Semester: III

Course Code	Course Title	Category	L	T	P	Hrs	Credits	Marks	
								ISA	ESA
15EMAB201	Statistics And Integral Transforms	BS	4	0	0	4	4	50	50
15EMAB231	Calculus And Integral Transforms								
18EARC201	Analog & Digital Electronic Circuits	ES	4	0	0	4	4	50	50
18EARC202	Kinematics Of Machinery	PSC	4	0	0	4	4	50	50
18EARC203	Data Structure Algorithm Design and Analysis	PSC	4	1	0	6	5	50	50
18EARC204	Mechanics Of Materials	ES	3	0	0	3	3	50	50
18EARC205	Manufacturing Technology	PSC	3	0	0	3	3	50	50
18EARP201	Analog & Digital Electronic Circuits Lab	PSC	0	0	1	2	1	50	50
18EARP202	Kinematics Of Machinery lab	PSC	0	0	1	2	1	80	20
18EARP203	Machine Drawing Lab	PSC	0	0	1	2	1	80	20
Total			**22**	**1**	**3**	**30**	**26**		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS**: Basic Science

Semester: IV

Course Code	Course Title	Category	L	T	P	Hrs	Credits	Marks	
								ISA	ESA
15EMAB206	Numerical Methods and Partial differential equations	BS	4	0	0	4	4	50	50
15EMAB241	Vector calculus and differential								
18EARC206	Machine Design	PSC	3	0	0	3	3	50	50
18EARC207	Control Systems	PSC	4	0	0	4	4	50	50
18EARC208	Microcontrollers Programming & Interfacing	PSC	4	0	0	4	4	50	50
18EARC209	Object Oriented Programming & DBMS	PSC	3	0	0	3	3	50	50
18EARC210	Robot analysis & design	PSC	4	0	0	4	4	50	50
16EARP205	Manufacturing Technology Lab	PSC	0	0	1	2	1	50	50
18EARP208	Microcontrollers Programming & Interfacing Lab	PSC	0	0	1	2	1	80	20
18EARP209	Object Oriented Programming & DBMS Lab	PSC	0	0	2	4	2	80	20
Total			**22**	**0**	**4**		**26**		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS**: Basic Science

Semester: V

Course Code	Course Title	Category	L	T	P	Hrs	Credits	Marks	
								ISA	ESA
17EARC301	Object Oriented Programing and Data base management systems	PSC	4	0	0	4	4	50	50
17EARC302	Programming Industrial Automation Systems	PSC	3	0	0	3	3	50	50
17EARC303	Mechatronics System Design	PSC	3	0	0	3	3	50	50
17EARC304	Measurement Systems	PSC	3	0	0	3	3	50	50
17EARC305	Machine Learning & ROS	PSC	3	0	0	3	3	50	50
17EARC306	Robot analysis & design	PSC	4	0	0	4	4	50	50
17EARP301	Object Oriented Programing and Data base management systems Lab	PSC	0	0	1	2	1	80	20
17EARP302	Programming Industrial Automation Systems Lab	PSC	0	0	1	2	1	80	20
17EARP303	Mechatronics & Measurement Lab	PSC	0	0	1	2	1	80	20
17EARW301	Mini project	PRJ	0	0	3	6	3	50	50
Total			**20**	**0**	**6**	**32**	26		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS**: Basic Science

Semester: VI

Course Code	Course Title	Category	L	T	P	Hrs	Credits	Marks	
								ISA	ESA
16EARC307	Real-time Embedded Systems	PSC	4	0	0	4	4	50	50
17EARC308	Hydraulics & Pneumatics	PSC	3	0	0	3	3	50	50
17EARE301	AI for Autonomous Robots	PSE	3	0	0	3	3	50	50
15EARE302	Computer Vision & Digital Image Processing	PSE	3	0	0	3		50	50
16EARE301	Power Electronics Motors & Drives	PSE	3	0	0	3	3	50	50
17EARE304	Digital System Design & FPGA programming	PSE	3	0	0	3		50	50
16EARP302	Hydraulics And Pneumatics Lab	PSC	0	0	1	2	1	80	20
17EARP306	Industrial Robotics Lab	PSC	0	0	1	2	1	80	20
16EARP307	Real Time Embedded Systems Lab	PSC	0	0	1	2	1	80	20
17EARW302	Minor project	PRJ	0	0	6	6	6	50	50
	PALR	HSC	3	0	0	3	3		
Total			**15**	**1**	**9**		25		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS**: Basic Science

Semester: VII

Course Code	Course Title	Category	L	T	P	Hrs	Credits	Marks	
								ISA	ESA
16EARC401	Industrial Data Networks	PSC	4	0	0	4	4	50	50
16EARE401	Measurement Systems	PSE	3	0	0	3	3	50	50
16EARE402	Advanced Microcontroller	PSE	3	0	0	3	3	50	50
16EARE403	Machine learning & ROS	PSE	3	0	0	3	3	50	50
	Open Elective	OE	3	0	0	3	3	50	50
15EHSN401	CIPE	HSC	3	0	0	3	0	50	50
	Total		**23**	**0**	**0**	**19**	**16**		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS**: Basic Science

Semester: VIII

Course Code	Course Title	Category	L	T	P	Hrs	Credits	Marks	
								ISA	ESA
15EARE404	Design of Automatic Machinery	PSE	3	0	0	3	3	50	50
XXX	Open Elective	OE	3	0	0	3	3	50	50
OR									
17EARW401	Project	PRJ	0	0	14	14	14	50	50
18EARI493	Internship	IE	0	0	6	6	6	50	50
18EARW494	Industry Internship -Project Work	IEPRJ	0	0	14	14	14	50	50
	Total		**6**	**0**	**20**	**0**	**20**		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS**: Basic Science

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 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.	7
Unit - 3	
7.0 Data conversions Introduction to data conversions, R/2^{n}R DAC, R/2R, Flash, Digital ramp ADC, Successive approximation ADC, Slope (integrating) ADC, Delta-Sigma ($\Delta\Sigma$) 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: 18EARC202	Course Title: Kinematics of Machinery	
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.

No	Content	Hrs
	UNIT – I	
1	**Chapter No. 1. INTRODUCTION TO KINEMATICS** The Subject of Kinematics and Dynamics of Machines, Kinematics and Dynamics as Part of the Design Process, Is It a Machine, a Mechanism, or a Structure?, Examples of Mechanisms; Terminology, Mobility of Mechanisms, Kinematic Inversion, Grashof's Law for a Four-Bar Linkage.	5
2	**Chapter No. 2. POSITION ANALYSIS** Kinematic Requirements in Design, The Process of Kinematic Analysis, Kinematic Analysis of the Slider-Crank Mechanism, Solutions of Loop-Closure Equations, Applications to Simple Mechanisms, Applications to Compound Mechanisms, Trajectory of a Point on a Mechanism.	7
3	**Chapter No. 3. VELOCITY &ACCELERATION ANALYSIS** Velocity Vector, Equations for Velocities, Applications to Simple Mechanisms, Applications to Compound Mechanisms. Acceleration Vector, Equations for Accelerations, Applications to Simple Mechanisms, Applications to Compound Mechanisms.	8
	UNIT - II	
4	**Chapter No. 4. CAMS: DESIGN AND KINEMATIC ANALYSIS** Types of Cam, Types of Followers, Prescribed follower motion, Follower motion schemes, Graphical disk cam profile design, Pressure angle, Design Limitations, Analytical disk cam profile design.	7

5	**Chapter No. 5. GEARS: KINEMATIC ANALYSIS AND SELECTION** Types of gears, spur gear terminology, involute tooth profiles, spur gear kinematics, rack and pinion kinematics, gear trains, idler gears, planetary gear trains.	7
6	**Chapter No. 6. BELTS AND CHAIN DRIVES** Types of Belt, Belt drive geometry, Belt drive kinematics, Types of Chains, Chain drive geometry, Chain drive kinematics.	6
UNIT - III		
7	**Chapter No. 7. SCREW MECHANISMS** Thread features, Thread forms, Ball screws, Lead Screw kinematics, Screw forces and torques, Differential screws, Auger screws.	5
8	**Chapter No. 8. STATIC FORCE ANALYSIS** Forces ,Moments and Torques, Laws of Motion, Free-Body Diagrams, Drawing a Free-Body Diagram, Characterizing Contact Forces, Static Equilibrium, Analysis of a Two-Force Member, Sliding Friction Force.	5

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.	6 hrs
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 Traveling Salesperson problem, Kruskal's algorithm, Huffman trees**.**	7 hrs
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, 8 hrs

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. 7 hrs

Course Content

Course Code: 18EARC204	Course Title: Mechanics of Materials	
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.Stress & Strain Introduction, Normal Stress Under Axial Loading, Direct Shear Stress ,Bearing Stress, Stresses on Inclined Sections, Equality of Shear Stresses on Perpendicular Planes, Strain, Displacement, Deformation, and the Concept of Strain, Normal Strain, Shear Strain	5 hrs
Chapter No. 2.Mechanical Properties of Materials	5 hrs

The Tension Test, The Stress–Strain Diagram, Hooke's Law, Poisson's Ratio, Design Concepts, Types of Loads, Safety, Allowable Stress Design, Load and Resistance Factor Design	
Chapter No. 3.Axial Deformation Introduction, Saint-Venant's Principle ,Deformations in Axially Loaded Bars ,Deformations in a System of Axially Loaded Bars, Statically Indeterminate Axially Loaded Members	5 hrs
Unit - 2	
Chapter No. 4.Torsion Introduction, Torsional Shear Strain, Torsional Shear Stress, Stresses on Oblique Planes, Torsional Deformations, Torsion Sign Conventions, Power Transmission, Statically Indeterminate Torsion Members.	5 hrs
Chapter No. 5. Equilibrium of Beams Introduction, Shear and Moment in Beams, Graphical Method for Constructing Shear and Moment Diagrams, Discontinuity Functions to Represent Load, Shear, and Moment	5 hrs
Chapter No. 6.Bending Introduction, Flexural Strains, Normal Stresses in Beams, Analysis of Bending Stresses in Beams, Introductory Beam Design for Strength, Flexural Stresses in Beams of Two Materials, Bending Due to Eccentric Axial Load, Un symmetric Bending	5 hrs
Unit - 3	
Chapter No. 7. Shear Stress in Beams Introduction, Resultant Forces Produced by Bending Stresses, The Shear Stress Formula, The First Moment of Area Q, Shear Stresses in Beams of Rectangular Cross Section, Shear Stresses in Beams of Circular Cross Section.	5 hrs
Chapter No. 8. Beam Deflections Introduction, Moment-Curvature Relationship, The Differential Equation of the Elastic Curve, Deflections by Integration of a Moment Equation, Deflections by Integration of Shear-Force or Load Equations, Deflections Using Discontinuity Functions	5 hrs

Course Content

Course Code: 18EARC205	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 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.	6 hrs

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, angle 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 **FMTH0303-3.1**

Semester: 3 *Year:* 2019-2020

Laboratory Title: **Analog and Digital Electronic Circuits Lab**	*Lab. Code*: **18EARP201**
Total contact Hours: **28**	*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: 10.00**		**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**
01	Demonstration of lab equipments and components: CRO, Multimeter, Function Generator, Power supply-Active/Passive Components & Bread Board. Demonstration of Software – Multisim / Ultiboard.	1.00		
	Learning Objectives: The students should be able to: 1. Identify and demo knowledge of functioning and purposes of different components like Resistors, Inductors, capacitors, transistors etc. 2. Identify and demo knowledge of functioning and purposes of different Test and Measuring equipments such as Multimeters, Power Supplies, CROs and Function generators etc. 3. Simulate circuits using Multisim software.			UNIT I Chapter 1
Category: Exercise		**Total Weightage: 5.00**		**No. of lab sessions:**

				1.00
2	Design and implementation of Rectifiers with and without filters.	1.00	5.00	
	Learning Objectives: The students should be able to: 1. Draw and understand the use of diodes in half wave and fullwave rectifiers without filter and with filter. 2. Calculate the ripple and efficiency. 3. Calculate the peak value of the output voltage of the rectifiers given the rms input value. 4. The process of AC to DC conversion			UNIT I Chapter 2
3	Construction and implementation of linear voltage regulators and Zener diode as a voltage regulator	1.00	10.00	
	Learning Objectives: The students should be able to: 1. Build, modify, and test the regulator ability to maintain the output voltage constant. 2. Learn about control element, reference voltage, error detector and sample circuit. 3. Study the Applications of the Zener diode as a voltage Regulators.			UNIT I Chapter 1
4	Construction and implementation of voltage dividers and optocoupler.	2.00	5.00	
	Learning Objectives: The students should be able to: 1. Designing, building and analyzing real circuits. 2. Using this techniques to design a circuit for a high intensity LED 3. Understand the design of optocoupler circuits in different applications			UNIT II Chapter 5
5	Verification of Superposition, Thevinen's and Network theorems.	2.00	5.00	
	Learning Objectives: The students should be able to:			UNIT II

	1. Explain and Learn circuit analysis using these theorems. 2. How to solve linear circuit problems and short circuit current. 3. Verifification of Network theorems using Multisim and Elvis Board			Chapter 5
Category: Structured Enquiry		**Total Weightage: 10.00**		**No. of lab sessions: 2.00**
6	Construction and implementation of Transistor biasing, Darlington amplifier and MOSFET as a switch.	2.00	10.00	
	Learning Objectives: The students should be able to: 1. Construction of transistors amplification circuit using Multisim. 2. Desugn and Implementation of transistor amplifier using NPN and PNP transistor. 3. Understand and analyze the transistor biasing, transistor amplifier, and Darlington amplifier. 4. Design and construction of MOSFET as a switch.			UNIT II Chapter 4
7	Construction and implementation of Summing amplifier and schimitt trigger	2.00	10.00	
	Learning Objectives: The students should be able to: 1. Learn how to design and implement of a Summing amplifier and Schmitt trigger using opAmp. 2. Simulation of summing amplifier and Schmitt trigger circuit using Multisim software.			UNIT II Chapter 5
8	Construction and implementation of verification of logic gates, and Adders/ Subtractor using logic gates	2.00	10.00	
	Learning Objectives: The students should be able to: 1. Learn to design and Implementation of the given boolean function using logic gates 2. Design and implementation of Adders and Subtractors using logic gates.			UNIT II Chapter 6

	3. Learn how to design the adders and Subtractors using using Multisim software 4. Applications of Adders and Subtractors.			
9	Design and implementation of code convertors, encoder, and decoder using logic gates	2.00	10.00	
	Learning Objectives: The students should be able to: 1. Design and implementation of converters using logic gates 2. Learn how to design and implementation of encoders and decoders 3. Learn how and where to use encoders and decoders			UNIT III Chapter 7
10	Design an 8-bit ADC circuit that utilizes LEDs to indicate its binary output value. Use a reference voltage of 2.5V to 5 VDC.	2.00	10.00	
	Learning Objectives: The students should be able to: 1. Learn how to design and implement 8 bit ADC circuit that to indicate its binary output values. 2. Understands why to use Analog to Digital converter.			UNIT III Chapter 7
Category: Viva, Journal and Attendance		**Total Weightage: 10**		**No. of lab sessions: 01**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
09	Viva, Journal and Attendance	01	5	
	Learning Outcomes : The students should be able to: 1. Command of appropriate communication skills such as technical reports, viva and presentations through the lab.			

	2. Maintaining the punctuality to all the lab sessions.			
Category: Open Ended Enquiry		**Total Weightage: 20**		**No. of lab sessions: 02**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
10	Project	02	20	
	Learning Outcomes : The students should be able to: 1. Carryout a project in a team. 2. Come up with PCB design using Ultiboard or Eagle.			

FMTH0303-3.1

Laboratory Plan

Semester :3

Year:2019-2020

Laboratory Title: Kinematics of Machinery	*Lab. Code:*18EARP202
Total Hours: 24	*Duration of Exam*:3 hrs
Total Exam Marks: 100	*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: 3.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	SolidWorks Motion	1.00		
	Learning Outcomes: The students should be able to: 1. Demonstratethe commands used in SolidWorks Motion interface. 2. Demonstrate the use of advanced mates and mechanical. The students are asked to answer the following questions: 1. How do you start a SolidWorks Motion session? 2. How do you activate SolidWorks Motion Add-In? 3. What types of motion analyses are available in SolidWorks?			UNIT – I

	4. What is analysis? 5. Why analysis is important? 6. What does SolidWorks Motion analysis calculate?			
2	Position, Velocity and Acceleration Analysis	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Simulate and compare the results obtained for the given scenario Graphically determine the combined effect of velocity vectors. Calculate the final position, direction and velocity of a ball.			UNIT – I
3	Simulations of sliding, and rigid body rotations (using SolidWorks motion)	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Demonstration of sliding, and rigid body rotation using SolidWorks motion 2. Examine problems involving objects sliding and/or rolling down inclined planes. The students are asked to answer the following questions: 1. What will be the motion of the block on the plane if there is no friction? 2. Calculate the velocity of the block at the bottom of the ramp if we know its starting position? 3. What will be the motion of the block on the plane if friction is included? 4. Calculate the velocity of the block at the bottom of the ramp? 5. How will the motion of a roller be different than that of the block?			UNIT – I
Category: Exercise		**Total Weightage: 50.00**		**No. of lab sessions: 9.00**

Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
1	Motion simulation 4 bar linkage(Tracing the path generated by the points on the mechanisms)	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Simulate and apply motors to the given mechanism The students are asked to answer the following questions Students simulate the motion of 4 bar linkage with respective to each other. This exercise shows the following key figures of Motion Simulation in SolidWorks. 2. Apply motors to simulate the movement. 3. Set the time flow and frame rate.			UNIT-I
2	Motion Analysis of a 4 bar mechanism (Using SolidWorks Motion)	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Simulation of 4 bar link mechanism 2. Apply motors to the joints 3. Plot angular acceleration and angular velocity The students should be able to: Use SolidWorks Motion Simulation to perform motion analysis on the assembly shown below. The green link is given an angular displacement of 45 degrees in 1 sec in the clockwise direction and it is required to determine the angular velocity and acceleration of the other links as a function of time & Create a Trace Path			UNIT-I
3	Modification of the geometry of 4 bar mechanism and its effect on kinematic properties (Using SolidWorks Motion)	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Modify the geometry of Link3 so that the 4-Bar mechanism looks like			UNIT-I

	the one shown in the image below. Now ask them to use SolidWorks Motion to calculate the new torque required to drive this mechanism. Use the same uniform angular velocity input of 45 deg/sec. Will the new driving torque be higher or lower? Why?			
4	Motion analysis of a Slider Crank Mechanism	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Use SolidWorks Motion to simulate a slider crank mechanism. The goal of the students is to calculate the velocity and acceleration of the center of mass of the reciprocating part (using SolidWorks motion)			UNIT-I
5	Analysis of Torque and Power of a rotating drum	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Compute the torque and power analytically 2. Obtain the results in SolidWorks.			UNIT-I
6	MATLAB Simscape Multibody Link	2.00	10	UNIT-I
	Simscape™ Multibody™ Link is a CAD plug-in for exporting CAD assemblies from SolidWorks®, Autodesk Inventor®, and PTC® Creo™ software. The plug-in generates an XML file detailing the structure and properties of your CAD assembly and 3-D geometry files for visualizing the various CAD parts. You can then import the files into Simscape Multibody software, which parses the XML data and automatically generates an equivalent multibody model.			UNIT-I
7	Simulation of CAM – Following mechanism	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Design and simulate the motion of CAM & Follower using SolidWorks motion 2. Applying motors to simulate the movement 3. Setting the			UNIT-II

	time flow and frame rate.			
8	Gears: Motion study of spur gears & Planetary gear.	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Import Standard Gears from SolidWorks toolbox. 2. Mesh and simulate the different types gears (Spur gear, Rack and Pinion and Planetary Gear).			UNIT-II
9	Simulation of Belt and Chain Drive Mechanism.	2.00	5.00	
	Learning Outcomes: The students should be able to: 1. Simulate the conveyor system using belt and chain command using SolidWorks Motion Study.			UNIT-II
Category: Structured Enquiry		**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	EVENT BASED MOTION ANALYSIS	2.00	10.00	
	Learning Outcomes: The students should be able to: 1. Easily simulate complex machine operations using event-based motion analysis with SolidWorks Simulation and validate the sequencing of the design to ensure correct operation, product quality, and safety. See how your product would move in the real world and measure the forces and loads while you design, helping you correctly size the motors and the structure and confirm the timing. Event-based motion can solve either kinematic or dynamic rigid body motion problems, and can			UNIT-III

	simulate the effect of: • Forces • Springs • Dampers • Gravity • Contact between components • Bushings	

Laboratory Plan

Semester: **III** *Year:2019-2020*

Laboratory Title: Machine Drawing Lab	*Lab Code*: 18EARP203
Total Contact Hours: **24**	*Duration of ESA Exam*:2 hrs
Total ISA Marks: **80**	*Total ESA Marks :20*

Experiment wise plan

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

Category: Demonstration		**Total Weightage: 10**	**No. of lab sessions: 3**
Expt./Job No.	***Experiment/job Details***	***No. of Lab. Session/s per batch (estimate)***	***Marks/Experiment***
1	*Title :**Blueprint Reading***	*1*	
	Learning outcomes • Explain the importance of information on blueprints. • Explain the differences between assembly drawings and detail drawings. • Describe methods used to create and reproduce blueprints. • Define and describe parts of a blueprint. • Identify elements located within the title block of a detail drawing. • List methods of care and security of blueprints. • Identify the standard lines used on blueprints. • Explain the meaning and applications of standard lines on blueprints. • Identify common views used on a blueprint. • Name the advantages and disadvantages of various projection types. • Explain the concept of visualization. • Requirement modeling		
2	***Experiment/job Details***	***No. of Lab. Session***	***Marks/Experiment***
	*Title: **Geometric Dimensioning and Tolerancing***	***1***	***5***

<table>
<tr><td></td><td colspan="3">Learning outcomes

• Concepts of zero defects & on-target Tolerancing
• Drawing conventions used in GD&T for ANSI and ISO applications
• Limits, fits and datum systems
• Form control, orientation control, location control , run-out and profile control
• Comparison of ANSI and ISO GD&T practices
• How to standardize GD&T concepts</td></tr>
<tr><td rowspan="2">3</td><td>Experiment/job Details</td><td>No. of Lab. Session</td><td>Marks/Experiment</td></tr>
<tr><td>Title: Selecting cabinets, enclosures and other packaging systems for electronic products

Learning outcomes

• Familiar with protection of equipment indicated by the IP code:</td><td>1</td><td>5</td></tr>
<tr><td rowspan="3">4</td><td>Experiment/job Details</td><td>No. of Lab. Session</td><td>Marks/Experiment</td></tr>
<tr><td>Title: Introduction to Solid Works® Interface</td><td>1</td><td></td></tr>
<tr><td colspan="3">Learning outcomes

• Familiar with the Solid Works® user interface
• Understand the basic functionality of the Solid Works® software
• Create part modeling
• Become familiar with Microsoft Windows
• Become familiar with the Solid Works® user interface
• Develop an understanding of 3D modeling and recognition of an object in 3D space
• Apply 2D sketch geometry, rectangle, circle, and dimensions
• Understand 3D features that add and remove geometry including Extruded Base, Extruded Cut, Fillet and Shell</td></tr>
<tr><td colspan="2">Category: Exercise</td><td>Total Weightage: 60.00</td><td>No. of lab sessions: 7.00</td></tr>
</table>

Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment
4	*Title:* **Part Modeling**	3	30
	Description: Solid Works® Essentials teaches you how to use the Solid Works® mechanical design automation software to build parametric models of parts and assemblies, and how to make drawings of those parts and assemblies.		
	Learning outcomes • Using Solid Works® 2018 students should be able to execute 20 problems using various commands • Reinforce the understanding of 3D features that add and remove geometry • Apply 2D sketch geometry, rectangle, circle, and dimensions • Understand 3D features that add and remove geometry including Revolve and Sweep • Apply 2D sketch tools such as ellipse, trim and centerline • Create the Candlestick part • Understand the 3D Loft feature created from multiple profiles sketched on different planes • Create the Chisel part		

Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment
5	*Title:* ***Modeling & Assembly***	*2*	*15*
	Learning outcomes • Should be able to assemble Knuckle joint, tailstock etc. • Familiar with the mating commands in assembly module • Develop an understanding of 3D assembly modeling by combining one part with another part • Apply 2D sketch tools to offset geometry and project geometry to the sketch plane		

Expt./Job No.	Experiment/job Details	No. of Lab. Session/s per batch (estimate)	Marks/Experiment
6	*Title* : ***Solid Works® Routing***	***1***	***10***

	The Routing application is an add-in to the SOLIDWORKS Premium software. With Routing, you can create a special type of subassembly that builds a path of pipes, tubes, electrical cables or ducts between components. When you insert certain components into an assembly, a route subassembly is created automatically. Unlike other types of subassemblies, you do not create a route assembly in its own window and then insert it as a component in the higher-level assembly. A route subassembly is made up of three types of entities: • Components, which are fittings and connectors, including flanges, tees, electrical connectors, and clips. • Route parts, which include pipes, tubes, wires, cables, and ducts. • Route feature, which includes a 3D sketch of the centerline of the route path.		
Expt./Job No.	***Experiment/job Details***	***No. of Lab. Session/s per batch (estimate)***	***Marks/Experiment***
	Title : ***Solid Works® Sustainability***	*1*	*5*
7	Why Solid Works® Sustainability? As an engineer or product designer, you have the power to dramatically alter how we interact with our environment. The question is how. Many designers don't know about the life cycle assessment (LCA) process or how it could guide them to more sustainable designs. Others may think the process is too complex and time-consuming, or is someone else's responsibility. Learning about designing for the environment now will put you ahead of the curve. With Solid Works® Sustainability, you'll have the built-in environmental intelligence to make more informed decisions about what materials to use. You'll also ESA how region-specific material sourcing, manufacturing, use, and disposal will affect your product's life cycle before manufacturing begins. Understand the basic concepts of sustainable design Measure the environmental impacts of various design choices, including material, manufacture location, and more on the various parts and assemblies		

Category: Open Ended	**Total Weightage: 20.00**	**No. of lab sessions:**

	Experiment / Job Details	No. of Lab Sessions per batch (estimate)	Marks / Experiment
8	*Title* : *Project Work*	2.00	20.00
	Learning Outcomes: The students should be able to: 1. The students should be able to: Reverse Engineering The process of duplicating an existing component, subassembly, or product, without the aid of drawings, documentation, or computer model is known as reverse engineering. Reverse engineering can be viewed as the process of analyzing a system to 1. Identify the system's components and their interrelationships 2. Create representations of the system in another form or a higher level of abstraction 3. Create the physical representation of that system Tasks Involved: 1. Study the system components and their interrelationships 2. Disassemble the given product 3. Take measurements with tolerance 4. Capture the surface details like texture, color, pattern etc. 5. Identify the material 6. Reproduce the same components using SolidWorks 7. Assemble all the components in SolidWorks		

Course Content

Course Code: 18EARC206	Course Title: Machine Design

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Duration of ESA: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1. THE DESIGN PROCESS Introduction, Materials in Design, The Evolution of Engineering Materials, The Evolution of Materials in Products, the Design Process, Types of Design, Design Tools and Materials Data, Function, Material, Shape, and Process.	5
Chapter No. 2. MATERIAL PROPERTY CHARTS Exploring Material Properties, Modulus–density chart Strength–density chart, Modulus–strength chart, Maximum service temperature chart, Cost bar charts, The modulus–relative cost chart, and The strength–relative cost chart. **ENGINEERING MATERIALS, THEIR PROPERTIES AND MATERIAL SELECTION** The Families of Engineering Materials, Materials Information for Design, Material Properties and Units.	5
Chapter No. 3. KINEMATICS OF GEARS AND GEAR DESIGN Spur Gear Geometry: Involute-Tooth Form, Interference Between Mating Spur Gear Teeth, Devising Gear Trains, Forces, Torque And Power In Gearing, Gear Manufacture, Gear Quality, Allowable Stress Numbers, Stresses In Gear Teeth, Selection Of Gear Material Based On Bending Stress, Design Of Spur Gears, Power-Transmitting Capacity, Practical Considerations For Gears And Interfaces With Other Elements. Forces and stresses on helical gear teeth, design of helical gears, bearing forces on shafts carrying bevel gears, bending moments on shafts carrying bevel gears, design of bevel gears for pitting resistance, forces, friction, and efficiency in worm gear sets, stress in worm gear teeth, surface durability of worm gear drives.	5
Unit - 2	
Chapter No. 4. KEYS, COUPLINGS, SEALS AND SHAFT DESIGNS Materials for keys, stress analysis to determine key length, other methods of fastening elements to shafts, couplings, universal joints, retaining rings and other means of axial location, types of seals, seal materials, shaft design procedure, forces exerted on shafts by machine elements, stress concentrations in shafts, design stresses for shafts, shafts in bending and torsion only, shaft design example, recommended basic sizes for shafts,	5

shaft rigidity and dynamic considerations, flexible shafts	
Chapter No. 5. LINEAR MOTION ELEMENTS, SPRINGS, FASTNERS Power screws, ball screws, application considerations for power screws and ball screws, bolt materials and strength, externally applied force on a bolted joint, thread stripping strength, other means of fastening and joining. Kinds of springs, helical compression springs, stresses and deflection for helical compression springs, analysis of spring characteristics, design of helical compression springs, helical torsion springs, improving spring performance by shot peening, spring manufacturing.	5
Chapter No. 6. CLUTCHES AND BRAKES Descriptions of clutches and brakes, types of friction clutches and brakes, performance parameters, time required accelerating a load, inertia of a system referred to the clutch shaft speed, effective inertia for bodies moving linearly, energy absorption: heat-dissipation requirements, response time, friction materials and coefficient of friction, plate-type clutch or brake.	5
Unit - 3	
Chapter No. 7. BEARINGS: ROLLING CONTACT & SURFACE CONTACT Types of rolling contact bearings, thrust bearings, mounted bearings, bearing materials, load/life relationship, design life, bearing selection: radial loads only, bearing selection: radial and thrust loads combined, mourning of bearings, tapered roller bearings, practical considerations in the application of bearings, importance of oil film thickness in bearings, life prediction under varying loads.	5
Chapter No. 8. MACHINE FRAMES, BOLTED CONNECTIONS AND WELDED JOINTS Machine frames and structures, recommended deflection limits, design to resist bending, design of members to resist torsion, eccentrically loaded bolted joints, types of joints, types of welds, size of weld, method of treating weld as a line, welded joints.	5

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 Inverted Pendulum, Modeling and design of Aircraft.	**5**

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	**7 Hrs**

	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.	
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:	**5 Hrs**

	Interrupt-Driven Blink LED Timer Demonstration, Test Run: Multi-rate Interrupt-Driven Blink LED Timer Demonstration	

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	7

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	
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 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	5
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	5

Options	

Course Content

Course Code: 18EARC210	Course Title: Robot Analysis & 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: 3 Hrs

No	Content	Hrs
	UNIT – I	
1	**Introduction to Robotics and Applications** Introduction, Classifications of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, and Robot Applications. **Representing Position and Orientation** Coordinate frames,representing Pose in 2-Dimensions, representing Pose in 3-Dimensions, representing Orientation in 3-Dimensions, orthonormal Rotation Matrix , three-Angle Representations, combining Translation and Orientation.	6
2	**Position Analysis of Serial Manipulators** Describing a Robot Arm, Link Parameters and Link Coordinate systems, Homogeneous transformation Matrices, Denavit-Hartenberg, Forward Kinematics, Inverse Kinematics, A 2-Link Robot, A 6-Axis Robot.	8
3	**Jacobian Analysis of Serial Manipulators** Different Kinematics of rigid body, Different Kinematics of serial manipulators, screw coordinates and screw systems, Manipulator Jacobian Matrix, conventional Jacobian, Screw-Based Jacobian, and Transformations of screw coordinates. Relationship Between Two Methods, condition number, singularity analysis.	6
	UNIT - II	
4	**Statics and Dynamics of Serial Manipulators** Types of gears/ motor/ drives/ encoders , Motion controller (Motion control software),Statics of Serial Manipulators, Transformations of Forces and Moments, mass properties, momentum, transformation of inertia matrix, kinetic energy. Newton-Euler Laws, Recursive Newton-Euler Formulation	6
5	**Trajectory planning** Path versus Trajectory, Joint-Space versus Cartesian-Space Descriptions, Basics of Trajectory Planning, Joint-Space Trajectory Planning, Third-Order Polynomial Trajectory Planning, Fifth-Order Polynomial Trajectory Planning, Linear Segments	7

	with Parabolic Blends, Linear Segments with Parabolic Blends and Via Points, Higher-Order Trajectories, Other Trajectories, Cartesian-Space Trajectories, Continuous Trajectory Recording.	
6	:**Wrist Mechanisms** Introduction, Bevel-Gear Wrist Mechanisms, structure representation of mechanisms, structure characteristics of epicyclic Gear Drives, Kinematics of Robotic Wrist Mechanisms, and static force analysis.	7
	UNIT - III	
7	**Tendon-Driven Manipulators** Introduction, classification of Tendon-Driven Manipulators, Planar Schematic Representation, Kinematics of Tendon-Driven Manipulators, Static Force Analysis, Feasible Structure Matrices, Redundant forces resolution.	5
8	**Robot End-Effectors** Classification of End-Effectors, Drive system for Grippers, Mechanical Grippers, Magnetic Grippers, Vacuum Grippers, Adhesive Grippers, Hooks, Scoops and Special gripper, Advanced grippers , Gripper Force Analysis & gripper design.	5

Laboratory Plan

Laboratory Course Plan: B E in A&R

Semester: **4th Semester** Year:2019-2020

Laboratory Title: **Manufacturing & Metrology lab**	Lab. Code: 16EARP205
Total Hours: **24**	Duration of ESA Hours: 3
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: 5**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1.	Material Removal Operations(Lathe)	4	15	
	Learning Objectives: The students should be able to: 1. Perform various operations like Facing, Turning, drilling, boring on a work piece using Lathe machine. 2. Perform operations like drilling of holes on a given work material using Drilling Machine. 3. Perform surface milling operation on a given slab of metal. 4. Demonstrate grinding operation on a given metal cube to achieve predefined dimensions. 5. Demonstrate arc welding process 6. Demonstrate sheet metal cutting operations- Shearing ,Bending operations, drilling & riveting process			Unit I, II & III

2.	Measurement	1	5	
	Learning Objectives: The students should be able to: 1. Extract the dimensions of the given part using (CMM) 2. Compare the dimensions of the given part between conventional machine & CMM			Unit III
Category: Exercise		**Total Weightage: 50**		**No. of lab sessions: 7**
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: 1. Select proper instruments for measurement 2. Calculate least count of instrument 3. Take reading using the instrument, Collection / recording of data, Interpret the observation, results 4. Measure dimensions of the given component using vernier caliper & micrometer 5. 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: 1. Demonstrate how to use tools and equipment safely 2. Mark & cut the sheet metal as per the drawing 3. Construct common sheet metal seams 4. 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: 1. To machine a given raw metal sheet to actual dimensions. 2. Perform drilling operations at suitable locations. 3. Mark the work piece before going for manufacture. 4. Taking measurements at every step of operations using vernier calipers. 5. Perform welding operation on hinges to achieve perfect right angle. 6. Fill machining time calculation chart. 7. Performing threading on a circular bar to a given pitch. 8. Fill operation chart and inspections reports			Unit I,II,III

Laboratory Plan

Laboratory Course Plan: B E in A&R

Semester: **4th Semester** Year:2020-21

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:* 1. *Study the data sheets and make a comparative study of the Architectures, resources, tools and applications of different microcontroller* 2. *Compare and contrast different microcontrollers.* 3. *Connect microcontroller to LED and blink LED with proper delay.* 4. *Apply suitable method or logic to solve given problem.*				

	Pre-lab: *i. 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* *ii. Draw the architectural layout of the following microcontrollers with pin out diagrams.* *a. PIC16F877a* *b. ATMEGA328* *c. 8051* *iii. Make a comparative study and fill up the table 1 given in lab manual.* *iv. Download the application notes.* *v. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital output device.* *vi. Study Proteus 8 Professional* *vii. Study different ports and understand the basic LED program* *In lab:* *i. Must be able to explain difference between various types of Microcontrollers and its architectures.* *ii. Setup the hardware platform and deploy the code on the hardware.* *iii. If any errors debug the code until it works.* *iv. Make a note of the number and types of errors.* *v. 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:* *1. Use 7Segment LED for counting numbers.* *2. Use appropriate logic or method for counting.* *Pre-lab* *i. Study the application notes of Arduino and PIC16F877a* *ii. Study advantages and disadvantages of Arduino and PIC16F877a microcontrollers* *iii. Understand 7segment LED.* *iv. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a*				

	simple digital input and output device *v. Study different segments of LED* *In-lab* *i. Write program for both Arduino and PIC* *ii. If any errors debug the code until it works.* *iii. Make a note of the number and types of errors.* *iv. Simulate in Proteus* *v. Setup the hardware platform and deploy the code on the hardware.* *vi. Execute the code and note the output.* *Post-lab* *i. 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 using PIC16F877A and Arduino board.	*1*	*5*		*Chap2,3*
	Learning Objectives : *The students should be able to:* *1. Connect LM35, LCD and microcontroller.* *2. Write function to read values from LM35 and display it on LCD.* *Pre-lab* *i. Study the application notes of Arduino and PIC for interfacing LM35 and LCD.* *ii. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital input and output device.* *iii. Study what is 16*2 LCD and how it works.* *iv. Analyze the driver required for LCD.* *In-lab* *i. Write program for both Arduino and PIC* *ii. Execute the code and note the output.* *iii. If any errors debug the code until it works.* *iv. Simulate LCD display in Proteus.* *v. Setup the hardware platform and deploy the code on the hardware.* *vi. Make a note of the number and types of errors.* *Post-lab* *i. 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:* *1. Connect Keypad, LCD with microcontroller.* *2. Write logic to read key press event from keypad.* *Pre-lab* *i. Study the application notes of Arduino and PIC for interfacing keypad and LCD.* *ii. Prepare flowcharts and develop the code to demonstrate the use of the microcontroller as a simple digital input and output device.* *iii. List down different types of keypads* *iv. Analyze the driver required for 4*3 keypad.* *In-lab* *i. Write programs for both Arduino and PIC* *ii. Execute the code and note the output.* *iii. If any errors debug the code until it works.* *iv. Make a note of the number and types of errors.* *v. Simulate both in Proteus* *vi. Setup the hardware platform and deploy the code on the hardware* *Post-lab* *i. 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	*1*	*5*		*Chapter 4*

	the flowchart and the code to perform the required operation.				
	Learning Objectives : *The students should be able to:* 1. *Connect Ultrasonic Distance Sensor and microcontroller* 2. *Logic to find distance in CM and Meters.* *Pre-lab* i. *Study the application notes of Arduino and PIC for interfacing Ultrasonic Sensors.* ii. *Understand different types of sensors.* iii. *List the advantages and disadvantages of different sensors.* iv. *Prepare flowchart and develop the code to demonstrate the use of the microcontroller as a simple analog input sensor and convertor.* *In-lab* i. *Write programs for both arduino and PIC* ii. *Execute the code and note the output.* iii. *If any errors debug the code until it works.* iv. *Make a note of the number and types of errors* v. *Setup the hardware platform and deploy the code on the hardware.* *Post-lab* i. *Record the results and experience in manual* ii. *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:* 1. *Understand the connections from microcontroller to DC motor using drives.* 2. *Discuss how motor driver helps in controlling the speed on a DC motor.* *Pre-lab:* i. *Study the application notes of Arduino and PIC for interfacing DC motor.* ii. *Study the working principle of DC motor.* i. *Study in detail about different types of DC motors and list out them* ii. *List advantages and disadvantages of DC motors* iii. *List the applications in the real world* *In lab:* i. *Write programs for both Arduino and PIC*				

	ii. Simulate in Proteus *iii. Demonstrate the hardware for both Arduino and PIC.* *Post-lab* *i. Record the results and experience in manual* *ii. 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 module controller.	*1*	*5*		*Chapter 4,5*
	Learning Objectives : *The students should be able to:* *i. Establish connection between different controllers and transfer the data.* *Pre-lab:* *i. Get familiar with Bluetooth module* *ii. Sketch circuit diagram on paper.* *In lab:* *i. Design circuit.* *ii. Simulate in Proteus* *iii. Demonstrate the hardware for both Arduino and PIC.* *Post-lab* *i. Record the results and experience in manual* *ii. 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:* *3. Develop an IOT system that must be able to record and store the data on cloud.* *Pre-lab:* *i. Get familiar with IOT and Wi-Fi module.* *In lab:* *i. Wire-up the circuit and place the sensor in the farm field/garden and collect the data .* *ii. Store the collected data on cloud for analysis.* *iii. Demonstrate the hardware for STM MCU.*				

	Post-lab *iii. 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:* *i. Differentiate between polling and interrupt.* *ii. Control the flow of program using timers.* *Pre-lab:* *i. Understand types of timers and interrupts* *ii. 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* *iii. Record the results and experience in manual* *iv. 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:* *i. Demonstrate the knowledge of data analysis.* *Pre-lab:* *i. Understand different trained modules that can be used on STM MCU.* *In lab:* *i. Analyze and predict data for the selected trained module.*				

	ii. Demonstrate the hardware for STM MCU. *Post-lab* *i. 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:* 1. *Identify the problem and solve.* 2. *Apply the knowledge of electronics, data science and programming.*				

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: 1. Demonstrate how to compile, debug and run a program in.NET environment. 2. Write programs using class, inheritance, and other fundamentals of OOP. 3. 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:

1. Design and model using ER models.
2. Write programs using class, inheritance, and other fundamentals of OOP.

3. Write SQL statements concerning data manipulation using retrieving, inserting, updating, and deleting commands.
4. Write packages/procedure for manipulating data and triggers to enhance data retrieval.
5. Design and model ER models for different scenarios.
6. 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:

1. Design, develop and implement application utilizing previously developed JAR/DLL files.
2. Store data from the application into the database.
3. 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:

1. Use the OOP concepts to implement the project.
2. Use database concept to implement the project
3. Select the appropriate tool/software to implement the project.
4. Write a technical report using a predefined template.
5. Present the technical report of the implemented project.
6. 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: 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-	6

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	
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	5

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	
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: 17EARC302	Course Title: Programming Industrial Automation 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. 01. Programmable logic controllers(PLC) & its building blocks Internal architecture of Programmable Logic Controllers systems, Input/ Output devices, Memory Organization, I/O processing, Signal conditioning, Remote connections, Networks, Processor Scan cycle, Error Checking and Diagnostics.	4 hrs
Chapter No. 02. The IEC 61131 , IEC61499 standards & Ladder , FB, IL, SFC and ST programming IEC 61131-3: Building Blocks , Goals , benefits, , Programming Languages of IEC 61131-3, Ladder diagrams, Analogy with Boolean Algebra and Binary Logic , Function blocks, Instruction lists, Sequential function charts, State chart modelling, Structured text programming with example programs for each, IEC 61499 models: models ,concepts and industrial examples like Temperature control system, Conveyor test station	6 hrs
Chapter No. 03.Advanced PLC functions PLC Sequencer, Shift registers, Program / Flow Control Instructions, Arithmetic Instructions, Data handling Instructions like FIFO, FAL, ONS, Data Transfer Instructions PLC MOVE, PLC Matrix functions, Network Communication Instructions, Analog PLC operation, PID control of continuous processes.	5 hrs
Unit - 2	
Chapter No. 04.Designing systems, PLC Start-up & Maintenance PLC Core application development, Development Cycle, Safe systems, Commissioning, Fault finding, PLC System Layout , Power Requirements and Safety Circuitry , Noise, Heat, and Voltage Considerations,, I/O Installation, System wiring strategies, and Precautions ,Safety Standards like NEMA & NEC, Electrical wiring diagrams PLC Start-Up and Checking Procedures , PLC System Maintenance & Troubleshooting	7 hrs
Chapter No. 05. PC based Automation, SCADA	8 hrs

Technologies and advantages of PC based Automation, Programmable Automation Controller systems (PACs) for Industrial control , Comparison of PLC with PAC Supervisory Digital Control and Data Acquisition (SCADA) system & Distributed Control Systems(DCS): SCADA Hardware and software ,Open SCADA protocols like DNP3 and IEC60870,	
Unit - 3	
Chapter No. 06. DCS & Field Bus Overview of DCS, Network Standards: Device net, CAN bus, Control Net, Profibus, Sercos, EtherCAT, Ethernet Powerlink, Comparison of each of them with other network standard.	5 hrs
Chapter No. 07. System Selection Guidelines & Commissioning PLC Selection process ,estimation of program memory and time requirements, PLC Sizes and Scope of applications, Special I/O modules, Electrical relay diagram symbols, Fail Safe Design, IEC 61508/61511 safety standards, Process modeling, Programming for large systems ,Control system documentation & Commissioning	5 hrs

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 Rotational Motion, 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	10

Actuators.	
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 of a Electromagnetic actuator, Control Prototyping and Hardware-in-the-loop 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.	5

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

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 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.	8 hrs
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: 17EARC306	Course Title: Robot Analysis & Design	
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

No	Content	Hrs
	UNIT – I	
1	Chapter 1:**Introduction to Robotics and Applications** Introduction, Classifications of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, and Robot Applications. **Representing Position and Orientation** Coordinate frames,representing Pose in 2-Dimensions, representing Pose in 3-Dimensions, representing Orientation in 3-Dimensions, orthonormal Rotation Matrix , three-Angle Representations, combining Translation and Orientation.	6
2	Chapter 2:**Position Analysis of Serial Manipulators** Describing a Robot Arm, Link Parameters and Link Coordinate systems, Homogeneous transformation Matrices, Denavit-Hartenberg, Forward Kinematics, Inverse Kinematics, A 2-Link Robot, A 6-Axis Robot.	8
3	Chapter 3:**Jacobian Analysis of Serial Manipulators** Different Kinematics of rigid body, Different Kinematics of serial manipulators, screw coordinates and screw systems, Manipulator Jacobian Matrix, conventional Jacobian, Screw-Based Jacobian, and Transformations of screw coordinates. Relationship Between Two Methods, condition number, singularity analysis.	6
	UNIT - II	
4	Chapter 4: **Statics and Dynamics of Serial Manipulators** Types of gears/ motor/ drives/ encoders , Motion controller (Motion control software),Statics of Serial Manipulators, Transformations of Forces and Moments, mass properties, momentum, transformation of inertia matrix, kinetic energy. Newton-Euler Laws, Recursive Newton-Euler Formulation	6
5	Chapter 5: **Trajectory planning** Path versus Trajectory, Joint-Space versus Cartesian-Space Descriptions, Basics of Trajectory Planning, Joint-Space Trajectory Planning, Third-Order Polynomial Trajectory Planning, Fifth-Order Polynomial Trajectory Planning, Linear Segments with Parabolic Blends, Linear Segments with Parabolic Blends and Via Points, Higher-Order Trajectories, Other Trajectories, Cartesian-Space Trajectories, Continuous Trajectory Recording.	7
6	Chapter 6:**Wrist Mechanisms** Introduction, Bevel-Gear Wrist Mechanisms, structure representation of mechanisms, structure characteristics of epicyclic Gear Drives, Kinematics of Robotic Wrist Mechanisms, and static force analysis.	7
	UNIT - III	

7	Chapter 7:**Tendon-Driven Manipulators** Introduction, classification of Tendon-Driven Manipulators, Planar Schematic Representation, Kinematics of Tendon-Driven Manipulators, Static Force Analysis, Feasible Structure Matrices, Redundant forces resolution.	5
8	Chapter 8: **Robot End-Effectors** Classification of End-Effectors, Drive system for Grippers, Mechanical Grippers, Magnetic Grippers, Vacuum Grippers, Adhesive Grippers, Hooks, Scoops and Special gripper, Advanced grippers , Gripper Force Analysis & gripper design.	5

Laboratory Plan **FMTH0303-3.1**

Semester: V *Year: 2019-20*

Laboratory Title: Object-Oriented Programming and Database	*Lab. Code*: 17EARP301

Management Systems Lab	
Total Hours: 24	*Duration of Exam*: 2 hrs
Total Exam Marks: 100	*Total ISA. Marks*: 80

Experiment-wise plan

3. 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:

4. *Design and model using UML diagrams and ER models.*
5. *Demonstrate how to compile and run a program in JAVA, Python, and .NET environment.*
6. *Write programs using class, inheritance, and other fundamentals of OOP.*
7. *Write SQL statements concerning data manipulation using retrieving, inserting, updating, and deleting commands.*
8. *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,	*1*	*5*	*Object-Oriented*

	interface, and package.			*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:

1. *Design and model using UML diagrams.*
2. *Implement classes in JAVA or .NET environment.*
3. *Compile and build JAR/DLL files.*
4. *Design and mode ER models for different scenarios.*
5. *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*

6.	*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:

4. *Design, develop and implement application utilizing previously developed JAR/DLL files.*
5. *Store data from the application into the database.*
6. *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 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:

7. *Use the OOP concepts to implement the project.*
8. *Use database concept to implement the project*
9. *Select the appropriate tool/software to implement the project.*
10. *Write a technical report using a predefined template.*
11. *Present the technical report of the implemented project.*
12. *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*	

Laboratory Plan

Laboratory Course Plan: B E in A&R 2019-20

Laboratory Title: **Programming Industrial Automation Systems Lab**	Lab Code: 17EARP302
Total Hours: **28**	Duration of ESA Hours: 2

Experiment wise Plan

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

Category: Demonstration		**Total Weightage: 20.00**		**No. of lab sessions: 4.00**
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 Safety guidelines & PLC and system wiring: Demo programs on Logic gates, switches and Pushbuttons.	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. *appreciate the guidelines to be followed while working with PLC and I/O devices and follow the procedures involved in wiring the PLC system elements*			UNIT I
2	Programming the PLC Via Ladder logic and structured text in TwinCAT Demo Programs on ALU ,Counter and timing functions	1.00	5.00	
	Learning Outcomes:			UNIT I

	The students should be able to: 1. *Identify the different input and output devices and their configuration for interfacing with Panasonic PLC* system elements 2. *Solve the problems on interfacing by using Panasonic PLC, sensors and different types of actuators through ladder logic, Function block and Structured Text programming*			
3	Demo on Electro Pneumatics : A. Time-dependent control of a double-acting cylinder with switch-on delay B. Sequential control of 2 double-acting cylinders with impulse valves in Automation studio.	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. *Simulate PLC logic using Indra logic Software by solving problems on ON - OFF control strategy , Counting Items coming on a conveyor with planned intervals*			UNIT I
4	**Burglar Alarm**: Consider the design of a burglar alarm for a house. When activated an alarm and lights will be activated to encourage the unwanted guest to leave. This alarm be activated if an unauthorized intruder is detected by window sensor and a motion detector. The window sensor is effectively a loop of wire that is a piece of	1.00	5.00	

	thin metal foil that encircles the window. If the window is broken, the foil breaks breaking the conductor. This behaves like a normally closed switch. The motion sensor is designed so that when a person is detected the output will go on. As with any alarm an activate/deactivate switch is also needed.			
	Learning Outcomes: The students should be able to: 1. *Implement PLC logic solution to drive electro-pneumatic elements based on stated case study problems* ems on ON - OFF control strategy , Counting Items coming on a conveyor with planned intervals			UNIT I
Category: Exercise		**Total Weightage: 20.00**		**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**
5	**Motor Control :**A PLC motor controller has two START buttons and two STOP buttons. The motor is to run if two RUN buttons depressed simultaneously. The motor should run when the buttons are released. Motor stops by depressing any STOP button stops. Construct a LAD/structured text for	1.00	4.00	

	this motor control task.			
	Learning Outcomes: The students should be able to: 1. *Solve problems based on given case studies using ladder logic and function blocks*			UNIT II and III
6	**Sequential Logic Control using SCADA**	1.00	4.00	
	Learning Outcomes: The students should be able to: 1. *Implement PLC control logic by interfacing sensors for control of DC motor/stepper motor using timers , counters and process indicators*			
7	Develop a PLC program that will control a miniature set of traffic lights. These lights will go through a normal sequence, but will have pedestrian cross walk buttons that will activate a cross walk signal when pressed. When done the student should understand the design and implementation of time dependent control circuits.	1.00	4.00	
	Learning Outcomes: The students should be able to: 1. *simulate exercises using Rexroth PLC software using ladder diagram, function block and structured text programming for the*			

	given case studies			
8	To explore PID control: Write simple programs to read and output analog voltages from the PLC and perform PID control of a motor speed. Demonstrate it on TwinCAT.	1.00	4.00	
	Learning Outcomes: The students should be able to: 1.			
9	Process controlled system in TwinCAT: A PLC-controlled system operates as follows. If the Start button is pressed, MV1 will be opened and dye starts to fill the tank. At the same time mixing-motor begins to run. As the level of the dye passes TBL2 and reaches to TBL1, MV1 will be closed and mixing-motor will stop. Then MV2 will be opened and dye begins to run out of the container. After the level of the dye reaches to the below of TBL2, MV2 will be closed. This process is repeated for two (2) times, then the system will stop. We can observe the stopping of the system with the lamp and the	1.00	4.00	

	buzzer. After the system stops, buzzer will continue to run for 2 sec and then it stops. But the lamp continues to light until the reset button is pressed. When the reset button is pressed, the system will be ready to begin the same process again. Construct a LAD for this system.			
	Learning Outcomes: The students should be able to: 1. *Solve case study problems using Rexroth PLC hardware interfaced with sensors, actuators and process indicators.*indent:-.25in;mso-list:l0 level1 lfo1'>*1. simulate exercises using Rexroth PLC software using ladder diagram, function block and structured text programming for the given case studies*			
Category: Structured Enquiry		**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**
10	To study Distributed Control System(DCS) programming using Function Block Diagram method	2.00	10.00	
	Learning Outcomes: The students should be able to: 1.			UNIT III

Category: Open Ended		**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**
11	Exploring PLC Serial communication using Ethernet	2.00	10.00	
	Learning Outcomes:			UNIT III

Laboratory Plan

Semester: V *Year: 2019-20*

Laboratory Title: Mechatronics & Measurements Lab	*Lab. Code*: 17EARP303
Total Hours: 24	*Duration of Exam*: 3 hrs

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,	1.00	5.00	Unit I & Unit II

	Temperature sensor, Strain gauge			
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

Laboratory Plan **FMTH0303-3.1**

Semester: V **Year: 2019-2020**

Laboratory Title: **Mini project**	Lab. Code: **17EARW301**
Total Hours: **30**	Duration of Exam: 2 hrs

Experiment wise plan

List of activities planned to meet the requirements of the syllabus

Week No	Activities	Deliverables	ISA Marks out of 50

1&2	Need analysis, Identification of problem statement, Engineering Design process	Problem statement, Project plan, Process plan	10
3&4	Product development	Component designs & Integration, Modeling and simulation	10
5,6,7&8	Rapid prototyping, Testing and validation	Prototype (hardware and software)	20
9&10	Reporting	Test reports and Conclusion	10

Course Content

Course Code: 16EARC307	Course Title: Real Time Embedded Systems	
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	
1.0 Introduction to System Structures and Real-time Embedded System System Structures types, Real-time systems & basics, Classification, Example case studies,namely, Process control system, Avionics system, Multimedia systems, Intensive Care Computing, Modern car, Digital Flight control system, Embedded system purpose, Quality attributes,Challenges and characteristics of Embedded Computing System Design, Embedded System Design Process, Core and Supporting components of the embedded system, Embedded firmware, discussion on real-time case studies and block diagram representation of systems, Embedded design cycle-case study- Engine Control Unit , GPS Moving Map, Automatic Chocolate Vending Machine (ACVM) using Finite State machine(FSM), Unified Modeling Language(UML), state charts etc.	6
2.0 Target Architectures : ARM Cortex M3 processors & its Programming Introduction to embedded computing with examples and arm processors, The architecture of ARM Cortex M3, Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming. Advanced Programming Features. Memory Protection. Debug Architecture. Digital Signal Processor (DSP), Field Programmable Generic Array (FPGA).Examples to demonstrate each of its architectural and programmable features. A case study on the AntilockBrake System(ABS) and stability control system	7
3.0 Real-Time Kernels and Operating Systems Introduction to Real-Time Kernels, Tasks, process and threads, Introduction to RTOS, key characteristics of RTOS, its kernel, components in RTOS kernel, objects, scheduler, services, context switch, Task scheduling, Task communication and synchronization, Multiprocessing and multitasking, Multi-Threading, Hyper-threading, State diagrams, timing diagrams, examples for each,Scheduling types: Preemptive priority-based scheduling, Round-robin and preemptive scheduling. First come first served scheduling, shortest job first scheduling, Device drivers and selection of an RTOS. Examples for each of the scheduling technique, objects, context switching, synchronization, and device drivers, Case study on Mars Pathfinder mission	7
Unit - 2	
4.0 Inter-task Communication in RTOS 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	7

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., Demonstration of each of the objects of Inter-process communication, namely, semaphore, Message Queue, MUTEX, Mailbox,etc. Case-study on Magnetic Resonance Imaging(MRI)	
5.0 Tasks and Task Management RTOS - task creation and Management, task scheduling, kernel services, inter-task-communication, Micro C/OS-II- task creation and Management, task scheduling, kernel services, inter-task-communication, Demo on Task creation and management functions.Casestudies on Industrial Robot, Weapons Defence System, Adaptive Cruise control	7
6.0 Handling Deadlocks Sharing Resources, Deadlock Model- Necessary Conditions, A Graph-Theoretic Tool—The Resource Allocation Graph, Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Demonstration on Handling of deadlocks, identification through a casestudy, The Dynamic Dining Philosopher problem.	6
Unit - 3	
7.0 Performance Analysis and Optimization Performance or Efficiency Measures, Complexity Analysis—A High-Level Measure, The Methodology, Analyzing Code, algorithms, Response Time, Time Loading, Memory Loading, Evaluating Performance, Performance Optimization, optimizing for Power Consumption. Demonstration of concepts of Performance Analysis and Optimization through a case-study.	5
8.0 Wired and Wireless Protocols used in Real-Time Embedded System: Bus communication protocol (USB, I2C, SPI), Wireless and mobile system protocol (Bluetooth, 802.11 and its variants, ZigBee), Examples of block diagrams to explain the working of each protocol for a specified application.	5

Text Books:

1. James K. Peckol, " Embedded Systems A Contemporary Design Tool," Wiley student edition
2. Joseph Yiu " The Definitive Guide to the ARM Cortex–M3"
3. Silberschatz, Galvin,andGagne, "Operating system concepts," 8th edition, WILEY Publication.

References:

1. Shibu K V, "Introduction to Embedded Systems Tata McGraw Hill, New Delhi, 6th reprint 2012.
2. Raj Kamal," Embedded Systems," McGraw-Hill Education
3. Steve Furber, "ARM System-on-Chip Architecture" LPE, Second Edition.

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	5hrs

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.	
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 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.	5hrs
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

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

1. Anthony Esposito, Fluid Power with Applications, 6th Edition, Pearson, 2003.
2. Michael J. Pinches and John G. Ashby, Power Hydraulics, Prentice-Hall, 1989.

References

1. Herbert E. Merritt, Hydraulic Control Systems, John Wiley & Sons, 1967.
2. Peter J Chapple, Principles of Hydraulic System Design, 1st Edition ,Cox moor Publishing Company, 2003.
3. S. R. Majumdar, Oil Hydraulic Systems, Tata McGraw Hill publishing Company Ltd, 2001.

CourseContent

Course Code:17EARE301	CourseTitle:**Artificialintelligenceforautonomoussystems**	
L-T-P:3-0-0	Credits:3	ContactHrs:40
ISAMarks:50	ESAMarks:50	TotalMarks:100
TeachingHrs:40		ExamDuration:3hours

Content	Hours
UNIT–1	
Chapter1:**IntroductiontoArtificialintelligenceandautonomoussystems**Foundation of artificialintelligence, robotics andtheAI approach,Semi-autonomouscontrol,SevenareasofAI**,**TheConceptofRationalityTheNatureofEnvironments , The Structure of Agents, Problem-Solving Agents, Searching for Solutions, UninformedSearch Strategies,Informed Search Strategies,Knowledge representationinAI,knowledgebasedagents,propositionallogic,predicatecalculus,inferencerules	5hrs
Chapter2:Roboticsoftwarearchitectures Subsumptionarchitecture,Three-layerarchitecture,Pipelinearchitecture,Hierarchical Paradigm- Attributes of the Hierarchical Paradigm, Reactive Paradigm-Attributes of Reactive Paradigm,HybridDeliberative/Reactive Paradigm-AttributesofHybridParadigm,Architectural Aspects,Managerial Architectures-AutonomousRobotArchitecture(AuRA),SensorFusionEffects(SFX),State-Hierarchy Architectures, Model-Oriented Architectures, Interleaving Deliberation and ReactiveControl.	5hrs.
Chapter3:BiologicalFoundationsoftheReactiveParadigm Agencyandcomputationaltheory,AnimalBehaviors,Reflexivebehaviors,Coordinationand ControlofBehaviors,Innatereleasingmechanisms,Concurrentbehaviors,PerceptioninBehaviors,Action-perceptioncycle,Twofunctionsofperception Gibson: Ecological approach , Neisser: Two perceptual systems , SchemaTheory,Behaviorsandschematheory,PrinciplesandIssuesinTransferringInsights toRobots	5hrs

UNIT–2	
Chapter 4:Capturing intelligence - Designing a reactive implementation withcommonsensingtechniquesforroboticsperception BehaviorsasObjectsinOOP,StepsinDesigningaReactiveBehavioralSystem,CaseStudy:UnmannedGroundRoboticsCompetition,Assemblagesof Behaviors,Logical sensors, Behavioral Sensor Fusion, Designing a Sensor Suite, ProprioceptiveSensors,ProximitySensors,ComputerVision,RangefromVision,CaseStudy :Hors d'Oeuvres,Anyone?	8hrs
Chapter5:Multi-agentsandnavigationinrobotics Heterogeneity,Control,Cooperation,EmergentSocialBehavior,TopologicalPathPlanning, RelationalMethods,AssociativeMethods,CaseStudyofTopologicalNavigationwithaHybridArchitecture	7hrs

UNIT–3	
Chapter6:LocalizationandMapMaking SonarSensorModel,Bayesian,Conditionalprobabilities,Conditionalprobabilities,Updating with Bayes'rule ,Dempster-ShaferTheory ,Shafer belief functions Belieffunction for sonarDempster's rule of combinationWeight of conflict metric,HIMMsonarmodelandComparisonofMethods,Examplecomputations,PerformanceErrors due toobservations from stationary robot ,Tuning ,Localization,Continuouslocalizationandmapping,Feature-basedlocalizationExploration,Frontier-basedexploration,GeneralizedVoronoigraphmethods.	6hrs
Chapter7:Deeplearningandnaturallanguageprocessing DeepLearning ImprovementoftheDeepNeural NetworkVanishing GradientOverfittingComputationalLoad.Languagemodels,textclassification,information retrieval	4hrs

TextBook(Listofbooksasmentionedintheapprovedsyllabus)

1. Stuart J. Russell andPeterNorvig"Artificial Intelligence,A Modern Approach"ThirdEdition,PearsonEducation,Inc.2010

2. RobinR.Murphy"IntroductiontoAIRobotics",Secondedition,TheMITPressCambridge,Massachusetts,2000

References

1. ElaineRich,KevinKnight:"ArtificialIntelligence",3rdEdition,TataMcGrawHill, 2009,ISBN-10:0070087709

2. Sebastian Thrun,WolframBurgard,DieterFox, "Probabilistic Robotics"MITPress;IntelligentRoboticsandAutonomousAgentsseries edition,2005

Course Content

Course Code: 15EARE302	Course Title: **Computer vision and digital image processing**	
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: FUNDAMENTALS OF COMPUTER VISION AND DIGITAL IMAGE PROCESSING Introduction to computer vision system, Geometric Camera Models- Pinhole Perspective, Cameras with Lenses, the Human Eye, Intrinsic and Extrinsic Parameters, Geometric Camera Calibration. Digital image processing system, application of computer vision and digital image processing. Design of machine vision system.	6 hrs
CHAPTER 2:LIGHT AND SHADING, COLOR Modeling Pixel Brightness, Reflection at Surfaces, Sources and Their Effects, the Lambertian+SpecularModel, Inference from Shading, Radiometric Calibration and High Dynamic Range Images, the Shape of specularities, Inferring Lightness and Illumination, Color- Human Color Perception, The Physics of color,representing Color, Inference from Color Finding specularities Using Color Shadow removal, usingColor Constancy: Surface Color from Image Color.	6 hrs
CHAPTER 3: IMAGE FORMATION AND PROCESSING Image Acquisition – Sampling and Quantization- Pixel Relationships, image enhancement Spatial Domain Gray level Transformations Histogram Processing Spatial Filtering –Smoothing and Sharpening, Introduction to the Fourier Transform and the Frequency Domain, DFT, FFT.	5 hrs
UNIT – 2	

CHAPTER 4:IMAGE SEGMENTATION AND FEATURE ANALYSI Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection –Thresholding – Region Based Segmentation, A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only–Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering	6hrs
CHAPTER 5: COLOR IMAGE PROCESSING AND IMAGE COMPRESSION Color Fundamentals, Color Models, Pseudo color Image Processing, Basics of Full-Color Image Processing Color Transformations, Smoothing and Sharpening, Color Segmentation, Noise in Color Images Color Image Compression, Image Compression-Fundamentals, Image Compression Models, Elements of Information Theory, Error-Free Compression, Lossy Compression	6hrs
UNIT – 3	
CHAPTER 6: MORPHOLOGICAL PROCESSING Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms.	6hrs
CHAPTER 7: RECOGNITION ANDBAYESIAN MODELING Object detection, Face recognition. Instance recognition, Category recognition, Context and scene understanding, Recognition databases and test sets, Prior models and Bayesian inference. Gradient descent and simulated annealing, Graph cuts, Markov random fields	5 hrs

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

1. David A. Forsyth and Jean Ponce- Computer vision A modern approach, 2nd Edition, Pearson publication, 2003.

2. Rafael C. Gonzalez and Richard E. Woods- Digital ImageProcessing-2nd Edition, Prentice Hall publication,2002

Reference book

1. Richard Szeliski , Computer Vision: Algorithms and Applications, Springerpublication,2010

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 ANDELECTRIC 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,	7 hrs

Performance parameters, Converter classification, Switching mode regulators: Buck regulator, Boost regulator, Buck-Boost Regulators.	
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

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

1. Gopal K Dubey, Fundamental of electric drives, Second, Narosa publication, 2005
2. P.S Bhimbhra, Power Electronics, Fourth, Khanna , 2007
3. Mohammed A Sharkawi, Fundamental of electric drives, Fourth, Brooks/Cole, 2000
4. Robert Boylestead and Louis Nashelsky “Electronic Devices and Circuit Theory, Eleventh edition, Pearson Publications
5. Rashid M H, Power Electronics Circuits,devices and applications, Second, PHI, 2000
6. P.C Sen, Power Electronics, Tata McGraw Hill, Ninth Edition.

References

1. P.S Bhimbhra, Power Electronics, Fourth, Khanna, 2007
2. Mohammed A Sharkawi, Fundamental of electric drives, Fourth, Brooks/Cole, 2000

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),	9 hrs

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	6 hrs
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	7 hrs
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	8 hrs
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 I. Robotic Car from Georgia Institute of Technology II. Robotic Controller: ASIC versus FPGA III. Expanding a robot's life: Low power object recognition via FPGA-based DCNN deployment IV. FPGA-powered parallel, pipelined vision algorithms	5 hrs

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

1. Charles Roth, Digital Systems Design using VHDL, 2/e, Cengage Learning, 2012.
2. Samir Palnitkar, Verilog HDL, 2/e, Pearson Education, 2013.
3. Charles Roth, Digital Systems Design using Verilog, Cengage Learning, 2014

References

1. John F. Wakerly, Digital Design Principles and Practices, 4/e, Pearson Education, 2013.
2. Michael Ciletti, Advanced Digital Design using Verilog HDL, 2/e, Prentice Hall Publications, 2012.
3. J. Bhasker, System Verilog HDL Primer, B.S. Publications, 2012.
4. J. Bhasker, Verilog Synthesis Primer, B. S. Publications, 2011.

Laboratory Plan

Semester: **6th Semester** *Year:* 2019-2020

Laboratory Title: **Hydraulics And Pneumatics Lab**	Lab. Code: **16EARP302**
Total Hours: **24**	Duration of ESA Hours: 3

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	1.00	4.00	

	be performed by a hydraulic motor. Despite varying loads, the motor speed must remain constant.			
	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: 1. Understand and record the table of the travel times 2. Calculate the velocity of the piston.			Unit – I
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:			Unit - II

	1. Understand the working of hydraulic accumulator.			
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. 2. Identify switches and push buttons and use them to build the circuits.			Unit - II
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			Unit - I

	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.			
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./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch**	**Marks / Experiment**	**Correlation 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	1.00	7.00	

	developing sequential diagrams and pneumatic circuit diagrams.			
	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 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.	1.00	7.00	
	Learning Objectives: The students should be able to: 1. Construct a control circuit using a pressure sequence valve for a given application.			Unit - I, II and III

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.

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: 1. Basic commands 2. Vectors and Matrices 3. Importing Data 4. 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. 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?			UNIT – I

<table>
<tr><td></td><td colspan="3">• 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>
</table></td><td>UNIT-I & II</td></tr>
</table>

	3	Understanding coordinate frames and transformations	DH Parameters, Robot 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: 1. Risk reduction 2. Quicker start-up 3. Shorter change-over 4. 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: 1. Create mechanism 2. AutoPath 3. Set Task Frame 4. Collision control 5. Reachability 6. 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	1	20.00	UNIT-I & II

	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			

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Laboratory Plan **FMTH0303-3.1**

Semester: **VI** Year: **2019-20**

Laboratory Title: **Real Time Embedded Systems Lab**	Lab. Code: 16EARP305
Total Hours: **28**	Duration of ESA Exam: **3hrs**

LIST OF EXERCISES & ISA COMPUTATION

Sl. No	EXPERIMENTS	MAX MARKS
1	Demo on Energia IDE and TM4C1294NCPDT, TIVA C series microcontroller board & Solving problems on Data Acquisition for Bio Medical / Process control/Industrial control application	**05**
2	Demo on Code Composer Studio(CCS) and TIVA C series TM4C1294NCPDT microcontroller board and problem solving on ADC,TIMERS,INTERRUPTS	**05**
3	Demo on LABVIEW on multitasking to implement Semaphores, Queue Demo on Introduction to Keil uvision 4 problem solving	**05**
4	Demo on Raspberry Pi Programming and peripheral programming	**05**
5	Exercises on basic RTOS program , RTX Kernel using peripherals like RTC, TIMERS , UART, SEMAPHORES	**10**
6	Exercises on implementing scheduling algorithms like Preemptive /Round Robin / Interrupts/ and Multitasking operations in RTX Kernel of Keil uvision 4.	**10**
7	Structured Query : Implementing Communication Protocols like I2C / SPI / UART /CAN / ETHERNET with Energia /CCS & TM4C1294 TIVA board	**10**
8	Study of real-time sensor data visualization in computational tool and triggering of power electronics devices.	**05**
9	Synopsis for ESA Project, Attendance & Timely Submission of document	**05**

	TOTAL ISA MARKS	**80**
ESA	Design using state machine architecture or Unified Modeling Language and implement solution for a real world problem using IOT technology for applications related Smart Home, Energy Management, Smart Grid, Smart Agriculture ,Wearable Device, Smart Health Care, Connected Car, Smart Machine involving Inter-process communication, Resource sharing and an effective scheduling technique satisfying real time constraints.	**20**
	TOTAL MARKS	**100**

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DEPARTMENT OF AUTOMATION & ROBOTICS

Laboratory Plan **FMTH0303-3.1**

Semester: VI *Year: 2019-20*

Laboratory Title: Minor Project	Lab. Code: 17EARW302
Total Hours: 30	Duration of Exam: 3 Hrs

At the end of the course student will be able to:

1. Apply the principles of engineering design to plan and manage the project.
2. Gather the requirements, do functional analysis and develop specifications for a machine controller from the identified problem statement.
3. Develop alternative designs and choose the most suitable design for implementation.
4. Apply principles of mechatronics system design for hardware and software co-design as per standards (VDI 2206 & VDI 2221).
5. Develop elaborate validation and verification plans for each phase of the process.
6. Design control and signal conditioning circuits including schematics and wiring diagrams as per standards (IEC standards).
7. Build the Virtual prototype and validate using hardware-in-loop simulation and software-in-loop simulation.
8. Prototype the controller, deploy the software & Interface the controller to the machine.
9. Test, evaluate and improve the system.
10. Prepare technical report.

Course Content

Course Code: 16EARC401	Course Title: Industrial Data Networks	
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 I	
Chapter No. 1. DATA NETWORK FUNDAMENTALS AND INDUSTRIAL ETHERNET Modern Instrumentation and Control Systems, Open Systems Interconnection (OSI) Model, Concepts of Parallelization, Sequential, Framing, Bit Encoding, Media Access Control, Error Correction, Time Division, Bit Rate, and Baud Rate, EIA-232, EIA-485, Fiber Optics Overview, Circuit Switching and Packet Switching, Network Topologies, Ethernet, Ethernet Topology, 10 Mbps Ethernet, 1 Gigabit Ethernet, Internetwork Connections Devices (Repeaters, Bridges, Hubs, Switches, Routers and Gateways)	8
Chapter No. 2. TCP/IP IP Version 4 (IPv4), IP Version 6 (IPv6), Address Resolution Protocol (ARP), Internet Control Message Protocol (ICMP), IP Routing, Transmission Control Protocol (TCP), User Datagram Protocol (UDP)	7
Chapter No. 3. MODBUS MODBUS: Protocol Structure, Function Codes	5
Unit II	
Chapter No. 4. FIELDBUS, PROFIBUS AND AS-INTERFACE FIELDBUS: Physical Layer, Data Link Layer and Application Layer of FOUNDATION Fieldbus PROFIBUS: PROFIBUS DP (Decentralized Periphery), PROFIBUS DP Communication	7

Protocol, Application Profiles, PROFIBUS PA (Process Automation) AS-Interface: AS-Interface, Physical Layer, Data Link and Application Layer of the AS-Interface	
Chapter No. 5. ETHERCAT, ETHERNET POWERLINK AND SERCOS III ETHERCAT: Architecture Model, Protocol, Topology, Distributed Clocks, Device Profiles, EtherCAT Master, EtherCAT Slave Ethernet POWERLINK: Slot Communication Network Management, Physical Layer, Data Link Layer, Transport and Application Layer of Ethernet POWERLINK, Ethernet POWERLINK Addressing, Frame Structures SERCOS III:OSI Layers of SERCOS III, Communication Cycle, Protocol Structure, Topology, Communication Network Infrastructure	8
Chapter No. 6. HART, BLUETOOTH AND OPC HART: HART Protocol, Physical Layer, Data Link Layer and Application Layer of HART. BLUETOOTH: Protocol Stack, Topologies, Generic Data Transport Architecture, Basic Rate/Enhanced Data Rate (BR/EDR) Radio Operation, Low Energy (LE) Operation, Operational Procedures and Modes, Profiles OPC: Enterprise Integration, Manufacturing Execution Systems (MES), Process Analysis, Process Modeling, Data Modeling, Data Flow Diagrams (DFDs), Communication Patterns, Data Collection Technologies, OPC (OLE for Process Control)	5
Unit III	
Chapter No. 7. CAN, CAN FD AND DEVICENET CAN: Physical Layer, Data Link Layer and Application Layer of CAN, Protocol, Bus Arbitration, Frames, Bit Stuffing, Bit Synchronization, Bit Timing CAN FD: Physical Layer, Data Link Layer and Application Layer of CAN FD, Protocol, Frames DEVICENET: Physical Layer, Data Link Layer, Network and Transport Layers, and Application Layer of DeviceNet	5

Chapter No. 8. FLEXRAY AND MOST FLEXRAY: Topologies, Protocol, Media Access Control (Communication Cycle), Frame Format, Clock Synchronization MOST: OSI Layers for MOST, Data Frame, Timing Master, Timing Slave, MOST Devices	5

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: **16EARE402**	Course Title: **Advanced Microcontrollers**	
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: **3h**
Content		**Hrs**
Unit - 1		
1.0. **Introduction to ARM and ARM Architecture:** Background, ARM cortex series portfolio, ARM program model, Instruction Set Development, The Thumb-2 Technology and Instruction Set Architectural features, R profile, M profile and A Profile, ARM Cortex-M3 Processor :Peripheral Interfacing, Exceptions and Interrupts, Cortex-M3 Programming, Low power modes, Hardware Features, Debug Support, Application development with Cortex M3/M4 controllers using standard		7

peripheral libraries .	
2.0 Controllers in embedded system design: Low power architectures, High performance capabilities, Microcontroller power saving strategies, Tradeoff between High Performance and low power capabilities for embedded systems. Power/Energy Profiling of Microcontroller/ Embedded systems, Applications	8
Unit - 2	
3.0 MSP430 series Microcontroller devices: Unique architectural features, block diagram, Low power DNA, Addressing modes, Instruction set, Power down modes , MSP430 Interrupts and Low Power, Digital Input-Output, On chip peripherals, Timers**:** Block diagram, Timer Modes, Timer Interrupts, Low Power Down Modes, Watchdog Timer	8
4.0 MSP430 Peripherals: Analog to Digital Convertors (ADC), Performance measures, Signal to Noise Ratio, ADC Architectural Block diagram, Timing and Triggering options, Low power and Interrupt operation. Digital to Analog Convertors: Architectural Block Diagram and Operation, Comparator Architecture and Operation, Special Function Registers, Hardware Multiplier: Operation, Registers, Direct Memory Access Controller (DMA and DMA Transfer Modes, Applications.	7
Unit - 3	
5.0 Power/ Energy profiling: Profiling of ARM Cortex & MSP430 family devices, Low-power operation Dynamic Voltage and Frequency Scaling ,CPU power modes , Optimizing for low power in embedded MCU designs: MCU power consumption, standby power, peripheral power, battery life.	5
6.0 Case studies: ARM cortexM3/M4 & MSP430 microcontroller based real-time solutions for application like biomedical system design, machine health monitoring, Energy metering applications etc.	5

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	5 hrs

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.	
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 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.	8 hrs
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: **15EARE404**	Course Title: **Design of Automatic Machinery**	
L-T-P-SS: 3-0-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 Hrs
UNIT – I		

No	Content	Hrs
1	**Chapter 1:** **Introduction and Steps to Automation** What is Automation, An Automation design process, examples of automation, problems and project assignments? **Justifying Automation** Traditional Project Cost Justification for a Purchase, Traditional Costing Estimating for Building and Selling Automation, Win–Win Purchasing Philosophy, Maximum Profit Cost Estimating for Building and Selling Automation, Justifying Flexible Automation over Hard Automation Intellectual Property, Patents, and Trade Secrets.	6
2	**Chapter 2:** **The Automation Design Process** System Specifications, Brainstorming, Machine Classification by Function, Machine Classification by Transfer Method, Machine Configuration Trade-offs Mechanisms Toolbox, TBBL Automation Project and Conclusions, Case Study Number 1: Case Opening, Case Study Number 2: Label Insertion and Printing, Case Study Number 3: Crossed Four-Bar BMC Unloader.	4
3	***Chapter 3:*** **Workstations** Workstation Basics, Drive Mechanisms, Case Study Number 1: TBBL Workstation Design, Case Study Number 2: Automated Screwdriver Workstation Design, Machine Design and Safety. **Feeders** Feeders, Automatic Feeding and Orienting — Vibratory Feeders, Escapement Feeders, Vibratory Bowl Feeder, Centripetal Feeder, Flexible Feeders, Gravity Feed Tracks, Powered Feed Tracks, Escapements, Parts-Placing Mechanisms, Assembly Robots, Case Study Number 1: Dropping Cookies, Case Study Number	5

	2: Feeding of TBBL Cases.	
	UNIT – II	
4	**Chapter 4: Conveyors** Flat Belt Conveyors, Tabletop Chain Conveyor, Belt Conveyors, Static (Gravity) Conveyors, Powered Conveyors, Heavy Unit Load Handling Conveyors, Case Study Number 3: Donut Loader Machine.	3
5	**Chapter 5:** **Single Station Manufacturing Cells** **Single station manned cells, single station automated cells, applications of single station cells, analysis of single station systems.** **Manual Assembly Lines** **Fundamentals of manual assembly lines, Analysis of single model assembly lines, Line balancing algorithms, Mixed model assembly lines, Workstation considerations, Other considerations in assembly line design, Alternative assembly systems.** **Automated Product Lines** **Fundamentals of automated product lines, applications of automated product lines, Analysis of transfer lines.**	6
6	**Chapter 6:** **Automated Assembly Systems** **Fundamentals of automated assembly systems, Quantitative analysis of assembly systems.** **Cellular Manufacturing** **Part families, part classification and coding, product flow analysis, cellular manufacturing, applications of group technology, quantitative analysis in cellular manufacturing.**	6

	Flexible Manufacturing Systems **Introduction to flexible manufacturing system, flexible manufacturing systems components, flexible manufacturing systems applications and benefits, flexible manufacturing system planning and implementation issues, quantitative analysis of flexible manufacturing systems.**	
UNIT - III		
7	**Chapter 7: System Specifications** Expectations, Other Problems Beyond Specifications, Example 1: Bulk Mail Carrier (BMC) Unloader, Specifications, Design Specifications, Comments, Request for Quote, Example 2: BMC Unloader Bid Award Package.	5
8	**Chapter 8: Packaging Machines** Liquid Filling Machines, Cartoning and Boxes, Labeling, Cases, Palletizing, Forming Pouche, Blister Packs and Bags.	5

Laboratory Plan

FMTH0303-3.1

Semester: VIII Year: 2019-20

Laboratory Title: Project	Lab Code: 17EARW401
Total Hours: 30	Duration of Exam: 3 Hrs
Total ESA Marks: 50	Total ISA. Marks: 50

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.

Evaluation Scheme

Students Assessment through ISA (50%) + ESA (50%)

Assessment	Weightage in Marks
ISA	50
ESA	50
Total	100

Laboratory Plan

Semester: VIII Year: 2019-20

Course Title: Internship - Training	Course Code: 18EARI493
Total Contact hrs: 50	Duration of ESA: 3 hrs
ISA Marks: 50	ESA Marks: 50

Course Outcomes (COs):

Upon completion of an internship, students will be able to demonstrate the following outcomes:

1. Gain knowledge to real-world challenges in an industry environment.
2. Engage in responsible conduct while working as an intern and allow decisions to be informed by a value-centered life.
3. Understanding an organization by proper insight into their structure, processes and functions.
4. Able to assimilate new technical knowledge, and integrate the same with the existing technical knowledge for industrial application.
5. Understanding of lifelong learning processes through critical reflection of internship experiences.
6. Enhance his/her verbal and written communication, and different modes of communication.

7. **Evaluation Scheme**

Assessment	Weightage in Marks
ISA	50
ESA	50
Total	100

Laboratory Plan

FMTH0303-3.1

Semester: VIII

Year: 2019-20

Laboratory Title: Internship - Project	Lab. Code: 18EARW494
Total Hours: 80	Duration of Exam: 3 hrs
Total ESA Marks: 80	Total ISA. Marks: 20

Course Outcomes (COs)

At the end of the course, students will be able to:

1. Generate and evaluate different alternative solutions
2. Formulate a detailed solution plan to solve the given problem.
3. Identify and employ tools that help to arrive at solutions
4. Understand and adhere to various standards, legislation and regulations
5. Distribute the work load based on competences among team members and integrate the various components of the solution
6. Adhere to promised deliverable, including bill of material, production drawings, manufacturing of components, assembly, and so forth.

Evaluation Scheme

Students Assessment through ISA (50%) + ESA (50%)

Assessment	Weightage in Marks
ISA	50
ESA	50
Total	100