIR) for given specifications.
2. Explore the feature of SDR to build signal processing applications like,
   - Noise cancellation
   - Audio file editing

Program: I Semester Master of Technology (Digital Electronics)			Teaching Hours
Course Title: RISC Architectures		**Course Code: 17EDEC706**	
L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 3 Hrs/week**	
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**	
Teaching Hours: 46 Hrs	**Examination Duration:**		
1. The 32 bit RISC Architecture: The Acorn RISC machine, Architectural inheritance, Architecture of ARM7TDMI, ARM programmers model, ARM development tools, 3 stage pipeline ARM organization, ARM instruction execution.			**06 Hrs**
2. 32 bit Instruction set: Data processing instruction, Branch instruction, Load store instruction, Software interrupt instruction, Program status register instruction, Conditional execution, Example programs, 16bit Instruction set-The Thumb programmer model, ARM-Thumb interworking, other branch instructions, Data processing instructions, Single/Multiple register load store instruction, Stack operation, Software interrupt instructions, example programs.			**06 Hrs**
3. Exception Handling: Introduction, Interrupts, error conditions, processor exception sequence, the vector table, Exception handlers, Exception priorities, Procedures for handling exceptions.			**04 Hrs**
4. Memory Hierarchy Design: Cache basics, Miss rate and penalty, Cache Hierarchy, Memory Organizations, Memory Hierarchy.			**06 Hrs**
5. Pipelining: Linear pipeline processor, Nonlinear pipeline processor, Instruction pipeline design, Branch handling techniques, Arithmetic pipeline design, Computer arithmetic principles, Static arithmetic pipeline, Multifunctional arithmetic pipeline.			**08 Hrs**
6. Cortex M4 : Functional description, programmer's model, memory protection unit, nested vectored interrupt			**06 Hrs**

controller.	
7. Multi-Core Architectures : Introduction to Intel Architecture, How an Intel Architecture System works, Basic Components of the Intel Core 2 Duo Processor: The CPU, Memory Controller, I/O Controller.	**07 Hrs**
8. Current Trends in Intel Architectures and Applications : Seminar on current trends in Intel Architectures	**03 Hrs**

Text Books

1. "ARM System- on-Chip Architecture" by 'Steve Furber', LPE, Second Edition.
2. "ARM Assembly Language fundamentals and Techniques" by William Hohl, CRC press, 2009.
3. D. A. Patterson and J. L. Hennessey "Computer Organization and Design", Morgan , Kaufmann,2002
4. H. Jonathan Chao and Bin Liu, "High performance switches & routers", Wiley Interscience, 2007.
5. Kai Hwang, " Advanced Computer Architecture – TMH – 1993
6. Web resources for Example Architectures of INTEL and Texas Instruments: http:/ /download.intel.com/design/intarch/papers/321087.pdf

References

1. Kai Hwang, Faye A. Briggs, Computers Architecture and Parallel Processing – MGH – 1985
2. David E Culler, Jaswinder Pal Singh, Anoop Gupta "Parallel Computer Architecture", Harcourt Asia Pte Ltd 2000
3. Stalling W." Computer Organization and Architecture- Designing for performance" PHI,2005
4. D. Sima,T. Fountain, P.Kasuk," Advanced Computer Architecture-A Design Space Approach" Addisson Wesley,1997.
5. M. J. Flynn,"Computer Architecture, Pipelined And Parallel Processing", Narosa Publications, 1998.

List of Experiments:

1. Write an ALP to verify data transfer w.r.t memory to achieve following
   i. 8 bit data transfer
   ii. 16 bit data transfer
   iii. 32 bit data transfer
2. Write an ALP for Tables and lists to do following:
   i. Add an entry to a list
   ii. Remove an element from the queue
3. Write an ALP to pass parameters to a subroutine.
   i. Ascending order
   ii. Descending order
4. Write a 'C' program & demonstrate an interfacing of Alphanumeric LCD 2X16 panel to LPC2148Microcontroller
5. Write a 'C' program & demonstrate concept of Interrupts interface to LPC2148 Microcontroller.
6. Write a 'C' program & demonstrate an interfacing of DAC to LPC2148 Microcontroller.
7. Write a 'C' program & demonstrate an interfacing of UART to LPC2148 Microcontroller.
8. Write a 'C' program & demonstrate an interfacing of ADC to LPC2148 Microcontroller.
9. Write a 'C' program & demonstrate an interfacing of RTC to LPC2148 and read time, date and year.
10. Write a 'C' program & demonstrate interface I2C to LPC2148
11. Develop a code for college bell system. (Use the following interfaces LCD, RTC and Buzzer).

Reference Books

1. "ARM System- on-Chip Architecture" by 'Steve Furber", LPE, Second Edition.
2. "Embedded Systems- Architecture, Programming and Design" by Raj Kamal, TMH
3. Dr. K.V.K.K. Prasad, "Embedded/Real-time systems: concepts, Design & Programming", published by dreamtech press.

Manual

1. LPC2148 datasheet by NXP.
2. LPC2148 board manual by ALS, Bangalore.

Program: I Semester Master of Technology (Digital Electronics)		**Teaching Hours**
Course Title: Machine learning	**Course Code: 17EDEC705**	

L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 5 Hrs/week**	
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**	
Teaching Hours: 40 Hrs	**Examination Duration: 3 hrs**		
Chapter No. 1: Introduction Introduction What is Machine Learning? Applications of Machine Learning, Types of Machine Learning: Supervised, Unsupervised and Reinforcement learning, Dataset formats, Basic terminologies.			**05 Hrs**
Chapter No. 2: Supervised Learning Linear Regression, Logistic Regression Linear Regression: Single and Multiple variables, Sum of squares error function, The Gradient descent algorithm, Application, Logistic Regression, The cost function, Classification using logistic regression, one-vs-all classification using logistic regression, Regularization.			**10 Hrs**
Chapter No. 3: Supervised Learning: Neural Network Introduction to perception learning, Implementing simple gates XOR, AND, OR using neural network. Model representation, Gradient checking, Back propagation algorithm, Multi-class classification, Application- classifying digits, SVM.			**10 Hrs**
Chapter No. 4: Unsupervised Learning: Clustering Introduction, K means Clustering, Algorithm, Cost function, Application.			**05Hrs**
Chapter No. 5: Unsupervised Learning: Dimensionality reduction Dimensionality reduction, PCA- Principal Component Analysis. Applications, Clustering data and PCA.			**05Hrs**
Chapter No. 6: Machine Learning System Design Evaluating a hypothesis, Model selection, Bias and variance, error analysis, error metrics for skewed classes. Building a Model.			**05 Hrs**

Text Book (List of books as mentioned in the approved syllabus)

1. Tom Mitchell, Machine Learning, 1, McGraw-Hill. , 1997
2. Christopher Bishop, Pattern Recognition and Machine Learning, 1, Springer, 2007

References

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning : Data Mining, Inference and Prediction, 2, Springer, 2009

Implementation Assignments:

1. Assignments are designed to explore the concepts like
   - Supervise and unsupervised learning,
   - Clustering,
   - Regression and estimation
2. Motivate students to take up open challenges like Kaggle, walmart, ect

Program: Digital Electronics			**Teaching Hours**
Course Title: Electronic System Design		**Course Code: 17EDEC707**	
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours:6 Hrs/week**	
ISA Marks: 100	**ESA Marks:**	**Total Marks: 100**	

Teaching Hours: 25 Hrs	**Examination Duration: --**		
To level specifications, Block level specifications, Timing of micro architecture, Verification and test plan, Schematic capture			05 Hrs
Simulation, Advanced simulation, Signal Integrity			05 Hrs
PCB layout- Floor planning, component pre planning, PCB printing- 2 layer			05 Hrs
Functionality and performance check, Failure analysis, Validation and system integration			05 Hrs
System Analysis			05 Hrs

References

1. A. S Sedra and KC Smith, Microelectronic circuits, Oxford, 1998.
2. G.L. Ginsberg, Printed Circuit Design, McGraw Hill, 1991.

Program: Digital Electronics		
Course Title: Automotive Electronics		**Course Code:** 17EDEC708
L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 5**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**
Teaching Hours: 40	**Examination Duration: 3 hrs**	

Chapter No. 1. Automotive Fundamentals Overview Introduction to Automotive Industry and Modern Automotive Systems Vehicle classifications and specifications need for electronics in automobiles, Application areas of electronics in the automobiles Four Stroke Cycle, Engine Control, Ignition System, Spark plug, Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System.	8Hrs
Chapter No. 2. Sensors and Actuators Oxygen (O2/EGO) Sensors, Throttle Position Sensor (TPS), Engine Crankshaft Angular Position (CKP) Sensor, Magnetic Reluctance Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Hall effect Position Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure (MAP) Sensor Strain gauge, Engine Coolant Temperature (ECT) Sensor, Knock Sensor, Throttle angle sensor, Fuel Injector Actuator, Ignition Actuator	7Hrs
Chapter No. 3. Electronic Engine Control Engine parameters, variables, Engine Performance terms, Electronic Fuel Control System, Electronic Ignition control, Idle sped control, EGR Control	5Hrs
Chapter No. 4. Vehicle Motion Control and Safety Systems Cruise Control, Antilock Brake System (ABS), Electronic Steering Control, Power Steering, Traction Control, Electronic Stability Program.	6Hrs
Chapter No:5. Automotive communication protocols Overview of Automotive communication protocols : CAN, LIN .	3Hrs
Chapter No. 6. Advanced Driver Assistance Systems (ADAS) Lane Departure Warning, Collision Warning, Automatic Cruise Control, Pedestrian Protection, Headlights Control, Connected Cars technology and trends towards Autonomous vehicles.	5Hrs
Chapter No. 7. Automotive safety standards ISO26262 and Diagnostics Functional Safety: Need for safety standard-ISO 26262, safety concept, safety process for product life cycle, safety by design, validation.	6Hrs

Fundamentals of Diagnostics: Basic wiring system and Multiplex wiring system, Preliminary checks and adjustments, Self-diagnostic system. Fault finding and corrective measures, OBD & off board diagnostic.	

Text books:

1. Denton.T – Automobile Electrical and Electronic Systems, Edward Arnold publication, 1995.

References:

1. William T.M – Automotive Electronic Systems, Heiemann Ltd., London ,1978.
2. Nicholas Navet – Automotive Embedded System Handbook, CRC Press, 2009.
3. BOSCH Automotive Handbook, Wiley Publications, 8th Edition, 2011.
4. Co-Verification of hardware & software for ARM SoC Design – Jason.R.Andrews, Newnes Publications, 2004.
5. Hardware Software co-design of embedded systems, F.Balarin, Kluwer Academic Oublishers, 1987.

Lab:

1. Demonstration of cut section modules: Engine, Transmission , Steering, Braking, Suspension - Automobile dept.
2. Electronic engine control system: Injection and Ignition control system Transmission trainer modules
3. Modeling an engine Vehicle model simulation with Simulink using PI CONTROLLER
4. Basic gate logic simulation and modeling using Simulink and realization on the hardware platform.
5. Seat belt warning system simulation and modeling using Simulink and realization on the hardware platform. Vehicle speed control based on the gear input simulation and modeling using Simulink and realization on the hardware platform.
6. Throttle control modeling and simulation using Simulink and realization on the hardware platform.
7. Accelerator pedal interfacing software modeling and simulation using Simulink and realization on the hardware platform.
8. Develop matlab code for stepper motor control and convert it to Simulink model and port it to embedded hardware

Course Code: **17EDEC710**	Course Title: **Multimedia and Signal Processing**		Teaching Hrs: **40 Hrs**
L-T-P: **3-0-1**	Credits: **4**		Contact Hrs: **5 Hrs/week**
ISA Marks: **50+100**	Exam Duration: **3Hrs**	ESA Marks: **50**	Total Marks: 2**00**

1	**Introduction to Multimedia:** Multimedia and Hyper media, WWW, overview of multimedia software tools.	**02Hrs**
2	**Graphics and Image representation:** Graphics / Image data types, Popular file formats.	**02Hrs**
3	**Fundamental concepts in video:** Types of video signals, analog video, digital video.	**06Hrs**
4	**Basics of digital audio:** Digitization of sound, MIDI, Quantization and transmission of audio.	**05Hrs**
5	**Lossless compression algorithms:** Introduction, run-length coding, variable length coding, dictionary based coding, arithmetic coding, lossless image compression.	**05Hrs**
6	**Lossy compression algorithms:** Introduction, distortion measures, quantization, transform coding, wavelet based coding, wavelet packets, embedded zero tree of wavelet coefficients.	**06Hrs**
7	**Image compression standards:** The JPEG standard, The JPEG2000 standard, The JPEG-LS standard, Bi level image compression standard.	**06Hrs**
8	**Basics video compression techniques:** Overview, video compression based on motion compensation, H.261 .	**08Hrs**

Text books

1. Ze-Nian Li & Mark S Drew**, "**Fundamentals of multimedia**"**, Pearson Education, 2004.

References books

1. Ralf Steinmetz & Kalra Nahrstedt , "Multimedia: Computing, Communication & Applications", Pearson Education, 2004
2. K R Rao, Zoran S Bojkovic, Dragord A Milovanvic, Pearson education, "Multimedia communication systems: Techniques, Standards, & Networks",. Second Indian reprint, 2004.

Course Code: 17EDEC711	**Course Title: Data Communication**	
L-T-P: 3-0-1	**Credits: 4**	**Contact Hrs: 5 hrs/week**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**
Teaching Hrs: 40		**Exam Duration: 03 hrs**

Content	Hrs
Chapter No. 1. Computer Networks and the Internet What is Internet? The Network Edge, the network Core,delay -loss—throughput in packet switched	06hrs

networks. Protocol layers (OSI layers) and their service models.	
Chapter No. 2. Application Layer Principles of network applications,the web and HTTP,DHCP, file transfer-FTP,electronic mail in the internet,DNS,peer-to-peer applications.	10hrs
Chapter No. 3. Transport Layer Introduction and transport-layer services-relationship between transport and network layers - overview of the transport layer in the internet, multiplexing and de multiplexing, connectionless transport: UDP, principles of reliable data transfer, connection oriented transport TCP, TCP congestion control.	08hrs
Chapter No. 4. Network layer Introduction, virtual circuit and datagram networks, what's inside router? The Internet protocol (IP): forwarding and addressing in the internet, routing algorithms, routing in the internet, broadcast and multi cast routing.	08hrs
Chapter No. 5. The link layer: Links, Access networks, and LANs Introduction to the link layer, error-detection and correction techniques, multiple access links and protocols, switched local area networks, link virtualization: A network as a link layer, data center networking.	08hrs

Text Book (List of books as mentioned in the approved syllabus)

1. Kurose & Ross, Computer Networking A Top-Down Approach, 6th editionPEARSON, 2013.

References

1. Larry L. Peterson & Bruce S. Davie, Computer Networks: A Systems Approach, 4th edition, Elsevier, 2004
2. Behrouz A. Forouzan, Data Communication and Networking, 4th edition, TMG, 2002

Lab:

1. Introduction to Hardware components and Ethernet LAN set up.
2. Introduction to socket programming
3. Implementation of FTP
4. Implementation of error control techniques.
5. Implementation of flow control ARQs
6. Introduction to Network operating system.
7. Subnet design
8. VLAN setup
9. OSPF and RIP configuration and performance analysis
10. eBGP and iBGP configuration and performance analysis

Text Book

1. Kurose & Ross, Computer Networking A Top-Down Approach, 6th editionPEARSON, 2013.

References

1. Cisco networking academy, https://www.netacad.com/
2. Juniper networking academy, https://learningportal.juniper.net/

Course Code: **17EDEE701**	Course Title: **Image and Video Processing**		Teaching Hrs: **40 Hrs**
L-T-P: **2-0-1**	Credits: **3**		Contact Hrs: **4 Hrs/week**
ISA Marks: **50+100**	Exam Duration: **3Hrs**	ESA Marks: **50**	Total Marks: **100**

1	**Introduction**: 2D systems, Mathematical Preliminaries- FT, Z-transform, Optical and Modulation Transfer Functions (OTF and MTF). Matrix theory, Image perception: Light, Luminance, Brightness, Contrast, MTF of the visual system, Visibility function, Monochrome Vision Models, Fidelity criteria, Color Representation, Color Vision Models, Temporal Properties of Vision.	2 hrs
2	**Image sampling and Quantization:** 2D Sampling theory, Quantization, Optimal Quantizer, Compander and Visual Quantization.	2 hrs
3	**Image Transforms:** 2D orthogonal and unitary transforms, DFT, DCT, Harr, KLT	4hrs
4	**Image Enhancement**: Histograms Modeling, Spatial operations, Transform operations, Multispectral Image Enhancement,	4hrs
5	**Image Filtering and Restoration:** Image Observation Models, Inverse and Weiner filtering , Frequency Domain Filters. Smoothing Splines and Interpolation.	4hrs
6	**Basics of Video:** Analog Video, Digital Video	2 hrs
7	**Two dimensional motion estimation:** Optical flow methods**,** Block based methods, Bayesian methods**.**	7 hrs

Text books

1. Jain, A.K., Fundamentals of Digital Image Processing, 3rd Edision, Pearson Education (Asia) 2013
2. A. Murat Tekalp, Digital Video processing Pearson Education (Asia) Pte. Ltd.
3. Li and, Z. Drew, M.S. Fundamentals of Multimedia, Pearson Education (Asia) Pte. Ltd,. 2010.

References books

1. Gonzalez, Rafael C., Woods, Richard E. and Eddins Steven L., Digital Image Processing Using Matlab, Pearson Education (Asia) Pvt. Ltd.,
2. Al. Bovik, Essential guide to Video Processing, Academic Press

Program: Digital Electronics		
Course Title: Digital Control Systems		**Course Code:** 17EDEE702
L-T-P: 2-0-1	**Credits: 4**	**Contact Hours: 5**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 hours**	

1. Introduction to digital control: Introduction, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction.	4hrs
2. Modeling discrete-time systems by pulse transfer function: Z-transform, Mapping of Z-plane to z-plane, Pulse transfer function , Pulse transfer function of closed loop system, Sampled signal flow graph.	3hrs
3. Time response of discrete systems: Transient and steady state responses, Time response parameters of a prototype second order system.	5hrs
4. Stability analysis of discrete time systems: Jury stability test, Stability analysis using bi-linear transformation.	
5. Design of sampled data control systems: Root locus method, Controller design using root locus, Root locus based controller ,design using MATLAB, Nyquist stability criteria, Bode plot.	5hrs
6. Deadbeat response design :Design of digital control systems with deadbeat response, Practical issues with deadbeat response design, Sampled data control systems with deadbeat response.	5hrs
7. Discrete state space model: Introduction to state variable model, Various canonical forms, Characteristic equation, state transition matrix, solution to discrete state equation.	6hrs
8. Controllability, observability and stability of discrete state space models: Controllability and observability, Lyapunov stability theorem.	2hrs
9. State feedback design: Pole placement by state feedback, Set point tracking controller, Full order observer, Reduced order observer.	5hrs
	5hrs

References:

1. B. C. Kuo,Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
2. K. Ogata, Discrete Time Control Systems, Prentice Hall, 2/e, 1995.
3. M. Gopal,Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.
4. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems,

Program: Digital Electronics		
Course Title: Multi Sensor Data Fusion		**Course Code:** 17EDEE703
L-T-P: 2-0-1	**Credits: 4**	**Contact Hours: 5**
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 hours**	

Chapter 1: **Fundamentals of Multi-sensor data Fusion system** Multi sensor data fusion strategies, formal framework, catastrophic fusion, Smart sensor, logical sensor, interface file system, sensor observation, sensor characteristics, sensor-sensor properties, Fusion node, simple fusion network, network topology.	**08 hours**
Chapter 2: Sensor modeling Mathematical modeling, Baye's Theorem, sensor modeling, sensor data normalization, Neural network approach.	**06 hours**
Chapter 3: State –Estimation techniques State-space approach: State-space representation, Time response of homogeneous systems: Kalman filtering: practical aspects of Kalman filtering, Applications	**06 hours**
Chapter 4: Representation Spatial-temporal transformation, geographical information system, common representation format, subspace methods, multiple training sets.	**06 hours**
Chapter 5: Spatial alignment Image registration, resample/interpolation, pair wise transformation, image fusion, mosaic image. .	**06 hours**
Chapter 6: Temporal alignment & Semantic alignment Dynamic time warping, dynamic programming, video compression, assignment matrix for semantic alignment, clustering algorithms	**06 hours**
Chapter 7: Data fusion: Bayesian Interface, Bayesian analysis, probability model, Posteriori distribution, Model selection, computation.	**06 hours**
Chapter 8: **Sensor management:** Hierarchical classification, sensor management techniques.	**06 hours**
Text Books: 1. H.B.Mitchell, "Multi Sensor Data Fusion, An Introduction" Springer,2007. 2. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House,Boston. 3. Madan Gopal, Digital control and state variables methods 2nd edition, PHI 4. Pattern Recognition and Machine Learning" by Christopher M. Bishop	

Program: III Semester Master of Technology (Digital Electronics)			**Teaching Hours**
Course Title: Embedded Software Design		**Course Code: 17EDEC801**	
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours: 6 Hrs/week**	
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**	
Teaching Hours: 40 Hrs	**Examination Duration:**		

1. Introduction To Real-Time Operating Systems: Introduction to OS, Introduction to real time embedded system- real time systems, characteristics of real time systems, and the future of embedded systems. Introduction to RTOS, key characteristics of RTOS, its kernel, components in RTOS kernel, objects, scheduler, services, context switch, Scheduling types: Preemptive priority-based scheduling, Round-robin and preemptive scheduling.	**08 Hrs**
2. Tasks, Semaphores and Message Queues:: A task, its structure, A typical finite state machine, Steps showing the how FSM works. A semaphore, its structure, binary semaphore, mutual exclusion (mutex) semaphore, Synchronization between two tasks and multiple tasks, Single shared-resource-access synchronization, Recursive shared-resource-access synchronization. A message queue, its structure, Message copying and memory use for sending and receiving messages, Sending messages in FIFO or LIFO order, broadcasting messages.	**08 Hrs**
3. Typical RTOSs: Study of VX works, RT Linux and Android OS and comparisons. Real time programming using RTX/free RTOS. Applications and Common Design Problems: Embedded RTOS for Image Processing & Control Systems, and common problems encountered in these applications.	**04 Hrs**
4. Introduction to embedded linux: Embedded Linux overview: Development-Kernel architectures and device driver model-Embedded development issues-Tool chains in Embedded Linux-GNU Tool Chain (GCC,GDB, MAKE, GPROF & GCONV)- Linux Boot process	**02 Hrs**
5. Boot sequence-System loading, sys linux, Lilo, grub-Root file system-Binaries required for system operation-Shared and static Libraries overview-Writing applications in user space-GUI environments for embedded Linux system	**02 Hrs**
6. File system in Linux: File system Hierarchy-File system Navigation -Managing the File system –Extended file systems-INODE-Group Descriptor-Directories-Virtual File systems-Performing File system Maintenance - Locating Files –Registering the File systems-Mounting and Un-mounting –Buffer cache-/proc file systems-Device special files	**08 Hrs**
7. Program design and Analysis : Components of Embedded system: State machines; stream oriented programming and circular buffers, queues. Models of programs: data flow graph and control flow graphs, Assembly, linking and loading. Basic compilation techniques: Statement translation, procedures, data structures. Program optimization: Expression simplification, dead code elimination, procedure inlining, loop transformations, register allocation, scheduling, instruction selection, interpreters and JIT compilers. Program level performance analysis, software performance optimization, program level energy and power analysis, analysis and optimization of program size. Program validation and testing: Clear box testing, black box testing, evaluating function tests.	**08 Hrs**

Text Books

1. Qing Li with Caroline Yao, "Real-Time Concepts for Embedded Systems", Published by CMP Books,2011
2. Dr. K.V.K.K. Prasad, "Embedded/Real-time systems: concepts, Design & Programming", published by dreamtech press .
3. "Embedded Systems- Architecture, Programming and Design" by Raj Kamal, TMH

References

1. Philip.A.Laplante, "Real Time System Design and Analysis", Prentice Hall of India, 3rd Edition, April 2004.
2. "Programming embedded systems" in C and C++ Micheal Barr orielly

List of Experiments:

1. Write a 'C' program & demonstrate concept of Task Scheduling.
2. Write a 'C' program & demonstrate concept of Semaphore.
3. Write a 'C' program & demonstrate concept of Mailbox.
4. Write a 'C' program & demonstrate concept of S/W Interrupts.
5. Write a 'C' program & demonstrate concept of interrupts.
6. Write a 'C' program & demonstrate concept of Inter Task Communication.

Reference Books

1. Dr. K.V.K.K. Prasad, "Embedded/Real-time systems: concepts, Design & Programming", published by dreamtech press.

Manual

1. LPC2148 datasheet by NXP.

LPC2148 board manual by ALS, Bangalore.

Program: Digital Electronics		
Course Title: Automotive Communication		Course Code: 17EDEC802
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3
CIA Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 40	Exam Duration: 3 hrs	

Content	**Hrs**
Chapter No. 1: Controller Area Network Introduction to CAN, Basic Concepts, Message Transfer, Frame Types, Message Validation, Error Handling, Fault Confinement, Bit Timing Requirements, Increasing Can Oscillator Tolerance, Protocol Modifications.	15 hrs
Chapter No. 2: Local Interconnect Network Overview of LIN protocol, LIN Workflow ,LIN Physical Layer ,LIN Communication, Synchronization of the LIN nodes, LIN Message & Scheduling, Message Types, Status & Network Management, Introduction to LIN slave diagnostics , Introduction to LIN slave configuration.	5 hrs
Chapter No. 3: Flexray Communication protocol Introduction to Fleray, Basic Concepts, Message Transfer, Static and dynamic data transmission, Flexray BUS, FlexRay controller states, Frame Types, Message Validation, Error Handling, Fault Confinement, Bit Timing Requirements, Fault tolerant and time triggered services implemented in hardware.	5 hrs
Chapter No. 4: Media oriented system transport protocol Technology background, MOST25, MOST50, MOST150, MOST topology, different masters in MOST	5 hrs

network, control channel, synchronous channel, asynchronous channel, MOST application frame work, addressing scheme, frame formats,	
Chapter No. Chapter 5: Keyword 2000 protocol Overview of KWP protocol, KWP Workflow , Physical topology ,message structure, frame format,	5 hrs
Chapter No. Chapter 6: SENT, I2C, SPI and UART Overview about SENT , I2C, SPI and UART, frame formats, application of I2C, SPI, SENT and UART in automotive.	5 hrs
Text Books (List of books as mentioned in the approved syllabus) Ronald K. Jurgen, Infotainment systems, 2007, SAE International, 2007	

Program: III Semester Master of Technology (Digital Electronics)			**Teaching Hours**
Course Title: Internet of Things		**Course Code: 17EDEE801**	
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 5 Hrs/week**	
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 200**	
Teaching Hours: 25 Hrs	**Examination Duration:**		

1	**Introduction to Internet of Things (IoT)** Definition & Characteristics of IoT, Things in IoT, IoT protocols, IoT functional blocks, communication models and APIs.	**04 hrs**
2	**IoT Architecture** Enabling technologies: Sensors, Zigbee, Bluetooth, IoT ecosystem, Data Link protocols: IEEE 802.15.4e, IEEE 802.11.ah, DASH7, Low Power Wide Area Network (LoRaWAN).	**04 hrs**
3	**Network protocols** Routing Protocol for Low-Power and Lossy Networks (RPL), cognitive RPL (CORPL), Channel-Aware Routing Protocol (CARP), Low power Wireless Personal Area Networks (LoWPAN).	**04 hrs**
4	**Application and Security protocols** Message Queue Telemetry Transport (MQTT), MQTT for Sensor Networks, Secure MQTT, Advanced Message Queuing Protocol (AMQP), Constrained Application Protocol (CoAP), OPC UA, 6LoWPAN), Routing Protocol for Low-Power and Lossy Networks (RPL).	**04 hrs**
5	**IoT Platforms Design Methodology** IoT Design Methodology, Case Study on IoT System for Weather Monitoring etc., Basic building blocks of an IoT device, Raspberry Pi, interface (serial, SPI, I2C), IoT Operating Systems: Contiki, RIOT.	**04 hrs**
6	**Programming with Raspberry Pi** XML, JSON, SOAP and REST-based approach, WebSocket protocol.	**04 hrs**
7	**IoT prototyping** Business models, example applications: Case studies on Home automation, Cities, Environment, Energy, Agriculture, Health with emphasis on data analytics and security.	**06 hrs**

Text Books:

1. Arshdeep Bahga, Vijay Madisetti "Internet of Things (A Hands-on-Approach)" Universities Press- 2014.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols"

John Wiley & Sons – 2012.

Reference Books:

1. Subhas Chandra Mukhopadhyay "Internet of Things Challenges and Opportunities" Springer- 2014.

Lab:

1. Programming with Raspberry Pi
2. Cloud service interface for data storage and retrieval
3. Performance analysis of Data link protocols, routing and application protocols
4. Open Ended Experiment with focus on data analytics and security

Course Code: 17EDEE802	Course Title: **AUTOSAR**	
L-T-P : 2-0-1	Credits: 3	Contact Hrs: 3 Hours
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3

Content	**Hrs**
Unit - 1	
Chapter No. 1: AUTOSAR Fundamentals Evolution of AUTOSAR – Motivations and Objectives AUTOSAR consortium – Stake holders – work Packages, AUTOSAR Partnership, Goals of the partnership, Organization of the partnership, AUTOSAR specification, AUTOSAR Current development status, BSW Conformance classes: ICC1, ICC2, ICC3, and Drawbacks of AUTOSAR.	8 hrs
Chapter No. 2: AUTOSAR layered Architecture AUTOSAR Basic software, Details on the various layers , Details on the stacks Virtual Function Bus (VFB) Concept Overview of AUTOSAR Methodology , Tools and Technologies for AUTOSAR AUTOSAR Application Software Component (SW-C) ,Types of SW-components AUTOSAR Run Time Environment (RTE): RTE Generation Process: Contract Phase, Generation Phase, MCAL, IO HW Abstraction Layer, Partial Networking, Multicore, J1939 Overview, AUTOSAR Ethernet, AUTOSAR E2E Overview , AUTOSAR XCP, Metamodel , From the model to the process , Software development process.	7 hrs
Unit - 2	
Chapter No. 3: Methodology of AUTOSAR and Communication in AUTOSAR CAN Communication, CAN FD, CAN in Automation, CANape, Application Layer and RTE, intra and inter ECU communication, Client-Server Communication, Sender-Receiver, Communication, CAN Driver, Communication Manager (ComM), Overview of Diagnostics Event and Communication Manager	10 hrs
Chapter No. 4: BSW Development and Integration BSW Constituents: Memory layer, COM and Services layer, ECU abstraction, AUTOSAR, Operating system, Interfaces: Standard interface, AUTOSAR standardized interface, BSW-RTE interface,(AUTOSAR interface), BSW-ECU hardware interface, Complex device drivers and BSW module configuration, AUTOSAR Integration.	5 hrs
Unit - 3	
Chapter No. Chapter 5: Infotainment Systems in Automobiles Infotainment Systems Fundamentals: Radio, Multimedia, and Navigation: Introduction to In Vehicle	5 hrs

Infotainment (IVI) systems, Use of operating systems in IVI , GENIVI Alliance, Tuner: AM/FM, XM/Sirrus, DAB/DMB, Software Defined Radio; Concepts of HD, radio, Ensemble, Traffic Announcements, Spread Spectrum, d. Multimedia: Types of Media; Music, Video, Podcasts, etc. Media management; Playback, Track Control, Metadata, Playlists, Categories, Trick play, Audio/Video Source Management, Navigation: Points of Interests, Routes, Waypoints, Dead Reckoning position, Traffic Info, GLONASS, GNSS, RTK, GPS, and SBAS/GBAS,INS f. Media types: CD, DVD, CDDA, USB, SDCARD, Media Formats:MP3, WMV, RealAudio/Video, QTP, Architecture – Design Patterns - Proxies, Adaptors, Interfaces, Singleton, Factory method	
Chapter No. Chapter 6: Communication Systems in Automobiles Automotive & Consumer Electronic Communication Systems: Introduction to Bluetooth – Pairing, HFP, A2DP, PAN, PBAP, DUN, Concepts of MOST network, DLNA, AVB, Concepts of TCP/IP, Ethernet, WiFi, WiFi Direct, MyWiFi and CAN, Mirror link, Tethering	5 hrs
Text Book (List of books as mentioned in the approved syllabus) 1. Ribbens, Understanding of Automotive electronics, 6th Edition, Elsevier, 2003 2. Denton.T, Automobile Electrical and Electronic Systems, Elsevier, 3rd Edition, 2004 3. Denton.T, Advanced automotive fault diagnosis, 2000 **References** 1. Ronald K Jurgen, Automotive Electronics Handbook, 2nd Edition, McGraw-Hill, 1999 2. James D Halderman, Automotive electricity and Electronics, PHI Publication, 2000 3. Allan Bonnick, Automotive Computer Controlled Systems Diagnostic Tools and Techniques, Elsevier Science, 2001 4. Nicholas Navet , Automotive Embedded System Handbook , 2009	

Program: III Semester Master of Technology (Digital Electronics)			**Teaching Hours 04 hrs**
Course Title: Multirate Signal Processing		**Course Code: 17EDEE803**	
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 5 Hrs/week**	
ISA Marks: 50+100	**ESA Marks: 50**	**Total Marks: 100**	
Teaching Hours: 25 Hrs	**Examination Duration: 3 hrs**		

Chapter No. 1. Introduction Definition of a signals and systems, classification of signals, basic operation on signals, elementary signals, Systems viewed as Interconnection of operation, properties of systems.	**08 Hrs**
Chapter No. 2. Time-Domain representation for LTI systems Convolution, Impulse response representation, convolution sum and convolution integral. Properties of impulse response representation.	**08Hrs**
Chapter No. 3. Discrete Fourier Transforms Discrete Fourier Transforms (DFT): Frequency domain sampling and reconstruction of discrete time signals. DFT as a linear transformation, its relationship with other transforms. use of DFT in linear filtering, overlap-save and overlap-add method. Fast-Fourier-Transform (FFT) need for efficient computation of the DFT (i.e. FFT algorithms). Radix-2 FFT algorithm for the computation of DFT and IDFT: decimation-in-time and decimation-in-frequency algorithms. Composite FFT.	**08 Hrs**
Chapter No. 4. Design of digital filters Design of digital filters: Considerations and Characteristics of practical digital filters. Design of digital filters: symmetric and anti symmetric FIR filters, design of linear phase FIR filters using windowing method-Rectangular, Hamming, Hanning, Bartlet and Kaiser windows. Design of linear phase FIR filters using frequency sampling technique.	**08Hrs**

Chapter No. 5. Design of IIR filters from analog filters Design of IIR filters from analog filters: Approximation of derivative, Impulse invariance method, bilinear transformation. Characteristics of commonly used Analog Filters: Butterworth and Chebyshev filters. Frequency transformation in the digital domain	**08Hrs**

Text Books

3. Simon Haykin and Barry Van Veen, Signals and Systems, second, John Wiley & Sons, 2002
4. Proakis & Monalakis, Digital signal processing Principles Algorithms & Applications, 4th Edition, PHI, New Delhi, 2007

References

2. Alan V. Oppenheim, Alan S Willsky and S. Hamid Nawab, Signals and Systems, second, Pearson Education Asia, 1997

<u>Implementation Assignments</u>:

3. Implementation assignments are designed using Python. Ex:
   - Generate different elementary signals and perform mathematical operations on them.
   - Calculate N point DFT and find the cost of computation, justify the use of FFT algorithms to calculate DFT.
   - Design Filters (FIR/IIR) for given specifications.
4. Explore the feature of SDR to build signal processing applications like,
   - Noise cancellation
   - Audio file editing

Program: Digital Electronics			**Teaching Hours**
Course Title: Advanced Computer Architecture & Programming		**Course Code: 17EDEC801**	
L-T-P: 2-0-1	**Credits: 3**	**Contact Hours: 4 Hrs/week**	
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**	
Teaching Hours: 40 Hrs	**Examination Duration: 3 hrs**		
Chapter 1: Instructions: Representing Instructions in the Computer, ARM Addressing for 32-Bit Immediates and more complex addressing modes, Parallelism and Instructions: Synchronization, Translating and Starting a Program.			**05**
Chapter 2: Arithmetic for Computers Addition and Subtraction, Multiplication, Division, Floating Point, Parallelism and Computer Architecture: Associativity.			**05**
Chapter 3: The Processor: Introduction, Logic Design Conventions, Building a Datapath , A Simple Implementation Scheme, An overview of pipelining, Pipelined datapath and control, Data Hazards: Forwarding versus Stalling, Control hazards, Exceptions , Parallelism and advanced instruction level parallelism, Real Stuff: AMD opteron pipeline, Advance Topic: an introduction to describe and model a pipeline and more pipelining illustrations.			**10**

Chapter 4: Large and Fast: Exploiting Memory Hierarchy Introduction, The Basics of Caches , Measuring and Improving Cache Performance, Virtual Memory A Common Framework for Memory Hierarchies, Virtual machines, using a finite state machine to control a simple cache, Parallelism and memory hierarchy: cache coherence ,Advanced material: Implementing cache controllers, Real Stuff: AMD Opteron & Intel Nehalem Memory hierarchies	**10**
Chapter 5: Storage, Networks, and Other Peripherals Introduction , Dependability, Reliability and Availability, Disk Storage, Flash storage, Connecting Processors, Memory, and I/O Devices, Interfacing I/O Devices to the Processor, Memory and Operating System, I/O Performance Measures: Examples from Disk and File Systems, Designing an I/O System, Parallelism and I/O: Redundant arrays of inexpensive disks, Real Stuff: Sun firwe x4150 server, Advanced topics: Networks	**10**
Chapter 6: Multicores, Multiprocessors and Clusters Introduction, Difficulty of creating parallel processing programs, Shared memory multiprocessors Clusters and other message passing multiprocessors,Hardware multithreading,SISD, MIMD, SIMD, SPMD, and vector,Introduction to graphics processing units,Introduction to multiprocessor network topologies, Multiprocessor benchmarks, Roofline : A simple performance model, Real Stuff: Benchmarking four multicores using the roofline model.	**10**
Text Books: 1. Computer Organization and Design, The hardware/Software interface, ARM edition– David A. Patterson, John L.Hennessy. 4th edition,MK publishers,2009	
Reference Books: 1. Computer Architecture and Organization- John P. Hayes, 3rd edition, McGraw-Hill, 1998	

Program: Digital Electronics			
Course Title: AUTOSAR and Infotainment Systems		Course Code: **17EDEE801**	
L-T-P : 2-0-1	Credits: 3	Contact Hrs: 4	
CIA Marks: 50	SEE Marks: 50	Total Marks: 100	
Teaching Hrs: 24	Exam Duration: 3 hrs		
Chapter No. 1: AUTOSAR Fundamentals Evolution of AUTOSAR – Motivations and Objectives AUTOSAR consortium – Stake holders – work Packages, AUTOSAR Partnership, Goals of the partnership, Organization of the partnership, AUTOSAR specification, AUTOSAR Current development status, BSW Conformance classes: ICC1, ICC2, ICC3, and Drawbacks of AUTOSAR.			4 hrs
Chapter No. 2: AUTOSAR layered Architecture AUTOSAR Basic software, Details on the various layers , Details on the stacks Virtual Function Bus (VFB) Concept Overview of AUTOSAR Methodology , Tools and Technologies for AUTOSAR AUTOSAR Application Software Component (SW-C) ,Types of SW-components AUTOSAR Run Time Environment (RTE): RTE Generation Process: Contract Phase, Generation Phase, MCAL, IO HW Abstraction Layer, Partial Networking, Multicore, J1939 Overview, AUTOSAR Ethernet, AUTOSAR E2E Overview , AUTOSAR XCP, Metamodel , From the model to the process , Software development process.			4 hrs
Unit - 2			
Chapter No. 3: Methodology of AUTOSAR and Communication in AUTOSAR			4 hrs

CAN Communication, Application Layer and RTE, intra and inter ECU communication, Client-Server Communication, Sender-Receiver, Communication, CAN Driver, Communication Manager (ComM), Overview of Diagnostics Event and Communication Manager	
Chapter No. 4: BSW Development and Integration BSW Constituents: Memory layer, COM and Services layer, ECU abstraction, AUTOSAR, Operating system, Interfaces: Standard interface, AUTOSAR standardized interface, BSW-RTE interface,(AUTOSAR interface), BSW-ECU hardware interface, Complex device drivers and BSW module configuration, AUTOSAR Integration.	4 hrs
Chapter No. Chapter 5: Infotainment Systems in Automobiles Infotainment Systems Fundamentals: Radio, Multimedia, and Navigation: Introduction to In Vehicle Infotainment (IVI) systems, Use of operating systems in IVI , GENIVI Alliance, Tuner: AM/FM, XM/Sirrus, DAB/DMB, Software Defined Radio; Concepts of HD, radio, Ensemble, Traffic Announcements, Spread Spectrum, d. Multimedia: Types of Media; Music, Video, Podcasts, etc. Media management; Playback, Track Control, Metadata, Playlists, Categories, Trick play, Audio/Video Source Management, Navigation: Points of Interests, Routes, Waypoints, Dead Reckoning position, Traffic Info, GLONASS, GNSS, RTK, GPS, and SBAS/GBAS,INS f. Media types: CD, DVD, CDDA, USB, SDCARD, Media Formats:MP3, WMV, RealAudio/Video, QTP, Architecture – Design Patterns - Proxies, Adaptors, Interfaces, Singleton, Factory method	4 hrs
Chapter No. Chapter 6: Communication Systems in Automobiles Automotive & Consumer Electronic Communication Systems: Introduction to Bluetooth – Pairing, HFP, A2DP, PAN, PBAP, DUN, Concepts of MOST network, DLNA, AVB, Concepts of TCP/IP, Ethernet, WiFi, WiFi Direct, MyWiFi and CAN, Mirror link, Tethering	4 hrs
Text Books 1. Ronald K. Jurgen, Infotainment systems, 2007, SAE International, 2007	

Program: Digital Electronics		
Course Title: Automotive Electronics and Communication		**Course Code:** 19EDEC701
L-T-P: 4-0-1	**Credits: 5**	**Contact Hours: 5 hrs**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 hrs**	

Chapter No: 1.Automotive Systems, Design cycle and Automotive industry overview Overview of Automotive industry, Vehicle functional domains and their requirements, automotive supply chain, global challenges. Role of technology in Automotive Electronics and interdisciplinary design. Introduction to modern automotive systems and need for electronics in automobiles and application areas of electronic systems in modern automobiles, Introduction to power train, Automotive transmissions system ,Vehicle braking fundamentals, Steering Control, ,Overview of Hybrid Vehicles, ECU Design Cycle : Types of model development cycles(V and A) , Components of ECU, Examples of ECU on Chassis, Infotainment, Body Electronics and cluster.	9 hrs
Chapter No: 2. Embedded system in Automotive Applications & Automotive safety systems Automotive grade microcontrollers: Architectural attributes relevant to automotive applications, Automotive grade processors ex: Renesas, Quorivva, and Infineon. EMS: Engine control functions, Fuel control, Electronic systems in Engines , Development of control algorithm for EMS, Look-up tables and maps, Need of maps, Procedure to generate maps, Fuel maps/tables, Ignition maps/tables, Engine calibration, Torque table, Dynamometer testing Safety Systems in Automobiles: Active and Passive safety systems:	10 hrs

ABS, TCS, ESP, Brake assist, Airbag systems etc.	
Chapter No: 3. Automotive Sensors and Actuators Sensor characteristics, Sensor response, Sensor error, Redundancy of sensors in ECUs, Avoiding redundancy, Smart Nodes, Examples of sensors: Accelerometer (knock sensors),wheel speed sensors, Engine speed sensor, Vehicle speed sensor, Throttle position sensor, Temperature sensor, Mass air flow (MAF) rate sensor, Exhaust gas oxygen concentration sensor, Throttle plate angular position sensor, Crankshaft angular position/RPM sensor, Manifold Absolute Pressure (MAP) sensor. Actuators: Engine Control Actuators, Solenoid actuator, Exhaust Gas Recirculation Actuator.	9 hrs
Chapter No: 4. Automotive communication protocols Overview of Automotive communication protocols : need for communication in Automotive, overview of vehicle network architecture, need for CAN in Automotive, CAN Bus logic ,CAN frame formats, CAN bus fault confinement, LIN , Flex Ray, MOST.	10 hrs
Chapter No: 5. Advanced Driver Assistance Systems (ADAS) and Functional safety standards Advanced Driver Assistance Systems (ADAS):Examples of assistance applications: Lane Departure Warning, Collision Warning, Automatic Cruise Control, Pedestrian Protection, Headlights Control, Connected Cars technology and trends towards Autonomous vehicles. Functional Safety: Need for safety standard-ISO 26262, safety concept, safety process for product life cycle, safety by design, validation.	7 hrs
Chapter No: 6. Diagnostics Fundamentals of Diagnostics: Basic wiring system and Multiplex wiring system, Preliminary checks and adjustments, Self-diagnostic system. Fault finding and corrective measures, Electronic transmission checks and Diagnosis, Diagnostic procedures and sequence, On board and off board diagnostics in Automobiles, OBDII, Concept of DTCs, DLC, MIL, Freeze Frames, History memory, Diagnostic tools, Diagnostic protocols: KWP2000 and UDS.	5 hrs

Text books:

2. William B. Ribbens, Understanding Automotive Electronics, 6, Newnes Publications, 2003
3. Denton.T , Automobile Electrical and Electronic Systems, Edward Arnold , 1995

References:

6. William T.M , Automotive Electronic Systems, Heiemann Ltd., London , 1978
7. Nicholas Navet , Automotive Embedded System Handbook, CRC Press , 2009

Lab:

9. Demonstration of cut section modules: Engine, Transmission , Steering, Braking, Suspension - Automobile dept.
10. Electronic engine control system: Injection and Ignition control system Transmission trainer modules
11. Modeling an engine Vehicle model simulation with Simulink using PI CONTROLLER
12. Basic gate logic simulation and modeling using Simulink and realization on the hardware platform.
13. Seat belt warning system simulation and modeling using Simulink and realization on the hardware platform. Vehicle speed control based on the gear input simulation and modeling using Simulink and realization on the hardware platform.
14. Throttle control modeling and simulation using Simulink and realization on the hardware platform.
15. Accelerator pedal interfacing software modeling and simulation using Simulink and realization on the hardware platform.
16. Develop matlab code for stepper motor control and convert it to Simulink model and port it to embedded hardware

I Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **17EPMC701**		Course Title: **Manufacturing Systems and Automation**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Introduction: Production system facilities, Manufacturing support systems, Automation in production system, Automation principles and strategies, Manufacturing operations, Basic elements of an automated system, Advanced automation functions, Levels of automation.

Material handling and identification technology: Considerations in material handling system design, 10 principles of material handling, Automated guided vehicle systems, Conveyor systems, Analysis of material transport system, Automated storage systems, Engineering analysis of storage system. Components of manufacturing systems, Single station automated cells, Applications and analysis of single station cells.

Flexible manufacturing systems: FMS components, FMS application and benefits, Quantitative analysis of flexible manufacturing systems.

Industrial control systems: Sensors, Actuators, Drives and other control system components. Electro-hydraulic and Electro-pneumatics in manufacturing automations

Machine vision systems: Importance of machine vision system in manufacturing automation.

Role of microcontrollers in manufacturing automation system: Microcontroller architecture, interfacing sensors and actuators with microcontroller for industrial automation, Microcontroller programming.

PLCs in manufacturing automation: Application of programmable logic controllers in manufacturing automation, PLC basic and advanced ladder logic programming using RsLogix and CoDeSys format, Usage of timers, counters, sequencing, and interlocking, latching, master control relay for developing programs for manufacturing automation. Temperature control, valve sequencing, conveyor belt control, control of a process etc

SCADA for Automation: Elements of SCADA, Benefits of SCADA, Applications, Types of SCADA systems, Features and functions of SCADA, Building applications using SCADA for manufacturing automation.

References:

1. Grover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education Asia.
2. Grover M.P., Weiss M. M., Nagel R.N. and Odrey N.G., "Industrial Robotics, Technology, Programming and Applications", Mc Graw Hill Book Publications.
3. Krishna Kant, "Computer Based Industrial Control" PHI.
4. W. Bolton , "Programmable Logic Controllers" Fifth Edition, Elsevier
5. Vijay R. Jadhav, "Programmable Logic Controller", Second Edition, Khanna Publishers.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **17EPMC702**		Course Title: **CNC Machining Technology and Additive Manufacturing**
L-T-P**: 4-0-0**	Credits: **4**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

Structure of CNC Machine Tools: Evolution of CNC Technology, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre-features and applications, Automatic tool changers and Multiple pallet system, types of control systems, CNC controllers, characteristics, interpolators. CNC Machine building, structural details, configuration and design, guide ways –Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, rack and pinion, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings. Swarf removal and safety considerations

Drives and Tooling Systems: Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives – stepper motor, servo principle, DC and AC servomotors, Open loop and closed loop control, Tooling requirements for turning and machining centres, Qualified, semi qualified and preset tooling, coolant fed tooling system, work holding devices for rotating and fixed work parts, modular fixtures.

Feedback systems and Adaptive Control: Axis measuring system, Adaptive control with constraints (ACC), Adaptive control with optimization (ACO), Geometric adaptive control (GAC), Variable gain AC systems-stability problem, estimator algorithm, variable gain algorithm,

CNC Programming: G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre, generation of CNC codes from CAM packages. Basics of APT

Additive manufacturing (AM) processes: AM based rapid prototyping (RP) Systems like Stereo-lithography, Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM), 3-D Printing, and LENS etc.

Role of additive manufacturing and rapid prototyping in product design and development: Solid modeling techniques for additive manufacturing with comparison, advantages and disadvantages, Process planning for rapid prototyping, STL file generation, Slicing and various slicing, procedures.

Accuracy issues in additive manufacturing: Properties of metallic and nonmetallic additive manufactured surfaces, Stress induced in additive manufacturing (AM) processes. Surface roughness problem in rapid prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost etc.

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References:

1. Radhakrishnan P “Computer Numerical Control Machines”, New Central Book Agency.
2. Rao P.N., “CAD/CAM”, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Pabla, B.S. & Adithan, M. “CNC Machines”, New Age Publishers, New Delhi.
4. Warren. S. Seames, “Computer Numerical Control: Concepts and Programming”, 4th edition, Delmar Thomson Learning Inc.
5. James Madison, “CNC Machining Hand Book”, Industrial Press Inc.
6. Peter Smid, “CNC Programming Hand book”, Industrial Press Inc., 2000
7. Chua, C.K., Leong, K.F., “Rapid Prototyping: Principles and Applications in Manufacturing”, John Wiley and Sons Inc.
8. Hopkinson, N., Hague, R.J.M. and Dickens, P.M., “Rapid Manufacturing and Industrial Revolution for the Digital Age”, John Wiley and Sons Ltd, Chichester.
9. Gebhardt, A., “Rapid Prototyping”, Hanser Gardner Publications, Inc., Cincinnati.
10. Noorani, R., “Rapid Prototyping: Principles and Applications”, John Wiley & Sons, Inc., New Jersey.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMC703**		Course Title: **Operations Management**
L-T-P: **3-1-0**	Credits: **4**	Contact Hrs: **5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**	Tutorial Hrs: **24 hrs**	Exam Duration: **3 hrs**

Overview of Operations Management: Functional sub systems of organizations, Systems concept of production, Types of production systems, Productivity, Strategic management.

Product Design and Analysis: New product development, Process Planning and Design, Value analysis and Value Engineering, Standardization, Simplification, Make or Buy decisions, Ergonomic considerations in Product design.

Capacity Planning and Investment Decisions: Capacity planning and strategies, Investment formulas and comparisons of alternatives.

Forecasting: Nature and use of forecasting, Measures of Forecasting, Factors affecting forecasting, Types and models of forecasting

Facility Location and Layout: Factors influencing plant location, location evaluation methods, Different types of lay outs for operations and production, arrangement of facilities within the department, CRAFT, ALDEP, CORELAP etc.

Aggregate Planning and Master Production Scheduling: Nature of aggregate planning, Methods of aggregate planning, Approaches to aggregate planning –graphical, empirical and optimization, Development of MPS, MRP-I and MRP-II.

Inventory Analysis and Control: ABC inventory systems, Inventory models, EOQ models for purchased and manufactured parts, lot sizing techniques.

Scheduling and Controlling: Objectives in scheduling, Major steps involved, Information systems linkages in production planning and control , Production control in repetitive, batch / flow shop and job shop scheduling environment - SPT, EDD, WMFT.

Project Planning and Management: Phases of project planning, Evolution of network planning techniques - Critical Path Method (CPM) and Project Evolution and Review Technique (PERT), Crashing of project network, Project scheduling with constrained resources –Graphical Evolution and Review Technique (GERT), Project monitoring, Line balance.

References

1. Vollman.T.E., "Manufacturing Planning & Control Systems", McGraw-Hill.
2. Dilworth. B. James., "Operations Management – Design, Planning and Control for Manufacturing and services", McGraw Hill Inc., New Delhi.
3. Bedworth D.D., "Integrated production control systems: management, analysis,design", John Wiley & sons, New York
4. Panneerselvam. R., "Production and Operations Management", Prentice Hall.
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Tutorial Exercises:

Forecasting, Facility location and layout, Aggregate Planning and MPS, Inventory Control, Scheduling and Controlling, Project Planning and Management

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMC704**		Course Title: **World Class Manufacturing**
L-T-P**: 4-0-0**	Credits: **4**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

World-Class Manufacturing (WCM): Manufacturing Excellence and Competitiveness, Meaning of World-class, Competing in World markets, WCM Techniques, Review of frameworks for WCM, Justification of WCM, Case studies.

Lean Manufacturing: Elements of Lean manufacturing: Stability, Standardized work, Just in time, Jidoka, Hoshin Planning, The culture of lean, Implementation of Lean manufacturing: Implementation framework for the Lean manufacturing, DEMAIC process, Case studies.

Total Productive Maintenance (TPM): An overview of various maintenance systems, Evolution of TPM, Productivity and TP, OEE, TPM and TQC, Small Group Activities, Pillars of TQM, Kobsu-Kaizen (Continuous Improvement), Jishu-Hozen (Autonomous maintenance), Planned Maintenance System, Skill upgrade training, Initial control (Equipment Life cycle management), Hinshitsu-Hozen (Quality Maintenance), Office TPM, Total safety management, Implementation, 5s,Case studies,

Total Quality Management (TQM): Understanding quality, Evolution of TQM, Framework for TQM, Commitment and leadership, Customer satisfaction, Employee involvement, Continuous process improvement, Supplier partnership, Performance, measures, Formulation and implementation of TQM

Concurrent engineering, Design Failure Mode Effects Analysis (DFMEA) and Process Failure Mode Effects Analysis (PFMEA), Manufacturing Quality in Supply Chain Management, Manufacturing Quality and its importance in Product Life Cycle, Case studies

References:

1. Todd J., "World Class Manufacturing", McGraw Hill, London.
2. Schonberger R.J., "World Class Manufacturing - The Lesson of Simplicity", Free Press.
3. Marcus, A. A., “Management Strategy: Achieving Sustained Competitive Advantage”, New York: McGraw-Hill/Irwin.
4. Voss C.A., "Manufacturing Strategy: Process and Content", Chapman & Hall, London.
5. Pascal D., "Lean production simplified", 2nd Edition, Productivity Press.
6. Nakajima S., "Introduction to Total Productive Maintenance", Productivity Press.
7. Besterfield D. H., et al., "Total Quality Management", Pearson Education.
8. Mohanty R.P. and Deshmukh S: G., "Advanced Operations Management", Pearson Education.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME701**	Course Title: **Intelligent Manufacturing Systems**	
L-T-P**: 4-0-0**	Credits: **4**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

Introduction: Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, -CAD, CAPP, CAM, CAQC, ASRS,Manufacturing Communication Systems -MAP/TOP, OSI Model, Data Redundancy, Top-down and Bottom-up Approach, Volume of Information, Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

Components of Knowledge Based Systems: Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

Machine Learning: Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks -Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing

Automated Process Planning: Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process Planning. Knowledge Based System for Equipment Selection (KBSES), Manufacturing System Design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving Approach in KBSES, Structure of the KRSES

Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology, Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) —Data Base, Knowledge Base, Clustering Algorithm.

References:

1. Andrew Kusiak, “Intelligent Manufacturing Systems”, Prentice Hall.
2. Yagna Narayana , “Artificial Neural Networks”, PHI.
3. Groover M.P, “Automation, Production Systems and CIM”, PHI.
4. Simon Hhaykin, “Neural networks: A comprehensive foundation”, PHI.
5. James A Freeman & David M S Kapura, “Neural Networks”, Pearson Education.
6. Jacek M. Zurada, “Introduction to Artificial Neural Systems”, JAICO Publishing House.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME702**	Course Title: **Design for Manufacture and Assembly**	
L-T-P**: 4-0-0**	Credits: **4**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

Tolerance Analysis: Introduction – Concepts, definitions and relationships of tolerancing – Matching design tolerances with appropriate manufacturing process – manufacturing process capability metrics – Worst care, statistical tolerance Analysis – Linear and Non-Linear Analysis – Sensitivity Analysis – Taguchi‘s Approach to tolerance design.

Tolerance Allocation: Tolerance synthesis – Computer Aided tolerancing – Traditional cost based analysis – Taguchi‘s quality loss function – Application of the Quadratic loss function to Tolerancing – Principles of selective Assembly.

GD&T: Fundamentals of geometric dimensioning and tolerancing – Rules and concepts of GD&T – Form controls – Datum systems – Orientation controls – Tolerance of position – Concentricity and symmetry controls – Run out controls – Profile controls.

Tolerance Charting: Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts – Determination of Required balance dimensions – Determination of Mean working Dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces.

Manufacturing Guidelines: DFM guidelines for casting, weldment design – Formed metal components – Turned parts – Milled, Drilled parts – Non metallic parts – Computer Aided DFM software – Boothroyd and Dewhurst method of DFMA – DCS – Vis/VSA – 3D Dimensional control – Statistical tolerance Analysis Software –Applications.

References:

1. M. Creveling, “Tolerance Design – A handbook for Developing Optimal Specifications”, Addison Wesley.
2. James D. Meadows, “Geometric Dimensioning and Tolerancing., Marcel Dekker Inc..
3. Alex Krulikowski, “Fundamentals GD&T.”, Delmar Thomson Learning.
4. James G. Bralla”Handbook of Product Design for Manufacturing”, McGraw Hill.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME703** Course Title: **Design and Analysis of Experiments**
L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Overview: Taguchi's approach to quality and quality loss function, noise factors and average quality loss, exploiting non linearity, classification of parameters

Analysis of variance: No-Way ANOVA, One-Way ANOVA, Two-Way ANOVA and Three-Way ANOVA

Two Level Experiments: Two factor factorial design, model adequacy checking and estimating model parameters, 2^2 full factorial design, 2^3 full factorial design, 2^k full factorial design and Two level fractional factorial design, General 2^{k-p} fractional factorial design.

Steps in Robust Design: Identification of process and its main function, Noise factors and testing conditions, Control factors and their levels, Matrix experiment and data analysis plan, Conducting the experiment and data analysis, Verifying experiment and future plan.

Signal to Noise Ratios: Comparison of the quality of two process conditions, Relationship between Signal to Noise Ratio and quality loss after adjustment, Identification of a scaling factor, Signal to Noise Ratios for static problems, Signal to Noise Ratios for dynamic problems, Analysis of ordered categorical data.

Taguchi inner and outer arrays, orthogonal arrays and fractional factorial designs, Parameter design and tolerance design, Analysis of inner/outer array experiment, Alternative inner/outer orthogonal array experiments.

Constructing orthogonal arrays, Dummy level technique, Compound factor method, Linear graphs and Interaction assignment, Modification of linear graphs, Column merging method, Branching design.

References:

1. Montgomery, D. C., "Design and Analysis of Experiments", John Wiley & Sons.
2. Khuri A. I. and Cornell J. A. "Response Surfaces: Designs and Analyses, Marcel Dekker, Inc., New York.
3. Myers R. H., Montogomery, D. C. and Anderson-Cook C. M. "Response Surface Methodology: Process and Product Optimization Using Designed Experiments", John Wiley & sons, Inc., New York.
4. Mason R. L., Gunst, R. F., Hess J. L., "Statistical design and Analysis of Experiments With Applications to Engineering and SISAnce", John Wiley & sons, Inc., New York.
5. Phadke M. S., "Quality Engineering using Robust Design", Prentice Hall PTR Englewood Cliffs, New Jersy.
6. Ross P. J., "Taguchi Techniques for Quality Engineering", McGraw -Hill International.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME704**		Course Title: **Finite Element Analysis**
L-T-P**: 4-0-0**	Credits: **4**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

Introduction: Introduction to FEA, General FEM procedure, Approximate solutions of differential equations: FDM method, W-R technique, collocation least square sub-domain and Galerkin method Numerical integration, Gauss Quadrature in 2-D and 3-D, Structure of FEA program, Pre and Post processor, commercially available, standard packages, and desirable features of FEA packages, Principal of minimum total potential, elements of variational calculus, minimization of functional, Rayleigh-Ritz method, Formulation of elemental matrix equation, and assembly concepts.

One Dimensional FEM: Coordinate system: Global, local, natural coordinate system, Shape functions: Polynomial shape functions, Natural co-ordinate and coordinate transformation, Linear quadratic and cubic elements, Shape functions using Lagrange polynomials. Convergence and compatibility requirement of shape functions, One dimensional field problems: structural analysis (step-bar, taper-bar), Structural analysis with temperature effect, Thermal analysis.

Two Dimensional FEM: Trusses, Thermal effects in truss members, Beams, Two dimensional finite elements formulations, Three noded triangular element, Four-noded rectangular element, Four-noded quadrilateral element, derivation of shape functions: natural coordinates, triangular elements, and quadrilateral elements, Six-noded triangular elements, Eight-noded quadrilateral elements, Nine noded quadrilateral element, Strain displacement matrix for CST element.

Three dimensional elements: Tetrahedron, Rectangular prism (brick), Arbitrary hexahedron, Three Dimensional polynomial shape functions, Natural co-ordinates in 3D, Three dimensional Truss(space trusses), Introduction to material models: Introduction to plasticity (Von-Mises Plasticity), Hyper –elasticity. Generating and using experimental data to model material behaviour, Errors in FEA, sources of errors, method of elimination, Patch test.

Applications of FEA in Manufacturing: FE analysis of Metal casting, Analysis of metal forming- Sheet metal stamping, Analysis of Machining using standard FE analysis packages

References:

1. Reddy J. N., “Introduction to Finite Element Method”, McGraw-Hill.
2. Rao S.S, “Finite Element Method in Engineering”, Academic Press, Elsevier.
3. Desai and Abel, “Introduction to the finite element method: A numerical method for engineering analysis”, CBS.
4. Chandrupatla R T and Belegundu A D, “Introduction to Finite Elements in Engineering”, PHI.
5. David Hutton, “Fundamentals of Finite Element Analysis”, McGraw-Hill.
6. Buchanan, G R., Finite Element Analysis, Adapted by: R Rudramoorthy, The McGraw-Hill, Indian Adapted Edition, Schaum’s Outlines.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMP701** Course Title: **Automation Lab**
L-T-P**: 0-0-1** Credit: **1** Contact Hrs: **2hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Practical Hrs: **24 hrs**

Laboratory Exercises:

- Non controller based applications
- Controller based applications
- Programming PLC system for small applications using CodeSys and RsLogix software
- Interfacing PLC system for analyzing industrial applications
- Building programs for manufacturing automation processes
- Building and analyzing circuits using electro hydraulics and electro pneumatics system.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **17EPMP702** Course Title: **Machining Lab**
L-T-P**: 0-0-1** Credit: **1** Contact Hrs: **2hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Practical Hrs: **24 hrs**

Laboratory Exercises:

- CNC programming practices on machining centers and WEDM.
- CAD/CAM integration with CNC machine tool.
- Practices in 3D printing**.**
- Machinability studies in turning, drilling, milling and non-traditional machining.
- Open ended experiments on
  - ✓ Parametric analysis in traditional/non-traditional machining for a work tool combination,
  - ✓ CNC Programming

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Curriculum Content

Course Code: **17EPMW701** Course Title: **Mini Project I**
L-T-P**: 0-0-3** Credit: **1** Contact Hrs: **6hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Practical Hrs: **72 hrs**

Mini Project I: The Guide shall define the problem statement for the Project work. The student shall execute the Project within during the 1st semester. The student who has opted Mini Project I shall opt automation theme to carry out their work.

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Curriculum Content

Course Code: **17EPMC705**		Course Title: **Data Analytics**
L-T-P**: 3-1-0**	Credits: **4**	Contact Hrs: **5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**	Tutorial Hrs: **24 hrs**	Exam Duration: **3 hrs**

Statistical Data Analysis: Data and Statistics- Review of Basic Statistical Measures-Probability Distributions-Testing of Hypotheses-Non Parametric Tests

Data Analysis I: Introduction – Basic concepts – Uni-variate, Bi-variate and Multi-variate techniques – Types of multivariate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation – Approaches to multivariate model building.

Data Analysis II: Simple and Multiple Linear Regression Analysis – Introduction – Basic concepts – Multiple linear regression model – Least square estimation – Inferences from the estimated regression function – Validation of the model.

Factor Analysis: Definition – Objectives – Approaches to factor analysis – methods of estimation – Factor rotation – Factor scores - Sum of variance explained – interpretation of results. Canonical Correlation Analysis - Objectives – Canonical variates and canonical correlation – Interpretation of variates and correlations

Data Analysis III: Multiple Discriminant Analysis - Basic concepts – Separation and classification of two populations - Evaluating classification functions – Validation of the model. Cluster Analysis – Definitions – Objectives – Similarity of measures – Hierarchical and Non – Hierarchical clustering methods – Interpretation and validation of the model.

Data Analysis IV: Conjoint Analysis – Definitions – Basic concepts – Attributes – Preferences – Ranking of Preferences – Output of Conjoint measurements – Utility - Interpretation. Multi Dimensional Scaling – Definitions – Objectives – Basic concepts – Scaling techniques – Attribute and Non-Attributes based MDS Techniques – Interpretation and Validation of models. Advanced Techniques – Structural Equation modeling.

References:

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, “Multivariate Data Analysis”, Pearson Education, New Delhi.
2. Richard A Johnson and Dean W. Wichern, “Applied Multivariate Statistical Analysis”, Prentice Hall, New Delhi.
3. David R Anderson, Dennis J Sweeney and Thomas A Williams, “Statistics for Business and Economics”, Thompson, Singapore.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **17EPMC706**		Course Title: **Enterprise Resource Planning**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

ERP as Integrated Management Information System: Evolution of ERP, Benefits of ERP,ERP versus Traditional Information Systems, Business Process Reengineering, Need and challenges.

Management concerns about BPR: BPR to build business Model for ERP, ERP & Competitive advantage, Basic Constituents of ERP, Selection criteria for ERP Packages.

Procurement process for ERP Package, ERP packages – PEOPLE SOFT, SAP-R/3, BAAN IV, MFG/PRO, IFS/AVALON, ORACLE-FINANCIAL, Survey of Indian ERP Packages regarding their Coverage, performance and cost

ERP Implementation: Issues, Role of Consultants, Vendors, Users, Need for training, customization. ERP implementation methodology and post implementation issues and options,

Supply Chain Management: Types of SCM, Potential benefits of SCM, Possible obstacles, Application systems supporting SCM – engineering, Product Data Management, Sales, Procurement, Production, MRP, Distribution, ERP case studies in HRM, finance, production, product database, materials, sales & distribution.

References:

1. Leon Alexis, "Enterprise Resource Planning", Tata McGraw Hill, New Delhi.
2. Garg V. K. and Venkatakrishna N. K., "Enterprise Resource Planning: Concepts and Practices", PHI, New Delhi.
3. Sadagopan S., "Enterprise Resource Planning: A Managerial Perspective", Tata McGraw Hill, New Delhi.
4. Brady, "Enterprise Resource Planning", Thomson Learning.

II Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **17EPMC707**		Course Title: **Manufacturing Systems Simulation**
L-T-P**: 3-0-0**	Credits: **4**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Principles of Modeling & Simulation: Basic Simulation Modeling, Systems – discrete and continuous systems, general systems theory, models of systems- variety of modeling approach, concept of simulation, simulation as a decision making tool, types of simulation, Principle of computer modeling- Monte Carlo simulation, Nature of computer modeling, limitations of simulation, area of application.

Random Number Generation: Random variables and their properties, Properties of random numbers, generation of Pseudo random numbers, techniques for generating random numbers, Various tests for random numbers-frequency test and test for Autocorrelation,

Random Variate Generation: Different techniques to generate random Variate: Inverse transform technique,-exponential, Normal, uniform, Weibull, direct transformation technique for normal and log normal distribution, convolution method and acceptance rejection techniques-Poisson distribution, **Statistical Techniques:** Comparison of two system designs, Comparison of several system designs – Bonferroni approaches to multiple comparisons for selecting best fit, for screening

Design and Evaluation of Simulation Experiments: Problem formulation, data collection and reduction , time flow mechanism, key variables, logic flow charts, starting condition, run size, experimental design consideration, output analysis, verification and validation of simulation models. **Simulation Languages:** Comparison and selection of simulation languages, study of any one simulation language.

Discrete Event Simulation: Concepts in discrete –event simulation, development of simulation models for queuing systems, production systems, inventory systems, maintenance and replacement systems, investment analysis and network, Programming for discrete event simulation, Case studies.

References:

1. Jerry Banks and John S Carson, Barry L Nelson, David M Nicol, “Discrete event system simulation”, Prentice Hall, India.
2. Khoshnevi. B., “Discrete system simulation”, McGraw Hill International.
3. Ronald G Askin and Charles R Standridge , “Modeling and analysis of manufacturing systems”, John Wiley & Sons.
4. Gordon G , “System Simulation”, Prentice Hall, India..
5. Thomas J Schriber., “Simulation using GPSS”, John Wiley & Sons.
6. Shannon, R.E., “System Simulation – The art and science”, Prentice Hall, India.
7. Averill Law & David M.Kelton , “Simulation, Modeling and Analysis”, TMH.

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME705** Course Title: **Flexible Manufacturing Systems**
L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Overview of FMS: Definition of an FMS-need for FMS, types and configuration, types of flexibilities and performance measures, Economic justification of FMS. Development and implementation of FMS- planning phases, integration, system configuration, FMS Layouts, Simulation

Automated Material Handling and Storage: Functions – types - analysis of material handling systems, primary and secondary material handling systems-conveyors, Automated Guided Vehicles-working principle, types, traffic control of AGVs. Role of robots in material handling, Automated storage systems- storage system performance – AS/RS-carousel storage system, WIP storage systems, interfacing handling and storage with manufacturing.

Computer control of FMS: Planning, scheduling and computer control of FMS, Hierarchy of computer control, supervisory computer. DNC system- communication between DNC computer and machine control unit features of DNC systems.

Computer Software, Simulation and Data base: System issues, types of software – specification and selection- trends-application of simulation and its software, Manufacturing Data systems- planning FMS data base, Modeling of FMS- analytical, heuristics, queuing, simulation and petrinets modeling techniques.

Scheduling of FMS: Scheduling of operations on a single machine- two machine flow shop scheduling, two machine job shop scheduling, - three machine flow shop scheduling-scheduling, ‘n’ operations on ‘n’ machines, knowledge based scheduling, scheduling rules, tool management of FMS, material handling system schedule.

References:

1. Jha. N.K., “Hand Book of Flexible Manufacturing Systems”, Academic Press Inc.
2. Raouf, A. and Ben-Daya, M., Editors, “Flexible manufacturing systems: recent development”, Elsevier Science.
3. Parish.D.J., “Flexible Manufacturing”, Butter worth-Heinemann Ltd.
4. Groover. M. P., “Automation production systems and computer integrated manufacturing”, PHI.
5. Taiichi Ohno, “Toyota production system: beyond large-scale production”, Productivity Press (India) Pvt. Ltd.
6. Parrish D. J., “Flexible Manufacturing”, Butter worth, Heinemann, Ltd., Oxford.
7. Luggen W. W., “Flexible Manufacturing Cells & Systems”, Prentice Hall, Englewood Cliffs.
8. Shivanand H K., “Flexible Manufacturing System”, Dhanpat Rai Publications, New Delhi.

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME706**	Course Title: **Sensors for Intelligent Manufacturing and Condition Monitoring**	
L-T-P**: 4-0-0**	Credits: **4**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

Introduction: Role of sensors in manufacturing automation – operation principles of different sensors - electrical, optical, acoustic, pneumatic, magnetic, photo -electric, electro-optical, vision, proximity.

Sensors in Manufacturing: Industrial sensors - Temperature sensors- Semiconductor absorption sensors, Non-contact sensors, Pyrometers, Pressure sensors-piezoelectric circuit, strain gauges, fiber optic pressure sensors, displacement sensors for robotic applications, Manufacturing of industrial sensors – Semiconductors, Fiber optics sensors and their principles and applications.

Sensors in CNC machine tools: Linear and Angular position sensors, Velocity sensors, Principles and applications. Sensors in Robots-Position sensors, encoder and revolvers, potentiometers, range proximity touch – torque sensors, Machine vision, Smart sensors

Condition monitoring of manufacturing systems: Principles, Sensors for monitoring force, Vibration and Noise, selection of sensors and monitoring techniques.

Acoustic Emission: Principles of Acoustic emission sensors, Concepts of pattern recognition, applications of Acoustic emission, on line monitoring of tool wear using Acoustic emission.

Automatic identification techniques for shop floor control, optical character and machine vision sensors, smart / intelligent sensors, integrated sensors, Robot sensors, Micro sensors, Nano sensors

References:

1. Jacob Fraden "Handbook of Modern Sensors physics, designs and applications" Springer-Verlag New York.
2. Sabrie Salomon, "Sensors and control systems in manufacturing", McGraw Hill Int. Edition.
3. Julian W. Gardner, "Micro sensor MEMS and Smart Devices", John Wiley & Sons.
4. Randy Frank, "Understanding smart sensors", Artech House, USA, 2011.
5. Julian W. Gardner, "Micro sensor principles and applications", John Wiley & sons.

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME707** Course Title: **Advanced Precision Engineering**
L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Concept of Measurement methods, Experimental Test plan, Calibration, Static and Dynamic characteristics of signals, Measurement system behavior, Probability and Statistics, Density functions, Infinite and finite statistics, Chi-squared distribution, Regression analysis, Data outlier detection, Uncertainty Analysis, Measurement errors, Design-stage uncertainty analysis, error sources, Bias and precision errors, error propagation, single and multiple measurement, uncertainty analysis, Surface roughness measurement, Stylus instruments (Mechanical and Electrical), Sources of error, Optical instruments (Profiling and Parametric techniques), Data acquisition and filtering, Amplitude and texture parameters, Coordinate Measuring Machines: Coordinate metrology, Configuration of CMM, Hardware components, Control system for CMM, Operating sequence, Measurement program,Automated inspection, Principles, Methods of online, offline, distributed and flexible inspections, Machine vision, Image Acquisition & digitization, Image processing & Analysis, interpretation, applications

References:

1. Figliola R. S. and Beasley, D. E., "Theory and Design for Mechanical Measurements", Third edition, John Wiley & Sons Inc.
2. Thomas Tom R., "Rough Surfaces 2nd ed", Imperial College Press, London.
3. Hooken Rabert and Pereira P. H., "Coordinate Measuring Machines and Systems", CRC press.
4. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", PHI.

Reference Books:

Ambrose, S., Bridges, M., DiPietro, M., Lovett, M., & Norman, M. (2010) How learning works: 7 Research-Based principles for smart teaching. San Francisco: Jossey-Bass.

Suggested Web Resources:

https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/
http://educationaltechnology.net/instructional-design/
https://www.nwea.org/blog/2014/33-digital-tools-advancing-formative-assessment-classroom/
http://oedb.org/ilibrarian/101-web-20-teaching-tools/

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMP703**		Course Title: **ERP Lab**
L-T-P**: 0-0-1**	Credit: **1**	Contact Hrs: **2hrs/week**
CIE Marks: **80**	SEE Marks: **20**	Total Marks: **100**
Practical Hrs: **24 hrs**		

- Introduction and selection criteria for ERP Packages, Survey of Indian ERP Packages
- Production Planning and Execution Module: - Exercises on production planning, machine scheduling, Material Requirement Planning, track daily production progress, production forecasting & actual production reporting with case studies.
- Supply Chain Management Module: - Exercises on Management of flow of products from manufacturer to consumer & consumer to manufacturer, demand & supply management, sales returns & replacing process, shipping & transportation tracking with case studies.
- Finance & Accounting module: - Exercises on Track of all account related transactions like expenditures, Balance sheet, account ledgers, budgeting, bank statements, payment receipts, tax management with case studies.
- Human Resource Module:- Exercises on Efficient management of human resources, employee information, track employee records like performance reviews, designations, job descriptions, skill matrix, time & attendance tracking. Payroll System, payment repots, travel Expenses & Reimbursement tracking. with case studies.

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMP704**		Course Title: **Simulation Lab**
L-T-P**: 0-0-1**	Credit: **1**	Contact Hrs: **2hrs/week**
CIE Marks: **80**	SEE Marks: **20**	Total Marks: **100**
Practical Hrs: **24 hrs**		

Laboratory Exercises:

Development of simulation models for the following systems

- Queuing and Inventory systems, manufacturing system and service operations.
- Maintenance and replacement systems
- Job shop with material handling and FMS
- Exercises on real life problems using discrete event systems simulation software on product, process and FMS layouts.

II Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **17EPMW702**		Course Title: **Mini Project II**
L-T-P**: 0-0-3**	Credit: **1**	Contact Hrs: **6hrs/week**
CIE Marks: **80**	SEE Marks: **20**	Total Marks: **100**
Practical Hrs: **72 hrs**		

Mini Project II: The Guide shall define the problem statement for the Project work. The student shall execute the Project within during the 2nd semester. The student who has opted Mini Project II shall opt automation theme to carry out their work.

I Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC701**		Course Title: **PLM Fundamentals**
L-T-P**: 2-0-0**	Credits: **2**	Contact Hrs: **2 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **30 hrs**		Exam Duration: **3 hrs**

Introduction to Product Lifecycle Management (PLM): PLM Overview, Background for PLM, Scope, Components/Elements of PLM, PLM Grid, PLM Paradigm - Concepts, Consequences and Corollaries, Strategic Benefits, Operational Benefits, Spread of PLM, Overcoming Problems, Enabling Opportunities, Challenges.

The PLM Environment: Issues in the Traditional Environment, Product Data Issues, A Complex Changing Environment-Change, Interconnections, Changes Driving PLM, Product Pains-Aerospace, Automotive and Other Products, Product Opportunities - Globalization Opportunity, Technology Opportunity, Social/Environmental Opportunity, Human Resource Opportunity.

Product Lifecycle Management System: Product Data or Product Information, System Architecture, Information Models and Product Structure, Information Model, Product Information Data Model, Product Model, Reasons for the Deployment of PLM Systems.

PLM in Different Verticals: Functionality of the Systems, Use of PLM Systems in Different Organizational Verticals, Product Development and Engineering, Production, After Sales, Sales and Marketing, Sub-Contracting, Sourcing and Procurement, Different Ways to Integrate PLM Systems, System Roles - ERP, CAD.

Project/Program Management in PLM Environment: Characteristics of Projects, People in Projects, Project Phases, Project Management Knowledge Area, Project Management Tools and Templates, The Importance of Project Management in PLM, Project reality in a Typical Company, Project Management Activities in PLM Initiatives, Pitfalls of Project Management, Top Management Role with Project Management.

References:

1. Stark John, "Product Lifecycle Management: 21st Century Paradigm for Product Realization", Springer, Third Edition, 2015
2. Antti Saakasvuori, Anselmi Immonen, "Product Lifecycle Management" - Springer, 1st Edition, 2003.
3. Grieves Michael, "Product Lifecycle Management - Driving the Next generation of LeanThinking" , McGraw-Hill, 2006.

I Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC702**		Course Title: **Engineering Data Management**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Introduction and Overview of Embedded Product Design: Background, Related Research and Research Problems, Structure of the Report, Design for Manufacture, Design of Embedded Products, Technical Design Disciplines and Document Management, Software Design, Electronics Design, Software-Hardware Co-Design, Mechanical design, Concurrent Engineering, Design Data Management, DFA and DFMA.

PDM Systems and Data Exchange: Product Data Management (PDM), State-of-the-art trends of PDM, Data Formats and Translators in Data Exchange, STEP (Standard for the Exchange of Product Model Data), CDIF (Case Data Interchange Format), SGML (Standard Generalized Markup Language).

PDM and SCM: PDM and Product Life Cycle, PDM Systems – Common Functionality, Product Structure and Document Management, System Architecture, Version Management, Configuration Selection, Concurrent Development, Build Management, Release Management, Workspace Management, Change Management.

Requirements of Design Data Management: Requirements for the Embedded Product's Design Data Management, Data Management, Process and Life-Cycle Management, Data Capture & Distribution, Support for Working Methods, Requirements for Enterprise-Level Design Data Management, Design Data Management Levels, The Design Data Management Features of Design Tools , Team-Level Design Data Management, Team-Level Design Data Management.

Analysis of Needs and Solutions: Comparison of Principles, Comparison of Key Functionalities, Requirements and Needs, Analysis, Different Scenarios in an Integrated Environment, Possible Integrations, Examples of integrations.

Product Data in PLM Environment: Relevance of Product Data in PLM, Product Data Across the Lifecycle, Tools to Represent Product Data, Data model diagrams, Reality in a Typical Company-Issues, Challenges and Objectives, Product Data Activities in the PLM Initiative-Product Data Improvement.

References:

1. Jukka Kaariainen, Pekka Savolainen,Jorma Taramaa & Kari Leppala, “Product Data Management (PDM) Design, exchange and integration viewpoints”, VTT- Technical research centre of Finland, 2000.
2. Rodger Burden “PDM: Product Data Management” Volume 1, Resource Publishing, 2003.
3. Annita Persson Dahlqvist et.al “PDM and SCM - similarities and differences”, The Association of Swedish Engineering Industries, 2001.

I Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC703**		Course Title: **Product Design and Development**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Introduction: Characteristics of successful product development, duration and cost of product development, Challenges of product development.
Development Process and Organizations: Generic development process, concept development – Front-end process, adapting the generic product development process
Identifying Customer Needs: Defining scope, gathering data from customers, establishing relative importance of needs etc.
Establishing Product Specifications: Target specifications & refining specifications
Concept Generation: Five step methodology of concept generation.
Concept selection: Structured methodology for selecting a concept using selection matrix & ranking of concepts.
Product Architecture: Meaning & implication of product architecture.
Industrial Design: Meaning of ID, & its impact, Aesthetic & Ergonomic considerations, ID process
Design for Manufacturing: DFM meaning, DFM Methodology**.**
Value Engineering and Product Design: Definition of value. Value analysis job plan, creativity etc.

References:

1. Karl T Ulrich and Steven D Eppinger, 'Product design and development', Tata McGraw Hill Publication.
2. A. K. Chitale and R. C. Gupta, 'Product Design and Manufacturing', Prentice Hall India.
3. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Publications.

I Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMC704**		Course Title: **Enterprise Resource Planning - I**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Introduction to ERP: Need for ERP, Characteristics and components of ERP, Suppliers of ERP, Integrated Management Information, Seamless Integration and Functional information system, Marketing, Accounting and Financial Management, Supply Chain Management, Resource Management, Integrated Data Model.

Business Functions and Business Processes: Functional Areas of Operation, Business Processes, A process view of business, Functional Areas and Business process of very small business. Marketing and Sales, Supply Chain Management, Accounting and Finance, Human Resources, Functional Area Information System

Business Process Reengineering: Need for reengineering, Reengineering Model, BPR Guiding principles , Business process reengineering and performance improvement, Enablers of BPR in Manufacturing, Collaborative Manufacturing, Intelligent manufacturing, Production Planning. BPR Implementation

Financial & Accounting Management: Differences between Financial accounting, Cost accounting and Management accounting, Basic finance – Concept of Cost Centre accounting, Cost – Volume – Profit Analysis, Cash Flow Analysis

Role of ERP in Purchasing: Features of purchase module, ERP Purchase System; Role of ERP in Sales and Distribution, Sub-Modules of the Sales and Distribution Module: Master data management, Order management, Warehouse management, Shipping and transportation, Billing and sales support, foreign trade, Integration of Sales and Distribution Module with Other Modules

Inventory Management: ERP inventory management system, Importance of Web ERP in Inventory Management, ERP Inventory Management Module and Sub-Modules of the ERP Inventory Management Module, Bill of Material, Safety stock, Lot number/Batch number, Inventory valuation methods

Material Requirement Planning: Product structure and Bill of Materials (BOM), MRP concept, MRP calculations, Lot sizing in MRP, capacity requirement planning, MRP-II, MRP Exercises

Production and Supply Chain Management Information Systems: Role of ERP in CAD/CAM, MRP, Closed Loop MRP, MRP-II, Manufacturing and Production Planning Module of an ERP System, Distribution Requirements Planning (DRP); ERP Approach to Production Planning, MRP to ERP.

References

1. Ellen Monk , Bret wagner “Concepts in Enterprise Resource planning” Third Edition Course Technology.
2. R.Radha Krishnan “ Business Process Reengineering PHI , New Delhi.
3. Garg V. K. and Venkatakrishna N. K., “Enterprise Resource Planning: Concepts and Practices”, PHI, New Delhi.
4. Sadagopan S., “Enterprise Resource Planning: A Managerial Perspective”, Tata McGraw Hill, New Delhi.

5. Pauline Weetman, "Financial and Management Accounting: An Introduction", Pearson Education Limited, 2015.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **18EPME701**	Course Title: **Design for Additive Manufacturing**	
L-T-P:**3-0-0**	Credits: **4**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Overview of Design for Additive Manufacturing (AM): How to design for AM? Challenges & opportunities, Design process, mechanical properties, performance of materials used in AM, process driven & designer driven shape, methods, Additive manufacturing principles & processes.

Drivers for AM: Material efficiency, flow optimization, integration of functions, mass customization, lead time, automated manufacturing, Limitations, Available material, accuracy of the technology, price of the industrial machines, certification of materials and processes, surface finish(supports, post processing), part dimensions.

DFMA Principles for AM: Maximum Part size, Faces requiring support, minimum wall thickness & rigidity, Minimum feature size & manufacturing quality, Typical geometries, DFX rules for additive manufacturing. cost considerations**.**

Topology Optimization for AM: Introduction to topology optimization, Topology optimization process, characteristics, link with AM potentials & Challenges, Current developments.

Accuracy Issues in AM: Properties of metallic and nonmetallic additive manufactured surfaces, Stress induced in additive manufacturing (AM) processes. Surface roughness problem in rapid prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost etc

References:

1. Ian Gibson, David W. Rosen, Brent Stucker, "Additive manufacturing technologies: rapid prototyping to direct digital manufacturing", Springer, 2010.
2. Andreas Gebhardt, "Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing", Hanser Publishers, 2011.
3. Christoph Klahn, Bastian Leutenecker, Mirko Meboldt, "Design for Additive Manufacturing – Supporting the Substitution of Components in Series Products", Procedia CIRP 21 2014, 24th CIRP design conference
4. Rosen, D.W., 2007. "Design for additive manufacturing: A method to explore unexplored regions of the design space". In Proceedings of the 18th Annual Solid Freeform Fabrication Symposium.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **18EPME702**		Course Title: **Industrial Robotics**
L-T-P:**3-0-0**	Credits: **4**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Robot fundamentals: History of robotics, Advantages & Applications of robots, Robot characteristics. Classification and structure of robotic systems, PTP and continuous path systems, JIRA and RIA, Robot components, Robot anatomy (configurations, Robot motions), Work volume, drive systems

Robot kinematics: Matrix representation, Homogeneous transformation matrices, Representation of transformations, Inverse transformation matrices, forward and inverse kinematics of robots, D-H representation of forward kinematic equations, degeneracy and dexterity

Differential motions and velocities: Differential relationships, Jocobian, differential motions of a frame, calculation of Jacobian, inverse jacobian

Dynamic Analysis and forces : Langrangian mechanics, Effective moments of inertia, Dynamic equations of multiple DOF robots, Static force analysis, Transformation of forces and moments between coordinate frames

Robot control systems: Components, Basic control system concepts and models, Controllers, control system analysis, robot actuation and feedback components

Actuators and Sensors: Characteristics of actuating systems, different types of actuators, sensor characteristics, different types of sensors

Robot Programming: Methods (lead through, textual language), program as a path in space, speed control, motion interpolation, wait, signal and delay, branching, capability and limitations of lead through methods

References:

1. Koren Yoram, "Robotics for Engineers', 2, McGraw-Hill Publication. , 2013

2. Groover M.P, 'Industrial Robotics', 3, Tata McGraw-Hill Publication, 2013

3. Niku Saeed B, "Introduction to Robotics', 4, Prantice Hall India Publication, 2014

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **18EPME703**		Course Title: **Supply Chain Management**
L-T-P:**3-0-0**	Credits: **4**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Supply Chain Concepts: Introduction to Supply Chain, SCOR model, Virtual/Extended Enterprise, Delivery Channel, Objective of a Supply Chain, Decision Phases in a Supply Chain, Production Approaches, Supply Chain Process, Push & Pull Production Systems, Push-Pull Boundary, Lack of Coordination and Bullwhip Effect, Order Management, Order-to-Cash Process, Procure-to-Pay Process, Call-off, Replenishment, Sourcing

Supply Chain Performance: Supply Chain Strategies, Value Chain, Capabilities, Uncertainties, Responsiveness vs Cost, Supply Chain Performance Drivers – Facilities, Inventory, Transportation, Information, Sourcing, and Pricing, Supply Chain Visibility, Resilience, Non-Financial Metrics Examples, Financial Metrics Examples, Sustainability

Designing Distribution Network: Introduction, Factors Influencing Distribution Network Design, Design Options for a Distribution Network, Distribution Network for Online Sales, Impact of Online Sales on Cost

Network Design: Introduction, Factors Influencing Network Design Decisions, Framework for Network Design Decisions, Facility Location Mathematical Models, Capacity Allocation Mathematical Models, Network Behavior, Types of Supply Relationship, Factors influencing Nature of Network Relationship, Vertical Integration

Demand Management and Forecast: House of SCM, Managing Demand, Managing Supply, Transportation Model, Just-in-Time in Supply Chain, Forecasting in Supply Chain, Characteristics of Forecasts, Approaches to Demand Forecasting

Inventory Management: Cycle Inventory, Cycle Inventory Related Costs, Economics of Scales, Economic Order Quantity, Multiechelon Cycle Inventory, Uncertainty and Safety Inventory, Safety Inventory Level

Logistic and Warehouse Management: Transportation in Supply Chain, Modes of Transportation, Transportation Network, Trade-offs in Transportation Design, Warehouse Layout and Design, Warehouse Types, Warehouse Operating Processes, Warehouse Management System, Procurement, Material Classification, Material Codification

Trends in SCM: Gartner's Hype Cycle, Capgemini's Consulting Hype Cycle, Trend Categories, Algorithmic Supply Chain Planning, Predictive Analytics, Global Logistics Visibility, Focus on Risk Management and Supply Chain Resiliency

References:

1. Sunil Chopra, and Peter Meindl, "Supply Chain Management – Strategy, Planning, and Operation," Pearson Education.
2. APICS, "Operations Management Body of Knowledge Framework."
3. Lora Cecere, "Supply Chain Metrics that Matter," Wiley.
4. Hartmut Stadtler, "Supply chain management and advanced planning – basics, overview and challenges," European Journal of Operations Research, 163, 2015.
5. Keely L. Croxton, Sebastián J. García-Dastugue and Douglas M. Lambert, "The Supply Chain Management Processes," The International Journal of Logistic Management.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **18EPMP701**	Course Title: **Collaborative Design - Modeling Lab**	
L-T-P**: 0-0-5**	Credits: **5**	Contact Hrs: **10 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Practical Hrs: **120 hrs**		Exam Duration: **2 hrs**

User Interface Platform:

Understand the user interface, Connect to the PLM platform, Access your Dashboard, Use the Tags for searching content, Share various documents with other users through, 3DSpace, Use standard menus and commands, Import new data and export to required file formats, Search for a 3D data using different methods, Explore and open 3D data, Manipulate the tree, Filter data

Sketcher: Exercises on sketch tools, profile tool bar and constraint tool bar.

Part Design: Exercise on 3D models using pad, slot, shaft, groove, hole, rib and stiffener commands, cut revolve etc.

Generative Shape Design (GSD): Exercises using GSD to generate complicate surfaces using sub tool bars

Sheet Metal: Setting sheet metal parameters, bend extremities tab, creating the base wall, creating the wall on edge, creating extrusions etc.

Assembly Design: Assembly design work bench Bottom-Up and Top-Down assembly approaches invoking existing components into assembly work exercise to demonstrate Top-Down assembly approach.

Drafting: Converting existing 3D models into 2D drawings with all relevant details, sectional views etc.

Data Exchange and Collaborative Lifecycle:

Import and export different file formats, manage the Mastership of imported objects, Create a new product structure, Use different sections of the Action bar effectively, Manage the changes in a product structure, Save the product structure in the database

Design Review:
Create a design review, add markups to it, Create slides, and add markers, Create sections and measures, Export sections and measures, compare 3D Objects and 2D Drawings

References

Companion Courses – https://companion.3ds.com/

I Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMP702**		Course Title: **PLM Functional Lab**
L-T-P**: 0-0-3**	Credits: **3**	Contact Hrs: **6 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Practical Hrs: **72hrs**		Exam Duration: **2 hrs**

Collaboration and Approvals:

Illustrate the structure of PLM Business Process Services, Create and manage your folders, Create workflows, Identify and manage your assigned tasks, Subscribe to various objects and events, Report and resolve issues in objects, Create, track and organize your documents

IP Classification:

Need of IP Classification, Create different types of libraries and their related hierarchies, Create and manage documents and parts, classify the library objects based on their features, Use the Classification functionality

Engineering Bill of Material:

Create parts and specifications, Create and edit Bill of Materials, Create a Change Request to make the changes in a part or a specification, Complete Change Orders and Change Actions to implement the changes, Review and release the parts

Project Management Fundamentals:

Create programs and projects, Assign members to a project, Add tasks and assign project members to the tasks, Create folders for managing project documents, Create process flow for tasks, Review the status of programs and projects, Exchange and view projects data using Microsoft Project Integration

Project Management Advanced:

Document the various risk areas of a project and track them, Create and manage the resource requirements for a project, Create budgets and benefits to monitor the financials of a project, Track the time spent on a project using time sheets, Create calendars for the projects, Identify the quality factors of a project and monitor them, Create an assessment to measure the project’s health, Use dashboards to monitor the status of your projects

Project Execution:

Manage the project schedule, Record risks for tasks, Create and submit timesheets

References

1. Companion Courses – https://companion.3ds.com/
2. Antti Saakasvuori, Anselmi Immonen, “Product Lifecycle Management" - Springer, 1st Edition, 2003.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **18EPMP703**		Course Title: **ERP Functional Lab**
L-T-P**: 0-0-3**	Credits: **3**	Contact Hrs: **6hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Practical Hrs: **72 hrs**		Exam Duration: **2 hrs**

Selection Criteria for ERP Packages: Survey of Indian ERP Packages

Financial Accounting: Basic Finance – Chart of accounts, Journal entries, Journal vouchers, Exchange rates; Banking (In and Out); Debit and Credit note

Master Data Management: Item master; Business partner master – Customer, vendor; Pricing; Tax

Supply chain Management

Sales: Sales quotation, Sales order, Delivery, Return, Invoice (A/R)

Purchase: Purchase quotation, Purchase order, Return, GRN, Invoice (A/P)
Production: Assembly BOM, Production order, Goods issue, Goods receipt

Reports: Generation of reports for various functions

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMC705**		Course Title: **PLM Advanced**
L-T-P**: 2-0-0**	Credits: **2**	Contact Hrs: **2 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **30 hrs**		Exam Duration: **3 hrs**

Deployment of the PLM System: Different stages of deployment, Leading a PLM Project, Understanding the need for change, PLM maturity model, Choosing a system, Realization stage of the project, Start up, Steering group, Project manager, Accomplishing change in the organization.

Challenges of Product Management in Manufacturing Industry: Life cycle thinking, value added services and after sales traceability, Special challenges of product management in the high tech industry, Case studies.

Service Industry and PLM: Introduction, Categorizing services, Rational for building service products, PLM in service business, PLM challenges in service business, Case studies.

Role of product Information Management in Collaborative Business Development: CIM, Concurrent Engineering, Product lifecycle management as an enabler of cooperation between companies, Contents of collaboration, Successful cooperation, Tools of collaboration.

Product and Product Management Strategy: PLM as a business strategy tool, Making a product strategy, Product management strategy, Time to market, Time to react, Time to volume, Time to service.

References:

1. Stark John, "Product Lifecycle Management: 21st Century Paradigm for Product Realization", Springer, Third Edition, 2015
2. Antti Saakasvuori, Anselmi Immonen, "Product Lifecycle Management" - Springer, 1st Edition, 2003.
3. Grieves Michael, "Product Lifecycle Management - Driving the Next generation of LeanThinking" , McGraw-Hill, 2006.

II Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC706**		Course Title: **Enterprise Resource Planning-II**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

ERP implementation Basics: Master Data Management – Item Master, Vendor Master, COA, Customer Master, Machine Master, etc. Vendors- Role of Vendor; Consultants: Types of consultants; Role of a Consultant, Employees; Role of employees; Resistance by employees; Dealing with employee resistance, Role of Top Management, Role of Implementation Partner

ERP –Functional modules: Functional modules of ERP software, integration of supply chain and customer relationship application.

ERP implementation Life cycle: Objectives of ERP implementation, Different phases of ERP implementation. Consultants, vendor and employees

ERP Projects: Project types, Implementation methodology, Project Preparation, Business Blueprinting, Gap Analysis, Realization, Final Preparation, Go Live and Support, User Training

ERP Post Implementation: Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors and ERP Implementation - Case studies.

ERP and e-Business: Introduction ERP and e-business process model, components of e-Business supply chain ERP/ e-business integration ERP to ERP II –Bringing ERP to the Entire Enterprise

Future Directions in ERP: Faster Implementation Methodologies; Business Modules and BAPIs; Convergence on Windows NT; Application Platform; New Business Segments; More Features; Web Enabling; Market Snapshot.

Other Related Technologies of SCM: Relation to ERP; E-Procurement; E-Logistics; Internet Auctions; E-markets; Electronic Business Process Optimization; Business Objects in SCM; E commerce

Case Studies: ERP case studies in HRM, Finance, Production, Product Database, Materials, Sales & Distribution

References:

1. Leon Alexis, "Enterprise Resource Planning", Tata McGraw Hill, New Delhi.
2. Garg V. K. and Venkatakrishna N. K., "Enterprise Resource Planning: Concepts and Practices", PHI, New Delhi.
3. Sadagopan S., "Enterprise Resource Planning: A Managerial Perspective", Tata McGraw Hill, New Delhi.
4. Brady, "Enterprise Resource Planning", Thomson Learning.

III Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC707**		Course Title: **Project Feasibility and Analysis**
L-T-P**: 3-1-0**	Credits: **4**	Contact Hrs: **5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

Planning Overview: Capital budgeting and Allocation, Strategic planning.

Market and Demand Analysis: Situational analysis, Demand forecasting and Uncertainties in demand forecasting.

Technical Analysis: Material inputs and utilities, Product mix, Plant capacity and Location, Environmental aspects, Project charts and layouts.

Financial Estimates and Projections: Means of finance, Estimates of sales and production, Working capital requirement and its financing, Profitability projections, projected cash flow statements. Project risk analysis: Sources, Measures and Perspectives on risks, Sensitivity analysis, Scenario analysis, Break-even analysis, Simulation analysis, Decision tree analysis, managing risk.

Sustainability in Project Management: Inter-relating life cycles, The impact of sustainability on project management processes, Measuring and reporting projects

References:

1. Prasanna Chandra, “Projects: Planning, Analysis, Financing, Implementation and Review”, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Nicholas J. M. and Steyn H. “Project Management for Business, Engineering and Technology: Principles and Practice”, Elsevier.
3. Harold R. Kerzner, “Project Management: A Systems Approach to Planning, Scheduling, and Controlling”, Wiley, New York.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **17EPME704**		Course Title: **Additive Manufacturing**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Additive Manufacturing (AM) Overview: Introduction to reverse engineering Traditional manufacturing vs AM, Computer aided design (CAD) and manufacturing (CAM) vs AM, Different AM processes and relevant process physics, AM process chain Application level: Direct processes – Rapid-Prototyping, Rapid Tooling. Rapid Manufacturing; Indirect Processes - Indirect Prototyping. Indirect Tooling, Indirect Manufacturing

Materials Science of AM: Discussion on different materials used, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, Structure property relationship, Grain structure and microstructure

AM Technologies: Powder-based AM processes involving sintering and melting (selective laser sintering, shaping, electron beam melting. involvement). Printing processes (droplet based 3D Solid-based AM processes - extrusion based fused deposition modeling object Stereo-lithography Micro- and nano-additive.

Mathematical Models for AM: Transport phenomena models: temperature, fluid flow and composition, buoyancy driven tension driven free surface flow pool) Case studies: Numerical Modeling of AM process, Powder bed melting based process, Droplet based printing process Residual stress, part fabrication time, cost, optimal orientation and optimal Defect in AM and role of transport Simulations (choice of parameter, Mo del validation for different

Process selection, planning, control for AM: Selection of AM technologies using decision methods. Additive manufacturing process plan: strategies and post processing. Monitoring and control of defects, transformation.

References:

1. Ian Gibson, David W. Rosen, Brent Stucker, “Additive manufacturing technologies: rapid prototyping to direct digital manufacturing”, Springer, 2010.
2. Andreas Gebhardt, “Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing”, Hanser Publishers, 2011.
3. J.D. Majumdar and I. Manna, “Laser-assisted fabrication of materials”, Springer Series in Material Science, e-ISBN: 978-3-642- 28359-8.
4. L. Lu, J. Fuh and Y.-S. Wong, “Laser-induced materials and processes for rapid prototyping”, Kluwer Academic Press, 200 I.
5. Zhiqiang Fan and Frank Liou, “Numerical modeling of the additive manufacturing (AM) processes of titanium alloy”, lnTech, 2012.
6. C.K. Chua, K.F. Leong and C.S. Lim, “Rapid prototyping: principles and applications”, 3rd Edition, World Scientific, 20 10.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **17EPME705**		Course Title: **Manufacturing Systems and Automation**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Introduction: Production system facilities, Manufacturing support systems, Automation in production system, Automation principles and strategies, Manufacturing operations, Basic elements of an automated system, Advanced automation functions, Levels of automation.

Material handling and identification technology: Considerations in material handling system design, 10 principles of material handling, Automated guided vehicle systems, Conveyor systems, Analysis of material transport system, Automated storage systems, Engineering analysis of storage system. Components of manufacturing systems, Single station automated cells, Applications and analysis of single station cells.

Flexible manufacturing systems: FMS components, FMS application and benefits, Quantitative analysis of flexible manufacturing systems.

Industrial control systems: Sensors, Actuators, Drives and other control system components. Electro-hydraulic and Electro-pneumatics in manufacturing automations

Machine vision systems: Importance of machine vision system in manufacturing automation.

Role of microcontrollers in manufacturing automation system: Microcontroller architecture, interfacing sensors and actuators with microcontroller for industrial automation, Microcontroller programming.

PLCs in manufacturing automation: Application of programmable logic controllers in manufacturing automation, PLC basic and advanced ladder logic programming using RsLogix and CoDeSys format, Usage of timers, counters, sequencing, and interlocking, latching, master control relay for developing programs for manufacturing automation. Temperature control, valve sequencing, conveyor belt control, control of a process etc

SCADA for Automation: Elements of SCADA, Benefits of SCADA, Applications, Types of SCADA systems, Features and functions of SCADA, Building applications using SCADA for manufacturing automation.

References:

1. Grover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education Asia.
2. Grover M.P., Weiss M. M., Nagel R.N. and Odrey N.G., "Industrial Robotics, Technology, Programming and Applications", Mc Graw Hill Book Publications.
3. Krishna Kant, "Computer Based Industrial Control" PHI.
4. W. Bolton , "Programmable Logic Controllers" Fifth Edition, Elsevier
5. Vijay R. Jadhav, "Programmable Logic Controller", Second Edition, Khanna Publishers.

6. II Sem M.Tech. (Production Management) Curriculum Content

Course Code: **17EPME706**		Course Title: **Robust Design Optimization**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Robust Design Overview: Taguchi's approach to quality and quality loss function, noise factors and average quality loss, exploiting non linearity, classification of parameters

Analysis of variance: No-Way ANOVA, One-Way ANOVA, Two-Way ANOVA and Three-Way ANOVA

Two Level Experiments: Two factor factorial design, model adequacy checking and estimating model parameters, 2^2 full factorial design, 2^3 full factorial design, 2^k full factorial design and Two level fractional factorial design, General 2^{k-p} fractional factorial design.

Steps in Robust Design: Identification of process and its main function, Noise factors and testing conditions, Control factors and their levels, Matrix experiment and data analysis plan, Conducting the experiment and data analysis, Verifying experiment and future plan.

Signal to Noise Ratios: Comparison of the quality of two process conditions, Relationship between Signal to Noise Ratio and quality loss after adjustment, Identification of a scaling factor, Signal to Noise Ratios for static problems, Signal to Noise Ratios for dynamic problems, Analysis of ordered categorical data.

Taguchi Inner and Outer arrays: Orthogonal arrays and fractional factorial designs, Parameter design and tolerance design, Analysis of inner/outer array experiment, Alternative inner/outer orthogonal array experiments.

Constructing orthogonal arrays: Dummy level technique, Compound factor method, Linear graphs and Interaction assignment, Modification of linear graphs, Column merging method, Branching design.

References:

1. Montgomery, D. C., "Design and Analysis of Experiments", John Wiley & Sons.
2. Khuri A. I. and Cornell J. A. "Response Surfaces: Designs and Analyses, Marcel Dekker, Inc., New York.
3. Myers R. H., Montogomery, D. C. and Anderson-Cook C. M. "Response Surface Methodology: Process and Product Optimization Using Designed Experiments", John Wiley & sons, Inc., New York.
4. Mason R. L., Gunst, R. F., Hess J. L., "Statistical design and Analysis of Experiments With Applications to Engineering and SISAnce", John Wiley & sons, Inc., New York.
5. Phadke M. S., "Quality Engineering using Robust Design", Prentice Hall PTR Englewood Cliffs, New Jersy.
6. Ross P. J., "Taguchi Techniques for Quality Engineering", McGraw -Hill International.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMP704**		Course Title: **Product Automation Lab**
L-T-P**: 0-0-4**	Credits: **4**	Contact Hrs: **8 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Practical Hrs: **96 hrs**		Exam Duration: **2 hrs**

Knowledge Based Engineering:

- Customize the tree to display knowledge ware features
- Create parametric models
- Embed design knowledge in the models
- Automate the design and modification processes
- Create design configurations using design tables

HTML:
Tags, Attributes and Elements, Links, Images, Tables, Forms
CSS: CSS basics, styles, CSS syntax

JavaScript:
JavaScript Output, JavaScript Statements, JavaScript Syntax, JavaScript Variables, JavaScript Operators, JavaScript Arithmetic, JavaScript Strings, JavaScript Events, JavaScript Loop, JavaScript Objects, JavaScript functions.

Python:
Python programming skills using data structures and constructs, python programming skills using functions and packages.

References:

1. Companion Courses – https://companion.3ds.com/

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **18EPMP705**		Course Title: **PLM Technical Lab**
L-T-P: **0-0-3**	Credits: **4**	Contact Hrs: **6 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Lab Hrs: **72 hrs**		Exam Duration: **2 hrs**

Variant Management Essentials & Product Architect:

Create the product structure, Define product portfolios based on product roadmaps, Create and manage product configurations and design variants, Use Enterprise Changes to track and release features, Generate BOMs

Traceable Requirements Management Essentials:

Capture requirements from MS Word and MS Excel documents, Create requirements and requirement specifications, Allocate requirements to products and models, Create test cases and use cases, Create revision and multiple versions of requirements, Generate traceability reports

Platform Management and Baseline Behavior:

Create collaborative spaces and users, Assign required access rights to different users, Explore the Control widget and its related features, Configure PLM platform to add additional features as per requirements

Data Model Customization Essentials:

Describe Unified Typing concepts, Create Subtypes and add attributes to it, Create Specialization, Customer and Deployment Extensions, Create Unique Keys, Create Specialization and Deployment Packages

Web Based Customization:

Use MQL to set up the schema, Create and maintain a web application based on UI configurable components, Configure automatic business rules (triggers, notifications) and automatic object naming, Execute advanced MQL commands needed for administration, Extend the application with JSP

References

1. Companion Courses – https://companion.3ds.com/
2. Stark John, "Product Lifecycle Management: 21st Century Paradigm for Product Realization", Springer, Third Edition, 2015
3. Antti Saakasvuori, Anselmi Immonen, "Product Lifecycle Management" - Springer, 1st Edition, 2003.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMP706**		Course Title: **ERP Technical Lab**
L-T-P**: 0-0-3**	Credits: **3**	Contact Hrs: **6 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Practical Hrs: **72 hrs**		Exam Duration: **2 hrs**

Financial Accounting (Advanced): Fixed assets, Budget, Cost center accounting

MRP: Sales forecast, MRP run, Order recommendation

Admin and Technical: Application installation (APP and DB), System initialization, Set-up, Technical Enhancement – UI, Report – Query generation, Crystal report, Print layout design, Basics of Integration

Reports: Generation of reports for various functions

III Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC801**	Course Title: **Manufacturing Execution Systems**	
L-T-P**: 3-1-0**	Credits: **4**	Contact Hrs: **5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

Enterprise and Enterprise Integration: Enterprise and its characteristics, Strategic Planning, Feedback Loops, Time Definitions, Business Processes, Manufacturing Processes, Enterprise Integration, Horizontal Integration and Interoperability, Vertical Integration and Temporal Gap, Digitalization, Standards (ISO 15704)

Manufacturing Execution Systems and its Functionalities: Manufacturing Execution Systems (MES), MES Functionalities, MES Models, Manufacturing Operations Management (MOM), Functional Control Model, MES in Discrete Industry, MES in Process Industry, Standards (IEC 62264, IEC 61512, VDI 5600)

Process and Data Modeling: Enterprise Modeling, Process Modeling, Business Process Modeling Language (BPMN), Sankey Diagram, Entity-Relationship Diagrams, ARIS (ARchitecture for integrated Information Systems), Integrated Definition for Function Modelling (IDEF), Event-Driven Process Chain (EPC), Data Modeling, Data Flow Diagrams (DFDs), Unified Modeling Language (UML), Business to Manufacturing Markup Language (B2MML)

Data Collection: Process Analysis, Process Modeling, Data Modeling, Data Flow Diagrams (DFDs), Communication Patterns, Technologies, OPC (OLE for Process Control)

Traceability And Tracking: Tracing, Traceability, Enterprise Entities, Forward and Backward Traceability, Traceability Granularity, Tracking, Tracking Approaches, Regulations (GMP, US FDA, EudraLex)

PERFORMANCE MEASUREMENT: Performance Measurement, Performance Management, Performance Measurement System and Characteristics, Key Performance Indicators (KPIs), Overall Equipment Effectiveness (OEE), Metrics Maturity Model, KPI Effectiveness, Process Improvement, Standards (ISO 22400, VDMA 66412)

Managerial Accounting: Managerial Accounting, Cost Assignment Techniques, Cost Hierarchal Levels, Activity Drivers, Standard Cost, Actual Cost, Job Costing, Process Costing, Activity-Based Costing (ABC), Time-Driven ABC (TDABC), Resource Consumption Accounting (RCA), Cost of Poor Quality (COPQ)

Real-Time Enterprise: Real-Time Enterprise (RTE), Event-Driven Architecture (EDA), Events, Complex Event Processing (CEP)

Industry 4.0: Industry 4.0, Challenges, Industrial Internet of Things (IIoT), Reference Architecture for Industry 4.0, Cyber-Physical Systems (CPS), Cyber-Physical Production Systems (CPPS), Smart Product, Smart Manufacturing, Smart Logistics, Smart Services

Business Analytics and Business Intelligence, Blockchain: Knowledge Management, Case-Based Reasoning (CBR), Big Data, Decision Analytics, Descriptive Analytics, Predictive Analytics, Prescriptive Analytics, Bitcoin and Blockchain, Merkle Tree, Blockchain Types, Scope and Application of Blockchain in Manufacturing

References:

1. Sachin Karadgi, "A Reference Architecture for Real-Time Performance Measurement," Springer, 2014.
2. Opher Etzion, Peter Niblett, "Event Processing in Action," Manning, 2011.
3. Roger Wattenhofer, "The Science of the Blockchain," CreateSpace Independent Publishing Platform, 2016.
4. Bruce Silver, "BPMN Method and Style - With BPMN Implementer's Guide," Cody-Cassidy Press, 2011.
5. Charles T. Horngren, George Foster, Srikant M. Datar, Madhav V. Rajan, Chris Ittner, "Cost Accounting: A Managerial Emphasis," Prentice Hall, 13th Edition, 2008.
6. Wood C. Douglas (Editor), "Principles of Quality Costs: Financial Measures for Strategic Implementation of Quality Management," ASQ, 4th Edition, 2013.
7. Gary Cokins, "Activity-Based Cost Management: An Executive's Guide," Wiley, 2001.
8. Robert S. Kaplan, Robin Cooper, "Cost & Effect: Using Integrated Cost Systems to Drive Profitability and Performance," Harvard Business Review Press, 3rd edition, 1997.
9. ISO 15704: Industrial Automation Systems—Requirements for Enterprise-Reference Architectures and Methodologies, 2000.
10. IEC 62264: Enterprise-Control System Integration. Multi—part standard.
11. IEC 61512: Batch Control. Multi—part standard.
12. ISO 22400–2: Automation Systems and Integration—Key Performance Indicators for Manufacturing Operations Management, Multi—part standard.
13. VDI 5600 Part 1: Manufacturing execution systems (MES), 2007.
14. OPC Foundation: OPC unified architecture specification part 1: overview and concepts, http://www.opcfoundation.org/.
15. MESA, MES Explained: A high level vision, white paper number 6, 1997.GMP
16. WHO Good Practices for Pharmaceutical Quality Control Laboratories, WHO Technical Report Series, No. 957, 2010.
17. Mike Bourne, Pippa Bourne, Handbook of Corporate Performance Management, Wiley, 2011.

III Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMC802**		Course Title: **Manufacturing Systems Simulation**
L-T-P**: 3-0-1**	Credits: **4**	Contact Hrs:**5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

Principles of Modeling & Simulation: Basic Simulation Modeling, Systems – discrete and continuous systems, general systems theory, models of systems- variety of modeling approach, concept of simulation, simulation as a decision making tool, types of simulation, Principle of computer modeling- Monte Carlo simulation, Nature of computer modeling, limitations of simulation, area of application.

Random Number Generation: Random variables and their properties, Properties of random numbers, generation of Pseudo random numbers, techniques for generating random numbers, Various tests for random numbers-frequency test and test for Autocorrelation,

Random Variate Generation: Different techniques to generate random Variate: Inverse transform technique,-exponential, Normal, uniform, Weibull, direct transformation technique for normal and log normal distribution, convolution method and acceptance rejection techniques-Poisson distribution, **Statistical Techniques:** Comparison of two system designs, Comparison of several system designs – Bonferroni approaches to multiple comparisons for selecting best fit, for screening

Design and Evaluation of Simulation Experiments: Problem formulation, data collection and reduction , time flow mechanism, key variables, logic flow charts, starting condition, run size, experimental design consideration, output analysis, verification and validation of simulation models. **Simulation Languages:** Comparison and selection of simulation languages, study of any one simulation language.

Discrete Event Simulation: Concepts in discrete –event simulation, development of simulation models for queuing systems, production systems, inventory systems, maintenance and replacement systems, investment analysis and network, Programming for discrete event simulation, Case studies.

References:

1. Jerry Banks and John S Carson, Barry L Nelson, David M Nicol, “Discrete event system simulation”, Prentice Hall, India.
2. Khoshnevi. B., “Discrete system simulation”, McGraw Hill International.
3. Ronald G Askin and Charles R Standridge , “Modeling and analysis of manufacturing systems”, John Wiley & Sons.
4. Gordon G , “System Simulation”, Prentice Hall, India..
5. Thomas J Schriber., “Simulation using GPSS”, John Wiley & Sons.
6. Shannon, R.E., “System Simulation – The art and science”, Prentice Hall, India.
7. Averill Law & David M.Kelton , “Simulation, Modeling and Analysis”, TMH.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **19EPMC708**		Course Title: **Research Methodology**
L-T-P**: 2-1-0**	Credits: **3**	Contact Hrs:**4 hrs/week**
ISA Marks: **100**	ESA Marks: **--**	Total Marks: **100**
Teaching Hrs: **26 hrs**	Tutorial Hrs: **24 hrs**	Exam Duration: **--**

Research: Definition, Characteristics and Objectives; Types of Research, Research Methodology, Research Process, Literature Review, Review concepts and theories, Formulation of Hypothesis, Research design, Data collection, Processing and analysis of data collected, Interpretation of data, Computer and internet: Its role in research, Threats and Challenges to research, Writing a research paper, research project, Thesis, Research ethics, Citation methods and rules. Case studies.

References:

1. Kothari C. R. "Research Methodology – Methods & Techniques", Wishwa Prakashan,
2. Ranjit Kumar, "Research Methodology – A step by step guide for Beginners", 3rd Edition, Pearson Edition, Singapore, 2011.
3. Dawson Catherine, "Practical Research Methods", UBS Publishers, New Delhi, 2002.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **19EPMW701**		Course Title: **Mini Project**
L-T-P**: 0-0-3**	Credits: **3**	Contact Hrs: **6 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Teaching Hrs: **72 hrs**		Exam Duration: **2 hrs**

Mini Project: The Guide shall define the problem statement for the Project work. The student shall execute the Project within three months duration during the 2nd semester. The student who has opted Mini Project shall opt either ERP or PLM theme to carry out their work.

1.1.2: Syllabus Revised Courses of PG Energy Systems Engineering

Course Code: 16EMEC707		**Course Title: Research Methodology**
L-T-P: 2-1-0	Credits: 3	Contact Hrs: 4hr/week
ISA Marks: 100	ESA Marks: --	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Research: Definition, Characteristics and Objectives; Types of Research, Research Methodology, Research Process, Literature Review, Review concepts and theories, Formulation of Hypothesis, Research design, Data collection, Processing and analysis of data collected, Interpretation of data, Computer and internet: Its role in research, Threats and Challenges to research, Writing a research paper, research project, Thesis, Research ethics, Citation methods and rules. Case studies	5hrs

Reference Books

1. Kothari C. R. “Research Methodology – Methods & Techniques”, Vishwa Prakashan, A Division of New Age International Pvt. Ltd., 2008.
2. Ranjit Kumar, “Research Methodology – A step by step guide for Beginners”, 3rd Edition, Pearson Edition, Singapore, 2011.
3. Dawson Catherine, “Practical Research Methods”, UBS Publishers, New Delhi, 2002

Course Code: 17EMEC704	Course Title: Instrumentation and Control in Energy Systems	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

1. **Generalized configurations:** functional descriptions of measuring instruments. Measurement Errors for mechanical instruments. materials, radiant storage. materials, radiant storage	6hrs
2. **Transducer classification.** Generalized performance characteristics of instruments, Static and dynamic characteristics of transducers, Transient analysis of a control system	7hrs
3. Temperature Measurement: Use of bimaterials, Pressure thermometers, Thermocouples, RTD, Thermisters, and Pyrometry pyrometers.	7hrs
4. **Pressure Measurement:** Manometers, dynamic response of manometers, Bourden tube, Elastic pressure elements, electromechanical pressure transducers, Measurement of High Pressure and low pressure. Calibration of Pressure measuring equipment.	5hrs
5. **Flow Measurement:** Flow measurement methods, variable head flow meters for incompressible Fluids. Rota meters, Electromagnetic flow meters, Hot wire anemometers, Hot film transducers, Ultrasonic flow meters	5hrs
6. Air pollution and Measurement: Introduction, Gas sampling techniques, particulate sampling techniques, Sulphur dioxide measurements, Combustion Products Measurements Opacity and odour measurements	5hrs
7. **Miscellaneous measurements:** Measurement of liquid level, Measurement of Humidity moisture, measurement of O_2, CO_2 in flue gases. pH measurement	5hrs
8. **Instruments for monitoring electrical parameters,** Moving Iron/coil, Energy measurement, power factor meter	5hrs
9. Analog signal conditioning, Amplifiers, Instrumentation amplifier, A/D and D/A converters, Digital data processing and display, Data acquisition system	5hrs

Text Books

1. J.P.Holman: Experimental methods for engineers Sixth edition, McGraw-Hill ,Inc.1994
2. E.O Doebelin: Measurement Systems Applications & Design, McGraw Hill, 1990

Reference Books

1. Bechwith. Marangoni. Lienhard: Mechanical Measurements 5th edition. Addison-Wesley 2000
2. A.K. Ghosh: Instrumentation and Control. McGraw-Hill Inc.2003

Course Code: 17EMEE701	**Course Title: Wind Energy Conversion Systems**	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Introduction: Metrology of wind, Wind speed variation with height, Wind speed statistics. Wind Measurements Biological indicators, Rotational anemometers, other anemometers, Wind direction	10hrs
Basic concepts of Wind energy: Power output from an ideal turbine, Aerodynamics, Practical turbines, Transmission and generation efficiency	10hrs
Energy production and capacity factor, Torque at constant speeds, Drive train oscillations, Turbine shaft power and torque at variable speeds.	10hrs
Wind Turbine Connected to the Electrical Network: Methods of generating synchronous power, AC circuits, The synchronous generator, Per unit calculations, The induction machine, Motor starting, Capacity credit, features of electrical network.	10hrs
Asynchronous Electric Generators: Asynchronous systems, DC shunt generator with battery load, Per unit calculation, Self excitation of the induction generators, Single phase operation the induction generator, Asynchronous Loads like Piston/ Centrifugal pumps, Paddle wheel heaters, Batteries	5hrs
Economics of Wind Systems: Capital costs, Economic concepts, Revenue requirements, Value of wind generated electricity, Hidden costs in Industrialized and developing nations	5hrs

Text Books

1. Gary L Johnson, Wind Energy Systems ,1ed., PHI, New Jersey, 2001
2. D.P.Kothari, I.G.Nagrath, Electrical Machines, 2ed.,TMGH, 2004

Reference Books

1 Rai G.D., Non-Conventional Energy Sources, 4 ed., Khanna Publications, 2002

Course Code: 17EMEE702	**Course Title: Solar Thermal Systems Design**	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

1	**Solar Radiation Analysis**: Solar constant, Basic earth sun angles, Beam and diffuse radiations, Radiation on titled surfaces, Measurement of solar radiation	10hrs
2	**Heat Transfer for Solar Energy Utilization**: Introduction, modes of heat transfer, Reflectivity, Transmissivity, Transmitance-absorptance product, Heat exchangers	10hrs
3	**Liquid Flat Plate Collectors(FPC)**: Liquid FPC, conversion of solar radiation into heat General description of FPCs, losses and efficiency of FPC, Characteristics of FPC, Evaluation of Overall Loss Coefficient, Thermal Analysis of FPC and Useful heat gain, Mean plate temperature, Collector performance, Selective coating, Effect of dust and shading, material selection for FPC, Evacuated tube collectors	10hrs
4	**Flat Plate air heating collectors**: Introduction and types, performance and applications, heating and drying of Agricultural products, Psychrometric chart and its use, Design of Forced convection dryer	10hrs
5	**Performance testing of Solar Collectors**: Introduction, Governing performance equations, measuring instruments and methods, Testing procedures, Testing of Liquid flat plate solar collectors, Solar Air heaters. Overall performance of solar heating panels	05hrs
6	**Energy Storage**: Sensible heat and latent heat storage systems, thermo-chemical storage, shallow Solar pond, Collector and Storage heaters, Salinity gradient solar pond, Solar thermal storage systems	05hrs

Text Books

1. JA Duffie, WA Beckman: Solar Engineering of Thermal Processes, 3rd Edn. John Wiley
2. Sukhatme S P., Nayak J., Solar Energy: Principles of Thermal Collection & Storage, 3rd Edn, TMGH, 2008

Reference Books

1. Garg H.P., Prakash J., Solar Energy: Fundamentals and Applications TMH, 2015
2. Rai G. D., Solar Energy Utilization, 5 ed., Khanna publishers,2006

Course Code: 17EMEE704		Course Title: Illumination Engineering
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Illumination Basics: Radiation, colour, eye & vision; different entities of illuminating systems; Light sources: daylight, incandescent, electric discharge, fluorescent, arc lamps and lasers; Luminaries, wiring, switching & control circuits	10hrs
Laws of illumination; illumination from point, line and surface sources. Photometry and spectrophotometry; photocells. Environment and glare. General illumination design.	10hrs
Interior lighting – Industrial, residential, office departmental stores, indoor stadium, theater and hospitals	10hrs
Exterior lighting- Flood, street, aviation and transport lighting, lighting for displays and signaling- neon signs, LED-LCD displays beacons and lighting for surveillance.	10hrs
Utility services for large building/office complex Layout of different meters and protection units. Different type of loads and their individual protections. Selection of cable/wire sizes; potential sources of fire hazards and precautions. Emergency supply – stand by & UPS. A specific design problem on this aspect	10hrs

Text Books

1 R. John Koshel, Illumination Engineering: Design with Nonimaging Optics, John Wiley & Sons, 2012
2 Jack L. Lindsey, Applied Illumination Engineering, The Fairmont Press, Inc., 1997

Reference Books

1. Kamalesh Roy,,Illuminating Engineering , Firewall Media,2006

Course Code: 17EMEW701		**Course Title: Mini Project-1**
L-T-P: 0-0-3	Credits: 3	Contact Hrs: 3hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 36		Exam Duration: 3 hrs

Theme: Renewable Energy	
The Mini-Project-1 envisages facilitating students for a real-time learning experience on working of renewable energy conversion and its performance characterization. The Project shall be executed as per the following methodology ✓ The review on Industry /scientific research status related to the product ✓ The study of product manuals related to renewable energy conversion devices available in market to capture the design-intent of the product. ✓ Apply fundamental concepts to work-out preliminary design calculation of the product envisaged through a customer survey and develop alternate design. ✓ Evidence use of computational tools to evolve product concept and its improvisation ✓ Fabrication of a working prototype/ scaled model /circuitry hardware ✓ Testing of the hypothesis through the fabricated device/ mathematical model The continuous assessment includes peer review and Faculty assessment at periodic intervals during the semester The Mini-project has to be documented by student in form of a Technical Report for submission during the End-semester Assessment.	36hrs

Course Code: 17EMEC705	Course Title: Energy Audit and Conservation	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

1. **Energy Management & Audit:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.	10hrs
2. **Energy Conservation:** Indian energy conservation act-2001, second law of thermodynamics, rules for efficient energy conservation of energy and materials, technologies for energy conservation (reducing demand using alternative supplies, load factor, balancing and energy storage), supply side options, demand side options, maximum demand controller, transmission and distribution side options	10hrs
3. **Energy Efficient Motors and Power factor:** Constructional details, factors affecting efficiency, losses distribution, soft starters, variable speed drives**.** Power Factor Causes and disadvantages of low power factor, methods to improve power factor, automatic power factor controllers	8hrs
4. **Energy efficient lighting** Terminology, cosine law of luminance, types of lamps, characteristics, design of illumination systems, good lighting practice, lighting control, steps for lighting energy conservation	7hrs
5. **Heat Recovery Systems:** Sources of waste heat, guidelines to identify waste heat, grading of waste heat, feasibility study of waste heat recovery, gas to gas heat recovery, rotary generators, heat pipes, gas to liquid heat recovery, waste heat boilers.	5hrs
6. **Cogeneration** Definition and need, basics of thermodynamic cycles, classification of cogeneration systems, steam turbine, gas turbine, typical heat to power ratio in various industries, operating strategies for cogeneration plant, typical cogeneration performance parameters, relative merits of cogeneration systems.	5hrs
7. **Compressed air network** Types of compressors, compressor selection, monitoring performance, specific power consumption, FAD test, capacity control and power consumption, compressed air distribution system, moisture separation**.**	5hrs

Text Books

1. WC Turner: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007)
2. LC Witte, PS Schmidt and DR Brown: Industrial Energy Management and Utilization (Hemisphere Publishing Corporation, Washington, 1998).

Reference Book

1. George Polimeros: Energy Cogeneration Handbook, (Industrial Press, Inc., NY, 1981)
2. W Trinks, MH Mawhinney, RA Shannon, RJ Reed, JR Garvey: Industrial Furnaces, Sixth Edition, (John Wiley & Sons, 2003)

Course Code: 17EMEC706		**Course Title: Demand-side Management**
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Types of DSM measures : Energy reduction programmes : Load management programmes, Load growth and conservation programmes	5hrs
Economic Analysis and Financial Management: Investment needs, appraisal and criteria, sources of funds. Anatomy of investment – Initial investment, Return on Investment, Economic life, Basic income equations. Tax considerations: Depreciation, types and methods of depreciation, Income tax Considerations. Financial analysis: Simple pay back period, Return on investment (ROI), Net Present value (NPV), Internal Rate of Return (IRR), and Annualized cost, Time value of money, Cash flows, Discounting, Inflation Risk and sensitivity analysis, financing options. Pros and cons of the common methods of analysis	4hrs
Project Management: Definition and scope of project, technical design, financing, contracting, implementation and performance monitoring. Implementation plan for top management, Planning budget, Procurement procedures, construction, Measurements and verification.	6hrs
Energy Monitoring, Targeting Review and Evaluation : Definition – Monitoring and targeting, elements of monitoring and targeting, data and information analysis, techniques energy consumption, production, cumulative sum of difference (CUSUM), Review and evaluation.	6hrs
Energy Policy :Need for Energy Policy for Industries, Formulation of Policy by any industrial Unit, Implementation in Industries, National & State level Policies	6hrs
Case Studies: Municipality Demand Side Management (Mu-DSM) scheme, Agriculture DSM, Small scale Enterprise DSM, Electrical power distribution DSM, Commercial Building DSM	3hrs

Text Books

1. W.R.Murphy, G.Mckay, Energy Management, Butterworths
2. C.B.Smith, Energy Management Principles, Pergamon Press).

Reference Books

1. CRC Handbook of Energy Efficiency – CRC Press

Course Code: 17EMEE705	**Course Title: Design of Heat transfer Equipments**	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

1	**Heat Exchangers:** Classification and selection, Heat exchanger theory and fouling Shell and tube heat exchangers	10hrs
2	**Plate heat exchangers**: heat transfer and pressure drop, heat transfer prediction using Leveque analogy, design of plate heat exchangers	10hrs
3	**Design of shell and tube heat exchanger**: 1-2 parallel and Counter flow heat exchangers. Flow arrangements for increased heat recovery. Double pipe and Stirred Heat exchanger.	10hrs
4	**Heat exchanger for Gases**: Properties of gases, film coefficients, coolers for Air compressor and wet gases.	10hrs
5	**Equipments for boiling and Evaporation**: Classification of vapour generating Equipment, Analysis and design	10hrs

Text Books

1. Das Sarit K., Process Heat Transfer 1st Edn. Narosa 2006
2. Ozisik N. M., Heat transfer: Basic approach, 1ed., MGH, 2002
3. Holman J. P., Heat transfer 8 ed., MGH, 2006

Reference Book

1. Kays W.M, London A.L., Compact heat exchangers, 2nd Edn, MGH, 1955
2. Kern D.G., Process Heat Transfer, 1 ed., TMH, 2000
3. Schlunder, Heat exchanger Data hand book, Vol 2 & 3, 1983

Course Code: 17EMEE706		Course Title: Solar Photovoltaic System Design
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

1. **Introduction to PV Systems:** The PV Cell, The PV Module, The PV Array, Energy Storage, PV System Loads, PV System Availability, Associated System Electronic Components, Generators, Balance of System (BOS) ,Components. Present and Proposed PV Cells and Systems: Silicon PV Cells, Gallium Arsenide Cells, Copper Indium (Gallium) Diselenide Cells, Cadmium Telluride Cells, Emerging Technologies, New Developments in System Design	10hrs
2. **Grid-Connected Utility-Interactive PV Systems:** Applicable Codes and Standards, Design Considerations for Straight Grid-Connected PV Systems, Design of a System Based on Desired Annual System Performance, Design of a System Based on Available Roof Space, Design of a Micro-inverter-Based System, Design of a Nominal 21 kW System that Feeds a Three-Phase Distribution Panel, Design of a Nominal 250 kW System, System Performance Monitoring	10hrs
3. Mechanical Considerations: Important Properties of Materials, Establishing Mechanical System Requirements, Design and Installation Guidelines, Forces Acting on PV Arrays, Array Mounting System Design, Computing Mechanical Loads and Stresses, Stand-off, Roof Mount Examples.	10hrs
4. **Battery-Backup Grid-Connected PV Systems:** Battery-Backup Design Basics, A Single-Inverter 120 V Battery-Backup System Based on Standby Loads, A 120/240 V Battery-Backup System Based on Available Roof Space, An 18 kW Battery-Backup System Using Inverters in Tandem, AC-Coupled Battery-Backup Systems, Battery Connections.	10hrs
5. **Stand-Alone PV Systems:** The Simplest Configuration: Module and Fan, A PV-Powered Water-Pumping System, A PV-Powered Parking Lot Lighting System, A Cathodic Protection System, A Portable Highway Advisory Sign A Critical-Need Refrigeration System, A PV-Powered Mountain Cabin, A Hybrid-Powered, Off-Grid Residence, Summary of Design Procedures	5hrs
6. **Economic Considerations:** Life-Cycle Costing, Borrowing Money, Payback Analysis, Externalities and Photovoltaics: Externalities, Environmental Effects of Energy Sources, Externalities Associated with PV Systems	5hrs

Text Books

1. Roger Messenger, Amir Abtahi, Photovoltaic Systems Engineering, 3rd Edition, CRC Press, 2010,
2. Solanki C.S. Solar Photovoltaics : Fundamentals, Technologies and Applications, PHI., 2011

Reference Books

1. Matthew Buresch, Photovoltaic Energy Systems-Design and Installation, 1ed., MGH, 1983
2. Seippel R.G., Photovoltaics, 1 ed., Roston publication, 1986

Course Code: 17EMEE707		Course Title: Industrial Process Equipment Design
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Boilers: Types, Combustion in boilers, Performances evaluation, Analysis of losses, Feed water	5hrs

treatment, Blow down, Energy conservation opportunities	
Steam System: Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings	4hrs
Furnaces: Classification, General fuel economy measures in furnaces, Excess air, Heat distribution, Temperature control, Draft control, Waste heat recovery.	6hrs
Electrical system: Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and transformer losses.	6hrs
Electric motors: Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy efficient motors	6hrs
Lighting System: Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues	3hrs
Fans and blowers: Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities	5hrs
Energy Efficient Technologies in Electrical Systems: Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of each technology	5hrs

Text Books

1. A.K.Shaha, Combustion Engineering and Fuel Technology, Oxford & IBH Publishing
2. Bureau of Energy Efficiency Publications

Reference Books/websites

1. http://www.em-ea.org

Course Code: 17EMEE708	Course Title: Heating Ventilating and Air-conditioning	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

1. **Air-conditioning :**ASHARE nomenclature, psychometric processes on psychometric chart, coil by pass factor, estimation of cooling / heating load, plotting air conditioning processes for summer using ESHF concept, concept of comfort air conditioning, effective temperature concept	
2. **Introduction to HVAC:** Basic Air-Conditioning System , Zoned Air-Conditioning Systems , Choosing an Air-Conditioning System , System Choice Matrix Thermal Comfort: What is Thermal Comfort? Seven Factors Influencing Thermal Comfort ,Conditions for Comfort , Managing Under Less Than Ideal Conditions	10hrs
3. **Ventilation and Indoor Air Quality:** Air Pollutants and Contaminants ,Indoor Air Quality Effects on Health and Comfort, Controlling Indoor Air Quality, ASHRAE Standard, Ventilation for Acceptable Indoor Air Quality , Zoning Design, Controlling the Zone, ,Single Zone Air Handlers and Unitary Equipment, Examples of Buildings with Single-zone Package Air-Conditioning Units, Air-Handling Unit Components , Refrigeration Equipment , System Performance Requirements, Rooftop Units, Split Systems	10hrs
4. **Multiple Zone Air Systems:** Single-Duct, Zoned Reheat, Constant Volume Systems, Single-Duct, Variable Air Volume Systems , By-Pass Box Systems, Constant Volume Dual-Duct, All-Air Systems, Three-deck Multizone Systems , Dual-Duct, Variable Air Volume Systems, Dual Path Outside Air Systems	10hrs
5. **Hydronic Systems:** Natural Convection and Low Temperature Radiation Heating Systems, Panel Heating and Cooling , Fan Coils, Two Pipe Induction Systems, Water Source Heat Pumps, Hydronic System Architecture, Steam - Water Systems , Hot Water, Chilled Water ,Condenser Water	
6. **Energy Conservation Measures:** Energy Considerations for Buildings, ASHRAE/IESNA Standard, Heat Recovery , Air-Side and Water-Side Economizers, Evaporative Cooling, Control of Building Pressure	
7. **Refrigerants:** desirable properties, designation, azeotrops, secondary refrigerants, Ozone depletion, global warming, alternate refrigerant Applications of refrigeration systems: Industrial, comfort, food preservation and medical	10 hrs
8. **Special Applications:** Radiant Heating and Cooling Systems, Thermal Storage Systems , The Ground as Heat Source and Sink, Occupant Controlled Windows with HVAC , Room Air Distribution Systems ,Decoupled or Dual Path, and Dedicated Outdoor Air Systems	

Text Books

1. Robert McDowall, Fundamentals of HVAC Systems, Elsevier Publications First edition 2006
2. Richard C.Jordan & Gayle B.Priester, Refrigeration and Air Conditioning– PHI
3. Norman C.Harris, Modern Air Conditioning Practice by– McGraw-Hill International Edition

Reference Book

1. ASHARE Handbook: Fundamental, ASHARE publication, 2013
2. ASHARE Handbook: Standards, ASHARE publication, 2013

Course Code: 17EMEE709	**Course Title: Renewable Energy Grid Integration**	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

1. **Introduction:** Introduction to renewable energy grid integration, concept of mini/micro grids, and smart grids	5hrs
2. **Synchronous Generator based Sources:** Review of synchronous generators, Introduction to power system stability problems: rotor angle stability, voltage stability and voltage collapse, classification of stability. Modeling of synchronous machines: dq transformations, synchronous machine representation in stability studies	8hrs
3. **Induction Generator based sources:** Introduction to induction machines: electrical characteristics, slip, speed-torque characteristics etc. Self excited induction generator, Constant speed Induction generators, Variable speed Induction generators, Doubly fed Induction generators.	12hrs
4. **Converter based Sources:** Introduction to power electronic devices, AC/DC converters, PWM, THD. Permanent magnet synchronous generator, solar PV systems, fuel cell, aqua-electrolizer	8hrs
5. **Grid Integration:** Issues in integration of synchronous generator based, induction generator based and converter based sources together. Network voltage management (discusses the issue of voltage levels). Power quality management (voltage dips, harmonics and flickers). Frequency management. Influence of WECs on system transient response System protection, Grid codes. ,Need of micro and smart grids	12hrs
6. **Various Power System Studies:** Various load forecasting techniques. Small signal stability, introduction to transient stability, voltage stability	5hrs
7. **Simulation Studies :** power system studies for grid connected/off grid PV system, grid connected/off grid WECS and small grid consisting of various renewable energy sources	5hrs

Text Books

1. Brendan Fox, Damian Flynn, Leslie Bryans, Wind Power Integration connection and system operational aspects, IET Power and Energy Series 50, 2007.
2. Marco H. Balderas (Edited): Renewable Energy Grid Integration- The Business of Solar Photo-voltaics , Nova Science Publishers, New York, 2009

Reference Books

1. Olimpo Anaya-Lara, Nick Jenkins, Janaka Ekanayake, Phill Cartwright, Michael Hughes, Wind Energy Generation Modeling and Control, Wiley and Sons, 2009
2. AJ Wood, BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 1996

Course Code: 17EMEW702		**Course Title: Mini Project-2**
L-T-P: 0-0-3	Credits: 3	Contact Hrs: 3hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 36		Exam Duration: 3 hrs

Theme : Demand-side Management (DSM)	
The Mini-Project-2 envisages facilitating students for a real-time learning experience on working of Demand-side Management of Municipal supplies, Agriculture sector, Small Manufacturing Enterprises (SMEs), Commercial Building sector, Electrical distribution transformers.. The Project shall be executed as per the following methodology ✓ The review on Industry /scientific research status related to the product ✓ The study of current strategies adopted in demand-side management in different sectors in domestic and industrial sectors to capture the design-intent of the practice. ✓ Apply fundamental concepts to work-out preliminary design calculation of the strategy envisaged through a customer survey and develop alternate design. ✓ Evidence use of computational tools to study existing concept and its improvisation ✓ Fabrication of a working prototype/ scaled model /circuitry hardware ✓ Testing of the hypothesis through the fabricated device/ mathematical model The continuous assessment includes peer review and Faculty assessment at periodic intervals during the semester The Mini-project has to be documented by student in form of a Technical Report for submission during the End-semester Assessment.	36hrs

Course Code: 17EESC801	Course Title: Economics and Planning of Energy Conversion	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Case studies on evaluation of Economics and Financial feasibility of Energy conversion devices	
1. Indicators of Financial Performance, Incremental Analysis of Investment Projects Approaches of uncertainty in Financial Analysis ,Social Cost-benefit Analysis of Projects	10hrs
2. Case Studies to assess : Solar Distillation Plant	5hrs
3. Family size Bio-gas plant	5hrs
4. Box type Cooker.	5hrs
5. Improved Bio-mass cook-stove	5hrs
6. Energy Efficient Motors in Industries	5hrs
7. Solar Photovoltaic lanterns	5hrs
8. Power Generation from Rice-Husk	5hrs
9. Wind power gererator	5hrs

Text Books

1. Khandpal T.C., Garg H.P., Financial Evaluation of Renewable Energy Technologies, Mac-Millan India Ltd., 1st Edn, 2003
2. Sukhatme S.P., Nayak J.K., Solar Energy: Principles of Thermal Collection and Storage, TMGH, 2008

Reference Book

1. Tiwari G.N., Solar Energy:Fundamentals, Design, Modelling and Applications, Alpha Science International Limited, 2015

Course Code:18EESP701	Course Title: **Energy System Lab**	
L-T-P: 0-0-2	Credits: 2	Contact Hrs: 4 hr/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching hrs: 24		Exam Duration: 02 hrs

Studies on : a. Operational experience on i) Pyranometer, ii) Sunshine recorder b. Measurement of temperature using Infrared Thermometers d. Measurement of illumination using Lux meter e. Exhaust gas analysis using gas analyzer **List of experiments** 1. Performance evaluation of a solar flat plate thermo-syphon water heating 2. Conversion efficiency of a solar flat plate forced solar water heating system 3. Conversion efficiency of a solar Concentrating water heating system 4. Determination of conversion efficiency of a solar air heating system 5. Study and analysis of a solar still / distillation plant 6. Performance estimation of photovoltaic water pumping system 7. Investigation on a solar dryer 8. Operational characteristics of P.V. Indoor lighting system 9. Determination of characteristics of a wind generator 10. Performance evaluation of solar cooker 11. P.V. System sizing exercise 12. Data acquisition system for monitoring of P.V system using LABVIEW s/w 13. Performance estimation of Solar fuel cell 14. Performance evaluation of vertical and horizontal axis wind turbine rotors.	24 hrs

Course Code:18EESP702	Course Title: **Industrial Instrumentation and Control Lab**	
L-T-P: 0-0-2	Credits: 2	Contact Hrs: 4 hr/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching hrs: 24		Exam Duration: 02 hrs

1. **Control technologies** Local manual, remote electrical, Local pneumatic, Remote analog/digital 2. **Basic electrical and math concepts**: Applications to instruments, Electrical principles and symbols, Series/parallel circuits 3. **Pressure instrumentation & measurements**: Pressure measurement devices, U-tube manometer, bourdon gauge, bellows gauge, piezoelectric 4. **Temperature instrumentation and measurements** • Measurement devices and techniques, Bimetallic temperature measurement, Filled capillary and bulb, thermocouple, resistance temperature detector (RTD), thermistors, thermowells, infrared 5. **Flow Instrumentation and Measurements:** Flow measurement methods, Factors influencing flow measurement, Flow measurement devices: orifice plates, venturi tube, flow nozzle, elbow taps, pitot tube, magnetic flow meter (Mag meter), vortex shedding meter, turbine meter, target flowmeter, ultrasonic, variable area rotameter, coriolis meter 6. **Level instrumentation and measurements:** Level measurement methods: sight glass, differential pressure level measurement, bubbler, displacer level sensor, float level sensors, capacitance, radiation-based, radar and ultrasonic level sensors 7. **Manipulating the process**: Final control element, Actuators, valve positioners, I/P, valves • Variable frequency drives 8. **Controllers:** Control modes: proportional, integral, derivative, Tuning feedback controllers ¼ decay, Zeigler-Nichols, damped oscillation, Ratio, cascade and feed-forward control 9. **Control systems**: Overview of PLCs, DCS and SCADA systems **Hands-on Exercises**: Sensor checkout, Hookup to calibration stands, Transmitter calibration check, Program/tune controller, Set up of differential pressure, temperature, and other process-simulation devices, Checking current output with Volt-Ohm Mille-ammeter (VOM) & tracing around loop, Simulate and source 4-20mA-DC signals	24 hrs

Course Code:18EESP703	Course Title: **Process Modeling and Simulation Lab**	
L-T-P: 0-0-2	Credits: 2	Contact Hrs: 4 hr/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching hrs: 24		Exam Duration: 02 hrs

MATLAB Analysis 1. Declination of earth, hour angle, day length, local apparent time. 2. Monthly average, hourly global and diffuse radiation on a horizontal surface and tilted Surfaces. 3. Power generation from a wind turbine, Variation of wind velocity and power with altitude. 4. Solution of ordinary differential eqations-4th order R K Method. 5. Solution of one-dimensional steady state heat conduction equation. 6. Solution of two-dimensional steady state PDE. 7. Solution of one-dimensional transient PDE. **Finite Element Analysis** 8. Two dimensional heat conduction. 9. One dimensional transient heat conduction. 10. Transient analysis of a casting process. **CFD Analysis** 11. Flow through a pipe bend. 12. Flow through a nozzle.	24 hrs

Course Code:18EESP704		Course Title: **IoT based Living Space Lab**
L-T-P: 0-0-2	Credits: 2	Contact Hrs: 4 hr/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching hrs: 24		Exam Duration: 02 hrs

1. Introduction to IoT, Automation, Arduino, Raspberry Pi and IoT.	24 hrs
2. Introduction to Arduino programming and interfacing with peripherals and sensors Motor, Servo motor, LDR, PIR sensor, ultrasonic sensor, DHT 11, MQ2 smoke sensor, LCD and RC522 RFID	
3. Wireless communication with Arduino: GSM Module, Ethernet Shield. Raspberry Pi and Raspbian operating system: Installing operating system ,Starting Raspberry Pi desktop and using Linux commands	
4. Connecting to the network: Wired networking and Wireless networking, Setting up static IP for raspberry pi, Remote accessing of Raspberry Pi	
5. Python programming with Raspberry Pi: Introduction to Python, Python commands and Python scripting for programming GPIO	
6. Interfacing of Arduino with Raspberry Pi: Programming Arduino from Raspberry Pi using IDE Programming Arduino from Raspberry Pi using Python	
7. Raspberry Pi as web server: Installing Apache Server	
8. Connecting Arduino and Raspberry Pi to cloud service: Uploading Arduino sensor data to cloud. Connecting Raspberry Pi to cloud and interfacing sensors	
9. Conduction Of Living Space Lab Experiments Design of IoT based weather DAQ system IoT based temperature data monitoring and DAQ IoT based humidity data monitoring and DAQ IoT based solar insolation data monitoring and DAQ IoT based wind speed data monitoring and DAQ	
10. Design of Energy management system IoT based SPV - Solar generation data monitoring IoT based Wind generation data monitoring IoT based SPV – Wind hybrid generation data monitoring	

<table>
<tr><td>Course Code:18EESC802</td><td colspan="2">Course Title: Energy Audit Practices</td></tr>
<tr><td>L-T-P: 1-0-3</td><td>Credits: 4</td><td>Contact Hrs: 7hr/week</td></tr>
<tr><td>ISA Marks: 100</td><td>ESA Marks: --</td><td>Total Marks: 100</td></tr>
<tr><td>Teaching Hrs: 15</td><td></td><td>Exam Duration: 3 hrs</td></tr>
</table>

<table>
<tr><td>Electrical Distribution and Utilization
Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F.improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements, Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches.
Thermal Systems
Boilers- performance evaluation, Loss analysis, Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers, Furnaces, Refractories, Insulators, Steam utilization
Cogeneration
Integrated analysis of steam base co-gen system, Gas turbine combine cycle operation, IC engine base co-generation and tri-generation, extraction turbines and steam cycle of cogeneration.
System Audit of Mechanical Utilities
Pumps, Blowers, Compressors, Cooling Towers, HVAC & Psychometric, refrigerants new trends, COP, Capacity</td><td>15hrs</td></tr>
<tr><td>Field Studies
Energy Audit & Management in Industries
(Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery.)
Electrical Energy audit and management
(pf improvement, Electric motors, Compressed air systems, Pumping systems, Fans and blowers, Cooling Towers, Industrial/Commercial Lighting system, Diesel based power Generation system)
Study of Energy Audit reports for various Industries and Organizations
Case-studies / Report studies of Energy Audits
Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities</td><td>25 hrs</td></tr>
<tr><td>Reference Books:
1. W.R.Murphy, G.Mckay Energy Management, Butterworths,
2. C.B.Smith, Energy Management Principles, Pergamon Press
3. G.C.Dryden, Efficient Use of Energy: Butterworth Scientific
4. A.V.Desai, Energy Economics ,Wiley Eastern
5. D.A. Reay, Industrial Energy Conservation, Pergamon Press
6. W.C. Turner, Energy Management Handbook, John Wiley</td><td></td></tr>
</table>

Course Code:**19EESC703**	Course Title: **Computational Methods in Engineering Analysis**	
L-T-P: 3-1-0	Credits: 4	Contact Hrs: 5
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

1.Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modelling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering.	06 hrs
2.Roots of Equations: Bracketing methods-Graphical method, Bisection method, False position method, Newton-Raphson method, Secant Method. Multiple roots, Simple fixed point iteration.	06hrs
3.Roots of polynomial- Polynomials in Engineering and Science, Muller's method, Bairstow's Method Graeffe's Roots Squaring Method.	06 hrs
4.Numerical Differentiation and Numerical Integration: Newton –Cotes and Guass Quadrature Integration formulae, integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae.	06 hrs
5.System of Linear Algebraic Equations and Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, iteration Methods.	06 hrs
6.Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method.	05 hrs
7.Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engg.	05 hrs

Reference Books

1. Erwin Kreyszig , Advanced Engineering Mathematics, 10th Edition , Willely India, 2016.
2. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
3. Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, TMGH, 4th Ed, 2002.
4. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.
5. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.
6. David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.

Course Code:**19EESE703**	Course Title: **Cogeneration and Electric Vehicles**	
L-T-P: 3-1-0	Credits: 4	Contact Hrs: 5hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

1. Concept of Cogeneration Review on Thermodynamics of conventional power producing plants - Selecting cogeneration technologies.	8 hrs
2. Thermodynamics of Cogeneration Power Plants Performance criteria and effect of irreversibility - Comparative thermodynamic performance of cogeneration plants – Numerical examples – Calculations of typical heat to power ratios and performance parameters.	8 hrs
3. Design of CHP Design of Cogeneration plant for varying plant heat to power ratio – Fuel savings from installation of cogeneration plant - Applications of cogeneration technology to various process plants.	8 hrs
4. Electric Machines and their Controllers The 'Brushed' DC Electric Motor, DC Regulation and Voltage Conversion, Brushless Electric Motors Motor Cooling, Efficiency, Size and Mass, Electrical Machines for Hybrid Vehicles, Electric Vehicles: Drive-trains: Basic concept of electric traction - Introduction to various electric drive-train topologies - Power flow control in electric drive-train topologies – Fuel efficiency analysis.	8 hrs
5. Electric Vehicle Modelling Tractive Effort, Modelling Vehicle Acceleration, Modelling Electric Vehicle Range, Simulations, Design Considerations: Aerodynamic Considerations, Consideration of Rolling Resistance, Transmission Efficiency ,Consideration of Vehicle Mass, Electric Vehicle Chassis and Body Design, General Issues in Design, Software in the use of electric vehicle design	8 hrs

Reference books:

1. Sirchis, J., Combined Production of Heat and Power, Elsevier Applied Science, 1990.
2. Spiewak, S. A., Cogeneration, Fairmont Press Inc., 1991.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, John Wiley & Sons Ltd, 2003
4. Tariq Muneer, Mohan Kolhe, Aisling Doyle, Electric Vehicles: Prospects and Challenges, Elsevier 2017
5. Zoran Stevic, New Generation of Electric Vehicles, InTech Publishers , Croatia, 2012

Course Code:**19EESE708**	Course Title: **Hydrogen and Fuel Cells**	
L-T-P: 3-0-1	Credits: 4	Contact Hrs: 5hr/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

1. **Hydrogen Energy Economy** Hydrogen Energy Economy – Conception, Present status and a vision – Applications of Hydrogen - Transport application-cars, light trucks, buses - Stationary and Portable-Electronic gadgets.	8 hrs
2. Hydrogen And Production Techniques HydrogenPhysical and chemical properties, salient characteristics - Production of hydrogen – Steam reforming – Water electrolysis – Gasification and woody biomass conversion – Biological hydrogen production – Photo dissociation- Direct thermal or catalytic splitting of water.	8 hrs
3. Hydrogen Storage & Transport Hydrogen storage options – Compressed gas – Liquid hydrogen – Hydride – Chemical Storage – Comparisons - Transport of Hydrogen Pipelines, gaseous, liquid and compound materials.	8 hrs
4. Fuel Cells HistoryPrinciple - Working - Thermodynamics and kinetics of fuel cell process – Performance evaluation of fuel cell – Comparison on battery Vs fuel cell - Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – Relative merits and demerits.	8 hrs
5. **Application Of Fuel Cell** Fuel cell usage for domestic power systems - Large scale power generation – Automobile - Space - Environmental analysis of usage of Hydrogen in Fuel cell - Future trends in fuel cells	8 hrs

Reference Books

1. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma (2005)
2. Bent Sorensen (Sorensen)Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK (2005)
3. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA (2002).
4. Viswanathan, B and M AuliceScibioh, Fuel Cells – Principles and Applications, Universities Press (2006)

1.1.2: Syllabus Revised Courses of PG Machine Design

Course Code: **16EMDC706**	Course Title: **Theory of Vibrations with Application**	
L-T-P-SS:**4-1-0-0**	Credits:**05**	Contact Hrs: **50**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50**		Exam Duration: **03 Hours**

No.	Content	Hrs
1	**Review of Mechanical Vibrations** Undamped and damped free vibrationsof single degreeof freedom systems: Importance of the study of vibration, Classification, Free vibration of an undamped translational systems, Equation of motion and natural frequency of systems, Types of damping, Response of single degree freedom viscous damped systems, Logarithmic decrement, Systems with Coulomb damping.	07
2	**Harmonically Excited Vibration** Introduction, Response of a viscous damped system under harmonic force, Response of a system under the harmonic motion of the base, Relative motion, Response of a system under rotating and reciprocating unbalance, Vibration isolation, transmissibilityandForce transmitted.	06
3	**Transient Vibrations of Single Degree of Freedom Systems** Impulse excitation, Arbitrary excitation, Laplace transform formulation, step input, Pulse excitation, Shock response spectrum, Shock isolation.	06
4	**Multi Degree-of-Freedom Systems** Introduction, Two degree-of-freedom systems:Free vibration analysis of an un-damped system, Torsional system, Coordinate coupling. Influence Coefficients, Natural frequencies using Matrix Iteration Method, Fundamental frequency usingDunkerley'smethod and Rayleigh's Method, Torsional Systems, Standard Eigenvalue problem-Choleskidecomposition.	07
5	**Vibration Control** Introduction; Vibration Nomo graph and vibration criteria; Reduction of vibration at the source, Control of vibration; Control of natural frequencies, Introduction of damping, Vibration isolation for different types of foundation, Shock isolation, Active vibration control, Vibration absorbers:Undampedanddamped dynamic vibration absorber.	06
6	**Nonlinear Vibration** Introduction; Examples of nonlinear vibration problems-Simple pendulum, Mechanical chatter, Belt friction system, Variable mass system, Exact methods, Approximate analytical methods-Basic philosophy, Lindstedt s Perturbation method, Iterative method, Ritz-Galerkinmethod, Subharmonic and Superharmonic Oscillations, Systems with time-dependent coefficients (Mathieu equation), Stability of equilibrium states-Stability analysis, Classification of singular points, Limit cycles.	06
7	**Vibration Measurement and Condition Monitoring** Introduction, Transducers, Vibration pickups, Frequency measuring instruments. Signal analysis: Spectrum analyzers, Bandpass filter. Dynamic testing of machines and structures, Experimental modal analysis: Exciter, Transducer, Signal conditioner and analyzer. Machine condition monitoring and diagnosis: Vibration severity criteria, Machine maintenance techniques, Machine condition monitoring techniques, Vibration monitoring techniques.	06
8	**Continuous Systems** Vibrating string, Longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.	06

References:

1. Mechanical Vibrations, - S. S. Rao, Fifth edition, Pearson Education, 2011.
2. Theory of Vibration with Applications, - William T. Thomson, Marie Dillon Dahleh and ChandramouliPadmanabhan, Fifth edition, Pearson Education, 2008.
3. Mechanical Vibrations: Theory and applications -S Graham Kelly, Cengage Learning , 2012.
4. Vibrations Problem Solving Companion- Rao V. Dukkipti, J. Srinivas, Narosa, 2007
5. Mechanical Vibration Practice with Basic Theory- V. Ramamurti, Narosa, 2000

Course Code: 16EMDP702	Course Title: Design Lab	
L-T-P:0-0-2	Credits: 2	Contact Hrs: 4 hrs / week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 24		Exam Duration: 120 min

Content	Hrs
➢ Kinematic Analysis of basic mechanisms using Multi body dynamic software. ➢ Fabrication and mechanical testing of Natural fiber reinforced Polymer Composite Materials (PMC). ➢ Machine condition monitoring. ➢ Real time collision detection system to detect ➢ Vibration overload.	**48**

***Materials and Resources Required*:**

1. S. S. Rao, **Mechanical Vibrations**, Pearson Education, 4th edition, 2004.
2. R. A. Caollacatt Chapman "**Mechanical Fault Diagnosis and Condition Monitoring**"- Chapman and hall 1977.
3. Robert M.Jones - **Mechanics of Composite Materials,** McGraw Hill Kogakusha Ltd.1998.

Course Code: 16EMDC801	Course Title: Machine Tool Design and Analysis	
L-T-P-S: 4-0-0-0	Credits: 4	Contact Hrs: 4
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 4		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1. Machine tool basics Introduction to machine tools, Design of shafts, keys, splines, poly V-belts, gears. Calculation of forces in lathe and milling machines. Calculation of motor power for a given application. Theory of metal cutting. Standards for bought out items like cap screws, hex bolts, nuts, washers etc. Selection of preferred sizes, Renard series.	10 hrs
Chapter No. 2. Elements of CNC Steels, CI used in M/C tools & heat treatment of steels, Surface finish and methods of improving them. GD&T and how to represent them in drawings. Types of ball and roller bearings, Spindle assemblies of turning and VMC machines, IS standards for various Lathe and CNC milling standards. Design of spindles for rigidity, speed, lubrication etc	10 hrs
Chapter No. 3. SQC & Testing of CNC Cp, Cpk calculations and their importance in CNC machines. How to establish positioning and repeatability by JIS method. Elements of CNC machines and introduction to CNC machines. Testing of CNC lathes and VMC machines.	7 hrs
Chapter No. 4. Selection of CNC elements Ballscrews, LM guide ways-types, accuracy, and method of selection for CNC machines. Calculation of static and dynamic loads etc. Servomotors, spindle motors and selection of the same for a specific application. Principle of operation of incremental and absolute encoders	6 hrs
Chapter No. 5. Hydraulics in CNC Design of hydraulic system for a lathe. Introduction to X, Y and Z assembly and how to compensate for thermal expansion of ballscrews.	7 hrs
Chapter No. 6. CNC assemblies Headstock, axes table, Declamping mechanisms of a tool in VMC. Ergonomics and aesthetics of machine tool	4 hrs
Chapter No. 7. Electrical & Electronics of CNC Basic electronics for mechanical engineers. Electricals for mechanical engineers-explanation of switch gear elements used in machine tools. Reading electrical diagrams and design of electrical system for CNC machines. PLC programme and ladder logics.	6 hrs

Course Code: **17EMDP701**	Course Title: **Finite Element Analysis Lab**	
L-T-P:0-0-1	Credits: 1	Contact Hrs: 2 hrs / week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 24		Exam Duration: 120 min

Content	**Hrs**
➢ Modeling of any automotive engine component using modeling software as two and three dimensional. ➢ Static analysis of above modelled components using different possible types of elements and materials. ➢ Non-Linear Analysis of 3D model created for any possible Nonlinearity criteria viz - Geometric, Material, and Contact. ➢ Dynamic Analysis of 3D model created by Modal or Harmonic or Transient for different Boundary Conditions. ➢ Thermal analysis of 3D model created. ➢ Fatigue Analysis & Fatigue life Prediction of created 3D model. ➢ Using theoretical concepts validation of the above analysis to be carried out. ➢ Report to be submitted in the prescribed format.	**24**

***Materials and Resources Required*:**

1. Nitin S. Ghokale, Sanjay Deshapande, Sanjeev Bedekar, "Practical Finite Element Analysis", Vikas Book house, Pune, 2008
2. Sham Tickoo, "Ansys Workbench 14.0 for Engineers and Designers-,A Tutorial Approach", Dream Tech Press, 2013
3. Liu G. R. and Quek S. S., "The Finite Element Method" A practical Course, 2nd Edition, Elsevier, 2014.
4. http://148.204.81.206/Ansys/150/ANSYS%20Mechanical%20Users%20Guide.pdf
5. http://abaqus.software.polimi.it/v6.12/pdf_books/CAE.pdf

Course Code: 17EMDC707	**Course Title: Fracture Mechanics**	
L-T-P:4-0-0	Credits: 4	Contact Hrs: 4 hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 180 min

No	Content	Hrs
1	**Introduction:** History andoverview, Fundamental concepts, Fracture mechanics in Metals, Ductile fracture, Cleavage, The Ductile-Brittle transition, Inter-granular fracture, Modes of Fracture Failure;	**04**
2	**Energy Release Rate:** Introduction, The Griffith energy balance, The energy release rate, Instability and the R-Curve, Thin plate vs Thick plate, Critical Energy release rate;	**06**
3	**Stress Intensity Factor:** Introduction, Stress analysis of cracks, The stress Intensity Factor, Relationship between K and Global behavior, Effect of Finite size, Principle of superposition, Weight Functions, Relationship between K and G, Crack tip plasticity, Plane stress versus plane strain, K as a failure criterion, Mixed mode fracture	**08**
4	**Elastic Plastic Fracture Mechanics:** Crack tip opening displacement**,** The J Contour Integral, Relationships between J and CTOD, Crack growth resistance curves, J-controlled fracture, Crack tip constraint under large scale yielding, HRR field;	**08**
5	**Mixed Mode fracture:** A simple Elliptical Model, Maximum Tensile Stress Criterion, Strain Energy Density Criterion, Maximum Energy Release Rate Criterion, Experimental Verifications;	**04**
6	**Fracture Toughness testing of metals:** General Considerations, K_{IC} testing, K-R Curve testing, J testing of metals, CTOD testing, Dynamic and crack arrest toughness, Fracture testing of weldments.	**06**
7	**Fatigue Crack Propagation** Similitude in fatigue, Empirical fatigue crack growth equations, Crack Closure, Variable amplitude loading and retardation, Growth of short cracks, Micro-mechanisms of fatigue, Experimental measurement of fatigue crack growth, Damage Tolerance.	**08**
8	**Dynamic and Time-DependentFracture** Dynamic Fracture and Crack Arrest, Rapid Loading of a Stationary Crack, Rapid Crack Propagation and Arrest, Crack Speed, Elasto dynamic Crack-Tip Parameters, Dynamic Toughness, Crack Arrest, Dynamic Contour Integrals, Creep Crack Growth, The C* Integral, Short-Time vs. Long-Time Behavior, The Ct Parameter , Primary Creep	**06**

Reference Book:

1. T.L.Anderson, “Fracture Mechanics -Fundamentals and Applications”, CRC Press, 2nd Edition, 1995.
2. Prashant Kumar, “Elements of Fracture Mechanics”, Tata McGraw-Hill Education Pvt. Ltd. New Delhi, 2010.
3. David Broek, ArtinusNijhoff , “Elementary Engineering Fracture Mechanics” , London, 1999.
4. J. F. Knott, “Fundamentals of Fracture Mechanics”, Bureworth, 2000.
5. C.T.Sun and Z.H.Jin , “Fracture Mechanics”, Elsevier, 2012.

Course Code: **17EMDC708**	Course Title: **Research Methodology**
L-T-P: 2-1-0	Contact Hrs: 4 hrs / week
ISA Marks: 100	Total Marks: 100
Teaching Hrs:25	Credits: 3

Content	Hrs
Research: Definition, Characteristics and Objectives; Types of Research, Research Methodology, Research Process, Literature Review, Review concepts and theories, Formulation of Hypothesis, Research design, Data collection, Processing and analysis of data collected, Interpretation of data, Computer and internet: Its role in research, Threats and Challenges to research, Writing a research paper, research project, Thesis, Research ethics, Citation methods and rules. Case studies.	**25**

Reference Book:

1. Kothari C. R. "Research Methodology – Methods & Techniques", VishwaPrakashan, A Division of New Age International Pvt. Ltd., 2008.
2. Ranjit Kumar, "Research Methodology – A step by step guide for Beginners", 3rd Edition, Pearson Edition, Singapore, 2011.
3. Dawson Catherine, "Practical Research Methods", UBS Publishers, New Delhi, 2002.

Course Code: **17EMDE707**	Course Title: **Mechanical Behavior of Materials**	
L-T-P:4-0-0	Credits: 4	Contact Hrs: 4 hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 180 min

No	**Content**	**Hrs**

1	**Introduction:** Materials in design , The evolution of engineering materials , Fundamental Characteristics of Composites, Interfaces in Composites, Fracture in Composites, , Functionally Graded Materials. Macro Mechanics of a Lamina**:** Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Numerical problems.	**10**
2	**Plastic Deformation and Dislocation Theory:** Lattice defects, deformation in a perfect lattice, dislocation in crystal and deformation, strain hardening of single crystal, low angle grain boundaries, Stress field of a dislocation, forces between dislocations, dislocation climb and jog, interaction with vacancy and impurity. Multiplication of dislocation and pile-up; Plastic Deformation in Tension, Plastic Deformation in Compression Testing, Plastic Deformation of Polymers.	**10**
3	**Behavior under Tensile loading:** Engineering and true stress-strain curves, yield point and strain ageing, strength coefficient and strain hardening exponent, necking or instability in tension, Effect of gauge length on strength and elongation, Effect of strain rate and temperature on tensile properties. Yield point phenomenon. Fracture under tension and torsion; Solid-Solution Strengthening, Mechanical Effects Associated with Solid Solutions.	**10**
4	**Deformation under cyclic loading:** Stress cycle, fatigue curve, fatigue fracture characteristics. Fatigue testing and testing machines, determination of fatigue strength. Factors affecting fatigue- contact under pressure. Under stressing, coaxing and overstressing. Effect of metallurgical impurities;	**10**
5	**Deformation under high temperature and Superplasticity of Metals**: Creep strain and creep-time curves, low temperature and high temperature creep theories. Fracture at elevated temperature, Stress rupture, Creep-Induced Fracture, Creep in Polymers, Heat-Resistant Materials, Superplasticity, Creep parameters and practical applications. Effect of metallurgical variables and materials for high temperature applications;	**10**

Reference Book:

1. Marc Andre Meyers and Krishan Kumar Chawla: “Mechanical Behavior of Materials”, Cambridge University Press, 2nd Edition 2008.
2. Norman Dowling, “Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture and Fatigue”, Prentice Hall, 4th Edition 2012.
3. G.E. Dieter: “Mechanical Metallurgy”. McGraw-Hill, 3rd Edition 1988.
4. Keith Bowman, “Mechanical Behavior of Materials”, Wiley international edition, 2003.
5. Thomas Courtney, “Mechanical Behavior of Materials”, Waveland Press Inc; 2nd Edition, 2005.
6. J. Roesler, H. Harders, M. Baeker, “Mechanical Behavior of Engineering Materials”, 1st Edition, Springer, 2007
7. W.F. Hosford, “Mechanical Behavior of Materials”, 2nd Edition, Cambridge University Press, 2009.

Course Code: 19EMDE702	Course Title: Mechanics of Solids	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 5
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Contents	hrs
1. Analysis of stress Introduction, body force, surface force and stress vector, the state of stress at a point, rectangular stress components, stress components on an arbitrary plane, equality of cross shears, differential equations of equilibrium, principal stresses, Mohr's circles for the three-dimensional state of stress, octahedral stresses, decomposition into hydrostatic and pure shear states.	**07**
2. Analysis of Strain Introduction, deformation, strain displacement relations, state of strain at a point, strain tensors, cubical dilatation, principal strains, spherical and deviator strain tensors, octahedral strains, compatibility conditions.	**07**
3. Stress-Strain Relations for Linearly Elastic Solids Generalized Hooke's law, stress–strain relations for isotropic materials, transformation of compatibility condition from strain components to stress components, relations between the elastic constants, Saint Venant's principle and uniqueness theorem.	**06**
4. Two Dimensional Problems in Cartesian Co-ordinates Plane stress and plane strain problems, Airy's stress function, solution of two-dimensional problems by the use of polynomials, pure bending of a beam, bending of a narrow cantilever beam under end load, simply supported beam subjected to point load and uniformly distributed load, use of Fourier series to solve two dimensional problems.	**07**
5. Two Dimensional Problems in Polar Co-ordinates General equations, biharmonic equation, stress distribution symmetrical about an axis, strain components in polar co-ordinates, thick-walled cylinders, rotating disks of uniform thickness, effect of circular holes on stress distribution in plates.	**07**
6. Torsion of Prismatic Bars Introduction, general solution of the torsion problem, torsion of circular, elliptical and equilateral triangular cross section bar, membrane analogy, torsion of thin tubes.	**06**
7. Thermal Stresses	**05**

Introduction, thermoelastic stress–strain relations, thin circular disk; temperature symmetrical about centre, long circular cylinder, normal stresses in straight beams due to thermal loading.	
8. Introduction to Plasticity Mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, theories of plastic flow, Tresca and Von Mises yield criteria, discussion of plasticity conditions, experimental evidence for yield criteria.	**05**

Reference Books:

1. L S Srinath, Advanced Mechanics of Solids, 3rd Edition, Tata Mcgraw Hill Company, 2009.
2. T.G. SitharamandL. Govindaraju,Elasticity for Engineers,I K International Publishing House, 2016.
3. Dr. Sadhu Singh, Theory of Plasticity and Metal Forming Process, 3rd Edition, Khanna Publishers, 2011.
4. J. Chakraborty, Theory of Plasticity, 3rd Edition, Butterworth-Heinemann, 2006.

1.1.2: Syllabus Revised Courses

Course Code: 16EMEP203 **Course Title: Engineering Design**

L-T-P: 0-0-3 Credits: 3 Contact Hrs: 6 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 72 Exam Duration: 2 hrs

Engineering Design [Part A]

1	Planning: Analyse Need, Formulate a Product Proposal, Clarify the Task, Requirements Modeling (SRS), Elaborate Requirements List, Design Specifications	6
2	Concept Development: Function to Architecture, Establish Functions Structure, Search for Working Principles & Working Structures, Combine & Firm-up into Concept Variants, Evaluate against Technical & Economic criteria, Best Feasible Design	9
3	System-level Design: Product Architecture -State Diagrams, Data-flow Diagrams, Configuration Design, Parametric Design, Construction Structure, Preliminary BOM, Co-simulation across domains	9
4	Detail Design: Geometry, Dimensions, Material, PCB Design, Component Selection, Class Diagrams, Code Generation, Design Verification, Detailed & Assembly Drawings Production & Assembly Instructions, Final BOM, Product Specifications	12

Text Books (List of books as mentioned in the approved syllabus)

1. Clive L Dym and Patrick Little, "Engineering Design: A Project Based Introduction", John Wiley & Sons
2. Yousef Haik, "Engineering Design Process", Cengage Learning India Private Limited, New Delhi

References

1. Pahl, G., Beitz, W., Feldhusen, J. and Grote ; "Engineering Design-A Systematic Approach" by, K.-H- Springer; 3rd ed. 2007

Laboratory Plan

Laboratory Title: **Engineering Design[Part B]**	Lab. Code: **15EMEP203[Part B]**
Total Hours: **40**	Duration of ESA Hours: -
ISA Marks: **40**	ESA Marks: **0**

Part – B

COURSE CONTENT

Course Code: **15EMEP203 [Part B]** Course Title: **Engineering Design Practice [Part B]**
L-T-P-S: **0-0-0-1.5** Credits:**1.5**
Contact Hrs: **3hrs/week** ISA Marks: **40** ESA Marks: **00**
Teaching Hours: **13 Sessions of 3 hours each (40hrs)**

Part – B1 [3D Modeling]	***7 sessions***
1. Introduction to 3D Modeling and different work benches: Sketcher Workbench: Demonstration of sketch tools, modifying tools, geometrical constraints and dimensional constraints.	***3 Hours / 1 sessions***
2. Part Modeling: Shape toolbar for adding materials, shape toolbar for removing materials, modifying tools, types of views etc.,	***6 Hours / 2 sessions***
3. Assembly and Co-simulation: Component placement, Placement types (Surface, Axis, and Planes), Feature settings etc. Integration of two different domain tools.	***9 Hours / 3 sessions***
4. Drawing: Drawing properties, Adding drawing models, View types, Scale factors, Section apply, View display	***3 Hours / 1 sessions***
Part – B2 [2D Drafting]	***6 sessions***
1. Orthographic Projections – Sectional [MANUAL drawings] Conversion of pictorial views into orthographic projections, Sectional views such as half section, full section, local section, removed section and offset section.[1st and 3rd angle projection]	***12 Hours / 4 sessions***
2. Thread forms and Threaded Fasteners: [MANUAL drawings] **Thread forms:** Thread terminology, thread profiles, [ISO Metric, BSW, Square and Acme, Sellers thread].**Fasteners:** Hexagonal headed bolt and nut with washer, square headed bolt and nut with washer (assembly).	***3 Hours / 1 sessions***
3. 2D Assembly Drawings: Part and Assembly Drawings, Generating bill of materials for assembly. [Creating sectional views of parts and assembly of protected type flanged coupling]	***3 Hours / 1 sessions***

Books/References:

Text books:

1. Machine Drawing by K.R. Gopalakrishna, Subhas Publications, 22nd Edition - 2013.
2. Machine Drawing byN.D.Bhat&V.M.Panchal, Charotar Publishing House.

Reference books:

1. A Text Book of Computer Aided Machine Drawing, S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007 Edition.

Course Code: 16EMEC201		**Course Title: Instrumentation & Control Engineering**
L-T-P: 3-1-0	Credits: 4	Contact Hrs: 5 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40 + 25		Exam Duration: 3 hrs

Unit – 1

1. Introduction to Instrumentation & Control Engineering Generalized configurations and functional description of measuring instruments, Static Performance characteristics of instruments, Generalized configurations and functional description of control systems. Control system design, Design examples - Open loop and Close loop automatic control	04 hrs
2. Measurement of Physical Parameter Motion measurement - Displacement: Translation and Rotational, Velocity: Translation and Rotational, Acceleration measurements, Force, Torque and Power measurement, Pressure and Temperature measurement, Flowrate measurement	07 hrs
3. Concepts of Control Engineering Introduction, Differential equations of physical systems, The Laplace Transform, Order of system, Block representation of system elements, Reduction of block diagrams to get transfer function	04 hrs

Unit – 2

4. Mathematical Models of Physical Systems: The transfer function of linear and rotational Mechanical systems, Thermal systems, Liquid system, Electrical systems, Transfer function of DC motor, Instrument modeling and static performance study	08 hrs
5. System Response Introduction, Poles, Zeros, and System Response, First-order system response to step, ramp and impulse inputs , Second-order system response to step input; Un-damped, Under damped, Critical damped and Over damped systems, Response specifications, Design of 1st and 2nd order system . Introduction to stability and the stability analysis by Routh-Hurwitz Criterion**.** Instrument Dynamic Performance Characteristics	07 hrs

Unit – 3

6. System Stability Introduction to Stability, Defining the Root locus, General rules for constructing root loci, Sketching the Root locus, Effect of gain adjustment, addition of pole and addition of zero on system response and system stability. Frequency Response Techniques: Bode Plots. Stability analysis using bode plots	05 hrs
7. Control Action Types of Controllers, Mathematical modeling of PID, ON-OFF controller, Effect of Proportional, Derivative and Integral elements on system behavior, Design of Controller for given simple applications	05 hrs

Text Book

1. Katsuhiko Ogata, Modern Control Engineering, 5th edition
2. Ernest Doebelin and Dhanesh Manik, Measurement Systems, 6th edition, Tata McGraw-Hill Education Pvt. Ltd., 2011

References

1. Richard C Dorf and Robert H. Bishop, 'Modern Control Systems', Addison Wesley.
2. Norman S. Nise, 'Control. Systems', John Wiley & Sons
3. T.G Beckwith, R.D Marangoni and J.H Lienhard, "Mechanical Measurements", 5th edition, Addison Wesley, 1993
4. R.S Figiola and D.E Beasley, "Theory and Design for Mechanical Measurement", 2nd edition, John Wiley 1995

Tutorial

Use of more examples and discussed at all places regularly. Assignment on a instrument's cost and specification. Solving more problems on various topics as per syllabus. Exploring experiments mentioned in Transducer and Instrumentation Virtual Lab at IIT Kanpur.

Course Code: 16EMEP204 **Course Title: Mechatronics Lab**

L-T-P: 0-0-3	Credits: 3	Contact Hrs: 6 Hrs/Week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 72		Exam Duration: 2 hrs

Introduction to Mechatronics: Definition & overview of Mechatronics, Key elements. Mechatronics Design approach, Mechatronics and sustainability, examples of mechatronic systems

Sensor, Actuators:
Review of Sensors and Actuators. Classification and application.

Signal conditioning:
ADC, DAC, MUX, Demux, encoder, Decoder; Data Acquisition System(DAQ)

Drive Circuits
power drives based on MOSFET- H bridge, SCR, TRIAC, IGBT, IPM; VFD; Servo drives-AC, DC;

Microcontrollers: Introduction to FF, Registers as memory element, Memory Hierarchy in Computer; Address/Data lines; Micro-controller Vs Microprocessor; RISC vs CISC, Harward Vs. Von neoman , Introduction to 8051 Architecture; Introduction to communication protocols-RS232, I2C, Ethernet Etc. Introduction to Programmable logic controller(PLC) and it's Architecture; examples of applications; Ladder diagrams, logic functions, latching, interlocking, Timer/counter, web controlled application, Programming on industrial applications;

Robotics: Types of robot, Robotic arm terminology, Robotic arm configuration, Robot applications, Evolution of Robots, Co-ordinates of Robots;

Automation & 3D printing: Introduction to Automation and Applications of Automation; Introduction to 3D printing Hardware and Software.

Machine Vision System & IOT: Introduction to Machine Vision; Image Acquisition; Image Processing; Visual Navigation; Introduction to IOT; Applications of IOT

Quad Copter & Simulators:: Introduction, Construction, Components Specification, tuning and working demonstration.

Text Books:

1. Devdas Shetty, Rechard A. Kolk, Mechatronics System Design, Cengage Learning – 2nd edition 2011 .
2. W. Bolton, 'Programmable Logic Controllers', Elsevier – 4th edition 2006.

Reference for Mechatronics:

1. David Bradley · David W. Russell, Mechatronics in Action: Case Studies in Mechatronics – Applications and Education, Springer 2010
2. Robert H Bishop, Mechatronics -an Introduction, Taylor & Francis Group 2006
3. W. Bolton, Mechatronics, Pearson Education Asia – 2nd edition 2001
4. Jacob Fraden, Handbook of Modern Sensor, Springer Science Business Media -Fourth Edition 2010
5. http://www.arduino.cc
6. Garry Dunning, 'Introduction to Programmable Logic Controllers' Thomson

List of planned Experiments:

Sl. No.	Particulars
1.	PLC1- software Familiarization and Basic Programming.
2.	PLC2- Timer, Counter programming.
3.	PLC3- Building applications
4.	PLC4- SAP applications: Water level controller, Sequencing of 3 motors, Washing machine sequencing, Welding process/ conveyor controller, Dc motor controller
5.	PLC5- Industrial Based Application, Demonstration
6.	PLC6- Web based control
7.	ADC, DAC Circuit realization.
8.	MUX, Demux realization using Trainer Kit
9.	encoder, Decoder realization using Trainer Kit
10.	Flip Flop as memory and counter
11.	Image Processing basics using Matlab/Simulink/LabVIEW
12.	Image Processing using Raspberry PI/myRIO as Target Hardware
13.	Ball tracking application based on image processing
14.	Quad Copter flight Control
15.	3DP working demonstration showing all components and its working.
16.	Building few IOT applications using Raspberry PI/myRIO
17.	DC Servo motor using Arduino/myRIO
18.	AC servo motor control demonstration
19.	Course Project

VII Semester Syllabus
Curriculum Content

Course Code: 18EMEW301		**Course Title: Minor Project**
L-T-P: 0-0-3	Credits: 6	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
		Exam Duration: 3 hrs

Themes for Minor Projects

Precision Agriculture

- Observe, Measure, Act,
- Replacing human labor with automation
- Eg: Moisture control in soil

Factory Automation

- Includes industry, workplace, assembly, machining operations, etc
- Eg: Automation of manual paper punching/ cutting machine

Hospital Automation

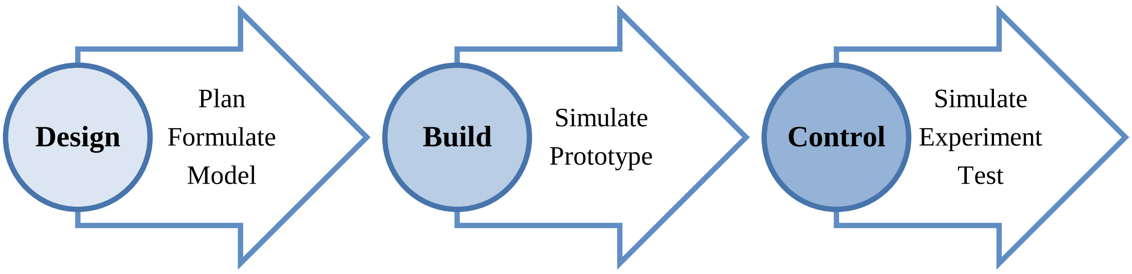
- Assistance for patients
- Hospital Logistics
- Medical instruments re/design
- Eg: Equipment to lift/ transfer patient from one place to another

Social Issues

- Issues concerned with water conversation, air pollution and public sanitation.
- Eg: An instrument to monitor, measure and control water pollution within a factory. (as per defined industry standards)

Any other Machatronics products

Methodology to be followed for carrying out the projects:



Role of Guide:

- The guide has to provide technical know-how from inception of project to execution
- Help students in identifying proper sources for raw materials, tools and other requirements
- Form a team and encourage students to take roles and responsibilities so that each one of them can enhance their knowledge and skills
- The Guide has to assess the student competencies with regard to his project work. More specifically to assess the student's individual contribution to the project
- Develop the clarity of assessment among the team in every phase of the project and advised to check for the formatting of the presentation and project report
- Continuous monitoring of project at different phases with the help of PLM e-NOVIA to work on paper-less office theme.

Evaluation of Minor-Project

The evaluation of project work shall be done in two stages as Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) having equal weightages in marks.

CIE Evaluation:

- The CIE evaluation of project work shall be done in stages by the expert review panel including guide. In addition the guide shall separately evaluate the progress of project till its completion.
- There shall be three reviews by the panel experts and marks shall be allotted as per the weightages given for each review. The student shall showcase the progress of work through the presentation, videos, models, prototypes, etc to the panel members during the reviews.
- Each of the micro activities involved in accomplishing a project have been identified and included in the evaluation criteria as performance indicators. These performance indicators are being made known to students from day one of the project which helps them to plan and be guided to reach the intended goal. The assessment of each of the performance indicators is carried out as per rubrics which are also shared with the students.
- The review panel will be given a detailed assessment rubrics for each review based on which the panel experts will award the marks.
- Project guide shall be having individual responsibility to assess the entire project work and award the marks as per the assessment rubrics.
- During each review the panel experts shall advice the students with various aspects of the work for continuous development and Implementation.

SEE Evaluation:

- Student shall prepare a detailed project report according to approved guidelines and duly signed by the guide(s) and the Head of the Department and submit it to the examiners.
- The SEE evaluation of the project work shall be based on the demonstration of the model/prototype, presentation, project report submitted and a Viva-Voce by a team consisting of the Guide, an Internal examiner (other than the guide) and an External Examiner appointed by the department.
- Student shall submit a copy of the approved project report after the successful completion of viva examinations to the department.

Course Code: 19EMEC301 **Course Title: Finite Element Methods**

L-T-P : 3-0-0 Credits: 03 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 03

Unit - 1

1. Introduction to FEM: 7 hrs

FEM paradigm : History, present/future, Research, Application, stress at a point, stress components on arbitrary plane, Equilibrium equations, compatibility equations, Generalized Hook's law, Plane stress and plain strain, principle of minimum potential energy and virtual work, RR method and Galerkin's methods, FEM steps, Advantages, disadvantages and limitations.

2 Interpolation Functions For General Element Formulation : 8hrs

Discretization process, types of elements, size of elements, location of node, node numbering scheme and mesh requirements in finite element method, polynomial form of interpolation functions, convergence requirements, Pascal triangle, shape functions (1D, 2D, LST, CST, Quad, Higher order elements).

Unit - 2

3. Basic FEA analysis: 8hrs

Elimination approach, Penalty approach and Thermal effect based practical engineering problems. Multi-point constraint, Iso-parametric and Axi-symmetric elements.

4. Advanced FEA analysis: 7hrs

Practical aspects of industrial machine components, Field issues related to structural applications using higher order polynomials.

Unit - 3

4. Post processing techniques: 5hrs

Validate and interpret the results, Average and Un-average stresses, Special tricks for post processing, Design modification, CAE Reports

5. Experimental Validation and Data Acquisition: 5hrs

Strain gauge, Photo elasticity, Load cells, Torque Sensors/Transducers, Dynamic tests, Acceleration test, Fatigue life measurement, Natural Frequency measurements.

Text Book

1. K. H. Huebner, D. L. Dewhirst, D. E. Smith and T. G. Byrom, The Finite Element Method for Engineers, 4th edition, Wiley, New York, 2001.
2. T. R. Chandraputala and A. D. Belegundu, Introduction to Finite Elements in Engineering, Third Edition, Prentice Hall of India, 2004.
3. Nitin Ghokale, Practical finite element analysis, Finite to infinite, 2008.

References

1. N. S. Ottosen and H. Petersson. Introduction to the Finite Element Method, Prentice-Hall, Englewood Cliffs, 1992.
2. S. S. Rao, Finite Element Method in Engineering , Fourth Edition, Elsevier Publishing, 2007.

Course Code: 19EMEP301 **Course Title: CAD modelling and PLM Lab**

L-T-P: 2-0-2	Credits: 4	Contact Hrs:6hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 80		Exam Duration: 3 hrs

Sl. No.	Work Benches of 3D PLM	No of weeks
1	**Sketcher**- Brief introduction on Sketcher work bench environment Structure of users and saving of files. **Exercises on Sketch** Tools, Profile Tool bar and Constraint Tool bar: Generate the following 2D sketches and make them Iso-constrained.	1
2	**Part Design**-Exercise on 3d models using pad, slot, shaft, groove, hole ,rib and stiffener commands, cut revolve, Dress up commands like chamfer, fillets etc. ***(***Multi-Sections Solid and Removed Multi-Sections Solid Commands	2
3	**Generative shape design (GSD**)- Exercises using GSD to generate complicate surfaces using sub tool bars: Extrude-Revolution, Offset Var and Sweeps Extrude, Revolve, Trim, Transformation and Fillet tools Exercises on Wireframe, Surfaces and Operations Tool bar: (Conversion of Surface model into Solid model	3
4.	**Assembly Design**- Introduction to Assembly Design Work bench Bottom-Up and Top-Down assembly approaches Invoking existing components into assembly work Exercise to demonstrate Top-Down assembly approach.	2
5	**Drafting**- Converting existing 3D models into 2d drawings with all relevant details, sectional views, sheet selection, indicating GD&T symbols and dimensioning**.**	3
6	**Enovia**- Introduction to CATIA 3D experience PLM Import the existing CATIA 3D experience data and store in Search and identify the data located in 3D experience database Modify the data in any PLM process Sharing information with users Analyze and Identify impacts of modifications Save the modifications into database	1

Reference Book:
Training material given by EDS on 3D experience

Course Code:19EMEP302		**Course Title: FEM Lab**
L-T-P: 0-0-1	Credits: 1	Contact Hrs: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 24	No of Sessions: 12	Exam Duration: 2 hrs

Category: Demonstration		**No. of Lab. Sessions per batch (estimate)**
1	Scientific Research Exposure (Research Education): Methods to search/extract Journal papers (Reputed journal paper), Referring papers, Drafting a paper. Introduction to ANSYS Workbench and familiarity. Real time Current/future field issues : Problem Identification	**03**
Category: Exercises		
Expt./Job No.	**Experiment/job Details**	**No. of Lab. Sessions per batch (estimate)**
1.	Static Structural analysis a) Uniform bar, b) Bracket, c) Machine Components	01
2.	Linear Buckling a) Columns & Struts (Different Boundary Conditions) b) Machine component	01
3.	Non-Linear Structural Analysis a) Geometric Nonlinearity b) Material Nonlinearity c) Contact Nonlinearity	02
4.	Dynamic Analysis (Modal/Harmonic/Transient Analysis) a) Beam (Different Boundary Conditions) b) Machine components	01
5.	Thermal Analysis a) Fins b) Heat Exchangers c) Machine component	01
6.	Drop Test & Impact Analysis a) Mobile drop test b) TV, Refrigerator etc.	01
7.	Optimization	01
8.	Model Test	01

Category: Structured Enquiry

Execute all the FEM Analysis modules which are dealt under the lab exercise.

Identify the component (Sub-assembly need have Minimum 3 to 4 components)
Start from scratch

- Measure the dimensions of component
- Generate the Solid Modeling of components with overall assembly (In any of the CAD Software)
- Import the model in neutral form to ANSYS Workbench
- Collection of data relevant to Material Properties
- Understand the physics of the problem (Working Principle with load's and boundary conditions)
- Interpretation of Results with conclusion.

Category: Open ended
1. Identify field issue pertaining to any component/product in today's industry. 2. Collect the information/literature on earlier worked project through external/internal search (Journal Paper/Patent/reports) 3. Comprehend the physics of the problem with working principle. 4. Prepare the abstract and apply to a national/international conference 5. Identify material properties, boundary conditions and load steps. 6. Carryout the analysis as per the FEA steps. 7. Provide engineering solutions to the identified sub assembly (deformation and stresses, material change, weight reduction, increasing load bearing capacity, fatigue life calculation, prediction of endurance limit of component and damage factor). 8. Prepare the draft on the worked out problem and apply to a national/international conference

Materials and Resources Required:

1. Books/References: Nitin Ghokale, Practical finite element analysis
2. Manuals: Sham Tickoo, ANSYS for Engineers and Designers

Course Code: 19EMEC201		**Course Title: Control Systems**
L-T-P: 2-1-0	Credits: 3	Contact Hrs: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit – 1

1. Introduction to Control System 3 hrs

Generalized configurations and functional description of control systems. Control system design. Examples of Control System. Introduction to Linear, Nonlinear, Time Variant and Time Invariant systems.

2. Modeling of Physical Systems: 8 hrs

Introduction, Differential equations of physical systems, The Laplace Transform, Order of system; The transfer function of linear and rotational Mechanical systems, Gear Train, Electrical systems, Electro-mechanical System, Thermal systems, Hydraulic System; Block representation of system elements, Reduction of block diagrams to get transfer function.

Unit – 2

3. System Response 6 hrs

Introduction, Poles, Zeros, and System Response, First-order system response to step, ramp and impulse inputs , Second-order system response to step input; Un-damped, Under damped, Critical damped and Over damped systems, Time response specifications. Design of 1st and 2nd order system.

4.Control Action 5 hrs

Introduction to PID controller design. Types of Controllers, Mathematical modeling of PID, ON-OFF controller, Effect of Proportional, Derivative and Integral elements on system behavior, Design of Controller for given simple applications. Design For Deadbeat Response.

Unit – 3

5. System Stability 4 hrs

Introduction to stability. Stability analysis by time response, S-plane and Routh-Hurwitz Criterion. Effect of gain adjustment, addition of pole and addition of zero on system response and system stability. Defining the Root locus, General rules for constructing root loci, Sketching the Root locus, Controller Design using root locus.

6. **Frequency Domain Analysis** 4 hrs

Nyquist stability criteria, Bode Plots. Stability analysis using bode plots.

Text Book

1. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 12th edition, Addison Wesley
2. A. Anandkumar, Control Systems, 2nd edition, PHI Learning Private Limited, 2014.

References

1. Katsuhiko Ogata, Modern Control Engineering, 5th edition, Pearson Publications.
2. Norman S. Nise, Control. Systems, 6th edition, John Wiley & Sons.

Course Code: 19EMEP201 **Course Title: Control Systems Lab**

L-T-P: 0-0-2	Credits: 2	Contact Hrs: 4 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 48		Exam Duration: 2 hrs

Experiment Number		Experiments	No of sessions
01	a)	Reduce a given block diagram using a tool and verify with analytical solution.	1
	b)	To solve differential equations using graphical programming.	1
	c)	To build Graphical User Interface for a given application with at least 5 functions.	1
02	a)	For a potential divider circuit (Zero order) find response by experimentally and analytical. Simulate both using a tool.	2
	b)	Evaluate the effects of varying system parameters on zero, first and second order systems for various standard test signals.	2
	c)	Determine the step response for a given mechanical system and validate the results through electrical analogous system.	2
	d)	Study the step response for Electro - Mechanical system, Gear Train, Hydraulic, Hydraulic lift, thermal physical modeled systems	4
03	a)	Design a positional control system for a DC servo motor and carryout investigations.	8
04	a)	Comparative study of Time response, root locus and Bode plot with respect to stability.	1

Course Code: 19EMAB301 **Course Title: Numerical methods and Statistics**

L-T-P: 3-0-1	Credits: 04	Contact Hours: 6 hrs/week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 40		Examination Duration: 3hrs

Unit I

1. Numerical Methods 8 hrs

Introduction to numerical methods. Roots of equations using Bisection Method, Newton- Raphson Method, Finite differences, Forward, Backward Operators. Newton Gregory forward and backward interpolation formulae. Newton's divided difference formula for un equal intervals. Numerical solution of first order ODE, Euler's and Modified Euler's method, Runge Kutta 4^{th} order method. Implementation using python-programming

2. Matrices and System of linear equations 8 hrs

Introduction to system of linear equations, Rank of a matrix by elementary row transformations. Consistency of system of linear equation solution of system by (i) Direct methods-Gauss elimination, Gauss Jordon method (ii) Iterative methods- Guass-Seidal method. Eigenvalues and Eigenvectors of a matrix. Largest Eigenvalue and the corresponding Eigenvector by power method. Implementation using python-programming.

Unit II

3. Curve fitting and regression 5 hrs

Introduction to method of least squares, fitting of curves $y = a + bx$, $y = ab^x$, $y=a + bx +cx^2$, correlation and regression.

4. Probability 9 hrs

Definition of probability, addition rule, conditional probability, multiplication rule, Baye's rule. (no proof) Discrete and continuous random variables- PDF-CDF- Binomial, Poisson and Normal distributions (Problems only).

Unit III

5. Sampling distributions 10 hrs

(a) Sampling, Sampling distribution, Standard error, Null and alternate hypothesis, Type-I and Type- II errors, Level of significance. Confidence limits for means (large sample).

(b) Testing of hypothesis for means. large and small samples and student's t- distribution and Confidence limits for means (small sample).

Text Books

1. Bali and Iyengar, A text book of Engineering Mathematics, 6ed, Laxmi Publications(p) Ltd, New Delhi,2003
2. Chapra S C and Canale R P, Numerical methods for Engineers, 5ed, TATA McGraw-Hill, 2007
3. Gupta S C and Kapoor V K, Fundamentals of Mathematical Statistics, 9ed, Sultan Chand & Sons, New Delhi, 2002

Reference Books:

1. Sastry S S, Introductory method for numerical analysis, 3ed, PHI, 2003.
2. J. Susan Milton, Jesse C. Arnold, Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, 4^{th} Ed, TATA McGraw-Hill Edition 2007.

Course Code: 15EMEC402		**Course Title: Design of Thermal Systems**
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit I

1. Heat exchangers Classification and Selection: 5 Hrs

Introduction, Recuperation and Regeneration, Transfer process, Geometry and Construction, - Tubular Heat Exchanger, Plate Heat Exchanger, Extended Surface heat exchanger, Heat Transfer Mechanisms, Flow arrangements, Applications and Selection of Heat Exchangers.

2. Design of Shell and Tube heat exchanger 10 Hrs

Construction of shell and tube exchanger, specifications and classification of S&T Heat Exchanger, some Typical operating limits for heat exchangers of S&T Type, Design of Shell and Tube Heat Exchangers.

Unit II

3. Condensers : Classification of condensers, various types of condensers and their applications, Shell and tube condensers : Analysis and design, special consideration in Reflux Condensers: Flooding , Condensers for mixtures , Design of shell and tube Exchangers, compact condensers, air cooled condensers , direct contact condensers , numerical problems 5 Hrs

4. Modeling of Thermal Equipment: 6 Hrs

Counter flow heat exchanger, Evaporators and Condensers, Heat exchanger effectiveness, Effectiveness of a counter flow heat exchanger, NTU, Pressure drop and pumping power, Numerical Problems.

5. Optimization: 4 Hrs

Mathematical representation of optimization problems, A water chilling system, Optimization procedure, Setting up the mathematical statement of the optimization problem.

Unit III

6. **Lagrange Multipliers:** 5 Hrs

The Lagrange multiplier equations, unconstrained optimization, Constrained optimization.

7. Dynamic Programming: 5 Hrs

Characteristic of the Dynamic programming solution, Apparently constrained problem, Application of Dynamic programming to energy system problems.

Text Books (List of books as mentioned in the approved syllabus)

1. W.F.Stoecker, Design of Thermal Systems, 3 ed., MGH, 1989.
2. Sarit K. Das., Process heat transfer, Narosa Publishing House 1st Edition, 2005
3. Sadik Kakac, Hongtan Liu, Heat Exchanger Selection, Rating and Thermal Design, 2 ed., CRC Press, 2002.

References.

1. Yogesh Jaluria, Design and Optimisation of Thermal Systems, 2nd ed., CRC Press,2008
2. Hodge B.K., Analysis and Design of Thermal Systems, 1 ed., PHI, 1990.

Course Code: 19EMEC401		**Course Title: I C Engines**
L-T-P: 2-0-0	Credits: 2	Contact Hrs: 2 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 26		Exam Duration: 3 hrs

Unit I

1. Introduction to I C Engines 5 Hrs

Internal Combustion Engine Classification, Operating Cycles, Spark Ignition and Compression-Ignition Engines.

Combustion in Spark Ignition Engines

Ignition limits, Normal combustion, Thermodynamic Analysis of SI Engine Combustion - stages, ignition lag, and effect of engine variables on ignition lag Causes of Cycle-by-Cycle and Cylinder-to-Cylinder Variations and flame propagation phase, detonation, Abnormal Combustion: Knock Fundamentals and fuel factors, Factors affecting knock.SI engine combustion chambers.

2. Combustion in Compression Ignition Engines 5 Hrs

Types of Diesel Combustion Systems, Direct and Indirect-Injection Systems, Comparison, Combustion Efficiency, Normal combustion – stages, delay period, variables affecting delay period. Diesel knock, comparison between diesel and petrol engine knocks. CI engine combustion chambers, Fuel spray behavior. HRR analysis.

Unit II

3. Engine Exhaust Emission Control 5 Hrs

Formation of NOX, HC/CO mechanism , Smoke and Particulate emissions, Green House Effect, Methods of controlling emissions , Three way catalytic converter and Particulate Trap, Emission (HC, CO, NO and NOX) measuring equipments, Smoke and Particulate measurement, Indian Driving Cycles and emission norms.

4. Overall Engine Performance 6 Hrs

Alternate fuels, Operating Variables that Affect SI Engine Performance, Efficiency, and Emissions: Spark Timing, Mixture Composition, Load and Speed, Compression Ratio. Variables that Affect CI Engine Performance, Efficiency, and Emissions: Load and Speed, Fuel-Injection Parameters.

Unit III

5. Recent Trends in IC Engines 5 Hrs

Dual fuel Engine, Common Rail Direct Injection Diesel Engine (CRDI), Homogeneous Charge Compression Ignition Engine (HCCI), Reactivity controlled compression ignition engine (RCCI) Lean Burn Engine, Surface Ignition alcohol CI Engine, VVT engines, Gasoline Direct Injection Engine.

Text Books:

1. John B Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw-Hill, 1988
2. Heinz Heisler, “Advanced Engine Technology”, SAE International Publications, USA, 1998
3. Patterson D.J. and Henein N.A, “Emissions from combustion engines and their control”, Ann ArborScience, publishers Inc, USA, 1978

Reference Books:

1. Ganesan V. “Internal Combustion Engines”, Third Edition, Tata Mcgraw-Hill, 2007.
2. Gupta H.N, “Fundamentals of Internal Combustion Engines”, Prentice Hall of India, 2006.
3. Ultrich Adler, “Automotive Electric / Electronic Systems”, Published by Robert Bosh GmbH, 1995.

Course Code: 15EMEE308 **Course Title: HVAC Systems**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit – I

1: Introduction to HVAC Systems and Psychrometry 5 hrs

Purpose, applications, definition and components of air conditioning - Need and methods of ventilation. Evolution of air properties and psychrometric chart - Basic processes such as sensible heating/cooling, humidification/dehumidification and their combinations, steam and adiabatic humidification, adiabatic mixing, etc. - Bypass factor and Sensible heat ratio, Numerical problems.

2: Human Comfort, Summer and winter AC 5 hrs

Heat transfer from body, convection, radiation, conduction, evaporation, clothing resistance, activity level - Concept of human comfort - Thermal response - comfort factors - Environmental indices - Indoor air quality. - Simple summer AC process, Room sensible heat factor, Coil sensible heat factor, ADP - Precision AC - Winter AC.

3: AC Systems and Equipment 6 hrs

Classification of air conditioning systems, Filters, types, efficiency – Fan laws, cooling coils and heating coils, sizing and off design performance - Cooling and dehumidifying coil, dry and wet, sizing, performance.

Unit – II

4: Heat Transfer 3 hrs

Heat transfer in wall and roof, sol-air temperature, insulation, cooling load temperature difference - Fenestration, types of glass, sun shade, shading coefficient, maximum radiation, cooling load factor

5: Cooling load and heating load estimation 7 hrs

Thermodynamics of human body and mathematical model, Human comfort chart, Design conditions, outdoor, indoor - External load, wall, roof, glass - Internal load, occupancy, lighting, equipments - Ventilation, air quantity, loads - Load estimation methods. Vapour transfer in wall, vapour barrier, load estimation basics.

Introduction to AutoCAD REVIT software

6: Air distribution, diffusion and Ventilation 6 hrs

Ducts, types, energy equation for pipe flow, friction chart, methods of sizing, air distribution systems, ADPI, outlet/inlet selection.

Need, threshold limits of contaminants, estimation of ventilation rates, decay equation, air flow round buildings, Natural, wind effect, stack effect, combined effect - Mechanical, forced, exhaust, combined - Displacement ventilation

Unit – III

7: Ventilation system design 4 hrs

Exhaust ducts, filters, blowers, hoods, chimney, etc.

8: Industrial ventilation 4 hrs

Steel plants, car parks, plant rooms, mines, etc.

Text Book:

1. Faye C. McQuiston, Jerald D. Parker, Jeffrey D. Spitler, Heating, Ventilating and Air Conditioning: Analysis and Design, 6th Edition, July 2004,
2. W P Jones, Air Conditioning Engineering ELBS 3rd edn Edward Arnold (Publishers) ltd. Londan.

Reference Book:

1. Harris, Modern Air Conditioning Practice 3rd Edn McGraw Hill Book Company
2. S. N. Sapali, Refrigeration and air conditioning 2nd Edn, PHI learning pvt ltd, Delhi 2016
3. C P Arora, Refrigeration and air conditioning 3rd edn

Code: 17EEEC201 **L-T-P: 3-0-0**

Course Title: Electrical Machines. **CIE: 50**

Teaching Hours: 40 **SEE: 50**

Unit –I

Chapter 1 : Transformer : Transformer construction and principle of operation, Ideal Transformer, Practical Transformer, Transformer phasor diagrams, Equivalent circuit of transformers, Open circuit and short circuit tests, Voltage regulation, transformer losses and efficiency, Testing of transformers, Three phase transformers, Auto-transformers.	**10 hours**
Chapter 2: DC Machines: Construction of DC machine and DC machine as generator, EMF equation of DC machine, Operating characteristics of types of DC generators, Operating characteristics of DC motors, DC motor starting, Speed control of DC motors.	**05 hours**

Unit – II

Chapter 3: Induction (Asynchronous) Machines: Induction motor as transformer, Principle of operation, Rotor frequency, e.m.f, current and power, Losses and Efficiency, Equivalent circuit, Torque slip and Power-slip characteristics, Determination of equivalent circuit parameters. Circle diagram, Starting of polyphase induction motors.	**10 hours**
Chapter 4 : Synchronous Machines: Cylindrical and salient pole machines, Phasor diagram of cylindrical rotor alternator. AC armature winding, Voltage regulation of alternator using e.m.f method.	**05 hours**

Unit – III

Chapter 5 : Synchronous Machines: Synchronous motor phasor, Power angle characteristic of synchronous machine, Measurement of Xd and Xq, Capability curves of synchronous generators, Power factor correction by synchronous motors.	**5 hours**
Chapter 6:Single phase induction machines:: Double field revolving theory, Equivalent circuit, Resistance split phase motors, capacitor start motor, permanent capacitor motor, two-value capacitor motor, shaded-pole motor. Performance and cost comparison and choice of single phase induction motors.	**5 hours**

Text Book

1. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons Publications, Canada, 2nd Edition, 2001.

References

1. Bhimbra, “Principles of Electrical machinery”, Khanna Publishers.2006.
2. D. P. Kothari and I. J. Nagrath, “Electrical Machines”, MGH Publishers. 4th Edition, 2011.
3. Fitzgerald, Kingsly & Stephen, “Electric Machinery”, 5ed., McGraw Hill, 1992

Course Code: 18EEEC301 **Course Title: Linear Integrated Circuits**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 40

CIE Marks: 50 SEE Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Chapter No.	**Unit-I**	
1	**Current Mirrors** Current Mirror circuits and Modeling, Figures of merit (output impedance, voltage swing), Widlar, Cascode and Wilson current Mirrors, Current source and current sink.	05 Hrs
2	**Basic OPAMP architecture** Basic differential amplifier, Common mode and difference mode gain, CMRR, 5-pack differential amplifier, 7-pack operational amplifier, Slew rate limitation, Instability and Compensation, Bandwidth and frequency response curve	06 Hrs
3	**OPAMP characteristics** Ideal and non-ideal OPAMP terminal characteristics, Input and output impedance, output Offset voltage, Small signal and Large signal bandwidth.	04 Hrs
	Unit-II	
4	**OPAMP with Feedback** OPAMP under Positive and Negative feedback, Impact Negative feedback on linearity, Offset voltage, Bandwidth, Input and Output impedances,Follower property, Inversion property	05Hrs
5	**Linear applications of OPAMP** DC and AC Amplifiers, Voltage Follower, Summing, Scaling and Averagingamplifiers (Inverting, Non-inverting and Differential configuration), Integrator, Differentiator, , Currentamplifiers, Instrumentation amplifier,Phase shifters, Voltage to current converter, Phase shift oscillator, Weinbridge oscillator, Active Filters –First and second order Low pass & High pass filters.	10 Hrs
	Unit-III	
6	**Nonlinear applications of OPAMP** Crossing detectors (ZCD. Comparator),Schmitt trigger circuits, Monostable & Astable multivibrator, Triangular/rectangular wave generators, Waveform generator, Voltage controlled Oscillator,Precisionrectifiers, Limiting circuits.Clamping circuits, Peak detectors, sample and hold circuits, Log and antilog amplifiers, Multiplier and divider Amplifiers, Voltage Regulators.	10 Hrs

Text Books

1 Sedra and Smith, "Microelectronics ", 5^{th} edition , Oxford University Press.

2 Ramakant A. Gayakwad, "Op - Amps and Linear Integrated Circuits", 4th edition, PHI.

Reference Books:

1 Robert. F. Coughlin &Fredrick F. Driscoll, "Operational Amplifiers and Linear Integrated Circuits", PHI/Pearson, 2006.

2 James M. Fiore, "Op - Amps and Linear Integrated Circuits", Thomson Learning, 2001

3 Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", TMH, 3e, 2005

4 David A. Bell, "Operational Amplifiers and Linear IC's", 2nd edition, PHI/Pearson, 2004

Laboratory Title: **Control System Lab** Lab. Code: **18EEEP302**

Total Hours: **32** Duration of Exam: **02**

Total Exam Marks: **20** Total ISA. Marks: **80**

Category: Demonstration	**Total Weightage: 10.00 No. of lab sessions: 2.00**
Expt./ Job No.	**Experiment/job Details**
1	Demonstration of heat tank simulator without controller using Labview Interactive learning model
2	Demonstration of temperature control of liquid tank simulator using Labview Interactive learning model
Category: Exercises	**Total Weightage: 40.00 No. of lab sessions: 5.00**
Expt./ Job No.	**Experiment/job Details**
1	Time response specifications of second order system
2	Frequency response of second order system
3	P,PI and PID controllers-effect on plant step response
4	Lag and Lead Compensators- determination of frequency response
5	Determination of Phase and Gain margin
Category: Structured Enquiry	**Total Weightage: 30.00 No. of lab sessions: 4.00**
Expt./ Job No.	**Experiment/job Details**
1.	Each batch consisting of 4 students work on a given design problem- To employ MATLAB to design compensator/controller for a system to meet given specifications and analyze the performance by simulating the time and frequency responses. To submit a technical report (consisting of objectives, specifications set, list of assumptions, design formulation, design calculations, simulation results, design validation)

Course Code: 18EEEE301 **Course Title: Object Oriented Programming with C++**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 03 hrs

Content	Hrs
Unit - 1	
Chapter 01: Introduction Principles of Object Oriented Programming, Procedure oriented and Object oriented Programming, Basic Concepts of OOP, Benefits and Applications of OOP, Beginning with C++, Simple C++ program, C++ with classes, Structure of C++ program, Creating, compiling and linking C++ programs.	4 hrs
Chapter 02: Classes and Objects Structures and Classes, Specifying a Class, Defining Member functions, C++ program with class, Access Specifiers, Scope Resolution Operators, Inline functions, Static Data Members, Static Member Functions, Friend Functions.	7 hrs
Chapter 03: Constructors and Destructors Introduction, Parameterized Constructors, Multiple Constructors, Copy Constructor, Dynamic Constructor, Destructors, Dynamic allocation of objects - new and delete operators.	4 hrs
Unit - 2	
Chapter 04: Inheritance Introduction, Defining Derived Classes, Types of Inheritance, Virtual Base Classes, Abstract Classes, Constructors in Derived Classes, Nesting of Classes.	6 hrs
Chapter 05: Virtual Functions and Polymorphism Pointers to objects, this pointer, Pointers to Derived classes, Virtual Functions. Pure Virtual Functions.	5 hrs
Chapter 06: Exception Handling Basics, Exception Handling Mechanism, Throwing, Catching and Rethrowing Exceptions.	4 hrs
Unit - 3	
Chapter 07: Function Overloading, Operator Overloading Function Overloading, Overloading Constructors, Defining operator Overloading, Unary and Binary operator overloading, Rules for overloading operators.	5 hrs
Chapter 08: Templates, STL Class Templates, Function Templates, Overloading of Template functions, Components of STL, Containers, Iterators, Application of Container Classes.	5 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. E.Balagurusamy, Object Oriented Programming with C++, 4th edition, Tata McGrawHill, 2008
2. Herbert Schildt, C++ The Complete Reference, Fourth Edition, Tata McGrawHill, 2003

References

1. Yashavant P. Kanetkar, Let Us C++, 1st, BPB Publications,
2. Stanley B.Lippmann, Josee Lajore, Barbara E. Moo, C++ Primer, 4th Edition, Pearson Education, 2005

Course Title: Digital System Design using Verilog Course Code: 18EEEP303

L-T-P: 0-0-2	Credits: 2	Contact Hours: 4Hrs/week
ISA Marks: 80	SEA Marks:20	Total Marks: 100
Teaching + Lab. Hours: 48 Hrs	Examination Duration: 2 Hrs	

1.	Chapter No. 1. Architecture of FPGA Architecture of FPGS: Spartan 3, What Is HDL, Verilog HDL Data Types and Operators.	4hrs
2.	Chapter No. 2. Data Flow Descriptions Highlights of Data-Flow Descriptions, Structure of Data-Flow Description, Data Type – Vectors, Testbench.	6 hrs
3.	Chapter No. 3. Behavioral Descriptions Behavioral Description highlights, structure of HDL behavioral Description, The VHDL variable –Assignment Statement, sequential statements, Tasks and Functions	10 hrs
4.	Chapter No. 4. Structural Descriptions Highlights of structural Description, Organization of the structural Descriptions, Binding, state Machines, Generate, Generic, and Parameter statements	10 hrs
5.	Chapter No. 5:Finite State Machine: Moore Machines, Mealy Machines	4hrs
6.	Chapter No. 6:Timing Issues in Digital Circuits: Setup Time Constraints, Hold Time Constraints, Static Time analysis, Critical Path, Clock Skew.	6hrs
7.	Chapter No. 7. Advanced HDL Descriptions File operations in Verilog, Memories: RAM, ROM, Block Memories(Xilinx IP)	8hrs

Course Code: 19EEEC401 **Course Title: Power System Modeling, Operation & Control**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Chapter No.	Unit-I	
1	**Formation of network matrices :**Multi-port power system representation, performance equations in bus frame of reference, definitions of Network models Ybus and Zbus, Primitive element representations, primitive performance equations,. Formation of Ybus by method of Inspection, Introduction to graph theory- definitions of terms, Bus incidence matrix, Ybus by the method of singular transformation, Examples on Ybus formation by singular transformation (with no mutual coupling) and Inspection method, Zbus building algorithm-addition of uncoupled branches and links, modification of Zbus for changes in elements not mutually coupled, Examples on Zbus formation	8 hrs
2	**Optimal load dispatch :** Importance and objective of economic load dispatch, Fuel cost and Incremental fuel cost, Optimal load allocation between plants neglecting transmission losses, Examples on optimal load allocation with and without generation constraints, Optimal load allocation considering transmission losses, General transmission loss formula, Examples.	7 hrs
	Unit-II	
3	**Load flow analysis :**Importance of Power flow, Classification of busses, General steps in load flow analysis, Off-nominal ratio tap changing ratio transformer representation. Bus voltage solution by Gauss and Gauss-Seidel methods without PV buses, Handling PV buses in Gauss-Seidel method, N-R load flow model in polar coordinates, formation of NR Jacobian, Introduction to FDLF load flow model, Comparison of Gauss-Seidel, NR and FDLF load flow methods, Examples on one iteration of load flow solution.	8 hrs
4	**Load frequency control :**Introduction to load frequency control problem, Working principle of speed governor, Model of isolated power system area –block diagram representation, Expression for steady-state frequency deviation, Parallel operation of generators –expression for operating frequency and load sharing,, two area load frequency control, steady-state operation of multi-area system under free governor operation, Examples on load sharing between areas.	7 hrs
	Unit-III	
5	**Reactive power and voltage control :** Power flow through a line, Relation between voltage, power and reactive power at a node, Brief descriptions of methods of voltage control-by injection of reactive power and tap changing transformer. Generator reactive power control by AVR-simplified AVR system model, AVR response.	5 hrs
6	**Power System Simulations:** Simulation of automatic generation control, simulation of small signal stability of a SMIB power system, Transient stability simulation of SMIB power system using trapezoidal integration, simulation of classical economic load dispatch Algorithm	5 hrs

Text Books

1 Stagg and El-Abid, Computer Methods in power system analysis, First Edition, Mc-Graw Hill, 1968

2 Kothari and Nagarath, Modern power system analysis, 3rd Edition, Tata McGraw Hill, 2004

Reference Books:

1 P. Kundur, Power system stability and control, First Edition, Tata McGraw Hill, 2007

2 Hadi Sadat, Power System analysis, Ed. First Edition, Tata McGraw Hill, 2002

3 A.R. Bergen and Vijay Vittal, Power system analysis, Ed. First Edition, Pearson Ed, 2009

Course Code: 19EEEE401 L-T-P: **3- 0- 0**
Course Title: **Flexible AC Transmission System (FACTS)** CIE Marks: **50**
Teaching Hrs: **40 hrs** SEE Marks: **50**

	UNIT I	Hrs
1.	**FACTS: Concept and General System Considerations:** Transmission Interconnection, Flow of power in AC system, Limits of loading capability, Power flow and dynamic stability consideration of a Transmission Interconnection, Relative importance of controllable parameters, and Basic types of FACTS controllers, Brief description and Definitions of FACTS controllers, Perspective: HVDC or FACTS	10 hrs
2.	**Voltage Sourced Converters:** Basic Concepts, Single Phase Full Wave Bridge Converter Operation, Single phase Leg operation, Three Phase Full Wave Bridge Converter, Transformer Connection for 12 pulse operation	05 hrs
	UNIT II	
3.	**Current Sourced Converters:** Basic concepts, Three phase full wave diode rectifier, Thyristor based converter Rectifier operation with gate turn ON, Current sourced converter with turn OFF devices, Current sourced versus Voltage sourced converter.	05 hrs
4.	**Objectives of Series and Shunt Compensation:** Objective of Shunt Compensation, Methods of Controllable VAR Generation, Static VAR Compensators SVC STATCOM, Objective of Series Compensation, Static Series Compensators, GCSC, TSSC, TCSC and SSSC	10 hrs
	Unit – III	
5.	**Static Voltage, Phase Angle Regulators:** Objectives of Static Voltage and Phase Angle Regulators, Approach to Thyristor Controlled Voltage and Phase Angle Regulators, TCVR and TCPAR,	05hrs
6.	**Combined Compensators:** Unified Power Flow Controller UPFC and Interline Power Flow Controller IPFC.	05hrs

Text Book:

1. Narain G. Hingorani, and Laszlo Gyugyi., "*Understanding FACTS*", IEEE Press, Standard Publishers Distributors, Delhi, 200, ISBN 81 86308 79 2.

References Book:

1. K. R Padiyar, "*FACTS controllers in Power Transmission and Distribution",* New Age International Publishers, New-Delhi, 2007, ISBN 978 81 224 2142 2.

Course Code: 19EEEO401 **L-T-P:3-0-0**

Course Title: Wind and PV Electrical Energy Systems **CIE: 50 Marks**

SEE: 50 Marks **Teaching Hours: 42**

1.	**Introduction to Wind Energy Systems** Historical development of wind power, types of wind turbines, power in the wind.	**2 hrs**
2.	**Wind Turbine generators** Impact of tower height, maximum rotor efficiency, wind turbine generators, importance of variable rotor speeds, pole changing induction generators, multiple gear boxes, variable slip induction generators, indirect grid connection systems.	**5 hrs**
3.	**Average power in the wind** Discrete wind histogram, wind power probability density functions, Weibull and Rayleigh statistics, average power in the wind with Rayleigh statistics. Annual energy using average turbine efficiency, wind farms.	**8 hrs**
	Unit–II	
4.	**Specific wind turbine performance calculations** Aerodynamics, idealized wind turbine power curve, optimizing rotor diameter and generator rated power, wind speed cumulative distribution function, using real power curves with Weibull statistics, using capacity factor to estimate energy produced.	**5 hrs**
5.	**PV materials and electrical characteristics** Introduction, generic PV cell, cells to modules to arrays, PV I-V curve at STC, impacts of temperature and insolation on I-V curve, shading impacts on I-V curve	**5 Hrs**
6.	**PV systems** Introduction, current-voltage curves for loads, grid connected systems, grid connected PV system economics, stand-alone PV systems, PV power water pumping	**5 Hrs**
	Unit -III	
7.	**The solar resource** Solar spectrum, earth's orbit, altitude angle of the sun, solar position at any time of day, sun path diagrams, solar time and civil time, sun rise and sun set, clear sky direct beam radiation.	**5 Hrs**
8.	**Insolation and its measurement** Total insolation on a solar collecting surface, monthly clear sky insolation, solar radiation measurements, average monthly insolation.	**5 Hrs**

Text Book

1. Gillbert M Masters, Renewable and efficient Electric Power Systems, Wily Interscience, New Jersey, 2004.

References:

1. B. H. Khan, Non Conventional Energy Resources, TMH Publishers, New Delhi , 2006.

Course Code: 19EEEP403	Course Title: Embedded Linux	
L-T-P: 3-0-0	Credits: 03	Contact Hrs: 03
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 03 hrs

Content	Hrs
Unit - 1	
Chapter 01: Introduction to Embedded Linux: A Brief History of Linux -Benefits of Linux -Acquiring and Using Linux -Examining Linux Distributions - Devices and Drives in Linux-Components: Kernel, Distribution, Sawfish, and Gnome.	4 hrs
Chapter 02: Overview of Embedded Linux: Overview: Development-Kernel architectures and device driver model- Embedded development issues-Tool chains in Embedded Linux-GNU Tool Chain (GCC,GDB, MAKE, GPROF & GCONV)- Linux Boot process.	5 hrs
Chapter 03: System Management and user interface: Boot sequence-System loading, sys linux, Lilo, grub-Root file system-Binaries required for system operation-Shared and static Libraries overview-Writing applications in user space-GUI environments for embedded Linux system.	5 hrs
Unit - 2	
Chapter 04: File system in Linux: File system Hierarchy-File system Navigation -Managing the File system –Extended file systems-INODE-Group Descriptor-Directories-Virtual File systems- Performing File system Maintenance -Locating Files –Registering the File systems- Mounting and Unmounting –Buffer cache-/proc file systems-Device special files.	6 hrs
Chapter 05: Configuration: Configuration, Compilation & Porting of Embedded Linux-Examining Shells -Using Variables -Examining Linux Configuration Script Files -Examining System Start-up Files -Creating a Shell Script.	4 hrs
Chapter 06: Process management and Inter process communication: Managing Process and Background Processes -Using the Process Table to Manage Processes -Introducing Delayed and Detached Jobs - Configuring and Managing Services -Starting and Stopping Services -Identifying Core and Non-critical Services -Configuring Basic Client Services -Configuring Basic Internet Services –Working with Modules. IPC-Benefits of IPC- Basic concepts-system calls-creating pipes-creating a FIFO-FIFO operations-IPC identifiers-IPC keys-IPCS commands- Message queues-Message buffer-Kernel Ring Buffer semaphores-semtools-shared memory semtools- signals-sockets.	8 hrs
Unit - 3	
Chapter 07: Linux device drivers: Devices in Linux- User Space Driver APIs- Compiling, Loading and Exporting- Character Devices- Tracing and Debugging- Blocking and Wait Queues- Accessing Hardware-Handling Interrupts- Accessing PCI hardware- USB Drivers- Managing Time- Block Device Drivers- Network Drivers- Adding a Driver to the Kernel Tree.	8 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. Embedded Linux – Hardware, Software and Interfacing - Craig Hollabaugh, Addison-Wesley Professional, 2002
2. Embedded / Real-Time Systems: Concepts, Design and Programming Black Book, New ed (MISL-DT) Paperback – 12 Nov 2003.

References

3. Building Embedded Linux Systems, Karim Yaghmour, First edition, April 2003.
4. Embedded Linux- John Lombardo, Newriders.com

Course Code: 18EEEP201 Title: Data Structure Using C Lab

L-T-P: **(0-0-3)** Credits:3 Contact Hrs: **4 hrs/week**

CIE Marks: **80** SEE Marks: **20** Total Marks: **100**

Teaching Hrs: 48**hrs** Exam Duration: **3 hrs**

Chapter No.	**Unit-I**	
1	**Programming on pointer concepts**: Pointer concepts,1D and 2D arrays, pointers to functions, memory management functions	02+02 Hrs
2	**Programming on string handling functions using pointers, structures, bit-fields**: Perform string handling functions like String length, String concatenate, Strings compare, String copy and Strings reverse, Implementing Structures, union and bit-field.	02+02 Hrs
3	**Programming on files:** Open, Close, Read, Write and Append the file.	02+02 Hrs
4	**Programming on stack data structures and applications:** Insert delete and display an integer in a stack, Conversion from Infix to postfix & Infix to Prefix, Recursion.	02+02 Hrs
5	**Programming on queue data structures:** Insert at rear end ,delete at front end and display the integers in queue, Deque and circular queue.	02+02 Hrs
6	**Programming on linked lists:** Insert, delete and display a node in Singly Linked List, Doubly Linked List and Circular Linked List.	06+03 Hrs
7	**Programming on trees:** Perform various operations on binary trees, find max, min value in a binary search trees, find the height of a tree, count nodes in a tree, delete a node in a tree.	02+02 Hrs
8	**Programming on sorting:** Merge sort, Quick sort, Heap sort, Shell sort, Radix sort**.**	02+02 Hrs
9	**Programming on graphs:** Compare Breadth First Sort Sort, and Depth First Sort	02+02 Hrs
10	**Programming on hashing tables:** Implement different methods of hash tables.	02+02 Hrs
11	**Open ended experiment:** Implement given Data structures.	02+02 Hrs

Text Books

1 Horowitz, Sahani, Anderson-Feed, "Fundamentals of Data Structures in C", 2ed,Universities Press, 2008

2 Aaron M. Tenenbaum , "Data Structures Using C", Pearson Education India, 2003

3 Richard F. Gilberg, Behrouz A. Forouzan "Data Structures: A Pseudocode Approach With C", 2nd Edition , Course Technology, Oct 2009.

Reference Books:

1 E Balaguruswamy, "The ANSI C programming Language", 2ed., PHI, 2010.

2 Yashavant Kanetkar, "Data Structures through C", BPB publications 2010

Course Code: 19EEEE301 **Course Title: CMOS VLSI Circuits**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 40

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Content	**Hrs**
Unit – 1	
Chapter No. 1. Introduction to VLSI and IC fabrication technology VLSI Design Flow, Semiconductor Technology - An Overview, Czochralski method of growing Silicon, Introduction to Unit Processes (Oxidation, Diffusion, Deposition, Ion-implantation), Basic CMOS technology - Silicon gate process, n-Well process, p-Well process, Twin-tub Process, Oxide isolation.	06 hrs
Chapter No. 2. Electronic Analysis of CMOS logic gates DC transfer characteristics of CMOS inverter, Beta Ratio Effects, Noise Margin, MOS capacitance models. Transient Analysis of CMOS Inverter, NAND, NOR and Complex Logic Gates, Gate Design for Transient Performance, Switch-level RC Delay Models, Delay Estimation, Elmore Delay Model, Power Dissipation of CMOS Inverter, Transmission Gates & Pass Transistors, Tristate Inverter.	14 hrs
Unit – 2	
Chapter No. 3. Design of CMOS logic gates Stick Diagrams, Euler Path, Layout design rules, DRC, Circuit extraction, Latch up – Triggering Prevention.	06 hrs
Chapter No. 4. Designing Combinational Logic Networks Gate Delays, Pseudo nMOS, Clocked CMOS, Dynamic CMOS Logic Circuits, Dual-rail Logic Networks: CVSL, CPL.	08 hrs
Unit – 3	
Chapter No. 5. VLSI Design Flow Structured Design Strategies: Hierarchy, Regularity, Modularity, Locality, SDEF Layout Flow, Case Study IC tape out.	06 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. John P. Uyemura, Introduction to VLSI Circuits and Systems, 1, Wiley, 2007
2. Neil Weste, David Harris & Ayan Banerjee, CMOS VLSI Design, 3, Pearson Ed, 2005
3. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, 3, Tata McGra, 2007

References

1. Wayne, Wolf, Modern VLSI design: System on Silicon, 3, Pearson Ed, 2005
2. Douglas A Pucknell and Kamran Eshraghian, Basic VLSI Design, 3, PHI, 2005
3. Phillip. E. Allen, Douglas R. Holberg, CMOS Analog circuit Design, 1, Oxford University, 2002

Course Code: 19EEEE302	Course Title: **Battery Management Systems**	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Content	**Hrs**
Unit – 1	
Chapter No. 1. Introduction: Introduction to electric vehicle & hybrid electric vehicle, types of batteries and their specific applications, Lithium-ion battery fundamentals: Battery Operation, Battery Construction, Battery Chemistry, Safety, Longevity, Performance, and Integration.	03 hrs
Chapter No. 2. Battery Models: Battery Models, Overview, self-Discharge Modeling, Thevenin Equivalent Circuit, Hysteresis, Coulombic Efficiency, Nonlinear Elements, parameter identification using SOC/OCV.	04hrs
Chapter No. 3. BMS (Black-box approach): Need for BMS, Typical inputs, typical outputs and typical functions Battery management system network in a typical electric vehicle.	02 hrs
Chapter No. 4. BMS Architectures: Monolithic, Distributed, Semi-Distributed, Connection Methods, Additional Scalability, Battery Pack Architectures.	02 hrs
Chapter No. 5. System Control: Contactor Control, Soft Start or Precharge Circuits, Control Topologies, Contactor Opening Transients, Chatter Detection, Economizers, Contactor Topologies, Contactor Fault Detection.	04 hrs
Unit – 2	
Chapter No. 6. Data acquisition (Measurement): Cell voltage, current and temperature measurement, Synchronization of Current and Voltage.	05 hrs
Chapter No. 7. Battery Management System Functionalities: CC/CV Charging Method, Target Voltage Method, Constant Current Method, Thermal Management, and Operational Modes.	03 hrs
Chapter No. 8. Charge Balancing(Cell balancing): Charge Balancing Strategies, Balancing Optimization, Charge Transfer Balancing, Flying capacitor.	05 hrs
Chapter No. 9. SoC Estimation: Columb counting, SoC corrections, OCV measurements, temperature compensation.	02 hrs
Unit – 3	
Chapter No. 10. BMS communications: Overview, Network Technologies ,I2C/SPI, RS-232 and RS-485 134, Local Interconnect Network, CAN 136 ,Ethernet and TCP/IP, Modbus, FlexRay, Network Design.	05 hrs
Chapter No. 11. Battery Safety: Functional Safety, Hazard Analysis, Safety Goals, Safety Concepts and Strategies, Reference Design for Safety.	05hrs

Text Books

1. Phillip Weicker *"A Systems Approach to Lithium-Ion Battery Management"* 2013, Artech house publisher

References

1. Jiuchun Jiang and Caiping Zhang, "*Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles*", John Wiley & Sons, 2015

Laboratory Title: **Electric Drives and Control Lab** Lab. Code: **19EEEP302**

Total Hours: **24** Duration of SEE Hours: 3

SEE Marks: **20** CIE Marks: **80**

Category: Demonstration	
Expt./ Job No.	**Experiment / Job Details**
1	Forward and Flyback DC-DC Converter
2	Single phase full bridge inverter
3	Half controlled Rectifier feeding R and RL load
4	Introduction to STEmbed Model based design and C-code generation for Power Electronics & Drives Application using TI's DSPs.
Category: Exercise	
Expt./ Job No.	**Experiment / Job Details**
1	Three phase full bridge controlled rectifier fed DC motor drive.
2	Fully controlled bridge rectifier feeding R and RL load
3	VSI based open loop volts/hertz control of three phase induction motor drive.
4	ADC, PWM pulse Generation and PI Controller design for PE and Drives application using STEmbed and TI's DSPs.
Category: Structured Enquiry	
Expt./ Job No.	**Experiment / Job Details**
1	To design, simulate and experimentally verify given drive system to meet defined specifications.

Course Code: 20EEEE401 Course Title: **Traction Systems for Electric Vehicles**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 40

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1. Motion and dynamic equations for vehicles Introduction to hybrid and electric vehicles, dynamics of hybrid and electric vehicles, motion and dynamic equations for hybrid and electric vehicles.	5 hrs
Chapter No. 2. Vehicle Power Plant and Transmission Characteristics The drive train configuration, Various types of vehicle power plants, The need of gearbox in a vehicle, The mathematical model of vehicle performance	5 hrs
Chapter No. 3: Basic Architecture of Electric Drive Trains Electric Vehicle Configuration, EV alternatives based on drivetrains, EV alternatives based on power source configuration, Single and Multi-motor drives in wheel drives	5 hrs
Unit - 2	
Chapter No. 4. Permanent Magnet Machines for Hybrid and Electric Vehicles Permanent Magnet (PM) Machines, Principle of Operation of PM Machine, Operation of PM Machine Supplied by DC-AC Converter with 120oMode of Operation, Operation of PM Machine Supplied by DC-AC Converter with 180oMode of Operation	7 hrs
Chapter No. 5. Permanent Magnet Machines suitability Electric Vehicles Relevance /operation of PM Motor specific to electric vehicles, Operation of PM Machine Supplied by DC-AC Converter with 120 degree Mode of Operation, Operation of PM Machine Supplied by DC-AC Converter with 180 degree Mode of Operation, Steady state characteristic operation of PM motor and importance of reluctance torque	8 hrs
Unit - 3	
Chapter No. 6. Control of PM machines Control Strategies of PM Machines, Constant Torque Angle Control, Constant Mutual Air gap Flux Linkage Control, Optimum Torque per Ampere Control	5 hrs
Chapter No. 7. Drive cycle analysis and sizing of Electric Machine for EVs and HEVs Power Train and Drive Cycles, New York City Cycle (NYCC), Federal Test Procedure (FTP-75), Sizing of Electric machine, Peak Torque and Power, Constant Power Speed Ratio, EM Sizing, Sizing Power Electronics	5 hrs

Text Book

1. Chris Mi and M Abul Masrur, "*Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives*", John Wiley & Sons, 2018.

Course Code: 20EEEE402 **Course Title: Powertrain Control Laboratory**

L-T-P: 0-0-3	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

EV Laboratory (0-0-3)
Plan for 12 Weeks (12*6 = 72 Hours = 24 Lab sessions of 3 Hrs each)

Content	Hrs
1. **Introduction to Matlab-Simulink** (Numerical methods, configuration settings, data acquisition, data representation)	
2. Battery Modelling and Simulation a. Series and Parallel connection b. Charge and discharge curves of individual cell and battery pack. c. SoC algorithms d. Passive and Active Cell Balancing	(4 Sessions)
3. Mathematical Modelling and Simulation of Power Converters a. Bi-directional DC-DC converters (For interface between Inverter and battery) b. Three phase voltage source inverter (motor driver)	(3 Sessions)
4. dq Transformation theory a. Parks transformation b. Clarke's transformation	(1 sessions)
5. Induction Motor Drive a. dq Model of Three Phase Induction Machine b. Scalar Control (Constant Voltz/Hertz Law) c. Vector Control strategies i. Direct Torque Control ii. Field Oriented Control	(4 sessions)
6. PMBLDC Drive a. Model of BLDC motor b. Speed Control Strategies	(4 sessions)
7. PMSM Drive a. dq Model of PMSM machine b. Scalar Control (Constant Voltz/Hertz Law) c. Vector Control strategies i. Direct Torque Control ii. Field Oriented Control	(4 sessions)
Course Project (4 lab Sessions)	
1. System Integration and testing (End-to-End Simulation)	
2. Experimental Verification (Build sub modules throughout the semester)	

Laboratory Title: **Project** Lab. Code: 20EEEW401

Credits: L-T-P**: 0-0-14** Credits: 14 Duration of SEE Hours: 3

SEE Marks: **50** CIE Marks: **50**

Capstone Project Guidelines

(I) Preamble

A project work essentially gives the students a platform to integrate the concepts studied during the study, enhance their analytical capabilities and develop abilities to effectively communicate technical information in multiple formats. During the course of projects, students are asked to follow the research methodology in identifying a problem of their interest though literature survey, carry-out feasibility study, formulate the problem, develop mathematical models, select suitable solution technique etc. Students are also encouraged to develop new formulations, alternate solution techniques, study and apply new optimization algorithms, develop new simulation models and use modern engineering/simulation tools.

(II) Project batch and Guide

Each project batch consists of 3 or 4 students. Students will be informed to form their own batch based on the kind of project work and their interest. Each batch is supposed to give four faculty names as guides based on faculty expertise in the order of their preference. Guides will be allocated based on the preference given by the batch. The primary role of the guide is to supervise the work, give appropriate guidance in successfully carrying out the project work.

(III) Project implementation

The principal steps in carrying out the project work are summarized below:

Step-1: Selection of a specialized area for the project work

A specialized area in which the project work is to be carried out depends on the interest and specialized skills acquired by the project team. This includes areas such as power system analysis, power system dynamics, renewable energy, electric drives, VLSI & Embedded system, Power quality issues etc. The proposed work may include simulation studies, hardware implementation or both.

Step-2: Selection of topic based on literature survey

A literature survey in the selected specialized area is to be carried out in order to understand the state of the current research. Further, a critical review of the collected literature will facilitate to summarize key observations. Key observations will lead to identifying a specific problem for the project work in terms of alternate/new solution techniques, possible improvements, new formulations or models, hardware implementations etc.

Step-3: Prepare a synopsis

A synopsis highlights the definition of identified problem and its significance. The synopsis will also contain detailed literature review giving the state of the current research on the selected specialized area. It will also brief the problem formulation, solution methodology, tools employed and possible outcomes.

Step-4: Project implementation

The work is to be carried out in phase wise manner, testing or analyzing the partial results obtained. Guide will periodically monitor the progress of the work done giving suitable suggestions as required.

(IV) Schedule

Sl. No.	Activity	Week No.	Evaluation Objectives
1	Announcement to form the batches	At the end of the previous 7th sem	NA
2	Allotment of guides	1st - 2nd	NA
3	Submission of Synopsis	4th- 5th	Literature review, problem formulation, methodology by respective Guides
4	Review-I	6th - 8th	Literature review, problem formulation, methodology, tools used in the presence Review Committee
5	Review-II	9th -10th	Implementation and analysis done
6	Review-III	12th - 14th	Completion along with Hardware/ Software/ Report. Results and Conclusions.

(V) Evaluation

Evaluation of the project work carried out by each batch will be reviewed periodically by a review committee. Review committee consists of guide and two/ three other faculty members who are guiding other batches. Generally, two to three reviews will be held during a semester. However, each project batch will be supervised by the guide on a weekly basis. Review committee will evaluate for 40% and guide will evaluate for 60% of the total marks.

Activity	Assessment	Marks
ISA (50%)	Project Review committee	20
	Evaluation by Project Guide	30
ESA (50%)	Using ESA Rubrics	50
	Total	**100**

Passing: 40% both in ISA and ESA

Review Committee Evaluation Schedule

Activity	Week	Marks
Review I: Problem Definition	6^{th}	05
Review II: Progress	8^{th}	05
Review III: Results & Conclusions	12^{th}	10
Guide Evaluation	12^{th}	30
Total		**50**

In Semester Assessment (ISA)

Review	Phases of the project	PI	Marks
1	Identification of problem, Literature survey, Methodology	2.4.1	10 Marks
	Relevance of project topic literature review	2..4.1	
	Tools/ Software/ Hardware using	2.2.3	
	Team and Individual Work	9.2.1	
2	Develop models and simulate power/ energy/ electronics systems using appropriate engineering tools	13.1.1	10 Marks
	Presentation and communication skills	10.3.2	
	Design/ Development of solutions	3.4.1	
	Investigation of complex problems	4.3.4	
	Work done	2.2.3	
	Team and Individual Work	9.2.1	
3	Develop models and simulate power/ energy/ electronics systems using appropriate engineering tools	13.1.1	30 Marks
	Work done	2.2.3	
	Design/ Development of solutions	3.4.1	
	Investigation of complex problems	4.3.4	
	Analysis and Results	3.4.1	
	Team and Individual Work	9.2.1	
Total (Average of three reviews)			50 Marks

End Semester Assessment (ESA)

CAPSTONE PROJECT					
End Semester Assessment (ESA)	**Group Evaluation**		**PO Assessed**	**PI Assessed**	**Weightage**
	Relevance of project topic and Literature review	• Problem identification • Problem objectives and scope	2	2.2.3 2.4.1	30%
	Quality and Quantity of work reported	• Problem formulation • Contribution to the field of knowledge • Experimentation/simulation • Analysis of results • Drawing conclusions • Assumptions and justifications	2 3 4 13	2.4.2 13.1.1 3.4.1 4.3.4	40%
	Quality of presentation and report	• Organization of the report/presentation • Clarity of language • Clarity of illustrations and Tables	10	10.3.2	20%
	Individual Evaluation				
	Presentation/ Communication skills	• Clarity of language • Technical Knowled	10	10.3.2	5%
	Viva Voce	• Demonstration of clear understanding of the concept	10	10.3.2	5%

Course Title: Signals and Systems **Course Code: 19EEEC205**
L-T-P: 3-0-0 **Credits:3** **Contact Hours: 3Hrs/week**
ISA Marks: 50 **SEA Marks:50** **Total Marks: 100**
Teaching Hours: 40 Hrs **Examination Duration: 3 Hrs**

1.	**Chapter No. 1. Introduction and Classification of signals:** Definition of signal and systems. Sampling of analog signals, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power. Elementary signals/Functions: exponential, sine, impulse, step and its properties, ramp, rectangular, triangular. Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration, time scaling, time shifting and time folding. Systems: Definition, Classification: linear and nonlinear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.	8hrs
2.	**Chapter No. 2. Time domain representation of LTI System:** Definition of impulse response, convolution sum, convolution integral ,computation of convolution sum using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Properties of convolution.	7hrs
3.	**Chapter No. 3. Fourier Representation of Periodic Signals:** Fourier Representation of Periodic Signals: Introduction to CTFS and DTFS, definition, properties and basic problems.	5hrs
4.	**Chapter No. 4. Fourier Representation of aperiodic Signals:** FT representation of aperiodic CT signals, definition, FT of standard CT signals, Properties and their significance. FT representation of aperiodic discrete signals DTFT, definition, DTFT of standard discrete signals, Properties and their significance, Impulse sampling and reconstruction: Sampling theorem and reconstruction of signals.	10hrs
5.	**Chapter No. 5: Z-Transforms:** Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform, Implementation of discrete time of LTI systems.	10hrs

Text Book

1. Simon Haykin and Barry Van Veen, Signals and Systems –2nd Edition, John Wiley, 2004 .

2016-17

Course Title: Environmental Engineering | **Course Code: 15ECVC204**

L-T-P: 4-0-0 | **Credits: 4** | **Contact Hours: 4 Hrs/ week**

ISA Marks: 50 | **ESA Marks: 50** | **Total Marks: 100**

Teaching Hours: 50 Hrs | **Examination Duration: 3 Hrs**

Unit I

1.Introduction

Impact of human activities on environment, Water pollution causes, need for protected water supply. **02 hrs**

2. Demand and conveyance of water

Human activities and environmental pollution need for protected water supply. Types of water demands, population forecasting- arithmetical, geometrical, incremental increase and simple graphical method. Surface and subsurface sources Intake structures. Design of the economical diameter of the rising main. **04 hrs**

3. Quality of Water

Concept of safe wholesome and palatability of water, Sampling of water, Examination of Water–Physical, chemical and Biological Examinations. Drinking water standards BIS & WHO guidelines. Health significance of Fluoride, Nitrates and heavy metals like Mercury, Cadmium, Arsenic etc. **04hrs**

4.Water Treatment

Treatment flow-charts. Aeration- Principles, types of Aerators. Sedimentation aided Coagulant, design, jar test, Theory of filtration, slow sand, rapid sand and pressure filters, design – excluding under drainage system .Theory of disinfection, types of disinfection. **10 hrs**

Unit II

5.Miscellaneous Treatment and Distribution of Water

Softening methods of removal of hardness by lime soda process and zeolite process. Adsorption technique, reverse osmosis technique, fluoridation and defluoridation. **05 hrs**

System of supply, service reservoirs and their capacity determination, methods of layout of distribution systems.

6. Sewerage systems

Types of sewerage systems. DWF, estimation of storm flow, design of storm water drain. Design of sewers - self cleansing and non-scouring velocities. Design of hydraulic elements for circular sewers flowing full and flowing partially full. **06 hrs**

7. Sewage characteristics

Physical, Chemical and Biological characteristics, CNS cycle. BOD and COD their significance. **03 hrs**

8. Disposal of Sewage

Self-purification phenomenon, Zones of purification, Oxygen sag curve. Sewage sickness Sewage farming. Numerical Problems on Disposal of Effluents using Streeter Phelps equation. **04 hrs**

9. Sewage Treatment

Flow diagram of municipal waste water treatment plant. Preliminary & Primary treatment: Screening, grit chambers, primary sedimentation tanks – Design. **03 hrs**

Unit III

10.Secondary treatment and sludge disposal

Theory and design of biological unit operation- Trickling filter and Activated sludge process and its modifications. **09 hrs**

Miscellaneous treatment – Oxidation pond, concepts of UASB and RBC.

Digestion of sludge, Sludge drying beds.

Text Books

1. Birdie, G.S., *Water Supply and Sanitary Engineering*, Dhanpath Rai and Son Publishers, New Delhi, 2003
2. Garg, S.K., *Sewage disposal and Air Pollution Engineering*, Khanna Publishers, 2003.
3. Garg, S.K., *Water supply Engineering*, 7ed., Khanna Publishers, New Delhi, 2005.
4. Modi, P.N., *Sewage Treatment and Disposal Engineering*, 15ed., Standard Book House, New Delhi, 2015.
5. Punima, B. C., and Jain Ashok, *Environmental Engineering-I,* 2ed., Laxmi Publications, New Delhi., 2008.
6. Punmia, B. C., Ashok K Jain and Arun Kumar Jain, *Wastewater Engineering*, Laxmi Publications, New Delhi, 2016.

Course C

Course Title: Structural Analysis-II

L-T-P: 3-0-0 **Credits:**

ISA Marks: 50 **ESA Ma**

Teaching Hours: 40 **Examina**

Unit I

1. Slope Deflection Method

Introduction, Sign convention, Development of slope-deflection equations and Analysis of Beams and Orthogonal Rigid jointed plane frames (sway and non sway) with kinematic redundancy less than/equal to three. (Members to be axially rigid) **08 hrs**

2. Consistency Deformation Method

Introduction, static indeterminacy, Analysis of continuous beam and frame by Consistency Deformation Method. **08 hrs**

Unit II

3. Stiffness Matrix Method

Degree of kinematic indeterminacy of one and two dimensional structures, generalised coordinates, Analysis of continuous beams with and without sinking of supports and portal frames kinematic redundancy ≤ 3. **08 hrs**

4. Flexibility Matrix Method

Development of element flexibility matrices, Development of global flexibility matrix, Analysis of continuous beams, and rigid plane frames to determine for internal forces and displacements. **08 hrs**

Unit III

5. Plastic Analysis

Introduction, plastic hinge and plastic moment capacity, Assumptions, Shape factor for general sections, Collapse load, Basic theorems for finding collapse loads, Methods of plastic analysis, Beam mechanism for continuous beam. **08 hrs**

Text Books

1. Bhavikatti S.S, *Structural Analysis II*, 4ed., Vikas Publishing House India Pvt. Ltd, Bangalore, 2016.
2. Pandit G.S. and Gupta S.P, *Matrix Method of Analysis* , 2ed., McGraw Hill Education India Pvt. Ltd, New Delhi, 2008.
3. Reddy C.S., *Basic Structural Analysis*, 3ed., Tata McGraw Hill Education India Pvt. Ltd New Delhi, 2017.

Ram chandra, *Design of steel structures-Vol II,* 12ed, Standard book house, New Delhi 2015

Reference Books:

1. Jain A.K., *Advanced Structural Analysis*, 3ed., Nemchand and Brothers, Roorkee, India, 2015.
2. Leet,, Uang, and Anne M., *Fundamentals of Structural Analysis*, 3ed., Tata McGraw Hill Publishing Company, New Delhi, 2017.
3. Noris, C.H. and Wilbur, J., *Elementary Structural Analysis*, 3ed., Tata McGraw Hill Publishing Company, New Delhi, 2005.
4. Bhavikatti S.S, *Matrix Methods of Structural Analysis*, 1ed., I K International Publishing House Pvt. Ltd., 2011.
5. Timoshenko, S.P., and Young, D.H., *Theory of Structures*, McGraw Hill Company, New York, 1965.
6. B. G. Neal, The Plastic Methods of Structural Analysis, Chapman and Hall, 1977

Course Title: Transportation Engineering		**Course Code: 15ECVC304**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 Hrs**	

Unit I

1. Development of Highway Engineering Importance of transportation, Different modes of transportation, Characteristics of road transport, Jayakar committee recommendations and implementation, Types of Roads, Road patterns, planning surveys, master plan-saturation system of road planning, Phasing of road development in India and problems, Salient features of 3rd and 4th 20year road development plans and problems, Highway development authorities – NHAI, MoRTH, KSHIP, KRDCL, Present scenario of road development nationally and at state level – Bharatmala Project, NGHM, NHDP, PMGSY, Vision 2021.	**08 hrs**
2. Highway Alignment Selection Criteria Guidelines for selection of Ideal alignment, factors affecting the alignment, Engineering surveys, Steps involved in Preparation of Detailed Project Report (DPR) for new highway alignment and realignment of highway.	**04 hrs**
3. Geometric Design of Highways Functional design of highways, Cross Section Elements of highways, Sight Distance, Design of Horizontal and Vertical Curves, Features involved in highway safety and traffic efficiency.	**12 hrs**

Unit II

4. Traffic Engineering

Sampling in Traffic Studies, Objectives, methods of traffic study, equipment used for traffic studies, data collection, analysis and interpretation of (i) Spot speed (ii) Speed and delay (iii) Volume (iv) Origin - Destination (v) Parking (vi) Accident studies, problems on above — **06 hrs**

5. Pavement Materials

Materials used in Highway construction – Soil, Stone aggregates, bituminous binders, bituminous paving mixes, Portland cement and cement concrete : Desirable properties, tests, requirements for different types of pavement. Innovative materials used in road construction. — **06 hrs**

6. Fundamentals of Pavement Engineering

Introduction of pavement design - Types of pavements, Desirable characteristics of pavement, components of flexible and rigid pavement and function of each component layer, Factors affecting pavement design, ESWL and its determination. Types of joints in rigid pavement and function of each type. — **04 hrs**

Unit III

7.Pavement Construction Technology

Specification and construction procedure of **:** Earthwork, Preparation of Embankment / Subgrade, Granular sub base course, Granular base course, Prime Coat, Cementaceous Subbase/Base course, Bituminous base course, Tack Coat, Bituminous surface course, Dry Lean Concrete base course, Pavement Quality Concrete surface course, Highway drainage system. — **06 hrs**

8. Highway Economics

Concept and principle of Engineering economics, Identification and measurement of Highway Benefits, Highway Transportation costs, Road User costs and Benefits.

Economic analysis by benefit cost ratio method- BCR, NPV-IRR. Highway Financing- BOO, BOT, BOOT Concepts, eProcurement system. — **04 hrs**

Text Books

1. Khanna S.K., and C.E.G. Justo, & A. Veeraragavan, *Highway Engineering*, 10ed., Nem Chand and Bros. Publishers, Roorkee, 2016.
2. Kadiyali L.R., *Traffic Engineering and Transportation Planning*, 7ed., Khanna Publishers, New Delhi, 2011.
3. Kadiyali L.R.., *Principles and Practices* of *Highway Engineering*, Khanna Publishers, New Delhi, 2005.
4. Papacostas C.S. and Prevedourous, P.D., *Transportation Engineering and Planning*, 3 ed., Prentice-Hall India, New Delhi, 2002.

Reference Books:

1. T. Fwa, *The Handbook of Highway Engineering*', Taylor & Francis Group, Newyork, 2006.
2. C. Jotin Khisty, B.Kent lal, *Transportation Engineering*, PHI Learning Pvt. Ltd. New Delhi, 2014.

3. Ministry of Road Transport and Highways, *Specification for Road and Bridge Works* (Fifth revision 2014), Indian Road Congress, New Delhi.
4. IRC: 73-1980-*Geometric Design Standards for Rural (Non Urban) Highways*, Indian Road Congress, New Delhi.
5. IRC: 37-2012 –*Guidelines for the Design of Flexible Pavements* (Third Revision), Indian Roads Congress, New Delhi.
6. IRC: 58-2015- *Guidelines for the Design of Plain jointed Rigid pavements for highway*, Indian Roads Congress, New Delhi.

Course Title: Traffic Engineering		**Course Code: 15ECVE302**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Traffic and Road user characteristics Objectives and scope of traffic engineering, Components of road traffic- vehicle, driver and road, vehicle performance characteristics, road user characteristics: human characteristics, factors affecting road traffic, concept of classified traffic, methods of measurements, and concepts of passenger car units (PUC) for mixed traffic flow.	**04 hrs**
2. Traffic Engineering studies and analysis Sampling in traffic studies, adequacy of sample size, sampling techniques, application of sampling methods for traffic studies, equipment, concept Data collection, analysis and interpretation of results of classified traffic volume, spot speed, speed and delay, origin and destination, parking studies and accident studies. Problems on above.	**08 hrs**
3. Traffic flow characteristics, traffic flow variables, speed Flow –density relationship, PCU values, level of service, factors influencing roadway capacity, capacity of roads at various levels of service, capacity of intersections.	**06 hrs**

Unit II

5. Traffic Regulation and control General regulations, regulation on vehicles, drivers and flow regulation and traffic control devices – Types & objectives of marking, signs, signals and islands, delineators, traffic and environment hazard- noise and air pollution due to road traffic and method of control.	**06 hrs**
4. Traffic features Design Design of intersection – Channelization and rotary, Design of signalized intersections including signal timings as per IRC guidelines, problems on above Design of on street and off street parking facilities.	**10 hrs**

Unit III

6. Traffic Management system

Traffic System Management (TSM) with IRC standards, Traffic regulatory measures, Travel Demand Model (TDM), Direct and Indirect methods, Congestion and parking pricing, all segregation methods-coordination among different agencies, ITS for traffic management system. **06 hrs**

Text Books

1. L.R. Kadiyali, *Traffic Engineering and Transport Planning*, Khanna Publications, Delhi, 2013.
2. S. K.Khanna, CEG Justo and A.Veeraragavan, *Highway Engineering*, Nem Chand Bros, Roorkee,2016.

Reference Books:

1. Matson T.M., Smith W.S., Hurd, H.W. *Traffic Engineering*, McGraw Hill Publishing Co. Inc., New York,2005.
2. Drew D.R., *Traffic Flow Theory and Control*, McGraw Hill Publishing Co. . Inc., New York, 2002.
3. Wiiliam R. McShane and Roger P, Roess, *Traffic Engineering*, Prentice Hall, New Jersey, 2000.
4. Papacostas, C.A., *Fundamentals of Transportation Engineering,* Prentice-Hall of India Pvt. Ltd., New Delhi, 2000.

Course Title: Construction Engineering & Management Laboratory		**Course Code: 15ECVP306**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 Hrs/ week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3 Hrs**	

1. Introduction to project management software such as Primavera P6, MS Project, etc.
2. Develop a Work Break-down Structure (WBS) for a residential building of 3 storey.
3. Create and add activities to the WBS and assign relationships as per the logic of the precedence diagram for the residential building. Determine the duration of the project.
4. Apply constraints and filters to the developed activities to develop two-week, one-month and three-month look-ahead schedule.
5. Develop different roles and resources in the resource library and assign to the various activities along with their unit rates.
6. Develop the cost-loaded schedule and create baseline of the project.

7. Perform earned value analysis to track and monitor the project.
8. Building a 3D model of a typical building in AutoCAD Revit 2018 and Synchro (Architectural, Structural and Construction Details)
9. Conduct simulations in Microsoft Visio process simulator to determine most efficient excavation cycles on large scale projects.
10. Conduct Monte-Carlo simulation in Microsoft Excel to perform risk analysis for the project.

Reference Books:

1. Kim Heldman & William Heldman, *Microsoft Excel for Project managers 2007*.
2. P. Harris, *Planning and Scheduling Using Primavera P6 2010.*

2017-18

Course Title: Building Technology and Services		**Course Code: 15ECVC201**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Components of a Building

Introduction, types of building as per NBC, Components of a building – Foundations, RCC components like columns, beams, slabs. Floor structures, roof structures, doors, windows and other openings, building finishes. **05 hrs**

2. Building Materials

Introduction. Properties of concrete and its ingredients, building stones, Clay products, Bricks and tiles; Timber, Plywood, Allied products, Plastics and glass, Paints, Steel, Gypsum and Allied products, Adhesives. **07 hrs**

3. Types of Foundations

Preliminary investigations of soil, Presumptive bearing capacity of soils, Masonry footings, Isolated footings, Grillage footings, Strap footings, Raft foundations, Pile foundations. **05 hrs**

Unit II

4. Stone and Brick Masonry

Rubble masonry, Ashlar masonry, Bonds in brick work (English and Flemish bond). Load bearing and partition walls. Damp proof construction. **05 hrs**

5. Floors and Roofs

Types of flooring (Materials and method of laying), Granolithic, Mosaic, Ceramic, Marble, Polished Granite, Industrial flooring, Flat Roof (R.C.C.), Sloped roof (R.C.C. and Tile roof), Lean to roof, Steel trusses, Water and Weather proof course. **03 hrs**

6. Stairs, Doors and Windows

Types (Classifications) and Technical terms in stairs, Requirements of a good stair. Geometric Design of RCC Dog Legged and open well stairs. (Plan and sectional elevation of stairs) Paneled doors, Glazed doors, Flush doors, Collapsible and rolling shutters, Louvered doors, Revolving, sliding and swing doors, Windows, Types, Paneled, Glazed, Bat window, Dormer window, Louvered and corner window, Ventilators **06 hrs**

Unit III

7. Plastering and Painting

Purpose of Plastering, Materials of plastering, Lime mortar, Cement Mortar, Methods of plastering, Stucco plastering, Lath plastering, Purpose of Painting, Distemper, Plastic emulsion, Enamel, Powder coated painting to walls and iron and steel surfaces, Polishing of wood surface. **05 hrs**

8. Introduction to cost effective construction and services

Necessity, Advantages, Pre fabrication techniques, Pre cast doors and windows (Pre cast frames and shutters), Alternative Building Materials, Hollow concrete blocks, Stabilized mud blocks, Micro concrete tiles, Precast roofing elements. Water supply and sanitation. Electricity illuminated. Modern services & Air condition, fire detection and protection. **04 hrs**

Text Books

4. Bhavikatti.S.S, *Building Materials,* Vikas Publishing House Pvt Ltd, 2012.
5. Punmia, B.C., Jain A.K., *Building Construction,* 10ed., Lakshmi Publications, New Delhi, 2008.
6. Rai, M. and Jai Sing, *Advanced Building Materials and Construction,* CBRI Publications, Roorkee, 2014.
7. Sushilkumar, *Building Construction,* 20ed., Standard Publisher and Distributors, Delhi, 2014.

Reference Books:

1. Arora, S.P. and Bindra, S.P., *A Text Book of Building Construction Technology*, Dhanapat Rai Publications (P) Ltd., New Delhi, 2014.
2. Jagadeesh, K.S., Venkatarama Reddy B.V. and Nanjunda Rao K.S., *Alternative Building Materials and Technologies,* New Age International (P) Ltd., New Delhi, 2007.
3. National Building Code of India 2016, Bureau of Indian Standards

Course Title: Survey Practice - I		**Course Code: 17ECVP201**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 Hrs / Week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3 Hrs**	

Demonstrations

1. Study of chain, tape, Ranging rod, Direct Ranging, Dumpy level, Compass and EDM device.
2. Use of planimeter and demonstration of minor instruments like clinometer, hand level, box sextant.
3. To locate contour by direct and indirect method.

4. To locate points using radiation & intersection method of plane tabling.

Experiments

1. Plot the boundary layout of a building by using direct ranging and set out the perpendiculars using chain, tape and cross staff.
2. To mark the center line for different types of civil engineering structures (using closed traverse methods) having different shapes.
3. To locate the various positions of objects (trees, electric pole, drainage) along the center line of a road.
4. To setup the temporary bench marks for a given topography using Auto level.
5. To determine difference in elevation between two points using reciprocal leveling and determine the collimation error.
6. To conduct profile leveling for water supply / sewage line / road alignment and to draw the longitudinal section to determine the depth of cut and depth of filling for a given formation level.

Open Ended Experiments:

- Determine and plot the contour map for a sloping terrain and locate the plinth level for the proposed building on sloping terrain.

Reference Books:

1. Bhavikatti S.S., *Surveying and Leveling Vol-I & II,* I.K., International Publishers, New Delhi, 2008.
2. Punmia, B.C., Ashok.K Jain, Arun.K., *Surveying Vol. l & 2*, 15ed., Laxmi Publishers, New Delhi- 2005.
3. SP:7, *National Building Code of India*, Bureau of Indian Standards, 2016

Course Title: Building Engineering Drawing		**Course Code: 17ECVP202**
L-T-P: 0-0-2	**Credits: 2**	**Contact Hours: 4 Hrs/ week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 40 Hrs	**Examination Duration: 4 Hrs**	

1. Introduction to NBC, Building Bye Laws, Model space and paper space, Bubble diagram.

2. Bubble diagram with circulation for a residential building

3. Draw plan, front elevation, section, site plan and write schedule of openings, as per Bye Laws, using AutoCAD, for a given site dimensions for different types of buildings and calculate FAR, Plinth area and Carpet area;

i. Residential Building
ii. Office Building
iii. School Building
iv. Hospital Building
v. College Building

4. Select any one of the building plans from above and draw water supply, sanitary system and rainwater recharging and harvesting system using ByLayer command in AutoCAD.
5. Select any one of the building plans from above and draw bubble diagram with circulation suing AutoCAD.

Open Ended Experiment

- Obtain contour details from the open ended experiment from survey practice-I. Propose a residential building on the sloping ground for the given site dimension as per NBC.
- Draw plan, front elevation, sectional elevation and site plan in AutoCAD with necessary details.

References

1. Bethune, J. D., *Engineering Graphics with AutoCAD*, Pearson Education Publishers, 2017.
2. Chandra, A.M and Chandra, S., *Engineering Graphics with AutoCAD*, 2ed., Pearson Education Publishers, 2004.
3. Gurcharan Singh., *Civil Engineering Drawing*, 7ed., Standard Publishers Distributors, 2014.
4. N. Kumara Swamy, A. Kameswara Rao, *Building Planning and Drawing*, Charator Publishing House Pvt. Ltd., 2007.
5. Shah, M.H and Kale, C.M, *Building Drawing*, Tata Mc Graw Hill Publishing Co. Ltd., 2012.
6. Malik R S and Meo G S, *Civil Engineering Drawing*, 2ed, Asian Publishers/Computech Publications Pvt Ltd, 2010.
7. SP:7, *National Building Code of India*, Bureau of Indian Standards, 2016

Course Title: Survey Practice - II		**Course Code: 15ECVP204**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 hr / week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3Hrs**	

List of Experiments

Demonstrations

1. Measurement of horizontal angles with method of repetition and reiteration using theodolite and Total Station, Measurement of vertical angles using theodolite and Total Station.
2. To determine height of a remote object, horizontal distance and coordinates of points using Total Station.
3. Introduction to GPS.

Experiments

1. To determine the elevation of an object using single plane method when base is accessible and inaccessible using theodolite and Total station.
2. To determine the distance and difference in elevation between two inaccessible points using double plane method using theodolite and Total station.
3. To set out simple curves using linear methods perpendicular offsets from long chord.

4. To set out simple curves using linear methods by offsets from chords produced.
5. To set out simple curves using Rankine's deflection angles method.
6. To set out compound curve with angular methods.
7. To set out reverse curve between two parallel line with angular methods.

Structured Enquiry

- To set out the center line of columns for different buildings using Total Station.

Open Ended

1. To collect various surveying data and build model using AutoCAD / Civil 3D software.
2. Plot the longitudinal and cross sections of a road and determine the volume of Earthwork.

Reference Books:

1. Bhavikatti S.S., *Surveying and Leveling Vol-I & II,* I.K. International Publishers, 2008.
2. Punmia B.C., Jain, Ashok K. J., and Arun.K. J., *Surveying Vol. l & 2,* 15ed., Laxmi Publications (P) ltd, New Delhi, 2005.
3. Duggal S. K., *Surveying Vol-II*, 4e, McGraw Hill Education Pvt. Ltd.,New Delhi, 2013.

IS Codes:

1. IS 11134:1984(R2000), *Code of practice for Setting out of Buildings.*
2. SP:7, *National Building Code of India, Bureau of Indian Standards*, 2016
3. IRC: 73-1980-*Geometric Design Standards for Rural (Non Urban) Highways, Indian Road Congress*, New Delhi.
4. IRC: 86-1983-*Geometric Design Standards for Urban Roads in Plains, India Road Congress,* New Delhi.

Course Title: Advanced Project Management		**Course Code: 15ECVC305**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction to Advanced Project Management

Introduction, Importance of advanced project management, the project management institute and PMBOK, the role of a project manager, project management in India. **05 hrs**

2. Work Breakdown Structure

Concept of WBS, Common usage of terms, Preparing a WBS, Factors to be considered, WBS measurement considerations, Challenges to be considered, WBS level of Detail, WBS life-cycle considerations, Project risk and the WBS, Resource planning and management with WBS, Problems – Detailed WBS of residential, commercial, industrial and Highway Road etc. CPM and PERT. **12 hrs**

Unit II

3. Cost Loaded Scheduling and Project Controls

Determination of unit costs and total cost of a typical construction project. Project Controls - Introduction, Project life cycle, Overview of project life cycle, earned value management, Cost performance Index, Schedule performance index, forecasting methods and problems, resource utilization and cumulative curves, Cost loaded Schedules. **08 hrs**

4. Resource Allocation

Introduction, Objectives of resource allocation, Methods of resource allocation, Resource smoothing, Steps in resource smoothing, Resource levelling, Steps in resource levelling. **04 hrs**

5. Contractor's Estimation of cost and Bidding Strategy

Pre-qualification process, study of tender documents, preparation of construction schedule, determination of bid price. **04 hrs**

Bidding and Estimation practices in Indian Construction Industry.

Unit III

6. Risk analysis and Project Close out

Risks involved in projects – determination and mitigation. Closing out of project, Lessons learnt, historical data - creation and uses. **03 hrs**

7. Quality Control

Need for inspection and Quality Control, principles of inspection, Stages of inspection and quality control. Status of construction labour, wages of construction workers, different labour acts. **04 hrs**

Text Books

1. James Lewis, *Project Planning, Scheduling, and Control*, 3ed., 2009.

Reference Books:

1. P. Harris, *Planning and Scheduling Using MS Project* 2010.
2. Ursula Kuehn, *Integrated Cost and Schedule Control in Project Management,* 2ed.,2011.

Course Title: Construction Simulation Practice		**Course Code: 17ECVP301**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 Hrs/ week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3 Hrs**	

Preamble:

Through the courses in the preceding semesters (3rd, 4th and 5th), the students are studying the basics of many courses in the fields of construction engineering and management, structural engineering, geotechnical engineering, environmental engineering and transportation engineering. This course aims to bridge the gaps between theoretical concepts learned in classroom and their practical applications in the industry.

Course will be delivered through a series of site visits and guest lectures from industry experts.

Deliverables:

Student group will be given a hypothetical site where in their job profile will be of a project manager. Guest lectures from project managers and site engineers will provide the necessary tools and work cultures on the site, which the students have to apply to their project.

The students will learn the following concepts as practiced in the field:

1. Roles and responsibilities of various stakeholders involved like the owner, architect, structural consultant and the general contractor.
2. The material procurement process – quality and cost negotiation process. Costs involved in using RMC or procurement of raw materials to produce concrete on site etc.
3. Labour cost negotiations, roles and responsibilities, basic amenities to be provided and person-hour tracking.
4. Safety protocol followed in the jobsite.
5. Process of material delivery on the job site and coordination with the accounts department.
6. Technical problems encountered during execution – For example, deep well located during excavation – design changes to be made, concrete strength failure after 28 days – what measures to be taken, errors during surveying of the building, honeycombing or bulging of concrete etc.
7. Tracking of the progress – both time and cost. Creating of monthly progress reports.
8. Equipment management – renting vs owning, maintenance.
9. Roles and responsibilities on the project manager, site engineers, supervisors, safety officers.
10. Store management.
11. On site testing and third party testing – advantages and disadvantages.
12. Site layout for optimum utilization of construction space.
13. Reconciliation of materials like formwork, steel etc.

The student team will submit a comprehensive report about the management of a construction site and the difficulties and solutions employed to their sites and present their case.

References books:

1. Kumar Neeraj Jha, *Construction Project Management: Theory and Practice*, 2ed., Edition, Pearson Publications, 2015.
2. Robert. L Peurifoy and William B. Ledbetter, *Construction planning and Equipment& methods*, Tata McGraw Hill Pvt. Ltd, New Delhi, 3ed., 2010.
3. Ursula Kuehn, *Integrated Cost and Schedule Control in Project Management*, 2ed.,2011.

Course Title: Horizontal and Vertical Construction Methods		**Course Code: 15ECVE405**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Planning for earthwork construction

Planning, Graphical presentation of Earthwork, Earthwork quantities, Mass diagram and its applications, Pricing of earthwork operations. **04 hrs**

2. Compaction and Stabilization Equipment

Compaction of soil and rock, Types of compaction equipment, roller production estimating, Dynamic compaction, Soil stabilization, stabilizing soils with lime, Cement-soil stabilization. **05 hrs**

3. Excavators and loaders **06 hrs**

Hydraulic Excavators, selection of front shovels, calculating shovel production, height of cut effect on shovel production, angle of swing effect on shovel production, Loaders – introduction, Loader buckets/attachments, operating specifications, Loader production rates, calculating wheel loader production, Calculating track loader production, Loader safety.

Unit II

4. Drilled Shaft Foundations

Introduction, Construction of drilled shafts – dry method of construction, casing method of construction, wet construction method, Installation of casings, Steel cages, Placement of concrete, Dewatering, open dewatering systems, deep well systems, well point systems – Types, techniques, Basement waterproofing systems. **05 hrs**

5. Formwork Systems **06 hrs**

Introduction, formwork materials, shores and scaffolding, Vertical formwork systems – Conventional wall/columns forming systems, Modular panel column form, adjustable wraparound column forms, circular steel forms for round columns, wall panel system, single sided wall formwork, formwork ties, Horizontal formwork systems – conventional wood form and metal systems, cup-lock type scaffolding system, slab flex system, tunnel form, flying formwork system, crane-jumped formwork, automatic climbing formwork, self-rising core system.

6. Concrete and Conveying Systems **06 hrs**

Introduction, Concrete – Mixers, Concrete plants, Pre-tensioning and Post tensioning, Transporting and handling – Concrete chute, concrete mixer with lift, concrete skip, truck mixer concrete pumps, concrete belt conveyors, concrete pump truck, trailer pump and pipeline with tower-mounted boom, trailer mounted pumps, pipeline system, mobile concrete placing booms, finishing.

Unit III

7. Cranes

Major cranes types, Mobile cranes, Crawler cranes, Telescoping-boom truck-mounted cranes, Lattice-boom truck-mounted cranes, Rough-terrain cranes, modified cranes for heavy lifting, crane booms, lifting capacities of cranes, Rated loads for lattice and telescopic boom cranes, Tower cranes – classifications, operation, Tower crane selection, Rated loads for tower cranes, rigging, slings, safety. **05 hrs**

8. Modular Construction Practices: **03 hrs**

Introduction to Modular Construction, Modular coordination, Modular Standardization, Modular System Building, Limitation and Advantages of Modular Construction

Text Books

1. Peurifoy, *Construction Planning, Equipment & Method*, 7ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010.
2. Basem M, *Construction Technology for High-rise Buildings-Handbook*, 2014.

Reference Books:

1. Stephens W. Nunnally, *Managing Construction Equipment*, 2ed, Pearson Publications, USA, 2000.
2. Gupta B. L., Amit Gupta, *Construction Management and Machinary*, 5ed, Standard Publications, New Delhi, 2015.

Course Title: Finite Element Methods **Course Code: 15ECVE403**

L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction to Finite Element method.

Introduction, Basic concepts on finite element analysis, Introduction to nodes, elements, and shape functions, Steps in Finite Element Analysis, Key concepts and Terminologies. **05 hrs**

2. Element Properties.

Natural Coordinates, Triangular Elements, Rectangular Elements, Introduction to Weighted integrals, Integration by parts-Review, Gradient and Divergence Theorems, Functionals. **05 hrs**

3. Finite Element Formulation Technique. **05 hrs**

Virtual Work and Variational Principle (Rayleigh-Ritz Method), Weighted Integrals and Weak Formulation, Different types of weighted integral methods such as Galerkin Method, Petrov-Galerkin Method, Collocation Method and Method of Least-squares.

Unit II

4. Second Order Boundary Value Problem.

FEA formulation of 2nd order boundary value problem, Development of element level equations, Assembly of element level equations and implementation of boundary conditions, Assembly process and Connectivity matrix. **08 hrs**

5 Applications of Second Order Boundary Value Problem. **10 hrs**

Radially symmetric problems, One-dimensional heat transfer problem, Euler-Bernoulli beam, Shear deformable beam, Eigen value problems, Introduction to time dependant problems.

Unit III

6. FEM Program

Structure of FEM program for FEM Analysis, Description of different modules in FEM software (ABAQUS), Introduction to different types of analysis, Pre and post processing. Comparison of manually solved problems with software results. **07 hrs**

Text Books

1. Reddy J.N., *An Introduction to Finite Element Method*, 3ed., McGraw- Hill Publishing Company Inc, New York, 2017.
2. Krishnamoorthy C. S., *Finite Element Analysis*, Tata McGraw-Hill Education Pvt. Ltd, New Delhi, 2004.

Reference Books:

Rajasekaran, S., *Finite Element Analysis in Engineering Design*, S. Chand Group, 2006.

1. Pandit G.S. and Gupta, S.P., *Structural Analysis, A Matrix Approach*, 2ed., Tata McGraw-Hill Education Pvt. Ltd, New Delhi, 2008.
2. Cook R.D., Malkus D.S., Plesha M.E. and Witt R.J. *Concepts And Applications Of Finite Element Analysis*, 4ed., John Wiley and Jous, Inc., 2013.
3. Bathe K.J., *Finite Element Procedures*, Klaus-Jürgen Bathe; 2ed., 2014.
4. Bhavikatti S.S., *Finite Element Analysis*, New Age International Publication Pvt. Ltd., New Delhi, 2010.
5. Daryl L. Logan., *A first course in the Finite Element Method*, 5ed, Cengage Learning, 2010.
6. Tirupathi R. Chandrupatla and Ashok D. Belegundu, *Introduction to Finite Elements in Engineering*, 4ed, Pearson, 2011

2018-19

Course Title: Surveying		**Course Code: 15ECVC202**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs / week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 Hrs**	

UNIT-I

1. Overview and Measurement of directions **05 hrs**

Basic principle of surveying, classification of surveying, Measurement of distance: chain surveying. chain and their types, tapes and their types. Errors in chain surveying and tape corrections.

Compass surveying, prismatic and surveyor's compass, bearings and their types. Calculation of included angles from bearings. Corrections to measured bearings – local attraction. Plotting a traverse, closing error and its adjustment by Bowditch's rule. Traverse computations – Latitude and departure (omitted measurements).

2. Measurement of elevations and contouring **07 hrs**

Levelling - Terminologies, Types of levelling instruments viz Dumpy level, Auto level, electronic or digital level and their temporary adjustments, taking observations.

Methods of calculating reduced levels – HI method and rise and fall method.

Types of leveling curvature and refraction correction, sensitiveness of bubble tube.

Contours and contouring, characteristics of contours, contour interval, Contouring methods – Direct and indirect. Interpolation of contours. Preparation of contour maps. Uses of contour maps.

3. Theodolite surveying and Trigonometric levelling **04 hrs**

Theodolite surveying, terminologies used in theodolite, parts of a vernier theodolite, temporary adjustments. Measurement of horizontal angle, vertical angle and other theodolite applications. Theodolite traversing, locating landscape details.

Basic principles, calculation of heights and distances using single plane method and double plane method

4. **Tacheometric Surveying** **04 hrs**

Basic principle of stadia tacheometry; tacheometric equations for horizontal line of sight, inclined line of sight (LOS), when staff vertical to LOS and when staff normal to LOS; Anallactic lens, tangential method of tacheometry, subtense bar, and Beaman's stadia arc; determination of tacheometric constants.

Unit II

5. Curve surveying **06 hrs**

Types of curves, circular curve-terminologies, elements of a simple curve, methods of setting out simple curve- linear method, angular method; compound curves- elements of a compound curve, setting out of compound curve; Reverse curve-element of elements of a reverse curve, setting out of reverse curve; Transition curve- requirements of a transition curve, elements of transition curve, setting out of transition curve;

6. Modern Surveying Instruments: Theodolite, EDM and Total Station **08 hrs**

Modern theodolites- Micro-optic theodolites, electronic theodolites, digital theodolite Electromagnetic spectrum radar, electromagnetic distance measurement (EDM), EDM equipment- Geodimeter, tellurometer, mekenometer, distomat. Corrections to measurements; Total station- principles and working, temporary adjustments, application- angle measurement, distance measurement (horizontal, vertical and slope)

7. Areas and Volumes **06 hrs**

Computation of areas: Area from co-ordinates, latitude and departures, Mid-ordinate method, average ordinate method, Trapezodial rule, Simpson's rule, Computation of volumes: Volumes from cross sections, Prismoidal formula, and Trapezoidal formula capacity of reservoirs volume of borrow pits, Construction surveying / setting out works: Prerequisites, instruments and methods.

Laying out buildings, Setting-out of culverts, Setting-out bridges – locating the center line – locating bridge piers, Setting-out tunnels – Transferring alignment, Transferring bench marks or levels, Setting out Sewer lines

Unit III

8. Introduction to Photogrammetry and Remote Sensing: Terrestrial and Aerial photographs, Photo interpretation, Stereoscopy. **05 hrs**

Remote Sensing: Principle, Idealized remote sensing system, Types, applications. Introduction and applications of LIDAR.

9. Modern methods of Surveying **05 hrs**

Area from digital planimeter**,** Satellite based positioning system, Global Positioning System (GPS), basic principles, Satellite configuration, positioning using satellite signals, receivers; Functions - determining position, navigation, tracking, mapping, precise time determination; Application in surveying.

Introduction to GIS (Geographic Information System): Components, software, data, users, features, subsystems, data acquisition, data processing and analysis, communication, management, capabilities, operations, Applications of GIS in civil engineering.

Text Books

1. Alak, D., *Plane Surveying*, S. Chand & Co., 2000.
2. Bhavikatti S.S., *Surveying and Leveling Vol-I & II,* I.K. International Publishers, 2008.
3. Chandra, A.M., *Higher Surveying*, 3ed. New Age India Ltd. 2015.
4. Chandra, A.M., *Plane Surveying*, 3ed. New Age India Ltd. 2015.
5. Punmia, B.C., Ashok.K. Jain, Arun.K. *Surveying Vol. 1*, *Vol. 2* and *Vol. 3*., Lakshmi Publishers, 2015.

Reference Books:

1. Anderson, J. M. and Mikhail E. M., *Introduction to Surveying*, TMH, New York, 1985
2. Roy, S.K., *Fundamentals of Surveying*, Prentice Hall of India, 2010.

Course Title: Construction Project Management		**Course Code: 15ECVC206**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3Hrs / Week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40 Hrs	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction to Construction Project Management
Phases of construction project, importance of construction and construction industry, Indian construction Industry, Construction project management and its relevance, stakeholders of a construction project. **04 hrs**

2. Drawings and Specifications
Types of Drawings-Architectural and Structural, Study of Scales Used, sequence of dimensioning, dimension lines and figures, Importance of Specifications, General specifications detailed specifications of a typical building. Scope definition using drawings and specifications. **05 hrs**

3. Work Breakdown Structure
Concept of WBS, Common usage of terms, Preparing a WBS, Factors to be considered, WBS measurement considerations, Challenges to be considered, WBS level of Detail, WBS life-cycle considerations, Project risk and the WBS, Resource planning and management with WBS, Problems – Detailed WBS of a residential building. **06 hrs**

Unit II

4. Project Management through Networks
Introduction, project feasibility, planning methods of projects– Objectives, planning stages. Scheduling, Bar charts and mile stone charts. Introduction, Terms & definitions, Elements of network, types of network, drawing the network. CPM – Event times, Activity times, floats, critical activity and critical path. Problems. PERT – Introduction, time estimates, expected time, earliest expected time, latest allowable occurrence time, slack, critical path. **08 hrs**

Probability of completing the project. Problems. Updating of network. Problems. Contraction of network. Problems.

5. Construction Safety Management

Introduction, evolution of safety, Accident causation theories, unsafe conditions and acts, health and safety act and regulations, role of safety personal, causes of accidents, principles of safety, safety and health management system. **05 hrs**

6. Inspection and Quality Control

Introduction, Objectives, principles and function, Inspector's role, Technical services required for field inspection, Laboratories required, Quality control, Factors affecting the quality of conformance, Quality control methods. **04 hrs**

Unit III

6. Construction Equipment

Introduction, standard and special equipment, factor for selecting equipment, cost of owning and operating, economic life of an equipment. Earth moving equipment (Bulldozers, Scrapers, Loaders and Excavators). Hoisting equipment, concrete mixer and plants, conveyors and rollers, trenching machines, equipment for highway construction. Live projects for course project. **08 hrs**

Text Books

1. Kumar Neeraj Jha, *Construction Project Management: Theory and Practice*, 2ed., Edition, Pearson Publications, 2015.

Reference Books:

1. Robert. L Peurifoy and William B. Ledbetter, *Construction planning and Equipment& methods*, Tata McGraw Hill Pvt. Ltd, New Delhi, 3ed., 2010.
2. Verma Mahesh, *Construction planning and Management*, Metropolitan Book Co. Delhi, 1982.

Course Title: Structural Analysis-I		**Course Code: 15ECVC203**
L-T-P: 4-0-0	**Credits: 3**	**Contact Hours: 4 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40 Hrs	**Examination Duration: 3 Hrs**	

Unit I

1. Structural Systems

Forms of structures, Conditions of equilibrium, Degree of freedom, Linear and Nonlinear structures, one, two, three dimensional structural systems, Static and Kinematics determinacy of structures. Theorem of minimum potential energy Law of conservation of energy Principle of virtual work. **6 HRS**

2. Deflection of Beams

Slope and deflection of simply supported and cantilever beams by Moment area method and Conjugate beam method. **6 HRS**

3. Strain Energy

Strain energy and complimentary strain energy, Strain energy due to axial load, bending and shear, Principle of virtual work, Unit load method, The first & second theorem of Castigliano, Betti's law, Clarke - Maxwell's theorem of reciprocal deflection, Problems on beams frames and trusses. **7 HRS**

Unit II

4 Analysis of beams and trusses

Analysis of beams (Propped cantilever and trusses) by strain energy and unit load method. **8 HRS**

5. Arches and cables

Three hinged circular and parabolic arches with supports at same levels and at different levels. Determination of thrust, shear and bending moment, Analysis of cables under point loads and UDL, length of cables - Supports at same level and at different levels. **6 HRS**

6. **Consistent deformation method**

Propped cantilever and fixed beams **6 HRS**

Unit III

7. Influence Line Diagrams

Influence line diagrams for simply supported, cantilever and over hanging beams, Influence line diagrams for girders supporting floor beams, Use of Influence line diagrams, Maximum S.F. and B.M. values due to moving loads

6 HRS

8. Two hinged arches:

Parabolic and circular arches

6 HRS

Text Books

1. Bhavikatti S.S, *Structural Analysis I*, 4ed., Vikas Publishing House Pvt. Ltd, Bangalore, 2011
2. Punmia, B. C. Ashok Kumar Jain and Arun Kumar Jain, *Mechanics of Materials*, Laxmi Publications Pvt. Ltd Ltd, New Delhi, 2005.

Reference Books:

1. Reddy C.S., *Basic Structural Analysis*, 3ed., Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2017.
2. A.K. Jain, *Advanced Structural Analysis*, 3ed., Nemchand and Brothers, Roorkee, India, 2015.
3. Leet,, Uang, and Anne M., *Fundamentals of Structural Analysis*, 3ed., Tata McGraw Hill Publishing Company Inc., New York, 2017.
4. Pandit G. S. and Gupta S. P, *Theory of Structures*, Vol I & II, Tata McGraw- Hill Publishing Company, New Delhi, 2017.
5. Ramamruthum, S. and Narayan, R., *Theory of Structures*, Dhanpat Rai Publishing Company, New Delhi, 2017.
6. Prakash Rao D. S., *Structural Analysis, A unified approach*, 1ed., University Press Limited, Hyderabad, 1996.
7. Timoshenko, S. P. and Young, D. H., *Theory of Structures*, Tata McGraw Hill Book Company, New York, 1965.

Course Code: **19ESEC701** Course Title: **Numerical Methods and Programming**

L-T-P**: 4-0-1** Credits: **5** Contact Hrs: **5 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Unit – I

1.Modelling, Computers and Error Analysis

Mathematical modelling, Analytical and numerical solutions, Computer programs, Algorithms, flow charts, Approximations, Round-off errors, Accuracy and precision, Machine epsilon **04 hrs**

2.Linear Algebra

Systems of linear algebraic equations, Uniqueness of solution, Ill-conditioned systems, Direct methods – Gauss elimination method, Gauss-Jordan method, LU decomposition by Crout method and Cholesky method; Iterative methods – Gauss Seidel method; Determinants and matrix inversion. **10 hrs**

3.Numerical Integration

Trapezoidal rule; Simpson's rules; Gaussian quadrature **06 hrs**

Unit – II

4.Solution of Nonlinear Equations

Bracketing methods – Bisection method, False position method; Secant method; Newton's method. **08 hrs**

5.Eigenvalue Problems

Eigenvalue problems, Eigenvectors, Jacobi method, Power method, Power methos with scaling, Power method with spectral shift, Inverse Power method. **06 hrs**

6.Interpolation and Curve Fitting

Interpolation, Lagrange's method, Newton's method, Polynomial methodCurve fitting, Least squares fit, Cubic splines. **06 hrs**

Unit – III

7.Solution of Ordinary Differential Equations

Euler's method; Second and fourth order Runge-Kutta methods; Systems of equations using Euler's and Runge-Kutta methods. **10 hrs**

Note

1. Emphasis must be on developing algorithms / flow charts and converting them into working programs. Computer implementation must be verified against solution obtained by built-in methods provided in programming language.
2. Programs can be written in Python/Scilab/MATLAB/Julia/C/C++ or any other programming language that the student finds suitable. In the class, Python will be used.
3. Pre-requisites: Working knowledge of Python/Scilab/MATLAB. This shall be done during an intensive hands-on workshop at the start of the semester.

References

1. Kiusalaas, J., *Applied Numerical Methods in Engineers with Python,* Cambridge University Press, 2005.
2. Gerald, C.F. and Wheatley, P.O., *Applied Numerical Analysis*, 6ed., Pearson Education, 1999.
3. Chapra, S.C. and Canale, R.P., *Numerical Methods for Engineers with Programming and Software Applications*, 3ed., Tata McGraw Hill, New Delhi, 1998.

Course Content

Course Code: **15ESEC801**		Course Title: **Advanced Material Science**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Unit – I

1. Structure of Concrete

Structure of aggregate phase & hydrated cement paste, mechanism of hydration, hydration products & micro structure, voids in cement paste, water in hydrated cement paste, properties of HCP, Transition zone in concrete. **08 hrs**

2.Special Conncretes

Fibre reinforced concrete, Carbon fibers, carbon nanotubes. Repair of Concrete structures, grouting shortcreting and guniting Epoxy resins, CFRP and GFRP sheets. **07 hrs**

Unit – II

1. Introduction to composite material

Introduction to materials, traditional materials, development, properties, strength of and mechanical properties of materials , introduction, definition, classification and characteristics of composite materials - fibrous composites, laminated composites, particulate composites **05 hrs**

2. Fiber, matrices and their application

Fiber, matrices and their application - Different types of fibers and matrices. Polymer composites, metal composites and ceramic composites, Application of composites in different industries. **05 hrs**

6. An overview of Nanoscience & Nanotechnology

Historical background – nature, scope and content of the subject multidisciplinary aspects – industrial, economic and societal implications, Experimental techniques and Methods **06 hrs**

Introduction to Nanomaterials- Carbon Nanotubes , synthesis and purification – filling of nanotubes , mechanical and physical properties – applications

Unit – III

7. Introduction to nano-composite

Nano composite polymer matrix, nano composite ceramic matrix, nano composite metal matrix Applications in engineering, future scope of nano-composite, research. **05 hrs**

8.Safety and environmental aspects

Safety and environmental aspects of nano-materials, future challenge, cost optimization and fabrication process of nano composite materials **04 hrs**

Text Book:

1. Mehta, P. K., *Concrete: Microstructure, Properties, and Materials*, 4ed., McGraw-Hill Education: New York,, 2014.
2. A.M. Neville, *Properties of Concrete*, Longmans, 4th Edition, 1995
3. Hull D. and Clyne T.W., *Introduction to Composite Materials*, Cambridge University Press, 2ed, 1996.
4. Pradeep T., *NANO: The Essentials – Understanding Nanoscience and Nanotechnology*, 1ed., Tata McGraw-Hill Education Pvt. Ltd, New Delhi, 2017

References:

1. Sidney Mindess and J. Frances Young, *Concrete*, PH NJ, 1981.
2. IS: 10262 -2007 Code of Practice for Concrete Mix Design.
3. ACI 318-2005, Code of practice for reinforced concrete structures
4. Ventra M.,Evoy S., Heflin J.R., *Introduction to Nanoscale Science and Technology [Series: Nanostructure Science and Technology]*, Springer (2006).
5. Chawla K.K., *Composite Material : Science and Engineering*, 3ed., Springer, 2012.
6. Linda Williams & Wade Adams, *Nanotechnology Demystified*, McGraw-Hill Company Inc, New York, 2007.
7. Johns R.M., *Mechanics of Composite Materials*, 2ed., CRC Press, 2015.

Course Code: **18ESEP701**		Course Title: **Structural Simulation Laboratory**
L-T-P**: 0-0-1**	Credits: **1**	Contact Hrs: 2**hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Teaching Hrs: **24hrs**		Exam Duration: **3 hrs**

List of experiments/jobs planned to meet the requirements of the course.

1. Introduction to ABAQUS modeling, material properties, meshing and element types.
2. Introduction to Loading, Boundary conditions and post processing.
3. Analysis of member forces in beams
4. Analysis of member forces in beams with surface interaction
5. Analysis of member forces and deflections in truss
6. Analysis of stress concentrations near the geometric imperfections
7. Analysis for member forces in portal frames.

Materials and Resources Required:

1. ABAQUS Benchmark manual 6.11.
2. ABAQUS release notes 6.13.
3. ABAQUS Example problem manual, Volume I (Statics and dynamics)
4. ABAQUS Example problem manual, Volume II (Other Applications and Analyses)
5. ABAQUS Verification manual

Course Title: Fire Resistance of Structures **Course Code:** 20ESEE701

L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I	
1.Introduction Overview, Fire Safety in Buildings, Fire Safety Objectives, Process of Fire Development, Fire Resistance, Controlling Fire Spread, Building Construction for Fire Safety.	**03 hrs**
2. Fire and Heat transfer Fuels, Combustion, Fire Initiation, t-squared fires, Heat Transfer.	**04 hrs**
3.Room Fires and Fire Severity Pre flashover, Flashover and Post flashover fires, Fire Severity and Fire Resistance, Equivalent Fire Severity.	**04 hrs**
4. Fire Resistance Introduction, Fire Resistance Tests, Listings, Fire Resistance by Calculation, Fire Resistance of Assemblies.	**03 hrs**
Unit II	
5. Design of Structures Exposed to Fire Overview of design of structures at normal temperature, Structural Design in Fire Condition, Material properties in fire, Design of individual members exposed to fire, Design of structural assemblies exposed to fire.	**10 hrs**
6. Design of Concrete Structures Exposed to Fire Behavior of concrete structures exposed to fire, Concrete and Reinforcing temperatures, Mechanical properties of concrete at elevated temperatures, Design of concrete members exposed to fire.	**08 hrs**
Unit III	
7. Design of Steel Structures Exposed to Fire Behavior of steel structures exposed to fire, Steel temperatures, Protection systems, Mechanical properties of steel at elevated temperatures, Design of steel members exposed to fire.	**08 hrs**

Text Books

1. Andrew H. Buchanan, *Structural Design for Fire Safety*, John Wiley and Sons, LTD, 2006.
2. John A. Purkiss, Long-Yuan Li, *Fire Safety Engineering Design of Structures*, CRC Press Taylor and Francis group Boca Raton, 2014.

Reference Books:

1. Yong Wang, Ian Burgess, Frantisek Wald, Martin Gillie, *Performance Based Fire Engineering of Structures*, CRC Press Taylor and Francis Group Boca Raton, 2013.
2. Naotake Noda, Richard B. Hetnarski, Yoshinobu Tanigawa, Thermal Stresses, Taylor and Francis group, New York, 2003.
3. EN 1992-1-1 Eurocode 2: Design of concrete structures - Part 1-2

Course Code: **20ESEC701** Course Title: **Earthquake Resistant Design of structures**
L-T-P**: 4-1-0** Credits: **5** Contact Hrs: **6 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **54 hrs** Exam Duration: **3 hrs**

Unit – I

1. Engineering Seismology **10 hrs**

Introduction, Reid's elastic rebound theory, Theory of plate tectonics; Seismic waves; Earthquake size – Intensity, Magnitude, Isoseismal map, Energy released in an earthquake; Local site effects; Seismicity of India; Classification of earthquakes.

2. Earthquake Load Specification

Response spectra, Design response spectrum; Equivalent static method; Response spectrum method; Time history analysis **12 hrs**

Unit – II

3.Design of Plan Asymmetric Buildings **10 hr**

Effect of plan asymmetry; Centre of mass, Centre of rigidity, Static eccentricity, dynamic eccentricity, accidental eccentricity; Design eccentricity; Design forces in asymmetric buildings; Seismic code analysis of buildings without locating centres of rigidity

4.Earthquake Resistant Design of Masonry Buildings **08 hrs**

Elastic properties of structural masonry; Lateral load analysis of masonry building

Unit – III

5.Design of Reinforced concrete buildings for earthquake resistance **08 hrs**

Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS1893. Structural behavior, design and ductile detailing of shear walls.

6. Techniques for Earthquake Resistance **04 hrs**

Base Isoloation, Passive and active control systems

References

1. Agarwal P. and Shrikhande M., *Earthquake Resistant Design of Structures*, Pentice-Hall of India Pvt. Ltd., New Delhi, 2011.
2. Chopra, A.K., *Dynamics of Structures*, 4ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2011.

3. Duggal, S.K., *Earthquake Resistant Design of Structures*, Oxford University Press, New Delhi, 2013.

IS Codes

1. IS:1893-2016 (Part 1), Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi, 2016.
2. IS:13920-2016, Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, Bureau of Indian Standards, New Delhi, 2016.
3. IS:4326-2013, Earthquake Resistant Design and Construction of Buildings – Codeof Practice, Bureau of Indian Standards, New Delhi, 2013

<table>
<tr><td colspan="2">Course Title: Structural Health Monitoring</td><td colspan="2">Course Code: 20ESEE701</td></tr>
<tr><td>L-T-P: 4-0-0</td><td>Credits: 4</td><td colspan="2">Contact Hours: 4 Hrs/ week</td></tr>
<tr><td>ISA Marks: 50</td><td>ESA Marks: 50</td><td colspan="2">Total Marks: 100</td></tr>
<tr><td>Teaching Hours: 40</td><td colspan="3">Examination Duration: 3 Hrs</td></tr>
<tr><td colspan="3">Unit I</td><td></td></tr>
<tr><td colspan="3">1.Introduction
Factors affecting Health of Structures, Causes of Distress, Regular Maintenance. Concepts, Various Measures, Structural Safety in Alteration.</td><td>08 hrs</td></tr>
<tr><td colspan="3">2. Structural Audit
Assessment of Health of Structure, Collapse and Investigation, Investigation Management, Assessment by NDT techniques, SHM Procedures.</td><td>08 hrs</td></tr>
<tr><td colspan="3">Unit II</td><td></td></tr>
<tr><td colspan="3">4. Static Field Testing
Types of Static Tests, Simulation and Loading Methods, Behavioral / Diagnostic tests - Proof tests, Sensor systems and hardware requirements, Static Response Measurement- strain gauges, LVDTs, dial gauges - case study</td><td>08 hrs</td></tr>
<tr><td colspan="3">5. Dynamic Field Test
Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Forced vibration method, Impact hammer and shaker testing, Hardware for Data Acquisition Systems, Network of sensors, Data compression techniques, Remote Structural Health Monitoring.</td><td>08 hrs</td></tr>
<tr><td colspan="3">Unit III</td><td></td></tr>
<tr><td colspan="3">6. Introduction To Retrofitting and Repairs Of Structures
Introduction to retrofitting of structures, Retrofitting of structural elements, Techniques, Material used for retrofitting, Case Studies, piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique.</td><td>08 hrs</td></tr>
<tr><td colspan="4">Text Books
1. Structural Health Monitoring Daniel Balageas, Claus-Peter Fritzen and Alfredo Güemes, John Wiley-ISTE, London, 2006.
2. Health Monitoring of Structural Materials and Components - Methods with Applications, Douglas E Adams, John Wiley & Sons, New York, 2007.</td></tr>
<tr><td colspan="4">Reference Books:
1. “Structural Health Monitoring and Intelligent Infrastructure”, Vol.-1, J.P. Ou, H. Li and Z. D. Duan, Taylor & Francis, London, 2006.
2. Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, Academic Press Inc., 2007</td></tr>
</table>

Course Content

Course Code: **16EARC201**	Course Title: Analog and Digital Electronic Circuits	
L-T-P-SS: 4-0-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
1.0 Modeling and Analysis of electrical circuits The Lumped Circuit Abstraction, Modeling Physical Elements using lumped circuit abstraction, Signal Representation, Dependent Sources and the Control Concept, Network theorems: The Node Method, Loop Method, Superposition, Thévenin's Theorem and Norton's Theorem.	7
2.0 Basics of Digital Electronics Number Representation , MOSFET Switch Implementation of Logic Gates, The SR Model of the MOSFET, Active Pullups Voltage Levels and the Static Discipline, Simplifying Logic Expressions using K-map, Combinational circuits: encoder/decoder, multiplexers/de-multiplexers , Binary adder/ subtractor, Binary comparator, Sequential Circuits: Gated D Latch, JK Flip-Flop, Registers, Counters.	7
3.0Transistors Operating point, Fixed bias circuits, Emitter stabilized biased circuits, Voltage divider biased, Bias stabilization, BJT transistor modeling, , Emitter follower, CB configuration, Collector feedback configuration, analysis of CE configuration using h- parameter model; Relationship between h-parameter model of CE,CC and CB configuration.	6
Unit - 2	
4.0 Operational Amplifiers Device Properties of the Operational Amplifier, Simple Op Amp Circuits: The Non-Inverting Op Amp, The Inverting Connection, A Special Case: The Voltage Follower, Op Amp RC Circuits: Op Amp Integrator, Op Amp Differentiator, An RC Active Filter, The RC Active Filter Impedance Analysis, Sallen-Key Filter, Op Amp in Saturation: Op Amp Integrator in Saturation, Positive Feedback : RC Oscillator.	7
5.0 Printed Circuit Board (PCB) Design Issues Partitioning , Resistance Of Conductors ,"Kelvin Feedback" , Ground Noise And Ground Loops , Ground Isolation Techniques , Static PCB Effects , Inductance , Parasitic Effects In Inductors ,Capacitative Noise And Faraday Shields , Buffering ADCs against Logic Noise, Skin Effect , Transmission Lines , Basic Linear Design, Decoupling Mixed Signals ICs With	7

Low Digital Content, Sampling Clock Considerations , Mixed Signal Grounding, Grounding DSPs with Internal Phase-Locked Loops, Decoupling ,Ringing , Thermal Management Thermal Basics ,Data Converter Thermal Considerations	
6.0 First Order Transients in Linear Electrical Circuits Analysis of RC & RL circuits, Propagation Delays, State and State variables, Problems	6
Unit - 3	
7.0 Energy and Power in Digital Circuits Energy Storage Elements; capacitors and inductors , Power and Energy Relations for a Simple RC Circuit, Average Power in an RC Circuit, Power Dissipation in Logic Gates: Static Power Dissipation, Total Power Dissipation, CMOS Logic Gate Design.	5
8.0 Transients in Second Order Circuits Undriven Series RLC circuit, Stored Energy in Transient Series RLC circuit, Undriven Parallel RLC circuit, Driven Parallel RLC circuit, State Space Analysis	5

Course Content

Course Code: 16EARC203	Course Title: Manufacturing Technology	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1. Turning , Shaping and Planing Machines Classification, constructional features of Lathe, Shaping Machine, Planing Machine. Driving mechanisms of Lathe, Shaping and Planing machines. Different operations on Lathe, Shaping Machine & Planing Machine. Cutting tools. Simple problems on machining time calculations	7 hrs
Chapter No. 2. Milling Machines Classification, constructional features of milling machines. Types of milling cutters & milling cutter nomenclature. Milling processes, up milling and down milling concepts. Various milling operations. Indexing: Simple, compound, differential and angular indexing. Simple problems on simple and compound indexing	7 hrs
Chapter No. 3. Drilling & Grinding Machines Classification, constructional features of drilling machine & related operations. Types of drill & drill bit nomenclature, drill materials. Types of abrasives, Grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines (Center less, cylindrical and surface grinding). Selection of grinding wheel, dressing and truing of grinding wheels. Analysis of the grinding process	6 hrs
Unit - 2	
Chapter No. 4. CNC Machine Tools Introduction to CNC machines- Principles of operation. Axes of CNC machine-Coordinate systems. Elements of CNC machines, Basics of Manual part programming methods.	7 hrs
Chapter No. 5. Nontraditional Machining Need for nontraditional machining, principle, equipment & operation of Abrasive Jet Machining, Water Jet Machining, Electro-Chemical Machining, Electrical Discharge Machining, Wire EDM, Electron Beam Machining, Laser Beam Machining & Plasma Arc Machining	7 hrs
Chapter No. 6. Metrology and Inspection:	6 hrs

Definition, need of inspection, terminologies, methods of measurement. Standards of measurement-line standards, end standards & wavelength standards. Limits, fits & gauges-introduction, tolerances, limits of size, fit and tolerances, Limit gauges classification.	
Unit - 3	
Chapter No. 7. Comparators and Angular Measurement Devices Characteristics of comparators , classification of comparators- Mechanical, Electrical & Pneumatic comparators. Introduction to angular measurement - Vernier & optical Bevel Protractor ,sine bar, sine centre, angel gauges.	5 hrs
Chapter No. 8. Advanced Metrology: Introduction & applications of: Co-ordinate Measuring Machine-important features of CMM, possible causes of errors in CMM, Performance, applications & advantages of CMM. Universal Measuring Machine- comparison of CMM & UMM ,inspection on UMM. Precision instruments based on laser – principle- laser interferometer- application in linear, angular measurements	5 hrs

Laboratory Plan

Semester: III *Year:* **2017 - 2018**

Laboratory Title: **Programming laboratory**	Lab. Code: 16EARP203
Total Hours: **24**	Duration of SEE Hours: 3
SEE Marks: **20**	CIE Marks: **80**

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: structured query		**Total Weightage: 80**		**No. of lab sessions: 11**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	Experiment on –Structure and union		10	
	Learning Objectives: The students should be able to: 1.Demonstrate how to compile and run a c program in Eclipse IDE C/C++ 2. Write program using operators and control statements. 3. Write program using structures and union.			Analysis of algorithms & Design of Programs -Unit II
2	Experiment on-queues		10	
	Learning Objectives: The students should be able to: 1. Write program using different types of arrays and strings. 2. Develop a program using circular queue.			Analysis of algorithms & Design of Programs -Unit II
3	Experiment on –doubly linked list		12	

	Learning Objectives: The students should be able to: 1.Demonstrate how to maintain information of an university 2. Demonstrate how to specify different types of constraints on a given set of operations. 3. Develop a program in c using doubly linked list.			Analysis of algorithms & Design of Programs -Unit II
4	Experiment on- self balancing binary tree		12	
	Learning Objectives: The students should be able to: 1. Demonstrate how to search operation in executed. 2. Develop a program in c using self balancing binary tree.			Analysis of algorithms & Design of Programs -Unit II
5	Experiment on –circular doubly link list.		12	
	Learning Objectives: The students should be able to: 1.Demonstrate how it will store Prerequisite subjects 2.Develop the programs using circular doubly linked list			Analysis of algorithms & Design of Programs -Unit II
6	Experiment on-Dynamic programming		12	
	Learning Objectives: The students should be able to: 1. Demonstrate the graphical solution for the problem. 2. Analyze the efficiency of the algorithm. 3. Develop the program in c using dynamic programming technique.			Analysis of algorithms & Design of Programs -Unit III
7	Experiment on-Dynamic programming		12	
	Learning Objectives: The students should be able to: 1. Demonstrate the graphical solution for the problem. 2. Analyze the efficiency of the algorithm. 3. Develop the program in c using dynamic programming			Analysis of algorithms & Design of Programs -Unit III

	technique.			
Category: Open Ended		**Total Weightage: 20**		**No. of lab sessions: 3**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
11	Implement software using the knowledge of Analysis of algorithms & Design of Programs for building the applications in automation and robotics engineering. (FOR SEE)	2	20	
	Learning Objectives: The students should be able to: 1. Use Analysis of algorithms & Design of Programs concepts to implement the project. 2. Select the appropriate tool/software to implement the project. 3. Write a technical report using IEEE standard. 4. Present the technical report for the implemented project. 5. Demonstrate the learning experiences of working in a team.			Analysis of algorithms & Design of Programs Unit I, Unit II , UnitI III

Course Content

Course Code: 16EARC207	Course Title: Microcontrollers	
L-T-P-**SS**: **4-0-0-0**	Credits:4	Contact Hrs: 4
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 100

Unit I

No	Content	Hrs
1	**Chapter 1: Introduction to Microcontroller** Introduction To Microprocessor and Microcontroller: History and Evolution, types of microprocessors, Difference between Microprocessors and Microcontrollers. CPU architectures: RISC/CISC and Harvard/Von-Neumann, Overview of PIC Microcontroller family, Introduction to different microcontroller families (8051, ATMEL/AVR, and ARM).	**5 Hrs**
2	**Chapter 2: PIC and AVR Microcontroller Architecture and ALP** Architecture and pin functions, Registers and Instructions, Data formats and directives, Introduction to assembly language programming, Program counter and program ROM space. Branch, Call and Time delay loop: Branch instructions and looping, Call instruction and stack, Time delay instructions and pipeline. Timing diagrams.	**7 Hrs**
3	**Chapter 3: I/O Port programming** I/O port programming, I/O bit manipulation programming, Arithmetic, logic instructions and programs: Arithmetic instructions, Signed number concepts and arithmetic operations, logic and compare instructions, rotate instructions and data serialization, BCD and ASCII conversion.	**8 Hrs**

Unit II

No	Content	Hrs
4	**Chapter 4: PIC and AVR programming in C** Data types and time delays in C, I/O programming, logic operations, data serialization, program ROM allocation, Program ROM allocation inC18, State diagrams, Timing diagrams in-depth.	**5 Hrs**
5	**Chapter 5: Timer and Serial port programming** Programming TIMERS 0 and 1, counter programming, Programming TIMER0 and 1 in C, Basics of serial communications, PIC18 connection to RS232, PIC18 serial port programming in assembly and C	**8 Hrs**
6	**Chapter 6: Interrupt programming in Assembly and C** Polling Vs interrupts, PIC18 Interrupts, Programming timer interrupts, programming external hardware interrupts, programming the serial communication interrupt, PortB change interrupts. ADC, DAC and sensor interfacing: ADC characteristics, ADC programming in the PIC18, DAC interfacing, sensor interfacing and signal interfacing.	**7 Hrs**

Unit – III

No	Content	Hrs
7	**Chapter 7: Using Flash and EEPROM Memories for data storage** Semiconductor memory, Erasing and writing to flash in the PIC18F, Reading and writing to data EEPROM in the PIC18.	**5 Hrs**

8	**Chapter 8: Applications of Microcontroller**: Event counter, Linear variable Differential Transformer (LVDT), Angular speed measurement (RPM meter), Digital Thermometer, Digital PID controller.	**5 Hrs**

Course Plan

Semester: IV Year: 2017-18

Course Title: **Product Realization**	Course Code: 16EARP208
Total Contact Credits: **2(0-0-2)**	Duration of SEE Credits:
ISA Marks: 80	ESA Marks: 20

Week wise Plan:

Week #	Particulars	Venue
Week 1 and Week 2	➢ Introduction to Prototyping - Specifications, Part Drawings, Assembly Drawings, PCB Layout, Wireframe , Pseudocode, BOM, Process Plan, Fabrication and Test Plan Validation ➢ IOT Workshop	Studio Engagement
Week 3	➢ Identifying sub-assemblies ➢ Procurement of logistics for proof of concept testing. ➢ Selection of materials for all the parts and joining techniques ➢ Selection of UI and Core Component of Android	Makers Space/
Week 4	➢ Process plan ➢ Identifying the proper machines, tools and operations required for prototyping. ➢ Selection of appropriate raw materials for prototyping. ➢ Demonstrate breadboard prototype of entire electronics in the system. (To have tested electronic circuit for PCB design) ➢ UI implementation using XML	
Week 5	➢ Fabricate the parts for sub assembly ➢ Initiate schematic entry in PCB design software, also refine and optimize thesize of the board. ➢ UI implementation and validation	
Week 6	➢ Fabricate the parts for sub assembly ➢ Generate gerber files for the optimal PCB design. ➢ Android core component implementation and Unit Testing	
Week 7	➢ Fabricate the parts for sub assembly ➢ Fabricate PCB using MITS machine, solder components and test the design. ➢ Android core component implementation and Unit Testing	
Week 8	➢ Assemble the sub assemblies and check for interference and	

	functionality ➢ Revisit PCB testing for increasing reliability of the design. (test to avoid/eliminate lose connections, dry soldering, andbad electronic components) ➢ Android core components integration and testing	
Week 9	➢ Test the functional prototype using proper identified test methods. ➢ Demonstrate working of fully functional PCB. ➢ Configuration of IoT Server	
Week 10	➢ Integratesubsystems for prototype testing. ➢ Analyse the test results ➢ System modification ➢ System integration	
Week 11	➢ Final concluding review ➢ Product catalog ➢ System Tesing.	Studio/ Makers Space

Laboratory Plan

Laboratory Course Plan: B E in A&R

Semester IV Year:2018-2019

Laboratory Title: **Manufacturing & Metrology lab**	Lab. Code: 16EARP205
Total Hours: **24**	Duration of ESA Hours: 3
ISA Marks: **80**	ESA Marks: **20**

<u>Experiment wise Plan</u>

List of experiments/jobs planned to meet the requirements of the course.

<table>
<tr><td colspan="2">Category: Demonstration</td><td colspan="2">Total Weightage: 20</td><td>No. of lab sessions: 5</td></tr>
<tr><td>Expt./ Job No.</td><td>Experiment / Job Details</td><td>No. of Lab Session(s) per batch (estimate)</td><td>Marks / Experiment</td><td>Correlation of Experiment with the theory</td></tr>
<tr><td>1.</td><td>Material Removal Operations(Lathe)</td><td>4</td><td>15</td><td></td></tr>
<tr><td></td><td colspan="3">Learning Objectives:
The students should be able to:
Perform various operations like Facing, Turning, drilling, boring on a work piece using Lathe machine.
Perform operations like drilling of holes on a given work material using Drilling Machine.
Perform surface milling operation on a given slab of metal.
Demonstrate grinding operation on a given metal cube to achieve predefined dimensions.
Demonstrate arc welding process
Demonstrate sheet metal cutting operations- Shearing ,Bending operations, drilling & riveting process</td><td>Unit I, II & III</td></tr>
<tr><td>2.</td><td>Measurement</td><td>1</td><td>5</td><td></td></tr>
<tr><td></td><td colspan="3">Learning Objectives:
The students should be able to:

Extract the dimensions of the given part using (CMM)
Compare the dimensions of the given part between conventional machine & CMM</td><td>Unit III</td></tr>
<tr><td colspan="2">Category: Exercise</td><td colspan="2">Total Weightage: 50</td><td>No. of lab sessions: 7</td></tr>
</table>

Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
3	Measurement for Linear and angular dimensions	1	10	
	Learning Objectives: The students should be able to: Select proper instruments for measurement Calculate least count of instrument Take reading using the instrument, Collection / recording of data, Interpret the observation, results Measure dimensions of the given component using vernier caliper & micrometer Measure unknown angle of a component using Sine bar and slip gauges			Unit II & III
4	Sheet metal	3	20	
	Learning Objectives: The students should be able to: Demonstrate how to use tools and equipment safely Mark & cut the sheet metal as per the drawing Construct common sheet metal seams Construct a sheet metal product (outer casing).			
5	Fabricate the Parts for Table Clamping Device	3	20	
	Learning Objectives: The students should be able to: To machine a given raw metal sheet to actual dimensions. Perform drilling operations at suitable locations. Mark the work piece before going for manufacture. Taking measurements at every step of operations using vernier calipers. Perform welding operation on hinges to achieve perfect right angle. Fill machining time calculation chart. Performing threading on a circular bar to a given pitch. Fill operation chart and inspections reports			Unit I,II,III

FMTH0303-3.0

Laboratory Plan

Semester: V Year: **2018 - 19**

Laboratory Title: **OOP and Python Practice**	Lab Code: **16EARP305**
Total Hours: **22**	Duration of ESA: 2 hours
ISA Marks: **80**	ESA Marks: **20**

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Demonstration		Total Weightage: 20		No. of lab sessions: 2
Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
1	Write programs using the concept of OOP (C++/Java) Language Fundamentals and concept of command line arguments.	1	10	
	Learning Objectives: The students should be able to: 1. Demonstrate how to compile and run a program in command prompt. 2. Write programs using operators and control statements. 3. Write programs for accepting command line arguments and process them in program. 4. Demonstrate how to compile and run a Java program using different IDE's like eclipse, Net beans etc.			Object Oriented Programming - I
2	Write programs using the concept of arrays, Strings and String Buffer class and exception Handling.	1	10	
	Learning Objectives: The students should be able to:			Object Oriented

	1. Write programs using different types of arrays and strings. 2. Write a program to catch different types of exceptions. 3. Demonstrate how the String Buffer is used in a program.			Programming - I
Category: Exercise		Total Weightage: 20		No. of lab sessions: 2
3	Develop a swing based GUI using swing components and containers and connect it to database .	1	10	Object Oriented Programming -I
	Learning Objectives: The students should be able to: 1. Develop a GUI using swing components and containers. 2. Demonstrate how to insert, update and retrieve data from a database by using a simple swing based program. 3. Demonstrate the procedure of database connection.			
4	Write programs using the concept of Generic class, Inheritance, Interface and Package.	1	10	
	Learning Objectives: The students should be able to: 1. Write a program to create base class and derived class and demonstrate the inheritance concept using the same program. 2. Write a program to create interface and demonstrate how to use the interface for other programs also. 3. Use the built in packages to write programs for defined task. 4. Create the user packages and demonstrate how to use the user package in other programs or other classes. 5. Demonstrate how to create parameterized constructors and how to use different types of access specifies in a program.			Object Oriented Programming -I
Category: Exercise		Total Weightage: 30		No. of lab sessions: 3
Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
5	Write a program using the concepts of python	1	10	Python programming-II

	scripting elements python constructs, data structures.			
	Learning Objectives: The students should be able to: 1. Demonstrate how to compile and run a program in command prompt. 2. Write programs using operators and control statements. 3. Write programs for accepting command line arguments and process them in program. 4. Demonstrate how to compile and run a python program using different IDE's like anaconda ,ipython etc.			
6	Write programs using the concept of functions, modules, packages and regular expressions	1	10	Python programming-II
	Learning Objectives: The students should be able to: 1. Write programs using functions and modules. 2. Write a program to use packages and regular expressions			
7	Write a python program to use the language scripting elements and constructs, data structures, and repository of standard library, to develop real world applications.	1	10	Python programming-II
	Learning Objectives: The students should be able to: 1. Write a program using scripting elements and data structures. 2. Create the user packages and demonstrate how to use the user package in other programs or other classes. 3. Write a program to create interface and demonstrate how to use the interface for other programs also			
Category: Structured Enquiry		Total Weightage: 10		No. of lab sessions: 3

Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
8	Solving a Maze: Program a robot to solve a maze by finding the goal position in the maze starting from a starting position. You will need a data structure to keep track of positions found in the maze that are yet to be explored, starting with positions around the starting position. You will compare the maze solutions found using a Stack versus a Queue for storing unexplored positions.	2	10	
	Learning Objectives: The students should be able to: 1. Select fundamentals concepts of object oriented programming concepts/python, based on the problem scenario to implement programs.			Object Oriented Programming –I/ Python programming-II
Category: Open Ended		Total Weightage: 20		No. of lab sessions: 2
Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
9	Implement a project using C++/Java/python concepts, for automation and robotics applications. (FOR SEE)	2	20	
	Learning Objectives: The students should be able to: 1. Use the C++/Java/python concepts to implement the project. 2. Select the appropriate tool/software to implement the project.			Object Oriented Programming –I/ Python programming-II

	3. Write a technical report using IEEE standard. 4. Present the technical report for the implemented project. 5. Demonstrate the learning experiences of working in a team.	

Laboratory Plan

FMTH0303-3.0

Semester: V   *Year:* **2018-2019**

Laboratory Title: **DBMS Practice**	Laboratory Code 16EARP306
Total Contact Hours: **48**	Duration of ESA: 3 Hours
Total ISA Marks: **80**	Total ESA Marks: **20**

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Demonstration		**Total Weightage: 10**		**No. of lab sessions: 1**
Expt./ Job No.	Experiment / Job Details	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the practice**
1	Preparing an ER diagram for given database	1	10	Basic Knowledge of data base design
	Learning Objectives: The students should be able to Demonstrate how structure of a database can be expressed graphically by an ER diagram. Demonstrate how to represent attributes, relationships among entity sets, link attribute to entity sets and entity sets to relationships			
Category: Exercise		**Total Weightage: 10**		**No. of lab sessions: 1**
2	Execute basic SQL queries on a given database. (DDL, DML, DCL commands)	1	10	DDL, DML, DCL commands

	Learning Objectives: The students should be able to: 1. Demonstrate how to use DDL, DML and DCL commands on a database. 2. Demonstrate how to specify different types of constraints on a table while creating a table.			
Category: Structured Enquiry		**Total Weightage: 60**		**No. of lab sessions: 10**
Expt./ Job No.	Experiment / Job Details	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
3	Execute nested, correlated queries using exist, like, union, intersection and joins on a given database.	2	10	Nested queries
	Learning Objectives: The students should be able to: 1. Write SQL queries to retrieve the required data, using correlated queries, nested queries, joins, and using keywords exist, like, union and intersection. 2. Demonstrate how to join two tables using different types of joins and use keywords exist, like, union, and intersection to retrieve data.			
4	Execute SQL queries on - group by, having clauses and aggregate functions on a given database to retrieve the required data.	2	20	Nested queries using clauses- group by, having &aggregate functions.
	Learning Objectives: The students should be able to: 1. Write SQL queries using group by, having clauses and aggregate functions to retrieve the required data.			
5	Specifying views in SQL	2	10	Views of SQL
	Learning Objectives: The students should be able to			

	1. Write SQL queries to create & update Views			
6	Design a database for the given schema using normalization concept and execution of given queries on the database and execution of queries.	2	10	Normalization-1NF,2NF,3NF & BCNF
	Learning Objectives: The students should be able to: 1. Design the database for the given schema using normalization concepts and use the given RDBMS software and implement the database.			
7	Design a database for the given specifications & implement the database and write and execute the queries for the given statements.	2	10	Basic Knowledge of data base design, DDL, DML, DCL commands
	Learning Objectives: The students should be able to: 1. Draw the ER diagram for a given specifications. 2. Design a database based on the specifications given and create tables by specifying different types of constraints on database and write SQL queries for given statements and execute them. 3. Select the proper RDBMS software to implement the database.			
Category: Open Ended		**Total Weightage: 20**		**No. of lab sessions:**
Expt./ Job No.	Experiment / Job Details	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
8	Implement a project using Java/database management systems concepts, for automation and robotics applications.		20	

	(FOR ESA)			
	Learning Objectives: The students should be able to: 1. Use the java /database management concepts to implement the project. 2. Select the appropriate tool/software to implement the project. 3. Write a technical report using IEEE standard. 4. Present the technical report for the implemented project. 5. Demonstrate the learning experiences of working in a team.			

Course Content

Course Code: 16EARE301	Course Title: Power Electronics, Motors & Drives		
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100	
Teaching Hrs: 50		Exam Duration: 3 hrs	

Content	Hrs
Unit - 1	
CHAPTER NO. 1. INTRODUCTION TO PE AND ELECTRIC DRIVE SYSTEMS - Power Electronics, Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switches. Basic components of an Electric drive system: Mechanical loads, electric motors, power sources, converters and controllers.	7 hrs
CHAPTER NO. 2. POWER DIODES, BJT, MOSFET AND RECTIFIERS: Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Freewheeling Diodes with Switched RL Load. power BJT, structure of BJT, MOSFET and IGBT, characteristics of BJT, MOSFET and IGBT, comparison of power devices. Introduction, Single-Phase Full-Wave Rectifiers, Single-Phase Full-Wave Rectifier with RL Load, Single-Phase Full-Wave Rectifier with a Highly Inductive Load.	7 hrs
CHAPTER NO. 3. THYRISTORS AND COMMUTATION THEORY Introduction, Principle of Operation of SCR, Static Anode-Cathode Characteristics of SCR, two transistor model of SCR, Gate Characteristics of SCR, Firing circuits for SCRs, Turn-On Methods, Turn-Off Mechanism, Turn-Off. Natural and Forced Commutation – Class A and Class B types, Gate Trigger Circuit: Resistance Firing Circuit, Resistance capacitance firing circuit.	6 hrs
Unit - 2	
CHAPTER NO. 4. STATIC SWITCHES AND POWER SUPPLIES Single phase ac static switches, three phase ac static switches, three phase reversing switches, Solid state relays, Design of static switches, DC power supplies, DC Switched Mode DC power supplies, bidirectional power supplies, Switched Mode AC power supplies.	7 hrs
CHAPTER NO. 5. DC-DC CONVERTERS - Introduction, principle of step-down operation and its analysis with RL load, principle of step-up operation, Step-up converter with a resistive load, Performance parameters, Converter classification, Switching mode regulators: Buck regulator, Boost regulator, Buck-Boost Regulators.	7 hrs
CHAPTER NO. 6. POWER ELECTRONICS FOR MOTOR AND DRIVE APPLICATIONS DC and AC motor control, Single phase SCR drive, Three phase SCR drive, Reversible SCR drive, Speed control of DC motor, chopper-controlled DC drives, Microprocessor-Controlled DC drives, AC motor characteristics, speed control methods of induction motor, commutator less DC motor and Electronic commutation.	6 hrs
Unit - 3	

CHAPTER NO. 7. STEPPER MOTOR Principle of Stepper motor, Classification of Stepper motor, Principle of variable reluctant stepper motor, Principle of Permanent magnet stepper motor, Principle of hybrid stepper motor, driver for stepper motor, Applications of Stepper motor.	5 hrs
CHAPTER NO. 8. DRIVES FOR INDUSTRIAL APPLICATIONS Rolling mill drives, cement mill drives, electric traction drives, textile mill drives and machine tool drives.	5 hrs

Laboratory Plan FMTH0303-3.1

Semester:6 *Year*: 2018-19

Laboratory Title: **Hydraulics And Pneumatics Lab**	*Lab. Code*: **16EARP302**
Total Hours: 24	*Duration of Exam*: 2 Hours
Total Exam Marks: 20	*Total ISA. Marks*: 80

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Demonstration		**Total Weightage: 25.00**		**No. of lab sessions: 5.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	To study hydraulic pump, its characteristics and calculate the hydraulic power	1.00	4.00	
	Learning Objectives: The students should be able to: 1. Differentiate between types of pumps. 2. Plot and infer characteristic curve of the Pump.			Unit - I
2	**A.** To study concepts of Meter-in and Meter-out circuits using Single-rod cylinder and 4/2 DCV **B.**To study the application of different center configuration of 4/3 DCV. (Tandem and closed centre)	1.00	8.00	

	Learning Objectives: The students should be able to: 1. Identify hydraulic cylinders and various direction control valves. 2. Explain meter-in and meter-out circuits used to control the speed of a single acting cylinder using meter in/out throttle. 3. Demonstrate how a hydraulic cylinder is controlled by a 4/3 directional valve with different spool shapes (blocked and circulation position).			Unit II
3	In a machining station, a hydraulic rotary drive is to swivel a drum from the horizontal to the vertical position after a welding process. The movement is to be performed by a hydraulic motor. Despite varying loads, the motor speed must remain constant.	1.00	4.00	
	Learning Objectives: The students should be able to: 1. Discuss the operating features of a hydraulic motor. 2. Explain how a 4/3 directional valves can be used to implement clockwise and counter-clockwise running of the hydraulic motor.			Unit - II
4	On a machine tool the velocity of a feed cylinder is to be increased and thus the cycle time of the system shortened without changing the pump flow. The advance velocity (extending time of the hydraulic cylinder) is to be adjustable independently of the load.	1.00	4.00	
	Learning Objectives: The students should be able to:			Unit – I

	1. Understand and record the table of the travel times 2. Calculate the velocity of the piston.			
5	In a fixture, a tool is to be moved by means of a hydraulic cylinder into and out of the machining area. In the event of a hydraulic pump failure, the tool must be extended by means of stored energy.	1.00	5.00	
	Learning Objectives: The students should be able to: 1. Understand the working of hydraulic accumulator.			Unit - II
Category: Exercise		**Total Weightage: 24.00**		**No. of lab sessions: 4.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch**	**Marks / Experiment**	**Correlation of Experiment with the theory**
6	A. Study of indirect control of a double-acting cylinder with a pneumatically operated 5/2 directional control valve. B. To study position dependent control of a double acting cylinder using mechanical limit switches.	1.00	6.00	
	Learning Objectives: The students should be able to: 1. Demonstrate how a 5/2 DCV can be used control a double acting cylinder.			Unit - II

	2. Identify switches and push buttons and use them to build the circuits.			
7	A. Study of Speed Control of Single Acting Cylinder - Slow Speed Extension and Rapid Retraction. B. Stop control, double-acting cylinder with 5/3 directional control valve, tensile load	1.00	6.00	
	Learning Objectives: The students should be able to: 1. Explain how the speed of a single acting cylinder is controlled using a quick-exhaust valve. 2. Explain the use of a 5/3 directional control valve with closed mid-position for stopping a double-acting cylinder.			Unit - I
8	The sequential control with two hydraulic drives.	1.00	6.00	
	Learning Objectives: The students should be able to: 1. Explain how the sequencing occurs between multiple cylinders.			Unit I and II
9	Control of hydraulic circuit using logic gates, timers and counters.	1.00	6.00	
	Learning Objectives: The students should be able to: 1. Identify different logic gates 2. Demonstrate circuit using timers and counters.			Unit - III
Category: Structured Enquiry		**Total Weightage: 14.00**		**No. of lab sessions: 2.00**
Expt./	**Experiment / Job Details**	**No. of Lab**	**Marks / Experiment**	**Correlation**

Job No.		Session(s) per batch		of Experiment with the theory
10	Hydraulic feed drive with electrical control and proportional valve.	1.00	7.00	
	Learning Objectives: The students should be able to: 1. Explain how the double acting cylinder is controlled using proportional valve.			Unit - I
11	The sequential control with two pneumatic drives. The signal overlapping occurring during this exercise is constructively solved by use of rollers with idle return. Practice is obtained in developing sequential diagrams and pneumatic circuit diagrams.	1.00	7.00	
	Learning Objectives: The students should be able to: 1. Use double acting cylinders, appropriate DCVs, flow control valves and push buttons and construct the circuit diagram for sequential control of two pneumatic drives.			Unit - II
Category: Open Ended		**Total Weightage: 7.00**		**No. of lab sessions: 1.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch**	**Marks / Experiment**	**Correlation of Experiment with the theory**
12	A double-acting cylinder is used to press together glued components. Upon pressing	1.00	7.00	

<table>
<tr><td></td><td>a push-button, the clamping cylinder is to extend and trip the roller valve. Once the fully extended position of the cylinder has been reached and sufficient clamping force has been developed, the cylinder is to retract to the initial position. Develop a control circuit using a pressure sequence valve.</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Learning Objectives:
The students should be able to:
1. Construct a control circuit using a pressure sequence valve for a given application.</td><td>Unit - I, II and III</td></tr>
</table>

Course Content

Course Code: **16EARE403**	Course Title: **Machine learning and ROS**	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration : 3 hours

Content	Hours
UNIT – 1	
Chapter 1:Introduction to Robot operating system ROS concepts, creating ROS packages writing a minimal ROS publisher, compiling ROS nodes, running ROS nodes, examining running minimal publisher node, scheduling node timing, writing a minimal ROS subscriber compiling and running minimal subscriber, minimal subscriber and publisher node summary writing ROS nodes more ROS tools: catkin simple, ROSlaunch, simplifying cmakelists.txt with catkin simple automating starting multiple nodes viewing output in a ROS console recording and playing back data with ROSbag.	5 hrs
Chapter 2:Messages, Classes and Servers in ROS Defining custom messages, ROS services- service messages, ROS service nodes, manual interaction with ROS services, example ROS service client, running, example service and client, using C++ classes in ROS creating library modules in ROS, introduction to action servers and action clients- creating an action server package, defining custom action-server messages, designing an action client running the example code, introduction to parameter server.	5 hrs
Chapter 3: **Introduction to machine learning** Introduction Machine Learning ,Well posed learning problem, Types of learning, supervised learning ,unsupervised learning and reinforcement learning, Learning Associations, Designing of learning system, perspectives & issues in machine learning, Concept learning task, concept learning search, Find-S: Finding a maximally specific hypotheses, version spaces & candidate elimination algorithm, Remarks - version spaces & candidate elimination algorithm, inductive bias.	5 hrs
UNIT – 2	
Chapter 4: Computational learning theory and decision tree learning Motivation, Estimating hypotheses accuracy, Basics of sampling theory, general approach for deriving confidence intervals, comparing learning algorithm. Probably learning an approximately correct hypothesis, sample complexity for finite hypnosis	8 hrs

spaces, sample complexity for infinite hypothesis spaces, instance based learning-K nearest neighbor learning, locally weighted regression, Representation, decision tree algorithm, hypotheses space search in decision tree algorithm inductive bias in decision tree algorithm, issues in DTL, Bayesian decision theory classification.	
Chapter 5:Kernel methods and Graphical models Embedding's into feature spaces, the kernel trick, Multiple kernel learning, Kernel dimensionality reduction Canonical Cases for Conditional Independence, Example Graphical Models, Naive Bayes' Classifier, Hidden Markov Model, Linear Regression, d-Separation Belief Propagation, Linkage–Based clustering algorithms-means and other cost minimization clustering.	7 hrs
UNIT – 3	
Chapter 6:Reinforcement Learning The learning task,Q-learning,Nondeterministic rewards & actions, temporal difference learning, generalizing from examples, relationship to dynamic programming.	5 hrs
Chapter 7: Artificial neural network Biological motivation, neural network representations, and appropriate problems for neural network learning, perceptron's, multilayer networks and the back propagation, algorithm, an illustrative example: face recognition	5 hrs

Course Content

Course Code: 16EARE401	Course Title: Measurement Systems	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40 hours
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Duration of ESA: 3 Hrs

Content	Hrs
Unit – I	
Chapter No. 1. Introduction to Measurement Systems Need for study of Measurement Systems, Classification of Types of Measurement Applications, Computer-Aided Machines and Processes, Functional Elements of an Instrument , Active and Passive Transducers , Analog And Digital Modes of Operation , Null and Deflection Methods , Input-Output Configuration of Instruments and Measurement Systems, Static Characteristics and Static Calibration, Dynamic Characteristics.	5 hrs
Chapter No. 2. Sensors and Signal conditioning Sensor characterization, Relations between physical quantities, Sensor Classification, Specifications, Error reduction techniques, Loading errors, Signal conditioning processes, The operational amplifier, Filtering, Wheatstone bridge, Pulse modulation.	5 hrs
Chapter No. 3. Motion Measurement Fundamental Standards, Relative Displacement: Translation and Rotational, Relative Velocity: Translation and Rotational, Relative-Acceleration Measurements, Displacement Pickups, Velocity Pickups, Acceleration Pickups, Calibration and Vibration Pickups, Jerk Pickups.	5 hrs
Unit – II	
Chapter No. 4. Force, Torque, and Shaft Power Measurement Standards and Calibration, Basic Methods of Force Measurement, Characteristics of Elastic Force Transducers, Torque measurement on Rotating shaft, Shaft Power Measurement (Dynamometers), Vibrating Wire Force Transducers.	5 hrs
Chapter No. 5. Pressure & Sound Measurement Standards and Calibration, Basic Methods of Pressure Measurement, Deadweight Gages and Manometers, Elastic Transducers, Vibrating-Cylinder and Other Resonant Transducers, Dynamic Testing of Pressure-Measuring Systems, High-Pressure Measurement, Low-Pressure Measurement, Sound Measurement.	5 hrs
Chapter No. 6. Flow and Temperature Measurement Local Flow Velocity, Magnitude and Direction, Gross Volume Flow Rate, Standards and	

Calibration of Temperature Measurement, Thermal-Expansion methods, Thermoelectric Sensors, Electrical-Resistance Sensors, Junction Semiconductor Sensors, Digital Thermometers, Radiation Methods.	5 hrs
Unit – III	
Chapter No.7. Data Acquisition Systems Data conversion devices, Signal sampling and aliasing, Sampling theorem, Quantization, Encoding, Digital to analog conversion methods, Analog to digital conversion methods, Sample & Hold circuit, Flash ADC, Successive approximation ADC, Dual slope ADC, Sigma Delta ADC, Multiplexers.	5 hrs
Chapter No. 8. Transmission and Recording of Data Cable Transmission of Analog Voltage and Current Signals, Cable Transmission of Digital Data, Fiber-Optic Data Transmission, Analog Voltmeters and Potentiometers, Electrical Instruments, Digital Voltmeters and Multimeters, Signal Generation, Electromechanical XT and XY Recorders, Fiber Optic Sensors.	5 hrs

Course Content

Course Code: 17EARC203	Course Title: **Algorithm Analysis & Program Design**		
L-T-P : 4-0-0	Credits: 4	Contact Hrs: 50	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100	
Teaching Hrs: 50		Duration of ESA: 03 hours	
Content			**Hrs**
Unit - 1			
Chapter 1: GENERAL PROBLEM SOLVING CONCEPTS- Problem Solving in Everyday Life, Types of Problems, Problem Solving with Computers - Problem Definition, Solution Design & Refinement, Testing Strategy Development, Program Coding and Testing, Using the Problem Solving Method, , Break-Out Diagrams**,** Difficulties with Problem Solving. How the Computer Stores Data, Functions-function prototypes, Operators, Expressions and Equations.			5 hrs
Chapter 2: SOLUTION PLANNING- Software Development Cycle,SDLC models, Requirement Modeling framework, Computer Communication methods, Unified modeling language: UML Building Blocks, UML Diagrams-Class Diagram, object diagram, component diagram, UML Modeling Types, UML Basic Notations, UML-SysML ,Using the Tools, Testing the Solution, Coding the Solution, Case studies-Modeling the sequence diagram for the Plant operation, Modeling the control strategy action			7hrs
Chapter 3: PROGRAMMING CONCEPTS FOR DESIGN AND ANALYSIS OF ALGORITHMS- Algorithms and Procedure oriented concepts, Object oriented programming concepts, data types, control structures, class and class concepts ,oop principles-inheritance,polymorphism,abstraction, exception handling mechanisms Their Representations, Modifying Algorithms, Alternative Algorithms. Review of Asymptotic Notations, Mathematical Analysis of Non-Recursive and Recursive Algorithms, Brute Force Approaches: Introduction, Selection Sort and Bubble Sort, Sequential Search and Brute Force String Matching , Divide and Conquer: General Method, Defective Chess Board, Binary Search, Merge Sort, Quick Sort and its performance.			8 hrs
Unit - 2			
Chapter 4: ARRAYS, STACKS & QUEUES: Arrays, Dynamically Allocated Arrays, , Polynomials, Sparse Matrices, Representation of Multidimensional Arrays,			10 hrs

Structures and Unions, Stacks, Stacks Using Dynamic Arrays, Queues, Circular Queues, Evaluation of Expressions, Multiple Stacks and Queues, Single- and Double-Ended Priority Queues.	
Chapter 5: LINKED LISTS, TREES & GRAPHS: Singly Linked lists and Chains, Representing Chains in C, Linked Stacks and Queues, Polynomials, Additional List operations, Sparse Matrices, Doubly Linked Lists. Introduction, Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Heaps, Graph representation, Adjacency matrix, Adjancey list, Application of graphs.	10hrs
Unit - 3	
Chapter 6:DYNAMIC PROGRAMMING & GREEDY METHOD: Depth First Search and Breadth First Search, The General Method, Warshall's Algorithm, Floyd's Algorithm for the All-Pairs Shortest Paths Problem, Single-Source Shortest Paths, The Traveling Salesperson problem,Kruskal's algorithm, Huffman trees**.**	5 hrs
Chapter 7: LIMITATIONS OF ALGORITHMIC POWER AND COPING WITH THEM: Lower-Bound Arguments, Decision Trees, P, NP, and NP-Complete Problems, Challenges of Numerical Algorithms	5 hrs

Course Content

Course Code: 17EARC207	Course Title: Microcontrollers	
L-T-P-**SS**: **4-0-0-0**	Credits:4	Contact Hrs: 4
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 100

	Unit I	
No	**Content**	**Hrs**
1	**Chapter 1: Introduction to Microcontroller** Introduction To Microprocessor and Microcontroller: History and Evolution, types of microprocessors, Difference between Microprocessors and Microcontrollers. CPU architectures: RISC/CISC and Harvard/Von-Neumann, Overview of PIC Microcontroller family, Introduction to different microcontroller families (8051, ATMEL/AVR, and ARM).	**5 Hrs**
2	**Chapter 2: PIC Microcontroller Architecture and assembly language programming** Architecture and pin functions, Registers and Instructions, Data formats and directives, Introduction to assembly language programming, Program counter and program ROM space. Branch, Call and Time delay loop: Branch instructions and looping, Call instruction and stack, Time delay instructions and pipeline. Timing diagrams.	**7 Hrs**
3	**Chapter 3: I/O Port programming** I/O port programming, I/O bit manipulation programming, Arithmetic, logic instructions and programs: Arithmetic instructions, Signed number concepts and arithmetic operations, logic and compare instructions, rotate instructions and data serialization, BCD and ASCII conversion.	**8 Hrs**
	Unit II	
4	**Chapter 4: PIC and AVR programming in C** Data types and time delays in C, I/O programming, logic operations, data serialization, program ROM allocation, Program ROM allocation inC18, State diagrams, Timing diagrams in-depth.	**5 Hrs**
5	**Chapter 5: Timer and Serial port programming** Programming TIMERS 0 and 1, counter programming, Programming TIMER0 and 1 in C, Basics of serial communications, PIC18 connection to RS232, PIC18 serial port programming in assembly and C	**8 Hrs**
6	**Chapter 6: Interrupt programming in Assembly and C** Polling Vs interrupts, PIC18 Interrupts, Programming timer interrupts, programming external hardware interrupts, programming the serial communication interrupt, PortB change interrupts. ADC, DAC and sensor interfacing: ADC characteristics, ADC programming in the PIC18, DAC interfacing, sensor interfacing and signal interfacing.	**7 Hrs**

Unit – III		
7	**Chapter 7: High end processors** Introduction to 80386 and 80486, architecture and pin definitions of 80386 and 80486, EFLAG Register Of The 80486, 80486 Memory System, Real Address Mode, Features of 80386 and 80486.	**5 Hrs**
8	**Chapter 8: Introduction to MicroPython**: Design Philosophy, Exploring MicroPython, Object-Oriented Programming and Some Python Basics, Using MicroPython with a Pyboard, Bare-Metal Approach, programming to handle interrupts, ADC.	**5 Hrs**

Course Content

Course Code: **17EARC209**	Course Title: **Control Systems**	
L-T-P : 4-1-0	Credits: 5	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 Hrs

Content	Hrs
Unit - 1	
Chapter No. 1. Introduction to Control Systems and System Modeling in Frequency domain System Configurations (open-loop & closed loop systems), Analysis and Design Objectives, The Design Process. Mathematical modeling of physical Systems: Transfer function, Electrical networks, Mechanical systems, Transfer Functions for Systems with Gears, Electromechanical System Transfer Functions, Analogous systems, Block diagram representation and reduction, Signal flow graph representation and reduction using Mason's Gain formula.	8
Chapter No. 2. Time Response Introduction, Poles, Zeros, and System Response, Standard test signals, First-order system response to step, ramp and impulse inputs , Second-order system response to step input; Un-damped, Under damped, Critical damped and Over damped systems. Time response specifications of first and second order systems, Analysis and Design of Feedback Systems, Steady state errors and error constants.	8
Chapter No. 3. Introduction to PID controller design Types of Controllers, Mathematical modeling of PID, ON-OFF controller, Effect of Proportional, Derivative and Integral elements on system behavior, Design of controller for simple applications.	4
Unit - 2	
Chapter No. 4. Stability Analysis Concepts of stability, Necessary conditions for Stability, Routh-Hurwitz Criterion, Routh-Hurwitz Criterion: Special Cases.	5
Chapter No. 5: Root Locus Techniques Defining the Root locus, General rules for constructing root loci, Sketching the Root locus, Effect of gain adjustment, addition of pole and addition of zero on system response and system stability.	5
Chapter No. 6 : Frequency Domain Analysis Introduction, Correlation between time and frequency response, Stability analysis, Bode plot and Nyquist plot to obtain phase margin and gain margin of a given system. Introduction to lead, lag and lead-lag compensating networks.	10
Unit - 3	

Chapter No. 7 : Design Via Frequency Response Transient Response via Gain Adjustment, Lag Compensation, Lead Compensation, Lag-Lead Compensation, tuning of PID controllers.	**5**
Chapter No. 8: Design Via Root Locus and Introduction to State Space Design Via Root Locus: Improving Transient Response and Steady-State Error via Cascade Compensation, Feedback Compensation, Physical Realization of Compensation, State Space: Introduction, General State-Space Representation	**5**

Laboratory Plan

Laboratory Course Plan: B E in A&R

Semester IV Year:2018-19

Laboratory Title: **Microcontroller Lab**	Lab. Code: 17EARP207
Total Hours: 28	Duration of ESA Hours: 3
Total Exam Marks: **20**	Total ISA Marks: 80

<u>Experiment wise Plan</u>

List of experiments/jobs planned to meet the requirements of the course.

<table>
<tr><td></td><td colspan="5">Category: Demonstration Total Weightage:20 No. of lab sessions: 2</td></tr>
<tr><td>Expt./ Job No.</td><td>Experiment/job Details</td><td>No. of Lab. Session/s per batch (estimate)</td><td>Marks/Experiment</td><td>Marks obtained</td><td>Correlation of Experiment with the theory</td></tr>
<tr><td rowspan="2">1</td><td>Compare Architectures of different microcontrollers w.r.t to time response, frequency response, delay, process time etc.
Write a program to demonstrate the blinking of LED in PIC16F877A and Arduino board.</td><td>1</td><td>5</td><td></td><td>Chap1</td></tr>
<tr><td colspan="4">Learning Objectives :
The students should be able to:
Study the data sheets and make a comparative study of the Architectures, resources, tools and applications of different microcontroller
Compare and contrast different microcontrollers.
Connect microcontroller to LED and blink LED with proper delay.
Apply suitable method or logic to solve given problem.
Pre-lab:
Download the data sheets of PIC16F877a, ATMEGA328, 8051 microcontrollers from the following websites
http://www.atmel.com/images/Atmel-8271-8-bit-AVR-Microcontroller-ATmega48A-48PA-88A-88PA-168A-168PA-328-328P_datasheet_Complete.pdf
http://ww1.microchip.com/downloads/en/DeviceDoc/39582b.pdf
http://ww1.microchip.com/downloads/en/devicedoc/41159d.pdf
http://www.atmel.com/images/doc8161.pdf
http://www.farnell.com/datasheets/46220.pdf
http://www.nxp.com/documents/data_sheet/LPC2921_23_25.pdf

Draw the architectural layout of the following microcontrollers with pin out diagrams.</td><td></td></tr>
</table>

	PIC16F877a ATMEGA328 8051 Make a comparative study and fill up the table 1 given in lab manual. Download the application notes. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital output device. Study Proteus 8 Professional Study different ports and understand the basic LED program In lab: Must be able to explain difference between various types of Microcontrollers and its architectures. Setup the hardware platform and deploy the code on the hardware. If any errors debug the code until it works. Make a note of the number and types of errors. Simulate LED blink program on Proteus 8 Professional Post-lab: Analyze the cause for errors and make a note.				
2	Write a program to demonstrate a counting machine which count from 0000 to 9999 and display on 7 segment LED display using PIC16F877A and Arduino board.	1	5		Chap2
	Learning Objectives : The students should be able to: Use 7Segment LED for counting numbers. Use appropriate logic or method for counting. Pre-lab Study the application notes of Arduino and PIC16F877a Study advantages and disadvantages of Arduino and PIC16F877a microcontrollers Understand 7segment LED. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital input and output device Study different segments of LED In-lab Write program for both Arduino and PIC If any errors debug the code until it works. Make a note of the number and types of errors. Simulate in Proteus Setup the hardware platform and deploy the code on the hardware. Execute the code and note the output. Post-lab Record the results and experience you got in lab Analyze the cause for errors and make a note				
3.	Write a program to read the values from the temperature sensor (LM35) and display the temperature in degree Celsius on LCD display	1	5		Chap2,3

	using PIC16F877A and Arduino board.				
	Learning Objectives : The students should be able to: Connect LM35, LCD and microcontroller. Write function to read values from LM35 and display it on LCD. Pre-lab Study the application notes of Arduino and PIC for interfacing LM35 and LCD. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital input and output device. Study what is 16*2 LCD and how it works. Analyze the driver required for LCD. In-lab Write program for both Arduino and PIC Execute the code and note the output. If any errors debug the code until it works. Simulate LCD display in Proteus. Setup the hardware platform and deploy the code on the hardware. Make a note of the number and types of errors. Post-lab Analyze the cause for errors and make a note. List down different types of LCDs and sensors.				
4	In bank lockers there is requirement of password protection to open the locker. Develop an application Using a 4*3 keypad and LCD to secure the lockers by providing password protection.	1	5		Chap2,3
	Learning Objectives : The students should be able to: Connect Keypad, LCD with microcontroller. Write logic to read key press event from keypad. Pre-lab Study the application notes of Arduino and PIC for interfacing keypad and LCD. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital input and output device. List down different types of keypads Analyze the driver required for 4*3 keypad. In-lab Write programs for both Arduino and PIC Execute the code and note the output. If any errors debug the code until it works. Make a note of the number and types of errors. Simulate both in Proteus Setup the hardware platform and deploy the code on the hardware Post-lab				

	Record the results and experience in manual List down the different applications of Keypad in real world.(eg. In Security applications)				
	Category: Exercises	Total Weightage: 20		No. of lab sessions:4	
Expt./ Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment	Marks obtained	Correlation of Experiment with the theory
5	Write a program to measure the distance of an object using ultrasonic Sensors and display the distance in terms of centimeters and inches. Make the connections as per the schematic and develop the flowchart and the code to perform the required operation.	1	5		Chapter 4
	Learning Objectives : The students should be able to: Connect Ultrasonic Distance Sensor and microcontroller Logic to find distance in CM and Meters. Pre-lab Study the application notes of Arduino and PIC for interfacing Ultrasonic Sensors. Understand different types of sensors. List the advantages and disadvantages of different sensors. Prepare flowchart and develop the code to demonstrate the use of the microcontroller as a simple analog input sensor and convertor. In-lab Write programs for both arduino and PIC Execute the code and note the output. If any errors debug the code until it works. Make a note of the number and types of errors Setup the hardware platform and deploy the code on the hardware. Post-lab Record the results and experience in manual Try interfacing at least two other sensors and note down the readings. List real world applications of sensors.				
6	Write a program to control the speed and direction of DC, stepper and servo motors.	1	5		Chapter 4,5
	Learning Objectives : The students should be able to: Understand the connections from microcontroller to DC motor using drives. Discuss how motor driver helps in controlling the speed on a DC motor. Pre-lab: Study the application notes of Arduino and PIC for interfacing DC motor. Study the working principle of DC motor. Study in detail about different types of DC motors and list out them List advantages and disadvantages of DC motors				

	List the applications in the real world In lab: Write programs for both Arduino and PIC Simulate in Proteus Demonstrate the hardware for both Arduino and PIC. Post-lab Record the results and experience in manual Measure the speed of the DC motor w.r.t voltage.				
7	Design a development board using Atmega328 or PIC 18 using eagle/ Dip-trace	1	5		Chapter 4,5
	Learning Objectives : The students should be able to: Design circuit diagram of development board. Pre-lab: Get familiar with circuit design software like eagle or diptrace Sketch circuit diagram on paper. In lab: Design circuit. Simulate in Proteus Demonstrate the hardware for both Arduino and PIC. Post-lab Record the results and experience in manual Measure the speed of the stepper motor w.r.t step angle.				
8	Develop a printed circuit board (PCB) for your designed Atmega328 or PIC18 development board.	1	5		Chap 6
	Learning Objectives : The students should be able to: Develop a PCB and assemble the components. Pre-lab: Design of the PCB has to be ready. In lab: Develop the PCB and mount the components. Simulate in Proteus Demonstrate the hardware for both Arduino and PIC. Post-lab Record the results and experience in manual				
	Category: Structured Enquiry Total Weightage: 20 No. of lab sessions:4				
Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment	Marks obtained	Correlation of Experiment with the theory
9	Design a programmer for your PIC18 development board to burn the program using PICkit2 or any similar software's.	1	10		Chapter 6,7

	Learning Objectives : The students should be able to: Design circuit diagram of development board. Pre-lab: Get familiar with circuit design software like eagle or diptrace Sketch circuit diagram on paper. In lab: Design circuit. Simulate in Proteus Demonstrate the hardware for both Arduino and PIC. Post-lab Record the results and experience in manual Measure the speed of the stepper motor w.r.t step angle.				
10	Develop a printed circuit board (PCB) for your designed and validated programmer which can burn programs on the PIC16 or PIC18 ICs.	1	10		Chapter 6,7
	Learning Objectives : The students should be able to: Develop a PCB and assemble the components. Pre-lab: Design of the PCB has to be ready. In lab: Develop the PCB and mount the components. Simulate in Proteus Demonstrate the hardware for both Arduino and PIC. Post-lab Record the results and experience in manual				
	Category: Open Ended	Total Weightage: 20		No. of lab session:2	
Expt./ Job No.	Experiment/job Details	No. of Lab. Slots per batch (estimate)	Marks/Experiment	Marks obtained	Correlation of Experiment with the theory
11	Write a program on Pyboard microcontroller using python programming and image processing to detect the tennis ball.	2	20		Chapter 1 to 7
	Learning Objectives : The students should be able to: Identify the problem and solve. Apply the knowledge of electronics and programming to measurement Liquid flow rate.				

Course Content

Course Code: 17EARC304	Course Title: Measurement Systems	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40 hours
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Duration of ESA: 3 Hrs

Content	Hrs
Unit – I	
Chapter No. 1. Introduction to Measurement Systems Need for study of Measurement Systems, Classification of Types of Measurement Applications, Computer-Aided Machines and Processes, Functional Elements of an Instrument , Active and Passive Transducers , Analog And Digital Modes of Operation , Null and Deflection Methods , Input-Output Configuration of Instruments and Measurement Systems, Static Characteristics and Static Calibration, Dynamic Characteristics.	5 hrs
Chapter No. 2. Sensors and Signal conditioning Sensor characterization, Relations between physical quantities, Sensor Classification, Specifications, Error reduction techniques, Loading errors, Signal conditioning processes, The operational amplifier, Filtering, Wheatstone bridge, Pulse modulation.	5 hrs
Chapter No. 3. Motion Measurement Fundamental Standards, Relative Displacement: Translation and Rotational, Relative Velocity: Translation and Rotational, Relative-Acceleration Measurements, Displacement Pickups, Velocity Pickups, Acceleration Pickups, Calibration and Vibration Pickups, Jerk Pickups.	5 hrs
Unit – II	
Chapter No. 4. Force, Torque, and Shaft Power Measurement Standards and Calibration, Basic Methods of Force Measurement, Characteristics of Elastic Force Transducers, Torque measurement on Rotating shaft, Shaft Power Measurement (Dynamometers), Vibrating Wire Force Transducers.	5 hrs
Chapter No. 5. Pressure & Sound Measurement Standards and Calibration, Basic Methods of Pressure Measurement, Deadweight Gages and Manometers, Elastic Transducers, Vibrating-Cylinder and Other Resonant Transducers, Dynamic Testing of Pressure-Measuring Systems, High-Pressure Measurement, Low-Pressure Measurement, Sound Measurement.	5 hrs
Chapter No. 6. Flow and Temperature Measurement Local Flow Velocity, Magnitude and Direction, Gross Volume Flow Rate, Standards and Calibration	

of Temperature Measurement, Thermal-Expansion methods, Thermoelectric Sensors, Electrical-Resistance Sensors, Junction Semiconductor Sensors, Digital Thermometers, Radiation Methods.	5 hrs
Unit – III	
Chapter No.7. Data Acquisition Systems Data conversion devices, Signal sampling and aliasing, Sampling theorem, Quantization, Encoding, Digital to analog conversion methods, Analog to digital conversion methods, Sample & Hold circuit, Flash ADC, Successive approximation ADC, Dual slope ADC, Sigma Delta ADC, Multiplexers.	5 hrs
Chapter No. 8. Transmission and Recording of Data Cable Transmission of Analog Voltage and Current Signals, Cable Transmission of Digital Data, Fiber-Optic Data Transmission, Analog Voltmeters and Potentiometers, Electrical Instruments, Digital Voltmeters and Multimeters, Signal Generation, Electromechanical XT and XY Recorders, Fiber Optic Sensors.	5 hrs

Laboratory Plan

*Semester:*V *Year: 2019-20*

Laboratory Title: Mechatronics & Measurements Lab	*Lab. Code*: 17EARP303
Total Hours: 24	*Duration of Exam*: 3 hrs
Total Exam Marks: 20	*Total ISA. Marks*: 80

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Demonstration		**Total Weightage: 10.00**		**No. of lab sessions: 2.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	Demo of Quanser Mechatronics Sensor kit, DC Motor Control Trainer module, Inverted Pendulum Trainer module with NI ELVIS Platform	1.00	5.00	Unit-1, Unit II
2	Data Acquisition process using DAQ card from NI using LABVIEW with strain guage load cell	1.00	5.00	
Category: Exercise		**Total Weightage: 20.00**		**No. of lab sessions: 3.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
3	Sensor characterization using sensor modules, namely, Accelerometer, Ultrasonic sensor, Temperature sensor, Strain gauge	1.00	5.00	Unit I & Unit II
4	Sensor fusion of IMU and compass	1.00	5.00	
5	Development of a Data acquisition system , DAQ hardware as an embedded system	1.00	10.00	

Category: Structured Enquiry		Total Weightage: 45.00		No. of lab sessions: 5.00
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
6	System identification of DC motor	2.00	15.00	Unit – 1, Unit - 2 and Unit - 3
7	Hardware in Loop model for a stated problem using Speed goat / Controller/ Processor and MATLAB2018A	1.00	15.00	
8	Develop a plant model using Inverted pendulum in MATLAB and analyze its performance characteristics	2.00	15.00	
Category: Open Ended		**Total Weightage: 5.00**		**No. of lab sessions: 2.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
9	Design and develop a Haptic kit for physically challenged people	2.00	5.00	Unit – 1, Unit - 2 and Unit - 3

Course Content

Course Code: **17EARC305**	Course Title: **Machine learning and ROS**	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration : 3 hours

Content	Hours
UNIT – 1	
Chapter 1:Introduction to Robot operating system ROS concepts, creating ROS packages writing a minimal ROS publisher, compiling ROS nodes, running ROS nodes, examining running minimal publisher node, scheduling node timing, writing a minimal ROS subscriber compiling and running minimal subscriber, minimal subscriber and publisher node summary writing ROS nodes more ROS tools: catkin simple, ROSlaunch, simplifying cmakelists.txt with catkin simple automating starting multiple nodes viewing output in a ROS console recording and playing back data with ROSbag.	5 hrs
Chapter 2:Messages, Classes and Servers in ROS Defining custom messages, ROS services- service messages, ROS service nodes, manual interaction with ROS services, example ROS service client, running, example service and client, using C++ classes in ROS creating library modules in ROS, introduction to action servers and action clients- creating an action server package, defining custom action-server messages, designing an action client running the example code, introduction to parameter server.	5 hrs
Chapter 3: **Introduction to machine learning** Introduction Machine Learning ,Well posed learning problem, Types of learning, supervised learning ,unsupervised learning and reinforcement learning, Learning Associations, Designing of learning system, perspectives & issues in machine learning, Concept learning task, concept learning search, Find-S: Finding a maximally specific hypotheses, version spaces & candidate elimination algorithm, Remarks - version spaces & candidate elimination algorithm, inductive bias.	5 hrs
UNIT – 2	
Chapter 4: Computational learning theory and decision tree learning Motivation, Estimating hypotheses accuracy, Basics of sampling theory, general approach for deriving confidence intervals, comparing learning algorithm. Probably	8 hrs

learning an approximately correct hypothesis, sample complexity for finite hypnosis spaces, sample complexity for infinite hypothesis spaces, instance based learning-K nearest neighbor learning, locally weighted regression, Representation, decision tree algorithm, hypotheses space search in decision tree algorithm inductive bias in decision tree algorithm, issues in DTL, Bayesian decision theory classification.	
Chapter 5:Kernel methods and Graphical models Embedding's into feature spaces, the kernel trick, Multiple kernel learning, Kernel dimensionality reduction Canonical Cases for Conditional Independence, Example Graphical Models, Naive Bayes' Classifier, Hidden Markov Model, Linear Regression, d-Separation Belief Propagation, Linkage–Based clustering algorithms-means and other cost minimization clustering.	7 hrs
UNIT – 3	
Chapter 6:Reinforcement Learning The learning task,Q-learning,Nondeterministic rewards & actions, temporal difference learning, generalizing from examples, relationship to dynamic programming.	5 hrs
Chapter 7: Artificial neural network Biological motivation, neural network representations, and appropriate problems for neural network learning, perceptron's, multilayer networks and the back propagation, algorithm, an illustrative example: face recognition	5 hrs

Course Content

Course Code: 17EARC301	Course Title: Object Oriented Programming and Database Management Systems	
L-T-P: 4-0-0	Credits: 3	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 50
Teaching Hrs: 50		Exam Duration: 3 hrs

Content	**Hrs**
Unit - I	
Chapter 1 Introduction to Software Development Lifecycle and Unified Modeling Language: Software Development Lifecycle, SDLC Models, Requirement Modeling Framework, Computer Communication Methods Unified Modeling Language (UML): UML Building Blocks, UML Diagrams - Class Diagram, Object Diagram, Component Diagram, UML Modeling Types, UML Basic Notations, UML-SysML, Using the Tools, Testing the Solution, Coding the Solution, Case Studies - Modeling the Sequence Diagram for the Plant Operation, Modeling the Control Strategy Action	6
Chapter 2 Data Modeling using the ER Model: Using High-Level Conceptual Data Models for Database Design, An Example Database Application, Entity Types, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, Refining the ER Design, Relationship Types of Degree Higher than Two, ER Diagrams, Naming Conventions and Design Issues	6
Chapter 3 Introduction to Object-Oriented Programming - I: Introduction to .NET Environment, The Java Virtual Machine, Variables and Data Types, Conditional and Looping Constructs, Arrays, Fields and Methods, Constructors, Overloading Methods, Garbage Collection, Nested Classes, Simple Inheritance, Multilevel Inheritance, Overriding, Overloading, Defining Interfaces, Implementing Interfaces, Polymorphism, Abstract Classes, Access Control, Access Modifiers, Access Protection	8
Unit - II	
Chapter 4 Object-Oriented Programming - II: Final Classes, Final Variables and Methods, Finalizer Method: finalise (), Exception Handling, Fundamentals of Exception Handling, Exception Types, Constructors and Methods in Throwable Class, Java’s Built-in Exceptions, Unchecked and Checked Exception, Creating Your Own Exception Sub-Classes	4
Chapter 5 Object-Oriented Programming - III: Features of Python Variables, Operators and Branching, Core elements of Programs - Bindings, Strings, Input/Output, IDEs, Control Flow and Iteration, Functions - Decomposition and Abstraction, Functions and Scope, Keyword Arguments, Specifications, Lists, Tuples, Sets, Mutation, Aliasing, Cloning, Functions as Objects, Dictionaries, Example with a Dictionary, Fibonacci and Dictionaries, Global Variables, Classes and Inheritance: Object-Oriented Programming, Class Instances, Methods Classes, Examples, Hierarchies	10

Chapter 6 Introduction to Database Management Systems: Introduction to DBMS with an example, Characteristics of Database Approach, Actors on and Behind the Scene, Advantages and Disadvantages of using DBMS, Data models, Schemas and Instances, Three-Schema Architecture and Data Independence, Database Languages and Interfaces, Database System Environment	6
Unit - III	
Chapter 7 Relational Data Model and SQL: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions and Dealing with Constraint Violations, SQL Data Definition and Data Types, Specifying Basic Constraints in SQL, Schema Change Statements in SQL, Insert, Delete and Update Statements in SQL, Specifying Constraints as Assertion and Trigger, Indexing Techniques, Views in SQL, Basic Queries in SQL, More Complex SQL Queries, Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form	5
Chapter 8 Object-Relational Databases and Semantic Modeling Approach: Overview of Object Database Concepts, Object-Relational Features: Object Database Extensions to SQL, The ODMG Object Model and the Object Definition Language ODL, Object Database Conceptual Design, The Object Query Language OQL, Semantic Introduction to Databases, Semantic Modeling, Semantic Binary Schemas, Schema Quality Criteria, Subschemas and User views, Transaction Processing Concepts	5

Course Content

Course Code: 17EARC303	Course Title: Mechatronics System Design	
L-T-P : 4-0-0	Credits: 4	Contact Hrs: 50 hours
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50 hours		Exam Duration: 3 Hrs

Content	Hrs
Unit - I	
1. Introduction to Mechatronics Systems and elements Introduction to Mechatronic Systems and Design, Mechatronic systems in Precision mechanics, Micromechanics and Process Engineering , Confinement of Mechatronic Systems , Functions, Distribution of Mechanical and Electronic Functions, Integration Forms of Processes and Electronics , Ways of Information Processing , Multi-level Control Systems , Special Signal Preprocessing,Design Procedures for Mechatronics Systems, V model	8
2. Modeling of Processes Theoretical and Experimental Modeling , Classification of Process Elements , Process Elements with Lumped and Distributed Parameters , Mechanical System model ,Mechanical Elements : Bars ,Springs, Dampers , Mechanical Systems with Friction , Backlash , Electrical System model, Analogies between Mechanical and Electrical Systems, Dynamics of Mechanical Systems, Newton's Laws of Kinetics , Translational and RotationalMotion, Principles of Mechanics, d'Alembert's Principle , Lagrange's Equations, Problems.	12
Unit - II	
3.Electrical Drives Types of Electrical Drives,Electromagnets , Direct Current Motors , Dynamic Behavior , Static Behavior , Special Types of DC Motors , Alternating Current Motors (AC) , Induction Motors, Synchronous Motors , Single-phase Motors , Commutator Motors (Universal Motors) ,Squirrel-cage Motors , Power Electronics Circuits , Internally or Externally Commutated Electro-motors , Electrical Motor Sizing and Selection Procedure, Electric Motor Operational Conditions, Motion Profile, Load Torque Calculation, Motor Shaft Torque Calculation, Load Torque–Speed Profile , DC Motor Parameter Estimation, Process Dynamics Particularities, Electrical Binary Actuators.	10
4. Model based Design of Systems & Identification Introduction to model based design ,Basic block diagrams, Model-based Methods of Control,Supervision and Fault Diagnosis, Intelligent Systems,Non-linear Control and Fault Detection , Model-based Compensation of Non-linearities, Modeling and Fault Diagnosis , Examples for the Design of Mechatronic Systems using UML and SysML, Identification Methods , classification of Identification Methods ,Test Signals , Closed-loop Identification , Type of Application, Parameter Estimation for Discrete Time-varying Systems, Non-linear Processes, Problems.	10
Unit - III	
5. Recent trends in Mechatronics System Design process Mechatronics systems contributing to economic growth, Changes in technological processes and products, Tools and methods in mechatronics system design and development, Use of Artificial Neural Networks and Fuzzy-logic Models , Fields of application, Future Mechatronics systems.	5
6. Case studies Dynamic Models ofa Electromagnetic actuator, Control Prototyping and Hardware-in-the-loop	5

Simulation, Rapid Control Prototyping for Engine Control, Hardware-in-the-loop Simulation for Industrial Robot , Process control system, etc, UML/ SysML and State chart modeling for each example.	

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DEPARTMENT OF AUTOMATION & ROBOTICS

Laboratory Plan

FMTH0303-3.1

Semester: V *Year: 2019-20*

Laboratory Title: Object-Oriented Programming and Database Management Systems Lab	*Lab. Code*: 17EARP301
Total Hours: 24	*Duration of Exam*: 2 hrs
Total Exam Marks: 100	*Total ISA. Marks*: 80

Experiment-wise plan

1. ***List of experiments/jobs planned to meet the requirements of the course.***

Category: Demonstration Total Weightage: 35 No. of lab sessions: 7

Learning Outcomes:
The students should be able to:
Design and model using UML diagrams and ER models.
Demonstrate how to compile and run a program in JAVA, Python, and .NET environment.
Write programs using class, inheritance, and other fundamentals of OOP.
Write SQL statements concerning data manipulation using retrieving, inserting, updating, and deleting commands.
Write packages/procedure for manipulating data and triggers to enhance data retrieval.

Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/ Experiment	Correlation of Experiment with the theory
1	SysML - Getting used to tool, use case, creating class diagram, sequence diagram, and state diagram.	1	5	Introduction to Software Development Lifecycle and Unified Modeling Language
2	Creating ER models considering different relationship and attributes.	1	5	Data Modeling using the ER Model
3	Write programs in Java or .NET using the concept of OOP like arrays, strings, functions, overloading, and exception handling.	1	5	Introduction to Object-Oriented Programming - I
4	Write programs in JAVA or .NET using the concept of a generic class, inheritance, interface, and package.	1	5	Object-Oriented Programming - II
5	Write programs in PYTHON using the concept of generic classes, inheritance, interface, and package.	1	5	Object-Oriented Programming - III

6	Write SQL statements related to data manipulation, like insert, delete, and update.	1	5	Relational Data Model and SQL
7	Write statements to create views, procedures, packages, and indexing for fast retrieval.	1	5	Relational Data Model and SQL
Category: Exercises	Total Weightage: 20	No. of lab sessions: 2		
Learning Outcomes: The students should be able to: Design and model using UML diagrams. Implement classes in JAVA or .NET environment. Compile and build JAR/DLL files. Design and mode ER models for different scenarios. Construct a database schema with data manipulation SQL statement, a proper procedure in place, and create triggers for fast data retrieval.				
Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment	Correlation of Experiment with the theory
1	Develop a class diagram concerning sensor, actuators and controls, implement these classes, and build JAR/DLL files.	1	10	Introduction to Software Development Lifecycle and Unified Modeling Language Introduction to Object-Oriented Programming - I Object-Oriented Programming - II Object-Oriented Programming - III
	Develop an ER model and construct a database schema for a given manufacturing scenario.	1	10	Data Modeling using the ER Model Relational Data Model and SQL Relational Data Model and SQL
Category: Structured Enquiry	Total Weightage: 25	No. of lab sessions: 2		
Learning Outcomes: The students should be able to: Design, develop and implement application utilizing previously developed JAR/DLL files. Store data from the application into the database. Design, development and implement the user interface for visualization of data from the database.				

Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/ Experiment	Correlation of Experiment with the theory
	Implement a project which utilizes previously generated JAR/DLL files and database schema to store data from automation devices and control the actuators. Additionally, proper checks have to be implemented and with necessary visualization.	2	25	
Category: Open Ended	Total Weightage: 20	No. of lab sessions: 2		
Learning Outcomes: The students should be able to: Use the OOP concepts to implement the project. Use database concept to implement the project Select the appropriate tool/software to implement the project. Write a technical report using a predefined template. Present the technical report of the implemented project. Demonstrate the learning experiences of working in a team.				
Expt./Job No.	Experiment/job Details	No. of Lab. Slots per batch (estimate)	Marks/ Experiment	Correlation of Experiment with the theory
1.	Implement a project using C++/Java/python/DB concepts, for automation and robotics applications.	2	20	

Course Content

CourseCode:17EARE301	Course Title: **Artificial Intelligence for autonomous systems**	
L-T-P:3-0-0	Credits:3	ContactHrs:40
ISAMarks:50	ESAMarks:50	Total Marks: 100
TeachingHrs:40		ExamDuration:3hours

Content	Hours
UNIT–1	
Chapter1:**IntroductiontoArtificialintelligenceand autonomoussystems**Foundationofartificialintelligence,roboticsandtheAIapproach,Semi-autonomouscontrol,SevenareasofAI,TheConceptofRationalityTheNatureofEnvironments, TheStructure of Agents,Problem-SolvingAgents,Searching forSolutions, UninformedSearchStrategies,InformedSearchStrategies,KnowledgerepresentationinAI,knowledgebasedagents,propositionallogic,predicatecalculus,inferencerules	5hrs
Chapter2:Roboticsoftwarearchitectures Subsumptionarchitecture,Three-layerarchitecture, Pipelinearchitecture,HierarchicalParadigm-AttributesoftheHierarchicalParadigm,ReactiveParadigm-AttributesofReactiveParadigm,HybridDeliberative/ReactiveParadigm-AttributesofHybridParadigm,ArchitecturalAspects,ManagerialArchitectures-AutonomousRobotArchitecture(AuRA),SensorFusionEffects(SFX),State-HierarchyArchitectures,Model-OrientedArchitectures,InterleavingDeliberationandReactiveControl.	5hrs.
Chapter3:BiologicalFoundationsoftheReactiveParadigm Agencyandcomputationaltheory,AnimalBehaviors,Reflexivebehaviors ,CoordinationandControlofBehaviors,Innatereleasingmechanisms,Concurrentbehaviors,PerceptioninBehaviors,Action-perceptioncycle,TwofunctionsofperceptionGibson:Ecologicalapproach,Neisser:Twoperceptualsystems,SchemaTheory,Behaviorsandschematheory,PrinciplesandIssuesinTransferringInsightstoRobots	5hrs
UNIT–2	
Chapter4:Capturingintelligence-Designingareactiveimplementationwithcommonsensingtechniquesforroboticsperception Behaviors asObjects inOOP,Steps inDesigningaReactiveBehavioralSystem,CaseStudy:UnmannedGroundRoboticsCompetition,AssemblagesofBehaviors,Logicalsensors,BehavioralSensorFusion,DesigningaSensorSuite,ProprioceptiveSensors,ProximitySensors,ComputerVision,RangefromVision,CaseStudy:Horsd'Oeuvres,Anyone?	8hrs

Chapter5: Multi-agentsandnavigation inrobotics Heterogeneity,Control,Cooperation,EmergentSocialBehavior,TopologicalPathPlanning,Relational Methods,AssociativeMethods,CaseStudyofTopologicalNavigationwithaHybridArchitecture	7hrs

Course Content

Course Code: 17EARE304	Course Title: Digital System Design and FPGA programming	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Content	**Hrs**
Unit – 1	
Chapter No. 1. Review of Logic Design Fundamentals: Combinational logic, Boolean algebra and algebraic Simplification Karnaugh maps, designing with NAND and NOR gates, hazards in combinational circuits, flip-flops and latches, Mealy sequential circuit design, design of a Moore sequential circuit, equivalent states and reduction of state tables, sequential circuit timing, tristate logic and busses. Advanced Design Issues: Meta-stability, Noise Margins, Power, Fan-out, TimingConsiderations, Brief overview of programmable logic devices, simple programmable logic devices (SPLDs), complex programmable logic devices (CPLDs), field-programmable gate arrays (FPGAs),	9hrs
Chapter No. 2. Introduction to State Machine Charts and Microprogramming: State machine(SM) charts, derivation of SM charts, realization of SM charts, implementation of the dice game, microprogramming,: Design Examples	6hrs
Unit – 2	
Chapter No. 3. Designing with Field Programmable Gate Arrays: Implementing functions in FPGAs, implementing functions using Shannon's decomposition, carry chains in FPGAs, cascade chains in FPGAs, examples of logic blocks in commercial FPGAs, dedicated memory in FPGAs, dedicated multipliers in FPGAs, cost of programmability, FPGAs and One-Hot state assignment	7hrs
Chapter No. 4. Modeling and design with HDL Basic Concepts, Dataflow Descriptions, Behavioral Descriptions ,Structural Descriptions, Design examples,Timing and Delays, BCD to 7-Segment Display Decoder, BCD Adder, 32-Bit Adders, Traffic Light Controller, Shift-and-Add Multiplier, Array Multiplier. **Introduction to Verilog and VHDL**: Data Types, Modeling Concepts, Task and Functions, Specify Block and Timing Checks , Architecture study of popular FPGA families	8hrs
Unit – 3	
Chapter No. 5. Testing and Verification What is Verification, what is a Test bench, The Importance of Verification, Convergence Model, What Is Being Verified, Functional Verification Approaches, Testing Versus Verification, Design and Verification Reuse, Cost of Verification	5 hrs
Chapter No. 6 Case studies on FPGA technologies in Automation and Robotics applications Robotic Car from Georgia Institute of Technology Robotic Controller: ASIC versus FPGA	5 hrs

Expanding a robot's life: Low power object recognition via FPGA-based DCNN deployment FPGA-powered parallel, pipelined vision algorithms	

Course Content

Course Code: **17EARC308**	Course Title: **Hydraulics and Pneumatics**	
L-T-P : : 3-0-0	Credits: 3	Contact Hrs: 40 hours
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40 hours		Exam Duration: 3 Hrs

Content	Hrs
Unit - 1	
Chapter No. 1. Introduction to Hydraulic Power and Hydraulic Pumps Pascal's law, Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, Variable displacement pumps, pump performance, pump selection. Problems on determining the pump flow rate, pump efficiency and pump power.	5hrs
Chapter No. 2. Hydraulic Actuators: Cylinders and Motors Linear Hydraulic Actuators (cylinders), Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic Motor Performance. Problems on determining motor speed, torque, power ,motor efficiency and Mechanics of Hydraulic Cylinder loading.	5hrs
Chapter No. 3. Hydraulic Valves Hydraulic Valves: Directional Control Valves- classification of directional control valves, direction control valves actuating devices, Symbolic representation as per ISO 1219 and ISO 5599, pressure control valves, flow control valves- classification of flow control valves, proportional control valves, and servo valves.	5hrs
Unit - 2	
Chapter No. 4. Hydraulic Circuit Design and Analysis Control of single acting and double acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, Speed control of hydraulic cylinder: Meter-in circuit, Meter-out circuit and Bleed-off circuit, speed control of hydraulic motors. Ancillary Hydraulic Devices: Reservoirs, Accumulators, Pressure Intensifiers, Sealing Devices.	5hrs
Chapter No. 5. Pneumatic Systems Structure of Pneumatic control system, Choice of working medium, characteristics of compressed air, Pneumatic Actuators: Types of Linear Actuators or Pneumatic cylinders, Cylinder mountings, Cylinder seals, End cushioning in pneumatic cylinders. Pneumatic Control Valves: Direction control valve- types of direction control valves, ISO designation of direction control valves, Non return valves, methods of actuation of pneumatic directional control valves, Flow control valves, and Pressure control valves.	5hrs
Chapter No. 6. Pneumatic Circuit Design	5hrs

Direct and indirect control of single acting cylinder, control of single acting cylinder using “or” valve, control of single acting cylinder using “and” valve, control of single acting cylinder using “not” valve. Direct control of a double acting cylinder, Indirect control of double acting cylinder using memory valve, Supply air throttling and exhaust air throttling, Various methods of checking end position of a cylinder, Pressure dependent controls and Time dependent controls.	
Unit - 3	
Chapter No. 7. Hydraulic Control Systems Servo Control, Valve servo systems: Valve lap, mechanical feedback, systems response, electro hydraulic servo valves, system response and stability, Pump servo systems, Proportional valves: Force control, force position control, spool position control, proportional pressure control, two stage proportional valves, proportional flow control, electrical control of proportional valve, Proportional versus Servo valves, Applications of proportional control valves.	5 hrs
Chapter No. 8. Electro Pneumatics Basic electrical devices- Manually actuated push button switches, Limit switches, Pressure switches, Solenoids, Relays, Timers, Temperature switches, Direct and indirect control of single acting cylinders using electro pneumatics, Direct and indirect control of double acting cylinders using electro- pneumatics, Control of double acting cylinder OR logic (Parallel circuit), Control of double acting cylinder AND logic.	5 hrs

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DEPARTMENT OF AUTOMATION & ROBOTICS

Laboratory Plan

Laboratory Course Plan: B.E in A&R

Semester: VI Year: 2019-2020

Laboratory Title: Industrial Robotics Lab	Lab. Code: 17EARP306
Total Hours: 28	Duration of Exam: 3 hrs.
ISA Marks: 80	ESA. Marks: 20

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Exercise		Total Weightage: 70.00		No. of lab sessions: 8.00
Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
1	Matlab Introduction	1.00	10	
	Millions of engineers and scientists worldwide use MATLAB® to analyze and design the systems and products transforming our world. The matrix-based MATLAB language is the world's most natural way to express computational mathematics. Built-in graphics make it easy to visualize and gain insights from data. The desktop environment invites experimentation, exploration, and discovery. These MATLAB tools and capabilities are all rigorously tested and designed to work together. MATLAB helps you take your ideas beyond the desktop. You can run your analyses on larger data sets, and scale up to clusters and clouds. MATLAB code can be integrated with other languages, enabling you to deploy algorithms and applications within web, enterprise, and production systems. Topics: Basic commands Vectors and Matrices Importing Data Plotting Data Technically speaking, MATLAB is not a programming language but it is a tool with which you can find engineering solutions based on mathematics. Robotic developers need to learn MATLAB if they want to analyze data, produce advanced graphs or implement control systems.			UNIT – I

<table>
<tr><td></td><td colspan="3">MATLAB, and its open source relatives, such as Octave, is very popular with some robotic engineers for analyzing data and developing control systems.
Programming for a robot requires designing the controller that governs robot behavior. Modeling and simulation became vital to understand how the controller interacts with the robot’s environment perception, mobility, and interaction.
Why MATLAB is the Most Used Programming Language in Robotics?
• MATLAB is highly useful in designing the entire robotic system.
• It is widely used in the robotics industry as it is deeply rooted in the foundation and development of robots.
• It is a simulation tool whereby you can provide your algorithm or design and it simulates the result.
• On the other hand, simulation helps engineers to refine the system design and eliminate errors before developing hardware prototypes.</td><td></td></tr>
<tr><td>2</td><td>Robotics Toolbox</td><td>1.00</td><td>10</td><td></td></tr>
<tr><td></td><td colspan="3">The Toolbox has always provided many functions that are useful for the study and simulation of classical arm-type robotics, for example such things as kinematics, dynamics, and trajectory generation. The toolbox contains functions and classes to represent orientation and pose in 2D and 3D (SO (2), SE (2), SO (3), SE (3)) as matrices, quaternions, twists, triple angles, and matrix exponentials. The Toolbox also provides functions for manipulating and converting between data types such as vectors, homogeneous transformations and unit-quaternions which are necessary to represent 3-dimensional position and orientation.</td><td>UNIT – I</td></tr>
<tr><td>3</td><td>RoboAnalyzer</td><td>2.00</td><td>20</td><td></td></tr>
<tr><td></td><td colspan="3">Explaining the concepts in a course on Robotics typically requires a 3D model of a serial-robot/manipulator, either in the form of a physical robot or a virtual robot in software environment, for a better understanding. With the experience of handling Robotics courses and the feedback received so far, we have come up with a list of Virtual Experiments using RoboAnalyzer.
List of Virtual Experiments using RoboAnalyzer

<table><tr><th>Sl No.</th><th>Practical Assignments using RoboAnalyzer</th><th>Topics Covered</th></tr><tr><td>1</td><td>Introduction to RoboAnalyzer</td><td>Usage of RoboAnalyzer</td></tr><tr><td>2</td><td>Virtual Models of Industrial Robots</td><td>Industrial Robots</td></tr><tr><td>3</td><td>Understanding coordinate frames and</td><td>DH Parameters, Robot</td></tr></table></td><td>UNIT-I & II</td></tr>
</table>

	transformations	Geometry
4	Forward kinematics of robots	Robot Kinematic Analysis
5	Inverse kinematics of robots	Robot Kinematic Analysis
6	Case Study: Kinematics of MTAB Mini Robot	Robot Kinematic Analysis
7	Case Study: Workspace Analysis of a 6 axis robot	Workspace Analysis
8	Inverse and Forward dynamics of robots	Robot Dynamics
9	Creating robot joint trajectories	Trajectory Planning

4	Introduction to ABB Robotstudio	1.00	5.00	
	Offline programming is the best way to maximize return on investment for robot systems. ABB’s simulation and offline programming software, RobotStudio, allows robot programming to be done on a PC in the office without shutting down production. RobotStudio provides the tools to increase the profitability of your robot system by letting you perform tasks such as training, programming, and optimization without disturbing production. This provides numerous benefits including: Risk reduction Quicker start-up Shorter change-over Increased productivity RobotStudio is built on the ABB VirtualController, an exact copy of the real software that runs your robots in production. This allows very realistic simulations to be performed, using real robot programs and configuration files identical to those used on the shop floor.			UNIT-I & II
5	Simulation/Offline Programming (Robotstudio)	2.00	15.00	
	Topics to be covered: Create mechanism AutoPath Set Task Frame Collision control Reachability Create MultiMove System from Layout			UNIT-I & II

6	Online Programming	1.00	10	
	To perform a particular action, robots are programmed either by guiding or by off-line programming. Most of the industrial robots are programmed by guiding a robot from point to point through the phases of an operation, with each point stored in the robotic control system. Robots receive instructions through computer commands and this is referred to as manipulator level off-line programming. Usage of off-line programming involves higher-level languages, in which robotic actions are defined by tasks or objectives. Robotic programmers must have knowledge on different types of programming languages as switching from computers to robots is not the smooth transition that many developers/programmers may think.			UNIT-I & II
Category: Structured Enquiry		Total Weightage: 20.00		No. of lab sessions: 1.00
Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
7	Project Students should form a team of 4 in numbers and select a problem or need statement in industrial robotics area. The project should consists of following requirements: Minimum 3 to 6 DOF robot arm DH Parameters Students are free to choose the software to complete the project	1	20.00	UNIT-I & II

Laboratory Plan

FMTH0303-3.1

Semester: VII Year: 2020-21

Laboratory Title: Project	Lab Code: 18EARW401
Total Hours: 30	Duration of Exam: 3 Hrs
Total ESA Marks: 50	Total ISA. Marks: 50

Prerequisites:

Subjects learnt up to VI semester.

Course Outcomes-CO

At the end of the course student will be able to:

1. Carry out market survey, do need analysis and identify suitable problems.
2. Write a project proposal, which will involve developing a complete solution for the identified problem from the real world.
3. Apply the principles of engineering design to plan and manage the project.
4. Apply suitable design processes and develop the best possible solution.
5. Develop proof of concepts and models for verification.
6. Prepare production drawings, bill of materials and process plans.

Course Content

Course Code: **18EARC201**	Course Title: **Analog and Digital Electronic Circuits**	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Duration of ESA: 3 hrs

Content	Hrs
Unit - 1	
1.0 Introduction of PN junctions and analog electronics Diode theory, forward and reverse biased junctions, reverse- bias breakdown, load line analysis, diode applications – limiters, clippers, clampers, voltage multipliers, half wave and full wave rectification, voltage regulators, voltage dividers,pull up, pull down, optocoupler,special purpose diodes – Zener diode, varactor, light emitting diodes, photodiodes. Network theorems and applications: KVL, KCL, Node Method, Loop Method, Superposition, Thevenin's Theorem and Norton's Theorem.	7
2.0 Transistors Bipolar Junction Transistors and introduction to MOSFET: Operating point, Fixed bias circuits, Emitter stabilized biased circuits, Voltage divider biased, Bias stabilization, BJT transistor modeling, , Emitter follower, CB configuration, Collector feedback configuration, analysis of CE configuration using h- parameter model; Relationship between h-parameter model of CE,CC and CB configuration, Introduction to MOSFETs, MOSFET as a switch.	7
3.0 Operational Amplifiers Op-Amp Basics, practical Op-Amp circuits, differential and Common mode operation, Inverting &Non-Inverting Amplifier, differential and cascade amplifier, Op-Amp applications: Voltage follower, Comparator, summing, integrator, differentiator, instrumentation amplifiers, Schmitt trigger, Op-amp based oscillators.	6
Unit - 2	
4.0 Number system and digital logic gates Decimal, binary, octal, hexadecimal number system and conversion, binary weighted codes, signed numbers, 1s and 2s complement codes, Binary arithmetic. Logical Operators, Logic Gates-Basic Gates, Other gates, Active high and Active low concepts, Universal Gates and realization of other gates using universal gates, Gate Performance Characteristics and Parameters.	6
5.0 Boolean algebra and combinational logic circuits Binary logic functions, Boolean laws, truth tables, half adder, full adder, subtractor, associative and distributive properties, DE Morgan's theorems, realization of switching functions using logic gates. Switching equations, canonical logic forms, sum of product & product of sums, Karnaugh maps, two, three and four variable Karnaugh maps, simplification of expressions.	7
6.0 Design of combinational logic circuits and sequential logic	7

Introduction to combinational circuits, code conversions, decoder, encoder, priority encoder, multiplexers as function generators, binary adder, subtractor, BCD adder, Binary comparator, arithmetic logic units. Sequential circuits, flip-flops, clocked and edge triggered flipflops, timing specifications, asynchronous and synchronous counters, counter design with state equations, Registers, serial in serial out shift registers, tristate register, timing considerations.	
Unit - 3	
7.0 Data conversions Introduction to data conversions, R/2^nR DAC, R/2R, Flash, Digital ramp ADC, Successive approximation ADC, Slope (integrating) ADC, Delta-Sigma (ΔΣ) ADC, Practical considerations of ADC circuits.	5
8.0 Digital integrated circuits Logic levels, propagation delay time, power dissipation fan-out and fan-in, noise margin, logic families and their characteristics TTL, LSTTL CMOS and ECL integrated circuits and their performance comparison, open collector and tristate gates and buffers.	4

Course Content

Course Code: 18EARC203	Course Title:**Data structures ,Algorithm design and analysis**	
L-T-P : 4-1-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 03 hours

Content	**Hrs**
Unit - 1	
Chapter 1: GENERAL PROBLEM SOLVING CONCEPTS- Problem Solving in Everyday Life, Types of Problems, Problem Solving with Computers - Problem Definition, Solution Design & Refinement, Testing Strategy Development, Program Coding and Testing, Using the Problem Solving Method, Break-Out Diagrams**,** Difficulties with Problem Solving. How the Computer Stores Data, Functions-function prototypes, Operators, Expressions and Equations.	6hrs
Chapter 2: DESIGN AND ANALYSIS OF ALGORITHMS-Algorithms and Their Representations, Modifying Algorithms, Review of Asymptotic Notations, Mathematical Analysis of Non-Recursive and Recursive Algorithms, Brute Force Approaches: Introduction, Selection Sort and Bubble Sort, Sequential Search and Brute Force String Matching , Divide and Conquer: General Method, Defective Chess Board, Binary Search, Merge Sort, Quick Sort and its performance.	7 hrs
Chapter 3: ARRAYS, STACKS & QUEUES: Arrays, Dynamically Allocated Arrays, , Polynomials, Sparse Matrices, Representation of Multidimensional Arrays, Structures and Unions, Stacks, Stacks Using Dynamic Arrays, Queues, Circular Queues, Evaluation of Expressions, Queues, Single- and Double-Ended Priority Queues.	7 hrs
Unit - 2	
Chapter 4: LINKED LISTS, TREES &GRAPHS: Singly Linked lists and Chains, Representing Chains in C, Linked Stacks and Queues, Polynomials, Additional List operations, Sparse Matrices, Doubly Linked Lists. Introduction, Binary Trees, Binary Tree Traversals, Graph representation, Adjacency matrix, Adjancey list, Application of graphs.	8 hrs
Chapter 5:DYNAMIC PROGRAMMING & GREEDY METHOD: Depth First Search and Breadth First Search, The General Method, Warshall's Algorithm, Floyd's Algorithm for the All-Pairs Shortest Paths Problem, Single-Source Shortest Paths, The	7 hrs

Traveling Salesperson problem, Kruskal's algorithm, Huffman trees.	
Unit - 3	
Chapter 6: INTRODUCTION TO C++: Overview of C++, Sample C++ program, Different data types, operators, expressions, and statements, arrays and strings, pointers & user defined types. Class Specification, Class Objects, Scope resolution operator, Access members, Defining member functions, Data hiding, Constructors, Destructors, Parameterized constructors,	8hrs
Chapter 7:BASIC OOP CONCEPTS: Base Class, Inheritance and protected members, Protected base class inheritance, Inheriting multiple base classes, Virtual function, Calling a Virtual function through a base class reference, Virtual attribute is inherited, and Virtual functions are hierarchical, Pure virtual functions, Abstract classes, Using virtual functions.	7hrs

Course Content

Course Code: 18EARC209	Course Title: Object Oriented Programming and Database Management Systems	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 2 hrs

Content	Hrs
UNIT I	
Chapter 1. Introduction to Software Development Lifecycle Software Development Lifecycle, SDLC Models, Agile Software Development, Requirement Engineering, System Modelling, Architecture Design, Design and Implementation, Software Testing, Software Evolution	4
Chapter 2. Introduction to Object-Oriented Programming - I Structure vs. Class, Components of a Class, Encapsulation, Access Specifiers, Member Functions, Instance of a Class, Default Constructors, Destructors, Accessing Data Fields, Constructors with Parameters, Static Class Members - Data Members and Member Functions, Scope Resolution Operator, Nested Classes, Local Classes, Passing Objects to Functions, Return Objects, Object Assignment, Friend Function, Operator Overloading, Function Overloading, Copy Constructors	7
Chapter 3. UML Diagram UML Walkthrough, Class Diagram, Use Case Diagram, State Chart Diagram, Activity Diagram, Sequence Diagram	4
UNIT II	
Chapter 4. Introduction to Object-Oriented Programming – II Inheritance, Derived Class, Calling the Base Class Constructor, Overriding Member Functions, Polymorphism, Class Inheritance Hierarchies, Revisiting Class Diagrams, Abstract Classes, Run-Time Information, Early vs. Late Binding, Virtual Base Classes, Multiple Inheritance, Interfaces	7
Chapter 5. Entity Relationship (ER) Model High-Level Conceptual Data Models for Database Design, Entity Types, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, Relationship Types of Degree Higher than Two, ER Notations, Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, First Normal Form (1NF), Second Normal Form (2NF) and Third Normal Form (3NF), Boyce-Codd Normal Form (BCNF)	8
UNIT III	
Chapter 6. Database Management System Introduction, Characteristics of Database Approach, Actors on the Scene, Workers Behind the	5

Scene, Advantages and Disadvantages of using DBMS Approach, Data models, Schemas and Instances, Three-Schema Architecture and Data Independence, Database Languages and Interfaces, Database System Environment	
Chapter 7. Cloud Computing Introduction to Cloud Computing, Virtualization Concepts, Main Players, Types of Cloud – Public, Private and Hybrid, Cloud Services – CaaS, SaaS, PaaS, and IaaS, Service Level Agreement, Cloud Security, Cloud Computing at Enterprise Systems Level, Hybrid Cloud Options	5

KLE Technological University
Creating Value
Leveraging Knowledge

DEPARTMENT OF AUTOMATION & ROBOTICS

Laboratory Plan **FMTH0303-3.1**

Semester: IV *Year: 2019-20*

Laboratory Title: Object-Oriented Programming and Database Management Systems Lab	*Lab. Code*: 18EARP209
Total Hours: 52	*Duration of Exam*: 2 hrs
Total Exam Marks: 100	*Total ISA. Marks*: 80

Experiment-wise plan

2. **List of experiments/jobs planned to meet the requirements of the course.**

Category: Demonstration	Total Weightage: 10	No. of lab sessions: 9		
Learning Outcomes: The students should be able to: Demonstrate how to compile, debug and run a program in.NET environment. Write programs using class, inheritance, and other fundamentals of OOP. Design and model using UML diagrams.				
Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/ Experiment	Correlation of Experiment with the theory
1	Visual Studio IDE, Hello World Project, Project Properties, Programming, Compiling, Debugging, Input, Output and Formatted Output, Number Types, String, Arrays, Variable Definition, Assignments, Constants, Namespace	1	1	
2	*if* Statement, *switch* Statement, Nested *if* and *switch* Statements, ? Alternative, *while* Loop, *for* Loop, *do* Loop, Nested Loops, Predefined Functions, Functions, Return Values, Arguments, Parameters, Debugging, Default Function Arguments, Procedures, Friend Function, Inline Function, Variable Scope, Global Variable, Program Styles	1	1	
3	Pointers, Pointer Variables, Pointer Operators, Pointer Expressions, Array of Pointers, Pointers to Functions, Structures, Structure Members, Structure Assignments, Passing Structures to Functions, Structure Pointers	1	1	
4	Structure vs. Class, Components of a Class, Encapsulation, Access Specifiers, Member Functions, Instance of a Class, Default Constructors, Destructors, Accessing Data Fields	1	1	Introduction to Object-Oriented Programming - I
5	Passing Objects to Functions, Return Objects, Object Assignment, Friend Function	1	1	Introduction to Object-Oriented Programming - I

6	UML Class Diagram, Use Case Diagram, State Chart Diagram, Activity Diagram, Sequence Diagram	1	1	UML Diagram
7	Abstract Classes, Multiple Inheritance, Interfaces	1	1	Introduction to Object-Oriented Programming - II
8	File Handling, MVC, User Interface	1	2	
9	Connecting Database through C++ Programs	1	1	

Category: Exercise Total Weightage: 30 No. of lab sessions: 10

Learning Outcomes:
The students should be able to:
Design and model using ER models.
Write programs using class, inheritance, and other fundamentals of OOP.
Write SQL statements concerning data manipulation using retrieving, inserting, updating, and deleting commands.
Write packages/procedure for manipulating data and triggers to enhance data retrieval.
Design and model ER models for different scenarios.
Construct a database schema with data manipulation SQL statement, a proper procedure in place, and create triggers for fast data retrieval.

Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/ Experiment	Correlation of Experiment with the theory
01	Exception Handling, Lists, Queues, Stack	1	3	
02	Constructors with Parameters, Static Class Members - Data Members and Member Functions, Scope Resolution Operator, Nested Classes, Local Classes	1	3	Introduction to Object-Oriented Programming - I
03	Function Overloading, Operator Overloading, Copy Constructors	1	3	Introduction to Object-Oriented Programming - I
04	Inheritance, Derived Class, Calling the Base Class Constructor	1	3	Introduction to Object-Oriented Programming - II
05	Overriding Member Functions, Polymorphism	1	3	Introduction to Object-Oriented Programming - II
06	Class Inheritance Hierarchies	1	3	Introduction to Object-Oriented Programming - II
07	ER Diagram	1	3	Entity Relationship (ER) Model
08	DDL (Data Definition Language), like CREATE, DROP, ALTER, TRUNCATE and RENAME commands, DML (Data Manipulation Language), like SELECT, INSERT, UPDATE and DELETE commands	1	3	Database Management System

09	DML (Data Manipulation Language), like SELECT, INSERT, UPDATE and DELETE commands, and TCL (Transaction Control Language), like COMMIT and ROLLBACK commands	1	3	Database Management System
10	Database Performance, Indexing, Views, Procedure	1	3	Database Management System

Category: Structured Enquiry Total Weightage: 20 No. of lab sessions: 2

Learning Outcomes:
The students should be able to:
Design, develop and implement application utilizing previously developed JAR/DLL files.
Store data from the application into the database.
Design, development and implement the user interface for visualization of data from the database.

Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/ Experiment	Correlation of Experiment with the theory
1	Implement an application that utilizes previously learnt concepts to replicate an automation system using classes	2	10	
2	Implement a database schema that utilizes previously learnt concepts to capture the data to and from an automation system	2	10	

Category: Open Ended Total Weightage: 20 No. of lab sessions: 2

Learning Outcomes:
The students should be able to:
Use the OOP concepts to implement the project.
Use database concept to implement the project
Select the appropriate tool/software to implement the project.
Write a technical report using a predefined template.
Present the technical report of the implemented project.
Demonstrate the learning experiences of working in a team.

Expt./Job No.	Experiment/job Details	No. of Lab. Slots per batch (estimate)	Marks/ Experiment	Correlation of Experiment with the theory
1	Implement an open-ended project using C++/DB concepts for an automation application	2	20	

Course Content

Course Code: 18EARC208	Course Title: Microcontrollers Programming & Interfacing	
L-T-P-**SS**: **4-0-0-0**	Credits:4	Contact Hrs: 4
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 100

Unit I

No	Content	Hrs
1	**Chapter 1: Introduction to Microcontroller** Introduction To Microprocessor and Microcontroller: History and Evolution, types of microprocessors, Difference between Microprocessors and Microcontrollers. CPU architectures: RISC/CISC and Harvard/Von-Neumann, Overview of PIC Microcontroller family, Introduction to different microcontroller families (8051, ATMEL/AVR, and ARM).	**5 Hrs**
2	**Chapter 2: PIC Microcontroller Architecture and assembly language programming** Architecture and pin functions, Registers and Instructions, Data formats and directives, Introduction to assembly language programming, Program counter and program ROM space. Branch, Call and Time delay loop: Branch instructions and looping, Call instruction and stack, Time delay instructions and pipeline. Timing diagrams.	**7 Hrs**
3	**Chapter 3: I/O Port programming** I/O port programming, I/O bit manipulation programming, Arithmetic, logic instructions and programs: Arithmetic instructions, Signed number concepts and arithmetic operations, logic and compare instructions, rotate instructions and data serialization, BCD and ASCII conversion.	**8 Hrs**
	Unit II	
4	**Chapter 4: PIC and AVR programming in C** Data types and time delays in C, I/O programming, logic operations, data serialization, program ROM allocation, Program ROM allocation inC18, State diagrams, Timing diagrams in-depth.	**5 Hrs**
5	**Chapter 5: Timer and Serial port programming** Programming TIMERS 0 and 1, counter programming, Programming TIMER0 and 1 in C, Basics of serial communications, PIC18 connection to RS232, PIC18 serial port programming in assembly and C	**8 Hrs**
6	**Chapter 6: Interrupt programming in Assembly and C** Polling Vs interrupts, PIC18 Interrupts, Programming timer interrupts, programming external hardware interrupts, programming the serial communication interrupt, PortB change interrupts. ADC, DAC and sensor interfacing: ADC characteristics, ADC programming in the PIC18, DAC interfacing, sensor interfacing and signal interfacing.	**7 Hrs**

Unit – III		
7	**Chapter 7: Introduction to the STMicroelectronics Line of Microcontrollers** STM Nucleo Boards, STM32CubeMX Application: Pinout Tab, MCU Alternative Functions, Integrated Peripheral (IP) Tree Pane, Creating a Project using CubeMX, ARM Cortex Microcontroller Software Interface Standard, Memory-Mapped Peripherals, Core Memory Addresses, Peripheral Memory Addresses, HAL_GPIO Module	**5 Hrs**
8	**Chapter 8: Interrupts and Timers:** Interrupts, NVIC Specifications, Interrupt Process, External Interrupts, Interrupt Demonstration, STM Timer Peripherals STM Timer Configuration, Update Event Calculation, Polled or Non-interrupt Blink LED Timer Demonstration, Test Run: Interrupt-Driven Blink LED Timer Demonstration, Test Run: Multi-rate Interrupt-Driven Blink LED Timer Demonstration	**5 Hrs**

Course Content

Course Code: **18EARC207**	Course Title: **Control Systems**	
L-T-P : 4-0-0	Credits: 5	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 Hrs

Content	Hrs
Unit - 1	
Chapter No. 1. Introduction to Control Systems Introduction to Control Systems, Classification of Dynamic Systems, Closed Loop Control System with Feedback, Mathematical Preliminaries – Complex Variables, Laplace Transform.	**4**
Chapter No. 2. System Modeling in Frequency domain Standard Inputs, Free and Forced Response, Transfer Function, Poles and Zeros, Response to various Inputs, Effect of Poles, Notion of Bounded Input Bounded Output (BIBO) stability, Block diagram reduction and signal flow graphs	**8**
Chapter No. 3. Time Response Effect of Zeros, Closed Loop Transfer Function, Dynamic Performance Specification, First Order Systems, Second Order Systems, Unit Step Response of Underdamped Second Order Systems, Concepts of Rise Time, Peak Time, Maximum Peak Overshoot and Settling Time, Steady state errors and error constants	**8**
Unit - 2	
Chapter No. 4. Controllers Controllers – Proportional (P), Integral (I) and Derivative (D) Blocks, Examples of PID controller design, Problems	**4**
Chapter No. 5: Stability Analysis Routh's Stability Criterion, Use in Control Design, Incorporation of Performance Specifications in Controller Design, Analysis of Steady State Errors, Root Locus and its Application in Control Design.	**8**
Chapter No. 6 : Frequency Domain Analysis Stability analysis, Bode plot, Nyquist Stability Criterion, Relative Stability – Gain and Phase Margins.	**8**
Unit - 3	
Chapter No. 7 : Design Via Frequency Response Control System Design via Frequency Response – Lead, Lag and Lag-Lead Compensation	**5**
Chapter No. 8: Case Studies Plants for Pressure Control, Electromechanical Plants, Modeling and design of InvertedPendulum, Modeling and design of Aircraft.	**5**

Laboratory Plan

Laboratory Course Plan: B E in A&R

Semester: **4th Semester** Year:2019-2020

Laboratory Title: **Microcontroller Lab**	Lab. Code: 18EARP208
Total Hours: 28	Duration of SEE Hours: 2
SEE Marks: 20	CIE Marks: 80

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

	Category: Demonstration Total Weightage:20 No. of lab sessions: 2				
Expt./ Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment	Marks obtained	Correlation of Experiment with the theory
1	Compare Architectures of different microcontrollers w.r.t to time response, frequency response, delay, process time etc. Write a program to demonstrate the blinking of LED in PIC16F877A and Arduino board.	1	5		Chap1
	Learning Objectives : The students should be able to: Study the data sheets and make a comparative study of the Architectures, resources, tools and applications of different microcontroller Compare and contrast different microcontrollers. Connect microcontroller to LED and blink LED with proper delay. Apply suitable method or logic to solve given problem. Pre-lab: Download the data sheets of PIC16F877a, ATMEGA328, 8051 microcontrollers from the following websites http://www.atmel.com/images/Atmel-8271-8-bit-AVR-Microcontroller-ATmega48A-48PA-88A-88PA-168A-168PA-328-328P_datasheet_Complete.pdf http://ww1.microchip.com/downloads/en/DeviceDoc/39582b.pdf http://ww1.microchip.com/downloads/en/devicedoc/41159d.pdf http://www.atmel.com/images/doc8161.pdf http://www.farnell.com/datasheets/46220.pdf http://www.nxp.com/documents/data_sheet/LPC2921_23_25.pdf Draw the architectural layout of the following microcontrollers with pin out diagrams.				

	PIC16F877a ATMEGA328 8051 Make a comparative study and fill up the table 1 given in lab manual. Download the application notes. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital output device. Study Proteus 8 Professional Study different ports and understand the basic LED program In lab: Must be able to explain difference between various types of Microcontrollers and its architectures. Setup the hardware platform and deploy the code on the hardware. If any errors debug the code until it works. Make a note of the number and types of errors. Simulate LED blink program on Proteus 8 Professional Post-lab: Analyze the cause for errors and make a note.				
2	Write a program to demonstrate a counting machine which count from 0000 to 9999 and display on 7 segment LED display using PIC16F877A and Arduino board.	1	5		Chap2
	Learning Objectives : The students should be able to: Use 7Segment LED for counting numbers. Use appropriate logic or method for counting. Pre-lab Study the application notes of Arduino and PIC16F877a Study advantages and disadvantages of Arduino and PIC16F877a microcontrollers Understand 7segment LED. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital input and output device Study different segments of LED In-lab Write program for both Arduino and PIC If any errors debug the code until it works. Make a note of the number and types of errors. Simulate in Proteus Setup the hardware platform and deploy the code on the hardware. Execute the code and note the output. Post-lab Record the results and experience you got in lab Analyze the cause for errors and make a note				
3.	Write a program to read the values from the temperature sensor (LM35) and display the temperature in degree Celsius on LCD display	1	5		Chap2,3

	using PIC16F877A and Arduino board.				
	Learning Objectives : The students should be able to: Connect LM35, LCD and microcontroller. Write function to read values from LM35 and display it on LCD. Pre-lab Study the application notes of Arduino and PIC for interfacing LM35 and LCD. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital input and output device. Study what is 16*2 LCD and how it works. Analyze the driver required for LCD. In-lab Write program for both Arduino and PIC Execute the code and note the output. If any errors debug the code until it works. Simulate LCD display in Proteus. Setup the hardware platform and deploy the code on the hardware. Make a note of the number and types of errors. Post-lab Analyze the cause for errors and make a note. List down different types of LCDs and sensors.				
4	In bank lockers there is requirement of password protection to open the locker. Develop an application Using a 4*3 keypad and LCD to secure the lockers by providing password protection.	1	5		Chap2,3
	Learning Objectives : The students should be able to: Connect Keypad, LCD with microcontroller. Write logic to read key press event from keypad. Pre-lab Study the application notes of Arduino and PIC for interfacing keypad and LCD. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital input and output device. List down different types of keypads Analyze the driver required for 4*3 keypad. In-lab Write programs for both Arduino and PIC Execute the code and note the output. If any errors debug the code until it works. Make a note of the number and types of errors. Simulate both in Proteus Setup the hardware platform and deploy the code on the hardware Post-lab				

	Record the results and experience in manual List down the different applications of Keypad in real world.(eg. In Security applications)				
	Category: Exercises Total Weightage: 20 No. of lab sessions:4				
Expt./ Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment	Marks obtained	Correlation of Experiment with the theory
5	Write a program to measure the distance of an object using ultrasonic Sensors and display the distance in terms of centimeters and inches. Make the connections as per the schematic and develop the flowchart and the code to perform the required operation.	1	5		Chapter 4
	Learning Objectives : The students should be able to: Connect Ultrasonic Distance Sensor and microcontroller Logic to find distance in CM and Meters. Pre-lab Study the application notes of Arduino and PIC for interfacing Ultrasonic Sensors. Understand different types of sensors. List the advantages and disadvantages of different sensors. Prepare flowchart and develop the code to demonstrate the use of the microcontroller as a simple analog input sensor and convertor. In-lab Write programs for both arduino and PIC Execute the code and note the output. If any errors debug the code until it works. Make a note of the number and types of errors Setup the hardware platform and deploy the code on the hardware. Post-lab Record the results and experience in manual Try interfacing at least two other sensors and note down the readings. List real world applications of sensors.				
6	Write a program to control the speed and direction of DC, stepper and servo motors.	1	5		Chapter 4,5
	Learning Objectives : The students should be able to: Understand the connections from microcontroller to DC motor using drives. Discuss how motor driver helps in controlling the speed on a DC motor. Pre-lab: Study the application notes of Arduino and PIC for interfacing DC motor. Study the working principle of DC motor. Study in detail about different types of DC motors and list out them List advantages and disadvantages of DC motors				

	List the applications in the real world In lab: Write programs for both Arduino and PIC Simulate in Proteus Demonstrate the hardware for both Arduino and PIC. Post-lab Record the results and experience in manual Measure the speed of the DC motor w.r.t voltage.				
7	Design and develop an interconnected connection of controllers to communicate and transfer data between them. Use Bluetooth modulecontroller.	1	5		Chapter 4,5
	Learning Objectives : The students should be able to: Establish connection between different controllers and transfer the data. Pre-lab: Get familiar with Bluetooth module Sketch circuit diagram on paper. In lab: Design circuit. Simulate in Proteus Demonstrate the hardware for both Arduino and PIC. Post-lab Record the results and experience in manual Measure the speed of the stepper motor w.r.t step angle.				
8	Design and develop an IOT (Internet of Things) system to collect data from NPK or pH sensor and store the data in the cloud. Use Wi-Fi-module and controller.	1	5		Chap 6
	Learning Objectives : The students should be able to: Develop an IOT system that must be able to record and store the data on cloud. Pre-lab: Get familiar with IOT and Wi-Fi module. In lab: Wire-up the circuit and place the sensor in the farm field/garden and collect the data . Store the collected data on cloud for analysis. Demonstrate the hardware for STM MCU. Post-lab Record the results and experience in manual				
	Category: Structured Enquiry	Total Weightage: 20		No. of lab sessions:4	
Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment	Marks obtained	Correlation of Experiment with the theory
9	Write Timer and interrupt programs on STM MCU.	1	10		Chapter 6,7

	Learning Objectives : The students should be able to: Differentiate between polling and interrupt. Control the flow of program using timers. Pre-lab: Understand types of timers and interrupts Applications and working principles of timers and interrupts. In lab: i. Simulate the working of timers and interrupts ii. Demonstrate the hardware for STM. Post-lab Record the results and experience in manual Measure the speed of the stepper motor w.r.t step angle.				
10	Develop an applications using STM MCU to predict the data using the existing trained module.	1	10		Chapter 6,7
	Learning Objectives : The students should be able to: Demonstrate the knowledge of data analysis. Pre-lab: Understand different trained modules that can be used on STM MCU. In lab: Analyze and predict data for the selected trained module. Demonstrate the hardware for STM MCU. Post-lab Record the results and experience in manual				
	Category: Open Ended	Total Weightage: 20		No. of lab session:2	
Expt./ Job No.	Experiment/job Details	No. of Lab. Slots per batch (estimate)	Marks/Experiment	Marks obtained	Correlation of Experiment with the theory
11	Develop an IOT system using NPK and existing prediction module to suggest the crop to be grown in the field considering weather forecasting.	2	20		Chapter 1 to 7
	Learning Objectives : The students should be able to: Identify the problem and solve. Apply the knowledge of electronics, data science and programming.				

Program: Biotechnology		
Course Title: Biochemistry		Course Code: 15EBTC202
L-T-P: 4-0-0	Credits: 4.0	Contact Hours: 04 Hours/Week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 03 Hours	

Unit I

1. Biochemical Foundation & Carbohydrates

Types of chemical reactions, Solution chemistry. pH (Henderson-hesselbatch equation) Buffers and their Biological importance, carbohydrates- chemical structure and properties classification-Monosaccharide's, Disaccharides, Sugar derivatives, deoxy sugars, amino sugars, and sugar acids, phosphorylated sugars, structure and properties of polysaccharides, Homopolysaccharides, Heteropolysaccharides - Peptidoglycan, Glycosaminoglycans, Glycoconjugates, Glycobiology . Biological importance of carbohydrates. **07 Hours**

2. Lipids

Definition and classification of lipid – simple, compound and derived lipids. Structure, classification and properties of fatty acids, Essential and non-essential fatty acid with physiological importance. Structure and physiogical functions of phospholipids, Sphingolipids, cerebrosides and gangliosides. Steroids- Structure and functions of cholesterol,. Eicosanoids, lipoproteins and terpenes. Vitamins-classifications and functions **05 Hours**

3. Amino acids and Proteins

Definition, Classification and properties of amino acids, reactions, rare amino acids, essential and nonessential amino acids with physiological importance. Peptides - Definition of peptide bond, Biologically important peptides. Proteins – Classification- primary, secondary- Alpha helix, Beta sheets, tertiary and quaternary proteins-hemoglobin. Ramachandran plot, polypeptide sequencing- Edman degradation, Chemical synthesis of Peptides. **05Hours**

4. Nucleic acids

Structure and properties of purines, pyrimidines, nucleosides and nucleotides. Nucleic acids- Structure of DNA, RNA -Types, **03 Hours**

Unit II

5. Carbohydrate metabolism

Glycolysis-aerobic and in anaerobic pathway, Energy yield of glycolysis Regulation of glycolysis-metabolic and hormonal. Fates of pyruvate. Glycogen - synthesis and degradation. Regulation of glycogen metabolism. Gluconeogenesis, Pentose phosphate pathway. Significance of pentose phosphate pathway and regulation. Production of Acetyl-CoA, Reactions of Citric acid cycle, Anaplerotic reactions, regulation of citric acid cycle. Glyoxylate cycle, Electron transport chain, ATP synthesis, shuttle systems and Oxidative phosphorylation. Cyclic and Non-cyclic Photophosphorylation and Calvin Cycle (C3) in plants Disorders of carbohydrate metabolism. Production of microbial polysaccharides; industrial and Medical application of exopolysaccharides.

10 Hours

6. Metabolism of Amino acids

General reactions of amino acid metabolism, urea cycle, amino acid biosynthesis-aspartate and glutamate family and degradation of aromatic amino acid - phenylalanine and tyrosine, metabolic disorders of amino acid metabolism, biosynthesis of plant substances and neurotransmitters, Environmental and Industrial Significance of Amino acid metabolism.

05 Hours

7. Metabolism of Fatty acids

Fatty acid oxidation, biosynthesis of fatty acids, Ketone bodies, phospholipids and spingolipids cholesterol biosynthesis, Regulation, metabolic disorders of lipid metabolism. Environmental and Industrial Significance of lipid metabolism **05 Hours**

Unit III

8. Metabolism of Nucleic acids

Biosynthesis and degradation of purines and pyrimidines, salvage pathway, uric acid production, regulation, metabolic disorders of nucleic acid metabolism. **05 Hours**

9. Biological Membranes And Transport Mechanism

Composition and functions of biological membranes (fluid mosaic model) – Proteins, Carbohydrates, Glycoprotein and glycolipids, Membrane transport - Passive transport and Active transport. Mechanism of Na+ and K+, glucose and amino acid transport. Role of transport in signal transduction processes. **05 Hours**

Text Books

1. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, Sixth Edition, W.H. Freeman, 2012.
2. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. , Biochemistry, 7th revised International edition, Palgrave MacMillan, 2011.

Reference Books

1. Donald Voet and Judith G. Voet. , Biochemistry, 4th edition, Wiley; , 2010
2. Geoffrey L. Zubay, Principles of Biochemistry , Edition: 4th, William C Brown Pub, 1999.

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter numbers	Instructions
I	3 Questions to be set of 20 Marks Each	1, 2, 3,4	Solve Any 2 out of 3
II	3 Questions to be set of 20 Marks Each	5,6,7	Solve Any 2 out of 3
III	2 Questions to be set of 20 Marks Each	8,9	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Enzyme Technology		**Course Code: 17EBTC201**
L-T-P: 4-0-0	**Credits: 4.0**	**Contact Hours: 04 Hours/Week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 03 Hours**	

Unit I

1. Introduction to enzymes

History, nomenclature, classification of enzymes, sources of enzymes, properties of enzyme, Types of specificities, mechanism of enzyme action-Lock and Key model and Induced fit model, Enzyme catalysis -Acid base catalysis, covalent catalysis, metal ion catalysis, Proximity and orientation effects. Mechanism of coenzymes (NAD/NADP,FAD/$FADH_2$,PLP, Coenzyme A, TPP, Biotin) **07 Hours**

2. Purification of enzymes

Objectives and strategies in enzyme purification, choice of source-plant, animal and microbial, purification of intracellular and extracellular enzymes (Comprehensive flow sheet for enzyme purification),methods of homogenization, methods of separation-Enzyme fractionation by precipitation (using Temperature, salt, solvent, pH, etc.), liquid-liquid extraction, ionic exchange, gel chromatography, affinity chromatography and other special purification methods., Methods of characterization of enzymes; Analysis of yield, purity and activity of enzymes. Molecular weight determination-SDS-PAGE, MALDI-TOF **08 Hours**

3. Enzymatic techniques

Enzyme assay, Enzyme and isoenzyme measurement methods with examples(fixed incubation and kinetic methods) Methods for investigating the kinetics of Enzyme catalyzed reactions-Initial velocity studies, rapid-reaction techniques, Standardization and optimization methods, stability and activity of enzymes **05 Hours**

Unit II

4. Enzyme Kinetics and Enzyme Inhibitions.

Kinetics of single substrate reactions; Derivation of Michaelis -Menten equation, turnover number; K_{cat} value, determination of Km and Vmax, Line Weaver Burk plot, Eadie Hofstee plot, Hanes woolf plot, Importance of Km & Vmax; Enzyme inhibitions- reversible, competitive, uncompetitive and non-competitive inhibitions and kinetics, allosteric and irreversible inhibition. Substrate inhibitions, Multi-substrate reactions-ordered mechanisms, random mechanisms, Ping-pong mechanism. Allosteric enzymes and regulation - The Monad - Changeux - Wyman model (MCW) and The Koshland - Nemethy - Filmer (KNF) model, Feedback regulation and covalent regulation.

07 Hours

5. Enzymes Of Medical Importance

Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudocholinesterase, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes.Importance of enzymes in diagnostics, Enzyme pattern in diseases like Myocardial infarctions, (SGOT, SGPT & LDH). Isoenzymes (CK, LD, ALP). Enzymes in immunoassay techniques, Therapeutic enzymes. **07 Hours**

6. Enzyme Immobilization

Techniques of enzyme immobilization, adsorption - matrix entrapment- encapsulation- cross-linking - covalent binding - examples; whole cell immobilization and their application, kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, uses of immobilized enzymes, Design of Immobilized Enzyme Reactors- Stirred tank reactors(STR), Continuous Flow Stirred Tank Reactors (CSTR), Packed- bed reactors (PBR), Fluidized-bed Reactors (FBR); Membrane reactor **06 Hours**

Unit III

7. Industrial Applications of enzymes:

Enzymes used in detergents, use of proteases in food, leather and wool industries, uses of lactase in dairy industry, methods involved in production of glucose and maltose syrup from starch (using starch hydrolyzing enzymes),Glucose from cellulose, glucose oxidase and catalase in food industry, **05 Hours**

8. Enzyme transformation and Enzyme Biosensors

The design and construction of novel enzymes- Enzyme Engineering and site directed mutagenesis, Designer enzymes, synzymes, Biocatalysts from extreme Thermophilic and Hyperthermophilic microorganisms (extremozymes) Elements of biosensors, Design of enzyme electrodes and their applications as biosensors in industry, health care and environment.

05Hours

Text Books

1. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry. , 6, W.H. Freeman, 2012 2. Trevor Palmer, 2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, 1, East-West Press Pvt. Ltd, 2004
References 1. Laurence A. Moran, Raymond S. Ochs, J. David Rawn, and K. Gray Scrimgeour. , Principles of biochemistry., 3, Prentice Hall, 2002 2. Faber, Biotransformation in Organic Chemistry , 4, Springer, 2000 Aehle W, Enzymes in industry- production and applications, 3, Wiley-VCH, 2007 3. Nicholas .C. Price and Lewis Stevens, Fundamentals of Enzymology , 3, Oxford University Press , 1991

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter numbers	Instructions
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III	2 Questions to be set of 20 Marks Each	7,8	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Bioprocess Plant Design and Economics		Course Code: 18EBTE301
L-T-P: 3-0-0	Credits: 3.0	Contact Hours: 03 Hours/Week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 03 Hours	

Unit I

1. Introduction to Process Design Development

Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design, and comparison of different processes, Equipment design and specialization, factors affecting the investment.

06Hours

2. General Design Considerations

Marketability of the product, availability of technology, Health and safety hazards, raw materials, human resources, loss prevention Environmental protection and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, structural design, storage, materials handling, materials and fabrication Selection, optimum design and design strategy. Waste disposal, physical treatment, chemical treatment and biological treatment, govt. regulations and other legal restrictions, community factors. Safety and hazard control measures.

10 Hours

Unit II

3. Cost Analysis and Manufacturing Cost

Cost Analysis: Factors involved in project cost estimation. Cash flow diagrams for the industrial operation, Cumulative cash position, factors affecting the Investment and production cost, Different methods employed for the estimation of the capital investment. Estimation of equipment cost by sixth tenth rule, Cost index. Marshall and swift installed – equipment indexes, Engineers News-Record construction index, Nelson –Farrar refinery construction index. and Chemical Engineering plant cost index Manufacturing Costs: Direct Production costs, indirect cost and fixed charges (including depreciation, taxes, insurance, rental costs etc.)

10 Hours

4. Bioprocess Economics:

Economic analysis for the production of following Products.(Historical Perspective, Fermentation Technology, Recovery of product and process economics of following products)High volume, low value products. (Citric acid, Ethanol and Amino acids etc) Medium volume, medium value products.(Antibiotics, Crude Enzymes and Vitamins etc)

- Low volume, high value products. (MAb, purified Enzymes and Therapeutic proteins etc)

06 Hours

Unit III

5. Profitability Analysis and Optimization Technique

i) Importance of profitability analysis in investment decision making. Different Methods for calculating the profitability. Minimum Acceptable Rate of return. Methods that Do not consider Time value of money.

04 Hours

ii) General procedure to find the optimum conditions, factors affecting the optimization, comparison of analytical and graphical methods. Linear programming, Simultaneous Equations and dynamic programming

04 Hours

Text Books:

1. Peters and Timmerhaus, Plant Design and Economics for Chemical Engineers, McGraw Hill 5th edition, 2004.
2 Chemical Engineering plant design, Frank C Vilbrandt and Charles E Dryden , McGraw Hill 4th edition, 1959

Reference Books:

1. Rudd and Watson, Strategy of Process Engineering, Wiley, 1987.
2. Backhurst, J.R And Harker, J. H - Process Plant Design, Heieman Educational Books, (1973).
3. Biochemical Engineering Fundamentals, James E Baily David F Oillis. McGraw-Hill 2nd Internat Edition

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III	2 Questions to be set of 20 Marks Each	5	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Environmental Biotechnology		Course Code: 18EBTE404
L-T-P: 3-0-0	Credits: 3.0	Contact Hours: 03 Hours/Week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 03 Hours	

Unit I

1. Introduction

Issues and scope of Environmental Biotechnology, Environment and Biotechnology, Areas of applications for Biotechnology. Microbes and Environment, Genetically modified organisms and Legislation. **03 Hours**

2. Waste Water Treatment

Sources of water pollution, Waste water characteristics: Physical, Chemical and Biological characteristics. Chemical Oxygen Demond (COD) and Biochemical Oxygen Demond (BOD). Introduction to physical and chemical waste water treatment methods. Biological wastewater treatment methods: Aerobic suspended growth treatment processes (Activated Sludge Process, aerared lagoons etc), Aerobic attached growth treatment processes (Trickling Filter, Rotating Biological contactors), Anaerobic suspended growth treatment processes- contact digestors, packed column reactors, UASB. **12 Hours**

Unit II

3. Solid waste Management

Basic aspects, Generation of solid wastes, general composition of Municipal solid waste, On site handling, storage and processing, Collection of solid wastes. Solid waste processing techniques and equipments. Recovery of biological conversion products from solid waste such as composting, sanitary landfilling, recycling, vermicomposting, incineration. Solid waste management for energy recovery-Biogas production, processing of lignocellulosic waste biomass for ethanol production

10 Hours

4. Bioremediation

Uses of bacteria for bioremediation, bioremediation of aromatic and aliphatic hydrocarbons, PCB dechlorination, immobilization techniques for bioremediation, biosorption & bioaccumulation, genetic engineering of microbes for bioremediation. Phytoremediation-plants capable of assimilating heavy metals **05 Hours**

Unit III

5.Bioleaching

Bioleaching using microbes, role of Thiobacilli, direct & indirect bioleaching, copper extraction by leaching, dump leaching **05 Hours**

6. Environmental Impact Assessment

Introduction, Scope and history of EIA, Need of Environmental Impact assessment. Stakeholder and public involvement, Identification and quantification of environmental effects and Environmental Impact statement (EIS) **05 Hours**

Text Books:

1. Metcalf and Eddy, Wastewater Engineering, International Edition, McGraw-Hill, 1991
2. George Tchobanoglous, Hilary Theisen and Rolf Eliassen, Solid Wastes, McGraw Hill Kogakusha

Reference Books:

1. Colin Ratledge, Basic Biotechnology , Cambridge Pub, 2001
2. Indu Shekhar Thakur, Environmental Biotechnology, IK Pub, 2006
3. Pradipta Kumar Mohapatra, Environmental Biotechnology, IK Pub, 2006

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Program: Biotechnology		
Course Title: Bioinformatics		**Course Code: 19EBTC301**
L-T-P: 4-0-0	**Credits: 4.0**	**Contact Hours: 04 Hours/Week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 03 Hours**	

Unit - I

1.Database

Introduction, meaning of databases, types of databases, Primary Database: NCBI, Genbank, DDBJ, EMBL. File formats, Secondary Database: PROSITE, PIR, UNIPROT, BLOCKS, Pfam, specialized databases: metabolic pathway database, Structure Database: PDB, MMBD, CATH, SCOP, Ligand Database, Enzyme database, human disease database, microbial and viral genome database, structure visualization tools.

7 Hours

2.Pairwise Sequence Alignment

Meaning and significance of Sequence alignment, Pairwise sequence alignment, Global alignment, Local Alignment, overview of methods, Methods & Algorithms-dot matrix, dynamic programming, substitution matrices, gap penalties, FASTA, BLAST, PSI-BLAST & PHI-BLAST.

8 Hours

3.Multiple Sequence Alignment

Meaning of Multiple Sequence Alignment, Global Multiple Sequence Alignment: Progressive Alignment methods, Iterative methods, Local Multiple sequence Alignment, Significance of Multiple Sequence Alignment, Multiple Sequence Alignment editors. Motifs and Patterns analysis

5 Hours

Unit - II

4.Molecular Phylogenetics

Meaning of phylogenetic analysis, Meaning & significance of evolutionary trees, Rooted and unrooted trees, Elements of phylogenetic Models, Phylogenetic Data Analysis, Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method, Minimum Evolution (ME) method, Character based methods: Maximum parsimony, Maximum Likelihood; Tree Evaluation methods, Phylogenetic Softwares

7 Hours

5.Gene Prediction

Prokaryote and Eukaryote gene prediction, Prokaryote and Eukaryote promoter site prediction Gene Prediction tools, Genomic database, Next Generation Sequencing.

5 Hours

6.Protein Prediction

Protein structures: Secondary Structure: Alpha helix, beta Sheets, phi & psi angles, Ramachandran plots. Protein Secondary Structure Prediction, Tertiary Structure Predictions: Homology modeling, Protein analysis software: Physicochemical parameters, binding site, sub-cellular location, protein stability, patterns

. **8 Hours**

Unit - III

7.In-silico Drug Designing-I

Introduction to traditional drug designing, Introduction in-silico drug designing approach, Methodology for in-silico drug designing: Structure based and Fragment based drug designing, Steps in drug designing: Target identification, target validation, lead identification and validation, different tools used for drug designing, molecular Modeling

5 Hours

8.In-silico Drug Designing-II

Identification of ligands, Lipinski's rule, Virtual Screening, Process of Docking, Quantitative structure-activity relationship (QSAR), Physical and Chemical basis of receptor ligand interactions, ADMET property analysis. **5 Hours**

Text Books

1. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd, Wiley-Inte, 2005
2. David Mount, Bioinformatics: Sequence and Genome Analysis , 2nd, Cold Sprin, 2004

Reference Books

1. P. Rastogi, N. Mendiritta, S. C. Rastogi, Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, 4th, Prentice-H, 2013.
2. Anand Solomon K, Molecular Modelling and Drug Design , 1st, MJP Publis, 2015
3. Richard Durbin, Sean R. Eddy, Anders Krogh, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 1st, Cambridge , 1998

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III	2 Questions to be set of 20 Marks Each	7,8	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Bioprocess Control and Automation		Course Code:19EBTC302
L-T-P: 4-0-0	Credits: 4.0	Contact Hours: 4 hours/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration:3 hrs	

Unit I

1 Instrumentation & Process Dynamics: Introduction to Measurement of important physicochemical and biochemical parameters in bioprocess. Methods of on line and off line estimation of biomass, substrates and products. Brief introduction to typical automatic control system and its components. Open loop and closed loop control systems.

05 Hours

2 First & Second Order Systems: Mathematical representation of physical systems. Transfer function representation of linear first order systems, Examples: mercury in glass thermometer & Liquid level system. Mathematical forms of standard Input function/Forcing Functions such as Step input, Impulse Input, Linearly increasing Input and Sinusoidal Input. Response of first order system for step input, Features of step response, Response of linearly increasing input. Conceptual numerical. First Order Systems in Series: Interacting and Non-Interacting systems & their Transfer function representation. Second Order Systems: Transfer function representation of Second order systems, Example: Pneumatic Control Valve.

10 Hours

Unit II

3 Controller and Final Control Elements: Different types of controllers-P (Special case of P-controller i.e ON-OFF controller), PI, PD, PID controllers. Derivation of Transfer Functions of different types of controllers. Final control element: The role of Final control Element in control system. Example: Pneumatic Control Valve: Working of Pneumatic control valve, Types of Pneumatic Control Valves i.e. Air to close & air to open.

10 Hours

4 Block Diagram Reduction: Block diagram representation of control systems, Block diagram reduction in case of Servo and Regulatory control systems. Reduction of block diagrams for single input & Single output systems (SISO) & Multiple Input & Multiple Output Systems (MIMO), Problems on block diagram reduction.

05 Hours

5 Block Diagram Reduction (MIMO systems): Analysis of Multiple Input Multiple Output Systems**:** Introduction to Multiple Input & Multiple Output Systems (MIMO), Examples of MIMO systems.Analysis of MIMO systems considering only one Input at a time while other Inputs are Suppressed. Considering only one output at a time while other outputs are Suppressed. Problems on block diagram reduction considering MIMO systems.

05 hours

Unit III

6 Transient response of different controllers for Servo & Regulatory control Problems: Transient response of P, PI, PD & PID controllers for servo and regulatory problems. The determination of offset in all cases. **05 Hours**

7 Analysis of Stability: Concept of stability, stability criterion. Routh test for stability. Theorems of Routh Array test, Conceptual numerical on Routh test for stability. **05 hours**

Text Books

1. Process System analysis and control by Donald R Coughnowr, 2^{nd} Edn.Mc Graw Hill,1991
2. Chemical Process Control by George Stephanopoulos, Prentice Hall of India, 1999

Reference Books

1. Process Control-Peter Harriott, Tata McGraw-Hill Publishing Company Limited, 2004.

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III	2 Questions to be set of 20 Marks Each	6,7	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Bioprocess Modeling and Simulation		**Course Code: 18EBTE401**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1.Introduction to modeling:

Introduction, Mathematical Modeling of Bioprocess Engineering System, General Aspects of the Modeling Approach, General Modeling Procedure: Fundamentals uses of mathematical model, scope of coverage, principles of formulation; Fundamental Laws of Modeling: continuity equation, energy equation with examples **05 Hours**

2.Fundamental Laws of Modeling:

Equation of motion, transport equation, equation of state, phase and chemical equilibrium, chemical kinetics; Lumped and distributor parameters with examples **05 Hours**

3. Mathematical models of Biochemical Engineering Systems:

Modeling of Batch reactors, modeling of CSTR, Numericals. Plug flow reactor, Fluidized bed reactor, Reactors used in effluent treatments, packed bed reactor. **05 Hours**

Unit II

4. Use of MATLAB in Process Simulation:

Basics-Data analysis-curve fittings, Numerical integration, Euler and fourth order RungeKutta method, Input and Output in MATLAB. Solving problems using MATLAB by numerical integration, Euler and fourth order Runge Kutta methods. Simulation of CSTR and Batch Reactor, Simulation of Plug flow reactor. **10 Hours**

4.Introduction to Process Design:

Steps involved in process design, Process flow diagram structure and hierarchical approach, importance of Material and Energy balance, selection of unit operations,

05 Hours

Unit III

5.Introduction to process simulation software

Bioprocess design with example: Process Description, Specifying Process Sections, Specifying Equipment Sharing, Initialization of Reaction Operations, Process Analysis, Cost Analysis and Economic Evaluation, Environmental Impact.

05 Hours

6. Use of Super Pro in Process Simulation:
Components and mixtures, Physical and Chemical properties of components, material and energy balance simulation, adding unit operation, scheduling the unit process, process cost estimation, sizing of the unit operation.Case study: Monoclonal antibody production, Enzyme production **05 Hours**
Text Books: 1.Luyben W.L., Process Modeling Simulation and Control for Chemical Engineers., McGraw Hill, 1988. 2. Pauline M. Doran, "Bioprocess Engineering Calculation", Blackwell Scientific Publications.
Reference Books: 1. Kenneth J. Beers. "Numerical Methods for Chemical Engineering Applications in MATLAB®", Massachusetts Institute of Technology, Cambridge University press 2007 edition. 2. Bailey and Ollis, "Biochemical Engineering Fundamentals", 2 nd ed.,McGraw Hill, 1986.

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III	2 Questions to be set of 20 Marks Each	5,6	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Downstream Processing Technology		Course Code: 19EBTC401
L-T-P: 4-0-0	Credits: 4.0	Contact Hours: 04 Hours/Week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 03 Hours	

Unit I

1. Introduction

Role and importance of downstream processing in biotechnological processes. Characteristics of biological mixtures, Process design criteria for various classes of byproducts (high volume, low value products and low volume, high value products), Steps involved, case studies, costing of product and numericals

09 Hours

2. Primary Separation Techniques

Cell disruption methods for intracellular products, Removal of insolubles, Biomass (and particulate debris) heat and photosensitive materials (considering lyophilization) separation techniques; Flocculation and Sedimentation, Centrifugation and methods of centrifugation, filtration methods and types of filter media, numericals.

11 Hours

Unit II

3. Membrane separation processes

Membrane – based separations theory; Design and configuration of membrane separation equipment; Concentration polarization and fouling – causes, consequences and control techniques; Applications: Reverse osmosis, Dialysis, Ultra filtration, Micro filtration, Numerical of membrane separation process, Case Studies.

12 Hours

4. Enrichment operations

Precipitation methods with salts, organic solvents, and polymers, Extraction methods for separations. Reversed micellar extraction and Aqueous two-phase extraction, Supercritical extraction; In situ product removal / integrated bio-processing, numericals.

08 Hours

Unit III

5. Product recovery-I

Introduction to chromatography (Van Deemter equation), reversed phase chromatography, Hydrophobic Interaction Chromatography, Ion Exchange Chromatography, numericals.

05 Hours

6. Product recovery-II Gel Filtration Chromatography, Affinity Chromatography, Polishing Operations: Crystallization, Drying **05 Hours**
Text Books: **1.** B. Sivasankar, Bioseparations: Principles and Techniques , Eastern Economy Edit, Prentice-H, 2005 **2.** P.A. Belter E.L. Cussler, W.S. Hu, Bioseparations: downstream processing for biotechnology, John-Wiley, New York, 1988
Reference Books: 1. BIOTOL, Product Recovery in Bioprocess Technology, VCH, 1990 2. Shuler and Kargi , Bioprocess Engineering , Prentice Hall, 1992 3. Asenjo J. and Dekker M, Separation Processes in Biotechnology , 1993 CRC Press

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Program: Biotechnology		
Course Title: Bioethics, Safety & IPR		Course Code:19EBTE401
L-T-P: 3-0-0	Credits: 3.0	Contact Hours: 03 Hours/Week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 03 Hours	

Unit I

1. Perceptions about Biotechnology: Biotechnology and social responsibility, Positive & negative perceptions of Biotechnology, Public acceptance issues, surveys, areas of public concern for Biotechnology. Socio, ethical, economic and legal aspects of Biotechnology. Public education & Biotechnology. **05Hours**

2. Bioethics: Legality, morality, and ethics, Principles of bioethics: autonomy, human rights, beneficence, justice, equity, etc. Expanding scope of ethics from Biomedical practice to Biotechnology, ethical conflicts in Biotechnology. **05 Hours**

3. Biosafety concept and issues : Rational vs. subjective perception of risks and benefits, Hazards of BT , relationship between risk and hazard, Ethical implications of biotechnology products and techniques, **05 Hours**

Unit II

4. National and International Regulations: Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI)

10Hours

5. Biosafety & Management: Laboratory associated Biosafety practices, assessment of biohazard, Biosafety levels,. Risk analysis and assessment, Containment levels-physical, biological containments,. Good manufacturing practice and Good lab practices (GMP and GLP). **05 Hours**

Unit III

6. Intellectual Property rights: Introduction to history of GATT, WTO, WIPO and TRIPS; Introduction to IPR, Types of IP: Patents, Trademarks, Copyright, Design & Related Rights. Plant variety protection, Traditional knowledge, breeders rights, Geographical indications, Biodiversity and farmers rights. Patenting in biotechnology, case studies.

05 Hours

7. Food, Agri and Pharma Sector: The GM-food debate and biosafety assessment procedures for biotech foods including transgenic food crops, case studies- Golden Rice and Flav Savr

Tomatto. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials. **05 Hours**
Text Books 1.Bioethics & Biosafety- Sateesh MK, I.K.International Publishing House 2.Intellectual Property rights on Biotechnology – Singh K, BCIL, New Delhi. 3.Biotechnology: Expanding Horizons - B D Singh, Kalayani Publishers, 2010
Reference Books: **1.** Bioethics & Biosafety – R. Rallapalli & Gita Bali, APH publication, 2007 **2.** Safety considerations for Biotechnology-Paris, OECD publications

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III	2 Questions to be set of 20 Marks Each	6,7	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Industrial Biotechnology		Course Code: 20EBTE401
L-T-P: 3-0-0	Credits: 3.0	Contact Hours: 03 Hours/Week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 03 Hours	

Unit I

1 Introduction

History of fermentation products, Range of fermentation process: Traditional approach: biomass, enzymes, metabolites and biotransformation; Modern fermentation process: rDNA products, animal cell culture: therapeutic proteins, monoclonal antibodies; application of system biology approach; generalized representation of typical fermentation process.

05Hours

2. Isolation and improvement of industrial microorganisms

Isolation methods: Primary screening and secondary screening; Improvement of industrial microorganism: selection of induced mutants for primary and secondary metabolites, isolation of revertant mutants, use of rDNA systems, and improvement by other properties.

05Hours

3. Fermentation products

Beverages(beer), Ethanol, Aminoacids, enzymes(lipase/protease), penicillin, therapeutic proteins, monoclonal antibodies and vaccines.

05Hours

Unit II

4 Bioreactor configuration-I

CSTR with recycle, CSTR in series, Airlift reactor, Fluidized bed bioreactor, bubble column bioreactor, packed bed bioreactor, tickle bed bioreactor, deep jet bioreactor, rotating disc bioreactor.

05Hours

5. Bioreactor configuration-II

Animal cell bioreactors:- Homogeneous reactor: Solid and macro porous micro carriers bioreactor; Heterogeneous reactor: Hallow fiber bioreactor, Packed glass bed bioreactor, fluidized bed bioreactor, cell encapsulation; Disposable bioreactor: Wave bioreactor and stirred bag bioreactor.

05Hours

6. Advance downstream processing

Process integration in product recovery, large scale refolding of therapeutic proteins, advanced membrane technology, Chromatography: column quantification and validation, AKTA purifier, reversed micellar technique for bio separation Single use technology in purification.

05Hours

Unit III
7. Fermentation monitoring and control: On-line and off-line monitoring instruments, Bioprocess modeling for control, Estimation technique: Traditional method, linear black-box model and non-linear model; control strategies for fermentation, real time data analysis: Raman spectroscopy. **05 Hours** **8. Fermentation data analysis**: Introduction, classification of fermentation measurement and quantities, calculation of metabolites, estimation of unmeasured variables, calculation of integral and averaged variable, physiological variable and pattern recognition technique, SIMCA software. **05Hours**
Text Books: 1. L.E.Casida,JR ,Industrial Microbiology, New Age International (P) Ltd Publication. 2. Prescot and Dun, Industrial Microbiology, McGraw-Hill Book Company, Inc. New York
Reference Books: 1. D.Lanch,Drew,Wang, Comprehensive Biotechnology-Volume 3,Elsevier Publication. 2. George T. Austin, Nicholas Basta; Shreves Chemical Process Industries Handbook; McGraw Hill Professional, 1998

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III	2 Questions to be set of 20 Marks Each	7a,7b	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Bio-business & Entrepreneurship		Course Code: 20EBTE402
L-T-P: 3-0-0	Credits: 3.0	Contact Hours: 3 hours/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 hrs	

Unit-I

1. Entrepreneurship

Concept of Entrepreneurship - Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs. Entrepreneurship in India: Small scale industries: Definition; Characteristics; Need and rationale. Objectives; Scope; Introduction to bio-business, from the Indian context, SWOT analysis of bio-business.

10 hours

2. Social Responsibilities of Business

Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance Institutional Support for Business Enterprises: Introduction, Policies & Schemes of Central Level Institutions, State Level Institutions.

05 hours

Unit-II

3. Entrepreneurship opportunity in biotechnology

Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case studies on entrepreneurship opportunities in different domains of Biotechnology (Agri biotechnology, industrial Biotechnology, food biotechnology, Biopharma, Nutraceuticals. etc).

05 hours

4. Project management, technology management and startup schemes

Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

10 hours

Unit-III

5. Startup Schemes

Building Biotech business challenges in Indian context-biotech partners (BIRAC, DBT, Incubation centers. Etc.), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Business incubation support schemes, Successful startups-case study.

05 hours

6. Funding Opportunities

Startup schemes in Indian government Sources of Funding for startups. Crowd funding, Self-funding, Venture Capitalists, Angel Investment. Banking support for startup business. Types of companies: Sole proprietorship company, Partnership company, Private Limited, Limited company etc.

05 hours

Text Books:

1. Principles of Management – P. C.Tripathi, P.N. Reddy – Tata McGraw Hill,
2. Entrepreneurship Development - S.S.Khanka - S.Chand & Co.
3. Project Management by Sahni, Ane Books.

Reference books

1. Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier - Thomson
2. Project Management for Business & Technology, Nicholas, PHI.

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter numbers	Instructions
I	3 Questions to be set of 20 Marks Each	1,2	Solve Any 2 out of 3
II	3 Questions to be set of 20 Marks Each	3,4	Solve Any 2 out of 3
III	2 Questions to be set of 20 Marks Each	5,6	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Numerical Methods and Differential Equations		Course Code: 20EMAB205
L-T-P: 4-0-0	Credits: 4.0	Contact Hours: 04 Hours/Week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 03 Hours	

Unit I

1. Interpolation techniques

Finite differences, Forward, Backward and central difference Operators. Newton Gregory forward and backward interpolation formulae. Stirling's formula for central difference. Newton's divided difference formula for unequal intervals.

08 Hours

2. Numerical Solution of Partial Differential Equations

Introduction, Classification of PDE, Parabolic, Elliptic and Hyperbolic Partial differential equations, Introduction to finite difference approximations to derivatives, finite difference solution of parabolic PDE, explicit and implicit methods, finite difference method to Elliptic PDE-initial –boundary vale problems, Hyperbolic PDE-explicit method. Engineering problems: Temperature distribution in a heated plate, steady-state heat flow and vibration of a stretched string.

12 Hours

Unit II

3. Matrices and System of linear equations

Introduction to system of linear equations, Elementary row transformations, Rank of a matrix, Consistency of system of linear equations, solution of system by (i) Direct methods-Gauss elimination, Gauss Jordon method (ii) Iterative method - Gauss-Seidel method. Eigen values and Eigenvectors of a matrix. Largest Eigen value and the corresponding Eigenvector by power method. Engineering problems. **08 Hours**

4. Introduction to Statistics

Introduction, Scope of biostatistics, Variables, Measurement scales, Ordered array, Graphical representation of data: Bar Chart, Line chart, histogram, frequency curve, Ogive curves. Descriptive statistics: Measure of central tendency (arithmetic mean, median, mode, quartiles); Measures of dispersion (Quartile deviation, Standard deviation, coefficient of variation), Measure of skewness (Pearson and Bowley's) **12 Hours**

Unit III

5. Introduction to Laplace transform and Solution of Differential Equations

Definition, transforms of elementary functions- transforms of derivatives and integrals-Properties. Periodic functions, Unit step functions and Unit impulse functions. Inverse Transforms- properties-Convolution Theorem. Applications to differential equations

10 Hours

Text Books:

3. **Numerical methods for Engineers,** Chapra S C and Canale R P, 5ed, TATA McGraw-Hill, 2007
4. **Advanced Engineering Methods,** Kreyszig E. 8Ed, John Wiley & sons, 2003.
5. **Applied Statistics and Probability for Engineers, Douglas Montgomery, George Runger, 6Ed, John Wiley, 2014**

Reference Books:

1. **Introduction to Probability and Statistics: Principles and Applications for Engineering and Computing**, J.Susan Milton, Jesse C Arnold, , 4, TATA Mc-Graw Hill Edition, 2007
2. **Fundamentals of Mathematical Statistics**, Gupta S.C and Kapoor V.K, 11Ed, Sultan Chand & Sons, New Delhi, 2002
3. **Higher Engineering Mathematics**, Grewal B S, 38ed, Khanna Publication, New Delhi, 2001.

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter numbers	Instructions
I	3 Questions to be set of 20 Marks Each	1,2	Solve Any 2 out of 3
II	3 Questions to be set of 20 Marks Each	3,4	Solve Any 2 out of 3
III	2 Questions to be set of 20 Marks Each	5	Solve Any 1 out of 2

Program: Biotechnology		
Course Title: Biostatistics		Course Code: 20EMAB210
L-T-P: 3-1-0	Credits: 4.0	Contact Hours: 03 Hours/Week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 03 Hours	

Unit I

1. Bivariate Distribution Fitting of curves

Introduction to biostatistics, Review of Central tendency and Dispersion, Correlation, linear regression, Curve fitting (Nonlinear and Exponential curves) **05 Hours**

2. Probability

Definition of probability, addition rule, conditional probability, multiplication rule, Baye's rule, sensitivity, specificity, predictive value positive and negative, Probability in Genetics: Punnett square, Hardy - Weinberg law, Wahlund's Principle **05 Hours**

3. Probability distributions

Discrete probability distributions - Binomial, Poisson, Continuous Probability Distribution – Normal, Exponential, Gamma distribution

05 Hours

Unit II

4. Sampling and Statistical Inference

Introduction, Sampling, Sampling distribution, sample size determination, Confidence intervals, Tests of hypothesis, p-value, t-test for single mean, difference of mean (with equal variance and unequal variance), paired t-test, Chi Square test for goodness of fit and independence of attributes, analysis of variance (one-way and two-way classifications). Case studies of statistical designs of biological experiments (RCBD, RBD)

08 Hours

5. Design of Experiments-1

Introduction, OFAT, 2^2 and 2^3 factorial experiments: Data table, Graphical representation, Main and interaction effects, ANOVA Table **07 Hours**

Unit III

6. Design of Experiments -2

Fractional factorial design, Placket-Burman design, Response Surface Methods-Central Composite Design

05 Hours

7. Population Growth Models

Introduction, Discrete time and continuous growth, Density Independent growth model: Geometric and Exponential growth model, Density dependent growth: Logistic growth model **05 Hours**

Text Books:

6. **Applied Statistics and Probability for Engineers,** Douglas Montgomery, George Runger, 6Ed, John Wiley, 2014
7. **Introduction to Probability and Statistics: Principles and Applications for Engineering and Computing,** J.Susan Milton, Jesse C Arnold, , 4, TATA Mc-Graw Hill Edition, 2007
8. **Mathematical Models in Biology and Medicine**, Kapoor J.N, EWP New Delhi, 2000

Reference Books:

4. **Fundamentals of Mathematical Statistics**, Gupta S.C and Kapoor V.K, 11Ed, Sultan Chand & Sons, New Delhi, 2002

Scheme for End Semester Assessment (ESA)

UNIT	8 Questions to be set of 20 Marks Each	Chapter numbers	Instructions
I	3 Questions to be set of 20 Marks Each	1,2,3	Solve Any 2 out of 3
II	3 Questions to be set of 20 Marks Each	4,5	Solve Any 2 out of 3
III	2 Questions to be set of 20 Marks Each	6,7	Solve Any 1 out of 2

Program: Architecture		
Course Title: BUILDING CONSTRUCTION & MATERIALS - I		**Course Code: 18AATC102**
L-S-P: 0-6-0	**Credits: 4**	**Contact Hours: 6**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 96	**Examination Duration: NA**	

UNIT I:

Basic building components, material convention, brick work & mortar building components - Introduction to and their functions in brief, like foundation, plinth, coping, DPC, floor, walls, lintels, D&W, weather shade, roof, parapet etc.

Material convention- Convention of construction materials, like brick & stone masonry, timber, ply wood, steel, glass, concrete, mortar, metal etc, used for representing, in plan, section and elevations

Tools- Introduction to various tools commonly used for excavation, masonry and carpentry works

Bricks and blocks- Introduction to burnt clay bricks, properties of good bricks, molding methods, and application. Blocks used as an alternative to bricks, such as i) adobe (stabilized mud), ii) hollow clay, iii) cement concrete iv) fly ash v) autoclaved aerated concrete (AAC), etc.

Brick masonry- Types of bonds used in brick masonry, for walls & pilasters of varying thickness.

Mortar- Types, uses, & properties of bonding materials like clay, lime, cement, gypsum etc. Sources and qualities of good sand & alternatives in preparing mortars.

UNIT II:

Stone, stone masonry, foundation, plinth formation, lintels & arches

Stones – Geological classification, types, properties and uses of stones for building. By-products of stones such as ballast, aggregate, graded crushed stone & powder (M- sand).

Stone masonry- Types of bonds used in stone masonry.

Foundation: Introduction to excavation- types & behavior of soil. Types of shallow foundations in brick and stone & purpose, for load bearing structure.

Plinth formation- Construction and formation of plinth for building with masonry walls, using i) bricks ii) stones iii) CC blocks including refilling in and consolidation.

Lintel and arches- Introduction to, types and functions for spanning of openings in building. Method of construction using various materials like stone slab, timber, metal, brick and stone masonry, concrete etc.

UNIT III:

Coping, dpc, plastering, guniting& cladding

Coping & dpc- Introduction to and use of coping & DPC in building using various materials.

Plastering – Types, preparation and application in interior & exterior, like i) mud ii) lime iii) cement iv) gypsum with different finishes.

Guniting& grouting– To fill in cracks, voids in masonry, concrete and for repairs.

Cladding – Using tiles such as clay, stone, decorative cement, etc. for walls & roof

Note – The Portfolio covering the above topics shall be presented for Term work. Site visits shall be arranged by studio teacher. Study of material application shall be submitted in the form notes, sketches and photo brief as a part of portfolio

Scheme for Internal semester assessment (ISA)

Regular Assignments, models.

Term work: Evaluation of Portfolio, assignments by internal examiner

Scheme for End Semester Assessment (ESA)–

Term work: Evaluation of Portfolio, assignments by internal and external examiners

Mode of assessment : Portfolio .

Text Books - Nill

Reference Books:

McKay J.K Building Construction Metric Vol 1-4, 4th edi Orient Longman Pvt. Ltd, Mumbai,2002

“Construction Technology” volume-I by R Chudley, ELBS & Longman group Ltd.

Barry R, “The construction of buildings” , Vol-2, 5th Edi, East West Press, New Delhi 1999.

Bindra S.P and Arora S.P, Building Construction-Planning Techniques and Method of Construction, 19th edi, Dhanpat Rai Pub ,NewDelhi, 2000

“Building Construction” by JanardhanJha, Khanna New-Delhi.

RangawalS.C ,“Building Construction” 22nd Edi, charotar Publishing house, Anand, 2004

“Engineering Materials” by Surendra Singh, Vikas Delhi.

“Building Materials” by S K Duggal, IBH New Delhi.

Sushil Kumar T.B of Building Construction 19th edi, Standard Pub House, NewDelhi, 2003.

Chowdhary K.P. Engineering Materials used in India, 7th Edi, Oxford and IBH Pub ltd New Delhi, 1990.

Building Construction Hand book : By R Chudly& R Greeno, Bullerworth Heinemann, New-Delhi.

Program : Architecture		
Course Title: Skill Development Workshop- I		**Course Code: 18AATC104**
L-S-P: 0-2-0	**Credits: 2**	**Contact Hours: 3**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 48	**Examination Duration: NA**	

Course contents:

Unit-I:

Free hand and objects drawing: Observation and recording through free hand drawing by using various drawing and sketching tools like pencil, pen, charcoal crayons etc.

Architectural Model Making :Introduction to Basics of the Model making skills like cutting, pasting etc.

Unit-II

Architectural sketching: Drawing of human figures, vehicles, small buildings, furniture, simple and complex geometrical objects with an emphasis on the perception of details and expressing them in lines, colour texture etc.

Architectural Model Making: Introduction to Basics of the following associated skills to enhance and understand spatial, scale, material, and aesthetical requirements of design, construction and presentation.

Unit-III

PAINTING: Understanding of colour wheel, components , types of colour, colour schemes, value and intensity by using painting tools and materials like brushes, paper, water color, poster colour etc.

Sessional Work (Internal semester assessment)

Regular Assignments, Architectural sketches, drawings and models

Scheme for Semester End Assessment (ESA)

Term work: Evaluation of Portfolio, assignments by internal and external examiners

Mode of assessment: Portfolio/ Models.

References: Book: Robert Gill: Rendering with pen &ink, Thames & Hudson New York 1984. Robert Gill: Basic Rendering, Thames& Hudson New York 1991. John Chen: Architecture in pen & ink, McGraw-Hill Inc- USA 1995. Colin Saxton: Art School, Chart well Books Inc New Jersey.

Program : Architecture		
Course Title: Prehistoric Architecture		**Course Code: 18AATC105**
L-S-P: 2-0-0	**Credits: 2**	**Contact Hours: 2**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours:32	**Examination Duration: 3Hours**	

Course contents:

Focuses on study of evolution of various styles of architecture, methods of construction and influence of art and culture on architecture.
Evolution of mankind-its impact – on primitive arts and crafts in various countries.
Evolution of shelter forms in different regions.
Growth of Human settlements and cultural influences.
Influence of religion and culture on domestic and civil architecture.

Unit-1
Pre-Historic world
Primitive man – Shelters, Settlements, religious and burial systems
Ex: Oval Hut, Nive, Dolmen Tomb, Gallery Grave, Passage Grave, Houses at CatalHuyuk, LepensikiVir settlements, stone Henge.

Unit-II
River valley cultures-
Study of political systems, concept of settlement, impact of climate, socio culture and their related shelter types, planning types, method of building structures and detailing. Study of building materials used.
Indus valley civilization-
Layout of Mohenjo-Daro, House Plans, Community well, Great Bath, Granary.
Egyptian-
Tombs, Pyramids, & Temples- Mastaba Tombs, Pyramid of Cheops, Temple of Khons, Karnak.

Unit-III
River Valley Cultures-
Tigris and Euphrates
Ziggurats at Warka, Ur and Tchoga Zanbil, Palace of Sargon, Mastaba Tombs.

Sessional Work (Internal semester assessment)
Students will be assessed by 2 theory minor exams of 20 marks each and 10 marks for sketch book submission.

Scheme for Internal semester assessment (ISA)

Regular Assignments, models.

Term work: Evaluation of Portfolio, assignments by internal examiner

Scheme for End Semester Assessment (ESA)

External examination-3 hrs

Mode of assessment :

Portfolio& Theory Exam

Text Books:NIL

References :

"History of Architecture in India "byTadgell Christopher.
Sir Banister Fletcher's "History of Architecture

Scheme for End Semester Assessment (ESA)

Sl.No	8 Questions to be set of 20 Marks Each	Chapter Number	Instructions
I	Q.No.-1, Q.No.-2, Q.No.-3	1, 2,3	Solve Any 2 out of 3
II	Q.No.-4, Q.NO – 5 Q.No.-6,	4, 5,6	Solve Any 2 out of 3
III	Q.No.-7, Q.No.-8	7,8	Solve Any 1 out of 2

Program : Architecture		
Course Title: Basic Design		**Course Code: 18AATC106**
L-S-P: 0-3-0	**Credits: 3**	**Contact Hours: 4**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 64	**Examination Duration: NA**	

Course contents:
To understand and interpret elements of design in Visual composition.
To develop creative skills to address design principles in Architecture.
To explore art forms and understand importance of art in architecture.
Unit-I:

Elements of Visual Composition: Understanding role of the following basic elements of visual design existing in paintings, compositions, murals, sculptures, building and in a nature – Dots, Lines, Planes, Patterns, Shapes, Forms, Spaces, Colour, Texture, Levels, Light, Fenestration's. Study of Textures and Textures Schemes.

Unit-II

Principles of Visual Compositions : To address design principles in architecture. Understanding and using principles like Repetition, Rhythm, Radiation, Focal point, Symmetry, Asymmetry, Background, Foreground, Sense of Direction, Harmony, Balance and Proportion.

Unit-III

EXPLORATION OF ART FORMS- study of traditional and contemporary art forms, relation between art and architecture from earliest times to present.

Sessional Work (Internal semester assessment)
Regular Assignments, Architectural models, rendered sheets and photos

Scheme for Semester End Assessment (ESA)
Term work: Evaluation of Portfolio, assignments by internal and external examiners

Mode of assessment: Portfolio, Model.

References :

Robert Gill : Rendering with pen & ink , Thames & Hudson New York 1984
Robert Gill : Basic Rendering ,Thames & Hudson New York 1991
John Chen : Architecture in pen & ink, McGraw-Hill Inc- USA 1995
Colin Saxton : Art School, Chartwell Books Inc New Jersy.

Program : Architecture		
Course Title: Skill Development Workshop- II		Course Code: 18AATC112
L-S-P: 0-2-0	Credits: 2	Contact Hours: 3
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 48	Examination Duration: NA	

Course contents:
Unit-I:
Allied skills for Architecture

Tools and materials

Hands-on working of advance model making and working tools. Various types of materials used for making scaled models, sculpting etc. (Paper, card sheet, mount board, Art card, foam, metal, plaster, clay, wax glass, vegetables etc.) Methods of cutting, joining, texture development, glue welding and joinery.

Unit-II
Introduction to Architectural rendering skill and mobile photography, Soft skills

1. Hands on rendering of Architectural plan, elevation and sections.
2. Hands on mobile photography of models, buildings, furniture, vehicles etc.
3. Soft skills like communication, speaking, reading & writing.

Unit-III

1. Introduction to scanning of rendered sheets
2. Introduction to Adobe Photoshop software for photo processing and composition
3. Using above skills create own imaginative forms or objects

Sessional Work (Internal semester assessment)
Regular Assignments, Architectural models, rendered sheets and photos

Scheme for Semester End Assessment (ESA)
Term work: Evaluation of Portfolio, assignments by internal and external examiner

Mode of assessment: Portfolio / Model

References :

Robert Gill : Rendering with pen & ink , Thames & Hudson New York 1984
Robert Gill : Basic Rendering ,Thames & Hudson New York 1991
John Chen : Architecture in pen & ink, McGraw-Hill Inc- USA 1995
Colin Saxton : Art School, Chartwell Books Inc New Jersy.

Program : Architecture		
Course Title: ARCHITECTURAL DESIGN – III		**Course Code: 18AATC201**
L-S-P: 0-6-0	**Credits: 6**	**Contact Hours: 9**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 144	**Examination Duration: NA**	

Course contents:

To understand/engage with the basic issues of socio-cultural and physical context of built environment and experiencing rural contexts of diverse typologies and in transformation.

To abstract the various elements of the village and their relationships, which influence design.

To study basic materials, technologies in design and question the notion of sustainability

UNIT 1

Understanding the rural ecosystem through anthropocentric surveys and architectural documentation

Drawings Project to Rural studio exploring elements of a village - with brief report - on Contemporary challenges, villages in transformation, typologies of villages.

UNIT 2

Analyzing the physical, socio-economic, environmental, visual and spatial characteristics of rural settlements towards identifying problems and potentials requiring strategic goals and objectives for implementation

Documentation Project (in-situ- travel to site and in Studio) - Drawings to understand dwelling typologies, materials, way of life, technologies, community spaces and natural resources. Drawings Analysis of the rural settlements - based on social, cultural, history, occupation, bio-diversity, institutions, settlement layout, dwelling typologies, local materials and technologies. With brief Report. character of institution, growth, materials and structure

UNIT 3

Providing appropriate architectural design solution to solve identified problems and harness available potentials.

Design Project to explore an innovative rural institution/ or a cluster of dwellings/ rural community center /cottage industry/sanitation/ women's self-help groups/, of an appropriate scale and area, etc.

Scheme for Internal semester assessment (ISA)

Regular assignments , Models , Reviews.

Term work: Evaluation of Portfolio and assignments by internal examiner.

Scheme for End Semester Assessment (ESA)

Term work: Evaluation of Portfolio and assignments by internal and external examiners/Viva

Mode of assessment: Portfolio, Physical models ,manual hand drafted drawings.

Text Books: NIL

Reference Books:

1. Time Saver Standard for Architectural Data by John Hancock.
2. Architectural Graphic Standards by Ramsey and Sleeper.
3. Architecture: Form, Space and Order, Ching, Francis DK
4. Design and Form: The basic course at the Bauhaus, Itten, Johannes.
5. Elements of space forming, Yatin Pandya.

6 NIASA Document – Rural Studies Program, Council of Architecture Publication, 2015
7 David Robson, Geoffrey Bawa: Complete Works, Thames & Hudson (November 17, 2002)
8 Elizabeth Baker, The other side of Laurie Baker, DC Books Pvt. Ltd, 2007
9 Dr Parr, New Directions in sustainable Design, Routledge Press, 2012
10. Architectural Composition, Krier, Rob
11 Daniel Williams “Sustainable Design: Ecology, Architecture & Planning”, John Wiley & sons,2007

Scheme for Semester End Examination (ESA)

Evaluation of Portfolio of Term Work / Viva

Program : Architecture		
Course Title: SERVICES – I (WATER SUPPLY & SANITATION)		Course Code: 18AATC203
L-S-P: 2-0-0	Credits: 2	Contact Hours: 2
ISA Marks:50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 32	Examination Duration: 3HOURS	

Course contents

UNIT I:

1: Sources and purification of water

Surface and underground sources of water supply, pollution and preventive measures.

Purification ----filtration, disinfection, softening, miscellaneous methods of water treatment.

2: Domestic water supply

Water requirement for different types of buildings, pipes, valves, wash basins, sink, bath tubs, flushing cisterns, showers, jets, faucets. Cold and hot water supply for ground and multi-storied buildings. Provision for fire fighting, solar heating systems, geysers.

Layout design and details of water supply distribution system in a Design Project.

UNIT II:

3: Sanitation

Importance of sanitation, definitions, types of refuse, collection and disposal systems. Rural sanitation. Types of fixtures and materials. Sanitary requirements for various types of buildings.

4: Drainage systems

Principles, location of sanitary units, separate and combined systems, septic tanks, aqua privy. Drainage system for ground and multistoried buildings including. storm water drainage, rain water harvesting. Roads and pavements, drainage of roads, drainage on sloping sites, sub soil drainage. Site planning from drainage and water supply point of view.

Layout design and details of sewage and drainage system for different building types. Storm water drainage and rain water harvesting system design for a building project. Course may be integrated with concurrent architectural design

UNIT III:

5:Recycling

Sewage pumping stations, waste water treatment, oxidation. recycling of sewage water.

6: Solid waste Management: Prevalent SWM practices and deficiencies: Storage of waste at source, collection, segregation, transportation of waste. Disposal of solid wastes: Sanitary land filling, Composting, Incineration, Pyrolysis – advantages and limitations. Biogas system and Modern renewable energy system

Scheme for Internal semester assessment (ISA)

Regular Assignments.

Scheme for End Semester Assessment (ESA)

External examination-3 hrs

Mode of assessment: Portfolio& Theory Exam.

Text Books: NIL

Reference Books:

1. Husain, S. K. T. B. of water Supply and Sanitary Engineering, 3rd ed. Oxford and IBH Pub. Ltd. New Delhi, 1994.
2. Kshirsagar,S.R. Water Supply Engineering, 6th ed. Roorkee Pub, Roorkee, 1980.
3. Rangawala, S.C. Water Supply and Sanitary Engineering ;Envirornmental Engineering, 19th ed. Charotar Pub. House, Anand, 2004.
4. S.C. Rangawala, fundamentals of water supply and sanitary engineering. Charotar Pub. House, Anand,
5. Ilussain S. K. water supply and sanitary engineering, Dhanapat Rai and Sons, Delhi Relevant I.S. Codes
6. Basic Plumbing techniques, Orthobooks, Chevron Chemical Company, Consumer products Div., Box 5047, San Ramon, CA 94583
7. G.M. Fair, J.C. Geyer and D.A. Oku, Water and Waste Water Enineering, vol.II, John Wiley and Sons, Inc. New York, 1968
8. Manual of water Supply and Treatment , 2nd edition , CPHEEO, Ministry of works And HOUSING New DELHI , 1980
9. Manual ON sewage Treatment , CPHEEO, Ministry of works And HOUSING New DELHI , 1977

Scheme for End Semester Assessment (ESA)

Sl.No	8 Questions to be set of 20 Marks Each	Chapter Number	Instructions
I	Q.No.-1, Q.No.-2,	1, 2	Solve Any **1** out of **2**
II	Q.No.-3, Q.NO – 4,	3, 4	Solve Any **1** out of **2**
III	Q.No.-5, Q.No.-6	4,5	Solve Any **1** out of **2**

Program : Architecture		
Course Title: CLIMATOLOGY		**Course Code: 18AATC204**
L-S-P: 2-0-0	**Credits: 2**	**Contact Hours: 2**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 32	**Examination Duration: 3hrs**	

UNIT I:

Introduction – Elements of Climate, Enumerating and representing climatic data. Classification of Climate, major Climatic Zones of the World, tropical Climate further Classification. Climatic Zones of India, Classifications, case study of one city within each Zone.

UNIT II:

Thermal Comfort, effect of Climatic Elements on thermal Comfort, Heat Exchange Process, Effective Temperature

Natural Ventilation, effect of openings in internal and external features, Design Considerations etc. Effect of Landscape elements and site topography, reading climate data, climate analysis and data validation through climate consultant software.

UNIT III:

Bioclimatic chart, Design Consideration for various climatic zones of INDIA, with respect to Shading devices, Day Lighting Factors, Components of day light factor and its design considerations, Rainfall considerations etc.

Construction Techniques for Improving Thermal Performance of Walls and roofs at various climatic Zones in India. Climate data representation through flow design and Ecotect software. Design project of not more than 500sqm. built up incorporating all the components of climate responsive architecture.

Scheme for Internal semester assessment (ISA)
Regular Assignments, Architectural models, rendered sheets and photos

Scheme for End Semester Assessment (ESA)
External examination-3 hrs

Mode of assessment :
Portfolio& Theory Exam.

Reference Books : NIL

Text Books:

1. Arvind Kishan , Baker &Szokolay, Climate Responsive Architecture.

2. Manual of Tropical Housing & Buildings (PartII)" Koenigsberger.
3. Buildings in the tropics by Maxwell Fry
4. Housing , Climate and Comfort by Martin Evans

Scheme for End Semester Assessment (ESA)

Sl.No	8 Questions to be set of 20 Marks Each	Chapter Number	Instructions
I	Q.No.-1, Q.No.-2,	1, 2	Solve Any **1** out of **2**
II	Q.No.-3, Q.NO – 4,	3, 4	Solve Any **1** out of **2**
III	Q.No.-5, Q.No.-6	4,5	Solve Any **1** out of **2**

Program : Architecture		
Course Title: Architectural Design – IV		**Course Code: 18AATC208**
L-S-P:0-6-0	**Credits: 6**	**Contact Hours:9**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 144	**Examination Duration: NA**	

Course contents:

To develop skills for comprehensive understanding and dealing with Climate Responsive Architecture. Provide skills for designing multi-user and multi level spaces.

The design issues to be addressed are

- Climate Responsive
- Integration of environment & built form.
- Integration the horizontal and vertical circulation
- Correlation of the materials and the resulting form.

The list of suggested spaces to be covered as design Public Libraries, Public and Semipublic Office Spaces, Resorts, Recreational Clubs, Automobile Showrooms etc.

Necessary theoretical inputs to be given highlighting the norms and design issues. At least one major exercise and one minor design/ time problem should be given. The topics covered as design projects will have to be covered by the studio faculty members through lecture/slide show session and site visits.

Scheme for Internal semester assessment (ISA)

The Portfolio covering the given topics and the study models shall be presented.

The evaluation shall be through periodic internal reviews.

The students have to present the entire semester work for assessment along with Models.

Regular Assignments, Architectural models, rendered sheets and photos

Scheme for Semester End Assessment (ESA)

Term work: Evaluation of Portfolio, assignments by internal and external examiners/ Viva

Mode of assessment :

Portfolio

Text Books: NIL

Reference Books:

1. Joseph De Chiara & John Hancock Calendar, Time Saver Standards for Building Types
2. Various books and magazines about architectural design
3. Architecture: Form, Space and Order, Ching, Francis DK

Program:		
Course Title: Elective -Art Appreciation		**Course Code:** 18AATE201
L-S-P: 0-2-0	**Credits: 01**	**Contact Hours:02**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 02	**Examination Duration: NA**	
Unit I Various art forms Scope in the various works of arts		
Unit II Analysis & aesthetic judgment Expression of individual /society values		
Unit III Personal reaction to works in the art		
Scheme for Internal semester assessment (ISA) The evaluation shall be through periodic internal assignments		
Scheme for Semester End Assessment (ESA) Term work: Evaluation of Portfolio, assignments by internal and external examiners		
Mode of assessment : Portfolio		
Text Books: NA		
Reference Books: 1. Books on architectural Design 2. *Architectural Periodicals* 3. *Art Periodicals*		

Scheme for End Semester Examination (ESA)

Program : Architecture		
Course Title: Elective – Human Centered Design - I		**Course Code: 18AATE202**
L-S-P: 0-1-0	**Credits: 1**	**Contact Hours: 2**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 32	**Examination Duration: NA**	

Course contents

Understanding Design as a very old human capability that has been forgotten by the mainstream educational system and traditionalist alike. A modern human activity that can help the products, services and policies of the future within the constraints of our contexts.

UNIT I:

What is Design? Multiple Dimensions of Design, Processes and Applications What is Human Centered Design? 1 Looking: Observing Human Experience 2 Understanding: Analyzing challenges and opportunities 3 Making: Envisioning Future Possibilities

UNIT II:

HCD to identify problem.

UNIT III:

Field Work, Define, Ideate, Prototype (Concept design, Detailed Design) ,Test, Feedback

Scheme for Internal semester assessment (ISA)

Field work Ideation, Concept design, Final Design Periodic reviews presentations of finding , concerns, Development stage of product and justification

Scheme for End Semester Assessment (ESA)

Final Report Prototype design

Mode of assessment :

Field work attendance

Assignment

Text Books:NIL

Reference Books:

1. Harold Nelson: The Design Way Intensions /Compositions/Value
2. John Heskett :Toothpics and Logos

Objects/Communication/Environments/Identities/Systems/Contexts/Future

3. Klaus Krippendorff:The Semantic Turn ,Meaning of Artifact in :Use/Language/Life Cycle/Ecology

Program:		
Course Title: Elective –ARCHITECTUTAL PAINTING		**Course Code:** 18AATE206
L-S-P: 0-2-0	**Credits: 01**	**Contact Hours:02**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 02	**Examination Duration: NA**	
Unit I **Nature and Object**: Study of two or three natural and geometric forms in pencil with light and shade from a fixed point of view. Natural forms like plants, vegetables, fruits and flowers, etc., are to be used. Geometrical forms of objects like cubes, cones, prisms, cylinders and spheres should be used.		
Unit II **Painting Composition:** Simple exercises of basic design in variation of geometric and rhythmic shapes in geometrical and decorative designs and colours to understand designs as organised visual arrangements.		
Unit III **Portfolio Assessment:** Five selected nature and object study exercises in any media done during the session including minimum of two still life exercises.		
Scheme for Internal semester assessment (ISA) The evaluation shall be through periodic internal assignments		
Scheme for End Semester Assessment (ESA) Term work: Evaluation of Portfolio, assignments by internal and external examiners		
Mode of assessment : Portfolio		
Text Books: NA		
Reference Books: 1) **Heritage of Indian Art.-Dr.Vasudevsharan Agarwal.** 2) **Hindustani Masavri- Dr.AnisFarooqi**		

Final copy

Date: 15-03-2021

Dept. of MCA: Change Summary Document

Change summary between 2015-16 and 2016-17 admitted batches
(i.e. 2015 to 18 batch 2016 to 19 batch)

Semester	Course Name	Total Hours	Revision Hrs	% Change	Year of Implementation
I	Problem Solving using C 15ECAC708	42	42	100	2016-17
II	PHP Programming 15ECAC711	48	48	100	2016-17
	Web Services Lab 15ECAP708	48	48	100	2016-17
	15ECAC706 - Software Engineering	48	10	20	2016-17
III	Python Programming 16ECAC803	50	50	100	2017-18
	Mini Project -1 16ECAP803	50	50	100	2017-18
IV	PL / SQL Lab. 16ECAP805	36	36	1000	2017-18
	16ECAC806 - Programming in C# With . Net	48	10	20	2017-18
	Mini Project-2 16ECAP806	50	50	100	2017-18
	Web Content Management 16ECAE804	50	50	100	2017-18
	Cyber Security and Forensics 16ECAE806	50	50	100	2017-18
	IT Infrastructure & Management 16ECAE807	48	48	100	2017-18
	16ECAE802 - NoSQL	48	48	100	2017-18
	16ECAE803 - Database Administration	48	48	100	2017-18
	Cloud Computing 16ECAE808	50	50	100	2017-18
V	Mobile Application Development 16ECAC903	50	50	100	2018-19
	Mini Project-3 16ECAP901	50	50	100	2018-19
	Wireless & Mobile Computing 16ECAE905	50	50	100	2018-19
	Machine Learning 16ECAE906	50	50	100	2018-19
	16ECAE903 - Information Security	48	10	20	2018-19

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HUBBALLI-580 031

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Semester	Course Name	Total Hours	Revision Hrs	% Change	Year of Implementation
	16ECAE904 - Service Oriented Architecture	48	10	20	2018-19
VI		0	0		
		0	0		
		0	0		
VII		0	0		
		0	0		
		0	0		
VIII		0	0		
		0	0		
		0	0		
	Number of Course Revised: 21	**1010**	**858**		

Evidence enclosed:

Schemes of 2015-18 batch and 2016-19 batch with changes shown in different colour.

Total Number of Courses Revised: 21

Total Number of Course in the Programme: 41

Percentage of course Changed : 51.00

Signature of HoS/HoD

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HUBBALLI-580 031

Date: 15-03-2021

Dept. of MCA: Change Summary Document

Change summary between 2016-17 and 2017-18 admitted batches
(i.e. 2016 to 19 batch 2017 to 20 batch)

Semester	Course Name	Total Hours	Revision Hrs	% Change	Year of Implementation
I	17ECAC701 Web Programming	42	42	100	2017-18
	17ECAP703 - UNIX Lab	48	16	30	2017-18
		0	0		
II	17ECAP706 Mini Project -1	48	48	100	2017-18
III		0	0		
IV	17ECAP802 OOAD Lab	36	36	100	2018-19
	17ECAE801 - Information Storage & Management	48	48	100	2018-19
	17ECAE803 Digital Image Processing	50	50	100	2018-19
	17ECAE802 Linux Administration	50	50	100	2018-19
V	17ECAP901 ASP .Net Lab	24	24	100	2019-20
	17ECAE903 RESTful Web Services	48	48	100	2019-20
	17ECAE902 Full Stack Development-MEAN	48	48	100	2019-20
	17ECAE901 Block Chain Technologies	48	48	100	2019-20
		0	0		
VI	17ECAP904 Robotic Process Automation (Certification Course)	30	30	100	2019-20
		0	0		
		0	0		
VII		0	0		
VIII		0	0		
		0	0		
	Number of Course Revised: 12	520	488		

Evidence enclosed:

Schemes of* 2016 to 19 batch 2017 to 20 batch *with changes shown in different colour

Total Number of Courses Revised: 12 **Total Number of Course in the Programme: 41**

Percentage of course Changed : 29.26

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Department of Master of Computer Applications
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HUBBALLI-580 031.

Date: 15-03-2021

Dept. of MCA: Change Summary Document

Change summary between 2017-18 and 2018-19 admitted batches
(i.e. 2017 to 20 batch 2018 to 21 batch)

Semester	Course Name	Total Hours	Revision Hrs	% Change	Year of Implementation
I	17ECAC702 - Web Programing	42	5	10	2018-19
		0	0		
II	Software Engineering Lab. 18ECAP701	48	48	100	2018-19
	15ECAC704 - Operating Systems	48	10	20	2018-19
III	17ECAC801 - JAVA Programming	48	10	20	2019-20
IV	18ECAE802 User Interface Design	48	10	20	2019-20
	18ECAE807 RESTful Web Services	50	50	100	2019-20
	17ECAC805 - Data Mining	48	10	20	2019-20
	18ECAE808 DevOps	50	50	100	2019-20
V	16ECAC902 - Advanced Java Programming	48	10	20	2020-21
	18ECAE907 -Machine Learning	48	48	100	2020-21
	18ECAE903 – Web Mapping	48	48	100	2020-21
	18ECAE908 - E-Commerce	48	10	20	2020-21
VI		0	0		
		0	0		
VII		0	0		
		0	0		
VIII		0	0		
	Number of Course Revised:12	574	309		

Evidence enclosed:

Schemes of* 2017 to 20 batch 2018 to 21 batch *with changes shown in different colour

Total Number of Courses Revised: 12 **Total Number of Course in the Programme: 41**

Percentage of course Changed : 29.26

Signature of HoS/HoD

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Date: 15-03-2021

Dept. of MCA: Change Summary Document

Change summary between 2018-19 and 2019-20 admitted batches
(i.e. 2018 to 21 batch 2019 to 22 batch)

Semester	Course Name	Total Hours	Revision Hrs	% Change	Year of Implementation
I	19ECAC701 Data Structures using C	50	10	20	2019-20
	19ECAP702 Rich Internet Application Lab.	36	18	50	2019-20
	19ECAP703 Unix & Shell Programming Lab.	48	12	30	2019-20
II	19ECAP706 Computer Networks Lab.	36	36	100	2019-20
		0	0		
III	19ECAC802 Information Security	50	50	100	2020-21
		0	0		
IV	19ECAE803 GIS Data Management	50	10	20	2020-21
	19ECAC801 - Cloud Computing	48	10	20	2020-21
	15ECAC901 - Big Data Analytics	48	10	20	2020-21
	16ECAE906 - Machine Learning	48	10	20	2020-21
		0	0		
V	19ECAE901 - LINUX Administration	48	48	100	2021-22
	19ECAE902 - Cyber Security and Forensics	48	48	100	2021-22
		0	0		
VI		0	0		
		0	0		
VII		0	0		
		0	0		
VIII		0	0		
		0	0		
		0	0		
	Number of Course Revised: 11	290	136		

Evidence enclosed:

Schemes of* 2018 to 21 batch 2019 to 22 batch *with changes shown in different colour

Total Number of Courses Revised: 11

Total Number of Course in the Programme: 41

Percentage of course Changed : 26.82

Signature of HoS/HoD

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Date: 15-03-2021

Dept. of MCA: Change Summary Document

Change summary between 2019-20 and 2020-21 admitted batches
(i.e. 2019 to 22 batch 2020 to 22 batch)

Semester	Course Name	Total Hours	Revision Hrs	% Change	Year of Implementation
I	20ECAC701 Data Structures using C	50	10	20	2020
	20ECAC702 Data Base Management System	50	10	20	2020
	20ECAC703 Computer Networks	50	10	20	2020
	20ECAC705 Web Technology	50	10	20	2020
	20ECAP701 Python Programming Lab.	48	10	20	2020
II	20ECAC706 OOPS using Java	50	50	100	2020
	20ECAC707 Data Mining	50	10	20	2020
	20ECAC709 Cloud Computing	50	10	20	2020
	20ECAC711 Design & Analysis of Algorithms	50	10	20	2020
		0	0		
		0	0		
III		0	0		
		0	0		
		0	0		
IV		0	0		
		0	0		
V		0	0		
		0	0		
VI		0	0		
		0	0		
		0	0		
VII		0	0		
		0	0		
		0	0		
VIII		0	0		
		0	0		
		0	0		
	Number of Course Revised: 9	**448**	**130**		

Evidence enclosed:

Schemes of **2019 to 22 batch 2020 to 22 batch** ***with changes shown in different colour***

Total Number of Courses Revised: 9 **Total Number of Course in the Programme: 22**

Percentage of course Changed : 40.90

Signature of HoS/HoD

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K. L. E Society's
KLE Technological University
School of Management Studies and Research

Course Code: **16MBAP702** Course Title: **Rural Immersion Phase - I**
L-T-P**: 0-0-1** Credits: **1** Contact Hrs: **02hrs/week**
ISA Marks: **100** ESA Marks: **--** Total Marks: **100**
Teaching Hrs: **28 hrs**

Rural set up with regard to:

- Education
- PEST
- Health Care: Oral Health and Hygiene
- Social evils
- Infrastructure: Road, Electricity, Water, Transportation, Housing Conditions, Banking, Postal services,
- Agri-business/SHG's(micro finance)/Business
- Weather

Village Mapping

Business prospects and development

- Innovative skills and excellence in planning, decision-making, organization and implementation in the sector. RURBAN model

K. L. E Society's
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School of Management Studies and Research

Course Code: **16MBAP704** Course Title: **Managerial Communication and Aptitude**
L-T-P**: 0-0-2** Credits: **2** Contact Hrs: **04hrs/week**
ISA Marks: **100** ESA Marks: **--** Total Marks: **100**
Teaching Hrs: **56 hrs**

Part 1: Managerial Communication

Topic 1: Discussions and Debates

- Understanding discussion
- Parameters measured in Group Discussions
- Video Analysis of Group Discussions **10 hrs**

Topic 2: Writing Skills

- Business letters
- Covering letter
- Resume writing
- Email etiquette

10 hrs

Topic 3: Interview Skills

- What companies expect
- Showing Commitment and Learning Ability
- Handling difficult questions
- Understanding interviewer psychology
- Situation Reaction and Presence of Mind
- Dressing right
- Interview etiquette

10hrs

Part 2: Managerial Aptitude

Arithmetical Reasoning:

- Number Systems and Speed Math
- Factors and Multiples
- Combinations
- Probability

- Percentages
- Interest
- Alligations and Averages
- Man-Hour Calculations

14 hrs

Analytical Thinking

- Data Analysis
- Data Interpretation
- Data Sufficiency
- Puzzles

06 hrs

Verbal Logic

- Verbal Analogy
- Verbal Classification
- Letter and Number Series
- Decoding the Codes

04 hrs

Non – Verbal Logic

- Non – Verbal Analogy
- Non – Verbal Classification
- Pattern Completion
- Pattern Comparison

02 hrs

References:

- Vilanilam J V, More Effective Communication: A Manual for Professionals, Sage Publications.
- Shirley Taylor, 2005, Communication for Business: A Practical Approach, 4th Edition, Pearson Longman.
- John M Penrose, Robert W. Rasberry, and Robert J. Myers, Advanced Business Communication, 3rd edition, Thomson South-Western.
- Raymond V. Lesikar, Basic Business Communication: Irwin/McGraw-Hill, 1999
- Sam Phillips, 3000 Synonyms and Antonyms 1st Edition, Goodwill Publishing House
- John Jackman and Wendy Wren, Nelson English Evaluation Pack – Book 5, Thomas Nelson

K. L. E Society's

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School of Management Studies and Research

Course Code: **16MBAC714** Course Title: **Indian Society and Citizenship**

L-T-P**: 1-0-1** Credits: **2** Contact Hrs: **03hrs/week**

ISA Marks: **100** ESA Marks: **--** Total Marks: **100**

Teaching Hrs: **14 hrs**

Indian society

- Structure of Indian Society
- Indian caste system
- Upbringing and family values
- Suppressive and pro-active to progressive and reactive society, paradigm shift in Indian societal behavior
- Factors that influence the social behavior of an Indian in today's day and age

Active Citizenship

- Civic Sense
- College Profile and Community Profile
- Local Government
- Right to Information
- Democracy and Freedom
- Celebrating our diversity, pluralism
- Our constitution and respect for law
    - Rights and Duties
    - Green Environment
    - Voting

14 hours

References:

- J. Dreze and A. Sen, India: Development and Participation, (New Delhi: Oxford University Press, 2002)
- Levinson, B. 2011. Towards an Anthropology of (Democratic) Citizenship Education
- Vicki S. Helgeson, Psychology of Gender (Carnegie Mellon University)

- David G. Myer, Exploring Social Psychology (Michigan's Hope College)
- Eric Shiraev & David Levy, Cross - Cultural Psychology: Critical Thinking & Contemporary Application (Eric - George Mason University, Northern Virginia Community College. David - Pepperdine University)
- Frank W.Schneider, Jamie A. Gruman, Larry M. Coutts, Applied Social Psychology: Understanding & Addressing Social and practical Problems.
- T.R Raghunandan, Decentralisation & Local Governments: The Indian Experience
- Mukul Sharma, Green & Saffron: Hindu Nationalism & Indian Environmental Politics
- Green, Duncan (2012) From Poverty to Power (2nd edition) - How active citizens & effective states can change the world, Oxfam London.
- Honohan, I.(2005) Active Citizenship in contemporary democracy, in Harris, C.(ed.) The Report of the Demcracy Commission: Engaging Citizens, the Case for Democratic Renewal in Ireland, Dublin: TASC and Democratic Dialogue
- Mody, Pillo (2003) Democracy Means Bread & Freedom. Abhinav Publications New Delhi.
- Branson, M.S. (1998)The Role of Civic Education - A Forthcoming Education Policy Task Force Position Paper from the Communitarian Network
- Galston, William (2001) Political Knowledge, Political Engagement and Civic Education in Annual Review of Political Science. University of Michigan.
- Shelley E. Taylor, Letitia Anne Peplau, David O. Sears, Social Psychology (12th Edition)

- Bipan, Chandra.1989. India's Struggle for Independence. Delhi: Penguin Books
- Deasi, A.R.1978. Rural Sociology in India. Delhi: South Asia Books
- Dumont, L. 1980. Homo Hierarchicus. University of Chicago Press
- Gupta Dipankar. 1992. Social Stratification. New Delhi: Oxford University Press
- Srinivas, M.N. 1987. The Dominant Caste and Other Essays. Delhi: Oxford University Press.
- Srinivas, M.N. 1995. Social Change in Modern India. Delhi: Orient Longman
- The Nestle Maggi fiasco in India, 2015
- The Uber Scandal India, 2014
- Vijay Mallya Willful defaulter case India, 2016

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Course Code: **16MBAC712**		Course Title: **Human Resource Management**
L-T-P**: 2-0-0**	Credits: **2**	Contact Hrs: **02hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching hrs: **28 hrs**		Exam Duration: **3 hrs**

Module 1:
Introduction, characteristics, scope, objectives, functions and role of Human Resource Management(HRM), HRM versus personnel management, difference between HRM and HRD (Human Resource Development), qualities of Human Resource (HR) manager, HR manager as a strategic partner.

08 hrs

Module 2:
Job design, analysis, description, specification, enrichment, enlargement and rotation,
Introduction to compensation and benefits management - purpose, meaning, factors, challenges

06 hrs

Module 3:
Acquisition of human resources: Man power planning, objectives, Recruitment, sources of recruitment, selection techniques, Placement, Induction.

08 hrs

Module 4:
Employee engagement, competency mapping, Managing careers, welfare facilities, industrial relations, work life balance, Introduction to IHRM (International Human Resource Management), HR Ethical issues, contemporary HRM

06 hrs

References:

- Gary Dessler, Human Resource Management, 10th edition, Prentice Hall
- Cynthia D. Fisher, Lyle F. Schoenfeldt, and James B. Shaw, Human Resource Management, Biztantra.
- Ashwatappa K, Human Resource and Personnel Management, 4th edition, Tata McGraw Hill.
- Rao V S P, Human Resource Management, Excel Books

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Course Code: **16MBAP706** Course Title: **Rural Immersion Phase - II**
L-T-P**: 0-0-1** Credits: **1** Contact Hrs: **02hrs/week**
ISA Marks: **100** ESA Marks: **--** Total Marks: **100**
Teaching Hrs: **28 hrs**

a) Review of RI Phase I
b) Identify area of improvement
c) Solution to an area of improvement
d) Recommendations and implementation plan

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Course Code: **16MBAC802**		Course Title: **Climate change & Sustainability**
L-T-P**: 2-0-0**	Credits: **2**	Contact Hrs: **02 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **28hrs**		**E**xam Duration: **3 hrs**

Module 1
Climate science and potential impacts:
Impacts of climate change on India, India in the Intergovernmental Panel on Climate Change, The UN Framework Convention on Climate Change.

5 hrs

Module 2
The international climate negotiations: stakes, debates and dilemmas
International climate negotiations and India's role , Equity in climate change : the range of metrics and views , Climate change debate : the rationale of India's position , India's official position : a critical view based on science , Views from the outside : international perspectives on India's climate positions. Environmental Economy

8 hrs

Module 3
Domestic politics of climate change
Climate politics in India , Climate change and Indian environmental movement , Climate change and parliament, Climate change and the private sector, Corporate responses to climate change in India.
Political Economy

8 hrs

Module 4
Integrating climate change and development: a sectoral view
Energy, development and climate change, Climate change and urbanization in India, Agriculture in the environment: sustainable climate friendly systems in India , Framework for India's strategic water resource management under a changing climate, The technology agenda.
Looking to the future
The geopolitics of climate change, Climate change regional perspective, Sustainable Development

7 hrs

Reference text book:

- Navroz K, Dubash , *Handbook of Climate Change and India*, Oxford

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Course Code: **16MBAC804**		Course Title: **Technology: an enabler**
L-T-P**: 1-0-0**	Credits: **1**	Contact Hrs: **01 hrs/week**
ISA Marks: **100**	ESA Marks:	Total Marks: **100**
Teaching Hrs: **14 hrs**		**E**xam Duration: 3 hrs

Module 1
Introduction
Data and information, Concepts of management information systems, Information systems in organization, information as resource of competitive advantage, Decision making with MIS, Contemporary approaches to MIS, Data Warehouse, ethical and social issues related to systems.
08 hrs

Module 2

Technology Management
Technology management, Internet on things (IoT), Smart city, GPS & RFID. **06 hrs**

References:

- Rahul De, *Managing Information Systems in Business, Government and Society*, Wily India Publication; 1st Edition
- Gordon B. Davis and Margrethe H. Olson, *Management Information Systems (Conceptual foundations, Structure and Development)*McGraw Hill Education India Private Limited; 2 edition
- James O'Brien and George Marakas, *McGraw Hill Education India Private Limited*; 10 edition

K. L. E Society's
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Course Code: **16MBAP707** Course Title: **Rural Immersion - III**
L-T-P**: 0-0-1** Credits: **1** Contact Hrs: **02hrs/week**
ISA Marks: **100** ESA Marks: **--** Total Marks: **100**
Teaching Hrs: **28 hrs**

List of activities planned:

- Review of RI Phase I and II
- Review of identified area of improvement
- Measure the impact of the improvement
- Continue the same improvement area or identify new, if necessary
- Working on the RI phase III with the support of SIIT/ industry/NGO/Government partner
- Possible solution to an area of improvement
- Recommendations and implementation plan

K. L. E Society's
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Course Code: **16MBAE801**	Course Title: **Sales Management**
L-T-P**: 2-1-0** Credits: **03**	Contact Hrs: **04hrs/week**
ISA Marks: **50** ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **28 hrs**	Exam Duration: **3 hrs**

Module 1:
Introduction to Sales Management:
Introduction, Evolution of sales management, nature importance of sales management, role and skills of modern sales people, sales management positions/sales as a career, responsibilities (social, ethical, legal) of sales person

06 hrs

Module 2:

Planning sales team:

Nature of organization, types, characteristics of the organization, sales budget, designing of sales territories, sales objectives, quotas and targets, role of ICT in sales organization

07 hrs

Module 3:
Sales-force Management: recruitment and placement, training and development, personal selling, motivation, leadership, analysis and evaluation

10 hrs

Module 4:

Contemporary topics: Global Sales-force management, Role of technology in Sales-force and Distribution channel management, ethical, social and technological issues in sales-force management.

5 hrs

References:

- Spiro, Stanton, Rich, *Management of Sales force*, 11th Edition Tata McGRAW Hill
- Krishna K Havaldar, M Cavale, *Sales and Distribution Management: Text and Cases*, McGRAW Hill
- Tapan K Panda, Sunil Sahadev, *Sales and Distribution Management,* 2nd Edition, Oxford Higher Education.

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Course Code: **16MBAE821**		Course Title: **Learning and Development**
L-T-P: **3-0-0**	Credits: **3**	Contact Hrs: **03 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Module 1:
Introduction to learning, training and development, Meaning and significance of learning, theories of learning, learning process, Training meaning, significance, purpose and process, Training Department and Trainers' Roles

08 hrs

Module 2:
Training Needs Analysis: Meaning and significance of training needs, types of needs, components of needs, data collection, analysis and interpretation. Training design and development

08 hrs

Module 3:
Training methods: on the- job and off –the- job training
Management Development Program (MDP): Need, factors affecting MDP, methods, process

10 hrs

Module 4:
Evaluating Training Programs: Meaning, significance, Donald Kirkpatrick's evaluation model, data collection for training evaluation, designs of training evaluation, process, Return on Investment in training, a search for best practices in evaluation

08 hrs

Module 5:
Trends of learning and development, E-learning and use of technology for training, creativity and its role in Learning and Development, knowledge management, Career in Training

06 hrs

References:

- Noe A Raymond, Employee Training & Development, McGraw Hill Publication.
- Rolf Lynton & Udai Pareek, Training for organizational transformation, Sage Publications, New Delhi.
- Jackie Clifford & Sara Thorpe, Workplace Learning & Development: Delivering Competitive Advantage for your organisation, Kogan Page Limited (2007)
- Tony Bingham, The New Social Learning, 1st Edition, , 2012, Cengage Learning India Pvt. Ltd, New Delhi
- Rao T.V, Performance Appraisal – Theory and Pract ice
- Jack J. Phillips, Butterworth-Heinemann Return on Investment in Training and Performance Improvement Programs, 2nd Edition

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Course Code: **16MBAE823**		Course Title: **HR Operations**
L-T-P**: 2-1-0**	Credits: **3**	Contact Hrs: **04 hrs/week**
ISA Marks: 5**0**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **28hrs**		Exam Duration: **3 hrs**

Module 1:
Introduction to HR Operations, HR Policies, importance, types of HR Policies, On boarding: importance, objectives, process, HRIS (human resource information system) – concept, objectives, how Managers Use the HRIS?, Implications on local organizations, Digitalization of HR

07 hrs

Module 2:
Compensation Management (CM):
Introduction to Compensation Management: Overview of HRM, role of compensation in organizations, introduction to compensation management, Factors influencing employee remuneration, Process of Compensation Management, Architecture of Compensation, Performance appraisal

07 hrs

Module 3:
Indian Industrial Relations (IR) – An overview, need and objectives. Importance of harmonious IR, Conditions for congenial IR, IR in the post Independence period,
Industrial relations in the region

Grievance procedure and Discipline management: Grievance, meaning and forms, approaches to grievance machinery, Grievance procedures, Industrial Discipline and Misconduct, Domestic Enquiry, Code of Discipline in Industry, Retention, Attrition, Exit interviews

08 hrs

Module 4:
Collective Bargaining in India: Definition, Essential conditions for the success of collective bargaining, collective bargaining process, prerequisites for collective bargaining.

Contemporary topics

06 hrs

References:

- Monappa Arun *Industrial Relations*, Tata McGraw Hill Publishing Company Ltd, 1/e, 2002.
- Mishra S.N.*Labour and Industrial Laws*, Central Law Publications, Allahabad
- Michael J. Kavanagh (Editor), Mohan Thite , *Human Resource Information Systems: Basics, Applications, and Future Directions,* SAGE Publications
- Piyali Ghosh, Shefali Nandan, *Industrial Relations and Labour Laws,* Mc Graw Hill Education(India) Private Ltd

K. L. E Society's
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School of Management Studies and Research

Course Code: **16MBAE806**		Course Title: **Digital Marketing**
L-T-P**: 2-1-0**	Credits: **03**	Contact Hrs: **04hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **28 hrs**		Exam Duration: **3 hrs**

Module 1:
Introduction to digital marketing: Need and relevance for digital marketing, evolution of digital marketing, challenges/issues concerning digital marketing and future of digital marketing.
06 hrs

Module 2:
Ethical components in digital marketing
Social media campaigns: analyzing successful green campaigns,
Social media and customer engagement: the social feedback cycle, open access to information and the connected customers.
The social web and engagement: the engagement process

Introduction to social media as a business tool: use of face book, YouTube, twitter and LinkedIn as modern tools for business operations and communications.

12 hrs

Module 3:
The new role of the customer: social interactions on social media.
Customer Relationships: Social CRM.
Overview of social business: building a social business ecosystem, social profiles, social applications, using brand outposts and communities
05 hrs

Module 4:
Contemporary topics **05 hrs**

References:

- Dave Evans,*Social Media Marketing: The Next Generation of Business Engagement* Wiley Publication Inc
- Sameer Deshpande and Nancy R Lee,*Social Marketing in India* , Sage Publications
- Diane Martin and John Schouten,*Sustainable Marketing,* Prentice Hall Publications
- Robert Dahlstorm, *Green Marketing: Theory, Practice, and Strategies* (English) 1st Edition South Western Publications

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Course Code: **16MBAE834**		Course Title: **Inventory Management**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **03 hrs/week**
ISA Marks: 5**0**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40hrs**		Exam Duration: **3 hrs**

Module 1
Dependent and independent demand, Demand Forecasting, Need for inventory, types of inventory, effect of inventory on profitability. **08hrs**

Module 2
Basic inventory Model, Inventory model with continuous replenishment, inventory model with discounts, Inventory model with uncertain demand, Inventory model with variable demand and fixed lead time, Inventory model with fixed demand and variable lead time, inventory model with variable demand and lead time **12 hrs**

Module 3
Selective inventory control, dependent inventory management(MRP), Collaborative Planning, Forecasting and Replenishment, JIT systems **06 hrs**

Module 4
Inventory as substitute for capacity, Multilocation inventory models –one origin several destinations, several origin several destinations system **10 hrs**

Module 5
Role of inventory in food security, impact of real time data communication on inventory management **04 hrs**

References

- Buffa and Sarin ,*Operations Management*
- Max Muller ,*Essentials of Inventory Management*
- NarasimhanSitaramn and Mcleavey Dennis, *Production Planning and Inventory Control*

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Course Code: **16MBAE835**		Course Title: **Logistics and Warehouse Management**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **03 hrs/week**
ISA Marks: 5**0**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40hrs**		Exam Duration: **3 hrs**

Module 1
Introduction
Inventory Flow, Information Flow, Planning and Coordination flows , Operational flows, Difference between Logistics and Supply Chain Management Linkage of Logistics to other functions, Objectives of Logistics Management, 5Ps and & 7 Rs of Logistics. Modes of transportation and documentation
10 hrs

Module 2
Location Selection and Network Design
Transportation – Location Trade-offs, , Location Models, Locating Service Organisations
Transportation Modeling, Routing, Transshipment, Multi location and multi item ware house modeling.
12 hrs

Module 3
Warehouse Management
Warehouse Operations, Material Handling and Packaging, Parts and Service Support, Bar coding, RFID, Electronic Data Interchange (EDI),Automated material handling,Warehouse Management Systems (WMS) **08 hrs**

Module 4
Strategic Logistic Practices
International Logistics, Third party and Fourth party logistics,ERP and Ecommerce & Logistics
06 hrs

Module 5
Reverse Logistics and its impact on Environment
Definition, evolution and trends. Economic and environmental impact

04 hrs

References

- G. Raghuram and Rangaraj,*Logistics and Supply Chain Management: Cases and Concepts* Laxmi Publications (2015)
- Christopher, M; Richard Irwin *Logistics and Supply Chain Management*
- Chopra and Mendal, *Supply Chain Management*

K. L. E Society's
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Course Code: **16MBAP708** Course Title: **Rural Immersion - IV**
L-T-P**: 0-0-1** Credits: **1** Contact Hrs: **02hrs/week**
ISA Marks: **100** ESA Marks: **--** Total Marks: **100**
Teaching Hrs: **28 hrs**

List of activities planned:

- Review of RI Phase III
- Measure the impact of the improvement
- Study RI phase IV with the support SIIT/ industry/NGO/Government partner
- Solution to an area of improvement
- Recommendations and implementation plan

K. L. E Society's
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Course Code: **17MBAC704** Course Title: **Business Research and Statistics**
L-T-P**: 3-1-0** Credits: **4** Contact Hrs: **05 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Module 1:
Introduction to business research:
Meaning and objectives of research, Types of research, Stages in research process, Characteristics of Good Research
Philosophy of Research Methodology: Ontology, Logic of Procedure, epistemology, Research Gap
07 hrs

Module 2:
Concepts in Research:
Variables, Qualitative and Quantitative Research
Research design: Meaning, Importance, Steps in research design,
Types- Descriptive, Exploratory and causal

Sampling :meaning of sample and sampling, methods of sampling-
i)Non– Probability Sampling Convenient, Judgment, Quota, Snow ball,
ii) Probability – Simple Random, Stratified, Cluster, Multi Stage.
06 hrs

Module3:
Types of Data& Data Collection:
Primary and secondary
Methods of Data collection– Personal Interviews, Telephonic or Internet Interview, Observation, Focus group interviews, Expert opinions, self administered questionnaire
Schemes of analysis Secondary data analysis, Qualitative data analysis

Introduction to business statistics: Importance of statistics in managerial decision-making, the nature of study, limitations and misuse of statistical data, subdivisions within statistics.

Data: types, Frequency Distribution, Representation, Measures of Central Tendency, Measures of dispersion
14 hrs

Module 4:
Types of measurement and Scales:
Nominal, Ordinal, Interval, Scale,
Types of Measurement Scales, Attitude rating, Likert, Thurstone, Semantic Differential
04 hrs

Module 5:
Hypothesis andProbability distribution:
Meaning, Nature, Significance, Types of Hypothesis,

Normal distribution, Correlation and Regression Analysis, Test for means and Proportions, Test for equality of population means, confidence interval, introduction to Chi-square test.
Report writing, ethical issues, and plagiarism

09 hrs

References:

- Cooper and Schlinder, *Business Research Methods,* TMH
- William Zikmund, *Business Research Methods*, Cengage Publication
- G. C. Ramamurthy, *Research Methodology*, Dreamtech Press
- Uma Sekaran and Roger Bougie, *Research Methods for Business*, Wiley Publications
- Uwe Flick, *An Introduction to Qualitative Research*, Sage Publications
- Gerard Guthrie, *Basic Research Methods*, Sage Publications

- G. C. Beri, 2005, *Business Statistics*, 2nd edition, Tata McGraw-Hill.
- R I Lewin and David S Rubin, *Statistics for Management*, 7th edition, Pearson.
- Robert E. Stine, Dean Foster, *Statistics for Business: Decision Making and Analysis*, 1st edition, Pearson
- Bruce Bowerman, Emly S. Murphree, Richard O'Connell*Business Statistics in Practice*, 5th edition, Tata McGraw-Hill.
- J K Sharma, *Business Statistics*, 2rd edition, Pearson

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Course Code: **17MBAP803** Course Title: **MS Excel for Managers**
L-T-P**: 0-0-2** Credits: **2** Contact Hrs: **04Sessions/week**
ITA Marks: **100** ETA Marks: **--** Total Marks: **100**
Teaching Hrs: **56hrs**

MS Excel

- MS Excel Basics
- Editing Worksheet
- Formatting Cells
- Formatting Worksheets
- Working with Formula
- Advanced Operations
- MS Excel Resources

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Course Code: **17MBAW802**	Course Title: **Project work Phase - I**
L-T-P**: 0-0-2** Credits: **2**	Contact Hrs: **04Sessions/week**
ITA Marks: **100** ETA Marks: **--**	Total Marks: **100**
Teaching Hrs: **56hrs**	

Student has to execute the below mentioned tasks about the industry related to his/her SIIT firm

Task s:

- Review of literature (Strategic Management models and tools)
- Value chain study
- Internal value chain and identification of drivers
- Report writing

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Course Code: **17MBAW803** Course Title: **Entrepreneurship Project -Phase III**
L-T-P**: 0-0-3** Credits: **3** Contact Hrs: **06Sessions/week**
ITA Marks: **100** ETA Marks: **--** Total Marks: **100**
Teaching Hrs: **56hrs**

Tasks

- Finalization of business model
- Prepare for commercial launch
- Report on Business plan and reflections on experience

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Course Code: **17MBAR802** Course Title: **Research Experience - Phase III**
L-T-P**: 0-0-3** Credits: **3** Contact Hrs: **06 Sessions/week**
ITA Marks: **100** ETA Marks: **--** Total Marks: **100**
Teaching Hrs: **56hrs**

Pre-requisite: Research Experience - Phase I

Tasks:

- Data analysis and Interpretation
- Findings and suggestions
- Report writing and presentation

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Course Code: **17MBAW804**	Course Title: **Project work Phase - II**
L-T-P**: 0-0-2** Credits: **2**	Contact Hrs: **04Sessions/week**
ITA Marks: **50** ETA Marks: **50**	Total Marks: **100**
Teaching Hrs: **56hrs**	Viva-voce: **3 hrs**

Project work Phase – I is prerequisite

Student has to execute the below mentioned tasks
Tasks

- Industry value chain and identification of drivers
- Compare and contrast Company value chain with industry value chain
- Industry Trends and futuristic outlook
- Report writing

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Course Code: **18MBC710** Course Title: **Society, Citizenship & Rural Immersion Phase -I**

L-T-P**: 1-1-1** Credits: **3** Contact Hrs: **05 Sessions /week**
ITA Marks: **100** ETA Marks: **--** Total Marks: **100**
Teaching Hrs: **28hrs**

Indian society

Structure of Indian Society, Indian caste system, Upbringing and family values, Suppressive and pro-active to progressive and reactive society, paradigm shift in Indian societal behavior, Factors that influence the social behavior of an Indian in today's day and age

Active Citizenship

Civic Sense, College Profile and Community Profile, Local Government: Village Panchayat/Town or City Municipality/ City Corporation, Taluk Panchayat, Zilla Panchayat, State and Central Government, Right to Information, Democracy and Freedom, Celebrating our diversity, pluralism, Our constitution and respect for law, Rights and Duties, Green Environment, Voting

Tasks in Rural Immersion

- Environment and infrastructure studying (Village mapping)
- Social Development and Business prospects

References:

- J. Dreze and A. Sen, India: *Development and Participation*, (New Delhi: Oxford University Press, 2002)
- Levinson, B. 2011. *Towards an Anthropology of (Democratic) Citizenship Education*
- Vicki S. Helgeson, *Psychology of Gender* (Carnegie Mellon University)
- David G. Myer, *Exploring Social Psychology* (Michigan's Hope College)
- Eric Shiraev& David Levy, *Cross - Cultural Psychology*: *Critical Thinking & Contemporary Application* (Eric - George Mason University, Northern Virginia Community College. David - Pepperdine University)
- Frank W.Schneider, Jamie A. Gruman, Larry M. Coutts, *Applied Social Psychology: Understanding & Addressing Social and practical Problems*.

Course Code: **18MBAE805** Course Title: **Integrated Marketing Communications**
L-T-P**: 2-1-0** Credits: **03**Contact Hrs: **04 Sessions/week**
ITA Marks: **50** ETA Marks: **50**Total Marks: **100**
Teaching Hrs: **28 hrs** Exam Duration: **3 hrs**

Module 1:

Integrated marketing communication: Integrated marketing communication: The evolution of IMC, reasons for growing importance of IMC, the promotional mix- advertising, direct marketing, internet marketing, sales promotion, publicity, public relations, personal selling, promotion management, IMC planning process

06hrs

Module 2:

Organizing for advertising and promotion: The role of advertising agencies, agency compensation, evaluating agencies, developing the integrated marketing communication program, Importance of creative advertising

Media planning & strategy: An overview on media planning, developing media plan, market analysis and target market identification, establishing media objective, developing and implementation media strategies, evaluation and follow up.

Internet and IMC: Measuring the effectiveness of Internet advertising, advantages of Internet marketing, direct marketing on Internet budgeting for marketing communication.

12hrs

Module 3:

Consumer Decision Making Process: Steps of effective communication, communication objectives, consumer decision making process, how advertising works- AIDA and hierarchy effects model, convincing senior executives on the marketing communication budget**.**

05hrs

Module 4:

Contemporary topics: Shift to Mobile and Beyond, Social Media Impact on Communication and Brand Journalism

05hrs

References:

- Belch, M.A., and Belch, G.E., *Advertising and Promotion*, Tata Mc-Graw Hill Publication
- Keller Kevin, Strategic Brand Management, Pearson Publication, Third Edition
- Shah, K. and D'souza, A., *Advertising & Promotion*, Tata Mc-Graw Hill Publication

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Course Code: **18MBAE807** Course Title: **Industrial Marketing**
L-T-P**: 2-1-0** Credits: **03** Contact Hrs: **04 Sessions/week**
ITA Marks: **50** ETA Marks: **50** Total Marks: **100**
Teaching Hrs: **28 hrs**Exam Duration: **3 hrs**

Module1:
Basic concept of Industrial Marketing: Industrial Marketing, consumer and industrial products, consumer and industrial marketing, differences of consumer and industrial marketing.
Industrial markets: Industrial customers, specificities of industrial markets, the environment of Industrial Marketing. The specificities and the risks in international markets. The trends in globalization of industrial markets

5 hrs

Module 2:

Organization's purchasing behaviour, system of purchasing decisions: System of taking decisions in the Industrial Marketing. The poles in the system of taking purchasing decisions in Industrial Marketing.Factors that affect the purchasing decision in Industrial Marketing.

Process of taking purchasing decisions for industrial products.Types of purchasing activities in Industrial Marketing.Marketing Strategies for the purchasing activities and the stages of the process of taking purchasing decisions. Information sources that are used from members of the Taking purchasing decisions' system

10 hrs

Module 3:
Pricing and Promotion in Industrial Marketing: The importance of pricing in Industrial Marketing. In-house and external factors determine the price. Procedures, processes and pricing policies.The mixture promotion in industrial marketing. Sales promotion, advertising, direct marketing, public relations and personal selling.
Distribution of industrial products: The importance of industrial products. Administration and revitalization of existing industrial products. The Marketing distribution functions, main forms of intermediate, forms of industrial channels. Design, selection and management of distribution channels.

08 hrs

Module 4:
Contemporary topics
Systematic approach to the management and control of supplier/customer relationships, interactive strategic marketing planning: A new approach. Smart Business to business strategy.

05 hrs

References:

1. Tomaras P. (2009). Industrial Marketing. Published by the author. Athens, (ISBN: 978-960-90674-3-0). (in Greek)
2. Ralph S Alexander, Richard M Hill, Industrial Marketing-Edition-3

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Course Code: **18MBAE808** Course Title: **Product and Brand Management**
L-T-P**: 2-1-0** Credits: **03**Contact Hrs: **04hrs/week**
ITA Marks: **50** ETA Marks: **50** Total Marks: **100**
Teaching Hrs: **28hrs** Exam Duration: **3 hrs**

Module 1:
Introduction to Product Management, Role and Functions of Product Managers,Product Mix and SBU Strategies, Portfolio analysis (BCG / GE Multifactor Matrix), Marketing Planning

7 hrs

Module 2:
Product Decisions over the PLC, New Product Development Process, Pricing and Promotion strategies, channel management

7 hrs

Module 3:
Introduction to Brand Management- Branded House Vs House of Brands, Corporate Brand,Brand prism by Kapferer Model, Brand Anatomy,Branding Decisions- Line Extensions, Category Extension, Brand Equity – Concept and measure

10hrs

Module 4:
Contemporary Practices **04hrs**

References:

- Donald R Lehamann, Product management 4th Edition, Mcgrow Higher Ed
- Marc Annacchino, New Product Development, 2003 Ed, Elsevier Butterworh-Heinemann
- Saaksvuori Antti, Product Lifecycle management, Springer- Verlag
- Kevin Lane Keller, M G Parameswaran, Isaac Jacob, Strategic Brand Management, 2008, Person publication
- David Aaker, Brand Management, TMH publication
- YLR Murthy, Brand management Indian prospective, Vikas Publications

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Course Code: **19MBAE811** Course Title: **Security Analysis and Portfolio Management**
L-T-P**: 2-1-0** Credits: **3** Contact Hrs: **04 Sessions/week**
ITA Marks: **50** ETA Marks: **50** Total Marks: **100**
Teaching Hrs: **28 hrs** Exam Duration: **3 hrs**

Module 1:
Introduction to Investments
Introduction to Investments: Concepts of investment-characteristics and objectives of investment, investment Vs speculation, forms of investment, alternative investments, marketable and non marketable financial assets, Foreign Portfolio Investment (FPI), Sovereign Wealth Funds (SWFs). Analysis of risk & return, concept of total risk, elements of risk – systematic and unsystematic risk, business risk, interest rate risk, market risk, management risk, purchasing power risk. Measuring Risk and Return.

08 hrs

Module 2:
Introduction of fundamental and technical analysis
Fundamental analysis, equity valuation, balance sheet techniques, discounted cash flow technique, dividend discount model, zero growth model, constant growth, two stage growth, earning multiplier approach Bond characteristics, bond price, bond yield, Price, yield relationship, risk in bonds, rating, yield theories, segmentation theory.
Technical analysis: introduction, the concept of Dow Theory, trend and trend reversals, chart patterns, Eliot wave theory, mathematical indicators

05 hrs

Module 3:
Efficient market hypothesis and portfolio Management
Behavior of market, efficient market hypothesis, portfolio Analysis, return and risk of portfolio, portfolios with more than two securities Portfolio Selection, feasible set of portfolios, optimal portfolio, Markowitz model, single index model, multi index model, CAPM, Arbitrage Pricing Theory.

09 hrs

Module 4:
Portfolio Performance, Evaluation and Revision
Portfolio revision, meaning and constraints, revision strategies portfolio evaluation, need and meaning, differential return, Treynor ratio pros and cons, residential and other forms

06 hrs

References:

- Punithavati Pandyan, *Security Analysis and Portfolio Management*, Latest edition, VikasPubl,
- Kevin S*, Portfolio Management*, 2nd edition, Prentice H,
- Alexander, Sharpe, Bailley*, Fundamentals of Investment,* Pearson,
- ChndraPrasanna*, Investment Analysis and Portfolio Management*, 3rd Edition, TMH

K. L. E Society's
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Course Code:**19MBAW802** Course Title: **Internship and Project work**
L-T-P**: 0-0-7** Credits: **7**Contact Hrs: **14Sessions/week**
ITA Marks: **50** ETA Marks: **50** Total Marks: **100**
Teaching Hrs: **98 hrs** Viva-voce: **3 hrs**

PART I

- Broad overview pertaining industry and detailed organization profile in the framework of foundation courses (Human Resource Management, Marketing Management, Operations Management and Financial Management)
- Student has to work on the research area
- Data collection
- Analysis and Interpretation
- Findings, recommendations and conclusion
- Report writing
- Experience worth noting

PART II

Detailed industry profile based on secondary source

Tasks

- Data collection
- Analysis
- Interpretation using tools leading to Challenges, Megatrends and Impact in the global context
- Scope and Opportunities in local prospective

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Course Code: **19MBAW803** Course Title: **Entrepreneurship Project -Phase II**
L-T-P**: 0-0-5** Credits: **5** Contact Hrs: **10 Sessions/week**
ITA Marks: **100** ETA Marks: **--** Total Marks: **100**
Teaching Hrs: **70 hrs**

Pre-requisite: Entrepreneurship Project - Phase I

Tasks:

- Report of feasibility study in the framework of effectuation
- Preliminary survey
- Developing alternative business models
- Selection of resources
- finalization of business model
- Prepare for commercial launch
- Report on Business plan and reflections on experience

K. L. E Society's
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School of Management Studies and Research

Course Code: **19MBAR802** Course Title: **Research Experience - Phase II**
L-T-P**: 0-0-5** Credits: **5** Contact Hrs: **10 Sessions/week**
ITA Marks: **100** ETA Marks: **--** Total Marks: **100**
Teaching Hrs: **70 hrs**

Pre-requisite: Research Experience - Phase I

Tasks:

- Instrument development
- Data collection, tabulation, coding
- Data analysis and Interpretation
- Findings and suggestions
- Report writing and presentation