Course Content

Course Code: **15EARC201**	Course Title: Analog and Digital Electronic Circuits	
L-T-P-SS: 4-0-0-0	Credits: 4	Contact Hrs: 50
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 01 Modeling and analysis of electrical circuits The Lumped Circuit Abstraction, Modeling Physical Elements using lumped circuit abstraction, Signal Representation, Dependent Sources and the Control Concept, Network theorems: The Node Method, Loop Method, Superposition, Thévenin's Theorem and Norton's Theorem.	8 hrs
Chapter No. 02 Basics of Digital Electronics Number Representation , MOSFET Switch Implementation of Logic Gates, The SR Model of the MOSFET, Active Pullups Voltage Levels and the Static Discipline, Simplifying Logic Expressions using K-map, Combinational circuits: encoder/decoder, multiplexers/de-multiplexers , Binary adder/ subtractor, Binary comparator, Sequential Circuits: Gated D Latch, JK Flip-Flop, Registers, Counters.	7 hrs
Chapter No. 03 Transistor Modeling 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.	5 hrs
Unit - 2	
Chapter No. 04 Power Amplifiers Definitions and amplifier types, series fed class A amplifier, Transformer coupled Class A amplifiers, Class B amplifier operations, Class B amplifier circuits, Amplifier distortions. Designing Power amplifiers: Heat flow calculations using analogous circuit. Calculation of actual power handling capacity of transistors with and without heat sink. Heat sink design.	6 hrs
Chapter No. 05 Operational Amplifiers Device Properties of the Operational Amplifier, Simple Op Amp Circuits: The Non-Inverting Op Amp, The Inverting Connection, A Special Case: The Voltage Follower, Op Amp RC Circuits: Op Amp Integrator, Op Amp Differentiator, An RC Active Filter, The RC Active Filter Impedance Analysis, Sallen-Key Filter, Op Amp in Saturation: Op Amp Integrator in Saturation, Positive Feedback : RC Oscillator.	8 hrs
Chapter No. 06 Energy and Power in Digital Circuits Energy Storage Elements; capacitors and inductors , Power and Energy Relations for a	6 hrs

Simple RC Circuit, Average Power in an RC Circuit, Power Dissipation in Logic Gates: Static Power Dissipation, Total Power Dissipation, CMOS Logic Gate Design.	
Unit - 3	
Chapter No. 07 First Order Transients in Linear Electrical Circuits Analysis of RC & RL circuits, Propagation Delays, State and State variables	5 hrs
Chapter No. 08 Transients in Second Order Circuits Undriven Series RLC circuit, Stored Energy in Transient Series RLC circuit, Undriven Parallel RLC circuit, Driven Parallel RLC circuit, State Space Analysis	5 hrs

Course Content

Course Code: 15EARC202	Course Title: Mechanics of Materials	
L-T-P-Self Study: 3-1-0-0	Credits: 4	Contact Hrs: 50
CIA Marks: 50	SEE 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,BearingStress,Stresses on Inclined Sections,Equality of Shear Stresses on Perpendicular Planes,Strain,Displacement, Deformation, and the Concept of Strain,NormalStrain,Shear Strain	5 hrs
Chapter No. 2.Mechanical Properties of Materials The Tension Test,The Stress–Strain Diagram,Hooke'sLaw,Poisson'sRatio,DesignConcepts,Types of Loads,Safety,Allowable Stress Design,Load and Resistance Factor Design	5 hrs
Chapter No. 3.Axial Deformation Introduction,Saint-Venant'sPrinciple,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, Unsymmetric 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: 15EARC203	Course Title: Manufacturing Technology & Metrology	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 50
CIA Marks: 50	SEE 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. 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 NC machine-Coordinate systems. 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. Measurement and Inspection Standards of measurement, allowance and tolerance, inspection methods of measurement, measuring instruments, gauges for attribute measurements, geometric dimensioning and tolerance, comparators & angular measurements	6 hrs

Unit - 3	
Chapter No. 7. Advancements in Metrology: Introduction & applications of: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology.	5 hrs
Chapter No. 8. Form Measurement Measurement of screw thread-Thread gauges, measurement of gears-tooth thickness, Measurement of surface finish, straightness, flatness and roundness measurements	5 hrs

Course Content

Course Code: 15EARC204	Course Title: **Analysis of algorithms & Design of Programs**		
L-T-P : 3-0-0-0	Credits: 3	Contact Hrs: 40	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100	
Teaching Hrs: 40		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,	5 hrs
Chapter 2: SOLUTION PLANNING- Software Development Cycle, Requirement Modeling framework, Computer Communication methods, Unified modeling language: UML Building Blocks, UML Diagrams-Class Diagram, object diagram, component diagram, UML Modeling Types, UML Basic Notations,UML-SysML ,Using the Tools, Testing the Solution, Coding the Solution, Case studies-Modeling the sequence diagram for the Plant operation,Modeling the control strategy action.	5 hrs
Chapter 3: DESIGN AND ANALYSIS OF ALGORITHMS-Algorithms and Their Representations, Modifying Algorithms, Alternative Algorithms. Review of Asymptotic Notations, Mathematical Analysis of Non-Recursive and Recursive Algorithms, Brute Force Approaches: Introduction, Selection Sort and Bubble Sort, Sequential Search and Brute Force String Matching ,Divide and Conquer: General Method, Defective Chess Board, Binary Search, Merge Sort, Quick Sort and its performance.	5 hrs
Unit - 2	
Chapter 4: 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, Multiple Stacks and Queues, Single- and Double-Ended Priority Queues.	.
Chapter 5: LINKED LISTS, TREES &GRAPHS: Singly Linked lists and Chains, Representing Chains in C, Linked Stacks and Queues, Polynomials, Additional List operations, Sparse Matrices, Doubly Linked Lists. Introduction, Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Heaps, Graph representation, Adjacency matrix, Adjancey list, Application of graphs.	
Unit - 3	
Chapter 6:DYNAMIC PROGRAMMING& GREEDY METHOD: Depth First Search and Breadth	5 hrs

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**.**	
Chapter 7:LIMITATIONS OF ALGORITHMIC POWER AND COPING WITH THEM: Lower-Bound Arguments, Decision Trees, P, NP, and NP-CompleteProblems, Challenges of Numerical Algorithms	5 hrs

Laboratory Plan

Semester: III *Year:* **2016 - 2017**

Laboratory Title: **Programming laboratory**	Lab. Code: 15EARP201
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: 10**		**No. of lab sessions:2**
Expt. / Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	program to sort the given N numbers using 1.bubble sort,2.Quick sort	1	5	
	Learning Objectives: The students should be able to: 1.Rearrange the given set of elements in ascending or descending order 2.Use different types of tool to execute programs			Unit I
2	Program to search an element from a given set of elements using 1.Linear search,2.Binary search.	1	5	Unit I
	Learning Objectives: The students should be able 1. Search an element based on the specific method			Unit I
Category :Exercises		Total weightage:5		No of lab sessions1
3	Program to simulate arrangement of goods in a box by robot on first come first serve basis and perform the following operations on it a.pushb.popc.display>The program should print	1	10	

	appropriate messages for stack overflow,stack,underflow and stack empty.			
	Learning Objectives: The students should be able to: 1.Developing of program using stack concepts			Unit II
	Category:Structured Enquiry	Total weightage:45		No of lab sessions 6
4	Design an algorithm to create a record to maintain details of 5 flights, having informationas name, source & destination stations, seatsavailable with category	1	10	
	Learning Objectives: The students should be able to: 1.Demonstrate how to compile and run a C program in Microsoft visual studio, 2. Develop programs using operators and control statements 3. Develop programs using structures and file concepts			Unit II
5	Design an algorithm to assign a job for a robot & make it to perform jobs in circular manner.	1	10	
	Learning Objectives: The students should be able to: 1. Illustrate using of structure definition. 2. Develop a program using circular queue.			Unit II
6	Develop menu driven program in C language for maintaining university information.	1	10	
	Learning Objectives: The students should be able to: 1. Demonstrate how to maintain information of a university 2. 2.Demonstrate how to specify different types of constraints on a given set of operations 3. Develop a program in C language using linked list. .			Unit III

7	Design an algorithm to a Student Prerequisite Subjects Management System to store different courses and their prerequisites and based on this list it will allow any student to take particular	1	10	
	Learning Objectives: The students should be able to: 1. Demonstrate how it will store Prerequisite subject details 2. Classify the method of course allocation for student 3. Develop the programs in C language using doubly linked list.			Unit II
8	Design an algorithm to find the optimal solution for travelling salesperson problem Leaming Outcomes: The students should be able to: 1. Demonstrate the graphical solution for the problem. 2. Analyze the efficiency of an algorithm. 3.Develop the program in C language using dynamic Programming technique.	1	10	Unit III
9	Design an algorithm to implement Floyd's algorithm Learning Outcomes: The students should be able to: 1.Demonstrate the graphical solution for the problem 2. Analyze the efficiency of an algorithm. 3. Develop the program in c using dynamic programming technique	1	10	Unit III

Category: Open Ended		**Total Weightage: 20**		**No. of lab sessions: 2**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
10	Implement a project using C language, for automation and robotics applications. (FOR SEE)	2	20	
	Learning Objectives: The students should be able to: 1. Use Analysis of algorithms & Design of Programs concepts to implement the project. 2. Select the appropriate tool/software to to implement the project. 3. Write a technical report using IEEE standard. 4. Present the technical report for the implemented project. 5. Demonstrate the learning experiences of working in a team.			Analysis of algorithms & Design of Programs Unit I, Unit II , UnitI III

Laboratory Plan

Laboratory Course Plan: B E in A&R 2015-2019

Laboratory Title: **Machine Drawing Lab**	Lab. Code: **15EARP202**
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: 15.00**		**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	Blueprint Reading	1.00	5.00	
	Learning Outcomes: The students should be able to: The students should be able to: 1. • 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			Workshop & CAD
2	Geometric Dimensioning and Tolerancing	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. The students should be able to:			Workshop & CAD

	• 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			
3	Introduction to SolidWorks® Interface	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Learning Objectives: The students should be able to: • Familiar with the SolidWorks® user interface • Understand the basic functionality of the SolidWorks® software • Create part modeling • Become familiar with Microsoft Windows • Become familiar with the SolidWorks® 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			CAD/CREO PARAMTERIC
Category: Exercise		**Total Weightage: 45.00**		**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**
4	Part Modeling	2.00	20.00	
	Learning Outcomes: The students should be able to: 1. The students should be able to: • Using SolidWorks® 2014 students should be able to execute around 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			CAD LAB

	different planes • Create the Chisel part			
5	Advanced Modeling & Assembly	1.00	15.00	
	Learning Outcomes: The students should be able to: 1. Learning Objectives: The students should be able to: • Assemble Knuckle joint, tailstock, table clamp 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			Engineering Graphics
6	SolidWorks® Routing-Electrical	1.00	10.00	
	Learning Outcomes: The students should be able to: 1. The students should be able to: Explains how to create, edit and manage Electrical routes, from the critical routing components and their design requirements to the sub-assemblies that contain the routes. Topics include: 1. Fundamentals of Routing 2. Basic Electrical Routing 3. Routing with Clips			CAD LAB
Category: Structured Enquiry		**Total Weightage: 10.00**		**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	Sustainability	1.00	10.00	

	Learning Outcomes: The students should be able to: 1. The students should be able to: 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 SolidWorks® Sustainability, you'll have the built-in environmental intelligence to make more informed decisions about what materials to use. You'll also see how region-specific material sourcing, manufacturing, use, and disposal will affect your product's life cycle before manufacturing begins. 1. Understand the basic concepts of sustainable design 2. 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: 1.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
8	Project Work	1.00	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			Elements of Mechanical Engineering

	the given product 3. Take measurements with tolerance 4. Capture the surface details like texture, colour, pattern etc. 5. Identify the material 6. Reproduce the same components using solidworks 7. Assemble all the components in solidworks 8. Render the product using solidworksphotoview 360	

Laboratory Plan

Laboratory Course Plan: B E in A&R 2015-2019

Semester-III

Laboratory Title: **Analog and Digital Circuits Lab**	Lab. Code: **15EARP203**
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: 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	0.00	
	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.			Chapter 1

	3. Simulate circuits using Multisim software.			
2	DOE: Study of different methods used for DOE and Obtain the step response of the Resonant circuit by taking fixed resistance of 10Ω and choosing the values of inductor (L) & capacitor(C).	1.00	10.00	
	Learning Objectives: The students should be able to: 1. Carryout design of experiments (DOE).			Chapter 2
Category: Exercise		**Total Weightage: 10.00**		**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**
3	Analyze the operation of a MOSFET as I. A Switch II. An Amplifier And conclude it for different regions	1.00	10.00	
	Learning Objectives: The students should be able to: 1. Study the behavior of the MOSFET as a Switch. 2. Study the behavior of the MOSFET as an Amplifier.			Chapter 1
Category: Structured Enquiry		**Total Weightage: 60.00**		**No. of lab sessions: 10.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
4	Design a Line sensor circuit using an Operational Amplifier.	2.00	10.00	
	Learning Objectives: The students should be able to: 1. Build, test, and troubleshoot a line sensor circuit. 2. Study the operation of an Op-Amp.			Chapter 5

	3. Analyze the behavior of a line sensor.			
5	Build a circuit that converts an input voltage of – 1 V to + 2.2 V to an output voltage of 0 to 5 V. Dual supply of ± 12 V available and need to drive a 10 kΩ load. Test designs under different input voltages and verify that output voltages are within ± 5% of the calculated ones.	2.00	10.00	
	Learning Objectives: The students should be able to: 1. Build, test, and troubleshoot an analog signal conditioning circuit using Multisim. 2. Analyze an analog signal conditioning circuit to provide a range of desired output voltages in respond to a certain range of input voltages.			Chapter 5
6	A sensor provides temperature sensitivity of 200 μV/°C. Design a circuit that activates an alarm when the temperature reaches 300 °C. Use a single 10 V supply. The alarm could be any type, visual- or sound-based.	2.00	10.00	
	Learning Objectives: The students should be able to: 1. Build, test, and troubleshoot a temperature sensor circuit using Multisim. 2. Hardwire the temperature sensor circuit of objective 1 and compare the measurements of the hardwired circuit with the measurements obtained in Multisim.			Chapter 4
7	Design a simple DAC circuit with 0-10V output voltage.	2.00	10.00	

	Learning Objectives: The students should be able to: 1. Learn how to design a DAC circuit that converts digital input signals to expected corresponding analog voltage levels. 2. Build, test, and troubleshoot a DAC circuit using Multisim.			Chapter 6
8	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	
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	10	
	Learning Outcomes : The students should be able to: 1. Command of appropriate communication skills such as technical reports, viva and presentations through the lab. 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.	

Course Content

Course Code: 15EARC205	Course Title: Kinematics of machinery	
L-T-P-Self Study: 4-0-0-0	Credits: 4	Contact Hrs: 50
CIA Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1.INTRODUCTION TO KINEMATICS Introduction, Mechanisms, kinematics, mechanism terminology, kinematic diagrams, kinematic inversion, mobility, four bar mechanism, slider crank mechanism, techniques of mechanism analysis.	4 hrs
Chapter No. 2.POSITION ANALYSIS Position, displacement, position analysis, position analysis applications to simple mechanisms – analytical analysis,Displacement Diagrams	5 hrs
Chapter No. 3.VELOCITY ANALYSIS Velocity of a point, velocity of a link, linear and angular velocities, relative velocity, velocity image, analytical velocity analysis: relative velocity method, algebraic solutions for common mechanisms, instantaneous center of rotation, velocity curves	6 hrs
Chapter No. 4. ACCELERATION ANALYSIS Linear acceleration of a point, acceleration of a link, normal and tangential acceleration, relative acceleration, relative acceleration analysis: analytical method, algebraic solutions for common mechanisms, acceleration of a general point on a floating link, coriolis acceleration, equivalent linkages, acceleration curves.	5 hrs
Unit - 2	
Chapter No. 5.CAMS: DESIGN AND KINEMATIC ANALYSIS Introduction, 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 hrs
Chapter No. 6.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 hrs
Chapter No. 7.BELTS AND CHAIN DRIVES Introduction, Belts, Belt drive geometry, Belt drive kinematics, Chains, Chain drive geometry, Chain drive kinematics.	6 hrs
Unit - 3	

Chapter No. 8.SCREW MECHANISMS Introduction, Thread features, Thread forms, Ball screws, Lead, Screw kinematics, Screw forces and torques, Differential screws, Auger screws.	5 hrs
Chapter No. 9.STATIC FORCE ANALYSIS Introduction ,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 hrs

Course Content

Course Code: 15EARC206	**Course Title: Control Systems**	
L-T-P: **4-1-0**	Credits: 4	**Teaching Hours: 50 hrs**
CIA Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs
Unit –I		

1.Introduction to control system and system modeling in frequency domain Introduction, A History of Control Systems, System Configurations (open-loop & closed loop systems), Analysis and Design Objectives, The Design Process.Mathematical modeling of physical Systems: Electrical networks, Mechanical systems, Electro mechanical systems, Analogous systems.	**7h**
2. Topological Models Transfer function, Block diagram representation and reduction, signal flow graph representation and reduction using Mason's Gain formula, Transfer functions of control components – dc servomotor.	**6h**
3. Time –Domain modeling and Analysis The General State-Space Representation, Applying the State-Space Representation, Converting a Transfer Function to State Space, Converting from State Space to a Transfer Function, Standard test signals, Unit step response of First and second order systems, Time response specifications of first and second order systems, steady – state errors and error constants.	**7h**
Unit – II	
4. Stability analysis Concepts of stability, Necessary conditions for Stability, Routh- stability criterion, Relative stability analysis; More on the Routh stability criterion.	**5h**
5. **Root-Locus Techniques and Design Via Root Locus** Introduction, The root locus concepts, Construction of root loci. Improving Transient Response and Steady-State Error via Cascade Compensation, Feedback Compensation, Physical Realization of Compensation.	**7 h**
6. Frequency domain analysis Introduction, Correlation between time and frequency response, Stability analysis, Bode plot and Nyquist plot to obtain phase margin and gain margin of a given system. Experimental determination of transfer functions, Assessment of relative stability using Bode Plots.	**8h**
Unit – III	
7. Design Via Frequency Response Transient Response via Gain Adjustment, Lag Compensation, Lead Compensation, Lag-Lead Compensation.	**5h**
8. State Space Design Controller Design, Controllability, Observability, Observer Design, Examples.	**5h**

Course Content

Course Code: 15EARC207	Course Title: Machine Design	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 50
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1. THE DESIGN PROCESS 1. Introduction, Materials in Design, 2. The Evolution of Engineering Materials, 3. The Evolution of Materials in Products, the Design Process, Types of Design, 4. Design Tools and Materials Data, Function, Material, Shape, and Process.	7
Chapter No. 2. MATERIAL PROPERTY CHARTS Exploring Material Properties, 2. modulus–density chart 3. strength–density chart 4. modulus–strength chart 5. maximum service temperature chart, Cost bar charts 6. The modulus–relative cost chart 7. The strength–relative cost chart **ENGINEERING MATERIALS, THEIR PROPERTIES AND MATERIAL SELECTION** The Families of Engineering Materials 2. Materials Information for Design 3. Material Properties and 4. Units	7
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.	7
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, shaft rigidity and dynamic considerations, flexible shafts	7
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,	7

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.	
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.	7
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 Content

Course Code: 15EARC208	Course Title: Microcontrollers	
L-T-P-**SS**: **3-0-0-0**	Credits:3	Contact Hrs: 4
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 100

No	Content	Hrs
	Unit I	
1	**Chapter 1: Introduction to Microcontroller** Introduction To Microprocessor and Microcontroller: History and Evolution, types of microprocessors, Difference between Microprocessors and Microcontrollers. CPU architectures: RISC/CISC and Harvard/Von-Neumann, Overview of PIC Microcontroller family, Introduction to different microcontroller families (8051, ATMEL/AVR, and ARM).	**5 Hrs**
2	**Chapter 2: PIC and AVR Microcontroller Architecture and ALP** Architecture and pin functions, Registers and Instructions, Data formats and directives, Introduction to assembly language programming, Program counter and program ROM space. Branch, Call and Time delay loop: Branch instructions and looping, Call instruction and stack, Time delay instructions and pipeline. Timing diagrams.	**7 Hrs**
3	**Chapter 3: I/O Port programming** I/O port programming, I/O bit manipulation programming, Arithmetic, logic instructions and programs: Arithmetic instructions, Signed number concepts and arithmetic operations, logic and compare instructions, rotate instructions and data serialization, BCD and ASCII conversion.	**8 Hrs**
	Unit II	
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:Using Flash and EEPROM Memories for data storage** Semiconductor memory, Erasing and writing to flash in the PIC18F, Reading and writing to data EEPROM in the PIC18.	**5 Hrs**

8	**Chapter 8: Applications of Microcontroller**: Event counter, Linear variable Differential Transformer (LVDT), Angular speed measurement (RPM meter), Digital Thermometer, Digital PID controller.	**5 Hrs**

Text Book

Mazidi&Mazidi, " PIC Micrcontroller and Embedded systems", Pearson Edition
Mazidi&Mazidi, " Introduction to AVR Micrcontroller and Embedded systems", Pearson Edition

Reference Books

Ramesh Gaonkar , Fundamentals of microcontrollers and Applications in Embedded Systems. Penram International Publishing(India) Pvt. Ltd.
Ajay V Deshmukh, "Microcontroller: Theory and Applications"

Course Content

Course Code:15EARC209	Course Title: **Engineering Design Practice**	
L-T-P:2-1-0	Credits:3	Contact Hrs: 4
CIE Marks: 80	SEE Marks: 20	**Teaching Hours: 30 hrs** **SEE: 20 marks**

Unit –I

1. Engineering Design and the Design Process Definition of engineering design, Design levels, Importance and challenges of engineering design, Introduction to systematic design, Design process and models.	**4 hrs**
2. Essential transferable skills, Identifying needs and gathering information Working In Teams, Forming a Team, Dynamics of a Team, Scheduling, Gantt Chart, CPM/PERT, Definitions, CPM/PERT Network Development, Problem Definition: Need Statement, Gathering Information: Clarifying the Need, How To Conduct a Market Analysis, Product Information, Industry Information, Company Information, Market Information.	**5 hrs**
3. Customer requirements & Design specifications Identifying Customer Requirements, Prioritizing Customer Requirements, Organizing Customer Requirements—Objective Tree, Kano Model Customer Needs Assessment, Design specifications	**3 hrs**

Unit – II

4. Functional analysis & performance specifications Functions, Function Decomposition and Structure, Bounding Box and Overall Function Diagram, Function Tree, Function Structure, Detailed Procedure to Establish Functional Structures, Function Structure, Reverse Engineering, Performance-Specification Method, Quality-Function-Deployment Method.	**4 hrs**
5. Conceptual design and evaluation Developing Working Structures, Steps to Develop Concepts From Functions, Brainstorming, Mechanism of Brainstorming Session, Ideation, Creativity, How to Increase Your Level of Creativity, Developing Concepts, Sketch Assembly of Alternatives, Evaluating Conceptual Alternatives, Pugh's Evaluation Matrix, Decision Matrix.	**4 hrs**
6. Embodiment design Product Drawings, Prototype, Design for "X", Design for Manufacturing, Design for Assembly, Design for Environment, Safety Considerations, Safety Analysis Techniques, Human Factors, Human Sensory Capabilities, Anthropometric Data.	**4 hrs**

Unit – III

7. Detailed design Analysis, Material Selection, Material Classifications and Properties, Material Selection Process, Primary Manufacturing Methods, Material Selection Theory,Bill of Material	**3 hrs**

8. Ethics in Design Ethics: Understanding obligations, Codes of ethics: What are our professional obligations? Obligations may start with the client. ..... But what about the public and the profession? On engineering practice and the welfare of the public, Ethics: Always a part of engineering practice.	**3 hrs**

Text Books:

1. Yousef Haik, Engineering Design Process, Cengage Learning India Private Limited, New Delhi

References:

2. Clive L Dym and Patrick Little, Engineering Design: A Project Based Introduction, John Wiley & Sons.
3. George Dieter and Linda C Schimdt, Engineering Design, Macgraw Hill

Laboratory Plan

Laboratory Course Plan: B E in A&R

Laboratory Title: **Manufacturing &Metrologylab**	Lab. Code: 15EARP204
Total Hours: **24**	Duration of SEE Hours: 3
SEE Marks: **20**	CIE Marks: **80**

Experiment wise Plan

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

Category: Demonstration		**Total Weightage: 20**		**No. of lab sessions: 2**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1.	Material Removal Operations	1	10	
	Learning Objectives: The students should be able to: 1. Demonstrate various operations like Facing, Turning, threading on a work piece using Lathe machine. 2. Perform operations like drilling of holes on a given work material using Drilling Machine. 3. Perform Tapping operation on a given slab of metal. 4. Demonstrate grinding operation on a given metal cube to achieve predefined dimensions. 5. Demonstrate taper turning operation on a circular bar			Unit 1
2.	Material Testing	1	10	
	Learning Objectives: The students should be able to: 1. To calculate various stresses acting on a circular bar subjected to axial loading using UTM and plot a graph by taking the readings.			Unit I

	2. To calculated Impact strength of a given material using CHARPY and IZOD testing machine. 3. To calculate Hardness of a given material			
Category: Exercise		**Total Weightage: 30**		**No. of lab sessions: 6**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
3.	Fabricate the Parts for Table Clamping Device	6	30	
	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
Category: Structured Enquiry		**Total Weightage: 10**		**No. of lab sessions: 1**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
4.	Assembly of parts Learning	1	10	
	Learning Objectives: The students should be able to: 1. Ensure all the parts are ready for assembly.			Unit I, II

	2. Make sure all the parts are within the defined limits 3. Prepare a process chart to ensure easy flow of assembly 4. Write specification of assembly .			
Category: Open Ended		**Total Weightage: 10**		**No. of lab sessions: 1**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
5.	DFM using Solid works Learning outcomes	1	10	
	Learning Objectives: The students should be able to: 1. Ensure all the parts can be manufactured without any difficulties. 2. Ensure dimensions given and machine selected can perform the operation. 3. Visualize all the parts and remember the location of each link in assembly. 4. Identify alternate dimensions to any failing part and correct without performing machining operations. 5. Select suitable machine to perform specific operations.			Unit I, II, III

Laboratory Plan

Laboratory Course Plan: B E in A&R 2014-2018

Laboratory Title: **Microcontroller Lab**	Lab. Code: **15EARP205**
Total Hours: **24**	Duration of SEE Hours: 3
SEE Marks: **20**	CIE Marks: **80**

Experiment wise Plan

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

Category: Demonstration		**Total Weightage: 15**		**No. of lab sessions: 6**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**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	2	5	
	Learning Objectives: The students should be able to: 1. 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.*			
2	Develop a counter machine which count from 0000 to 9999 and display on 7 segment LED display using PIC16F877A and Arduino	2	5	

	board.			
	Learning Objectives: The students should be able to: 1. 1. *Use 7Segment LED for counting numbers.* 2. *Use appropriate logic or method for counting.*			
3	In a manufacturing industry there is a need of continuous temperature monitoring and inform to the concern authority. Develop an application that reads the values from LM35 temperature sensor and display the temperature in degree Celsius on LCD display using PIC16F877A and Arduino board.	2	5	
	Learning Objectives: The students should be able to: 1. 1. *Connect LM35, LCD and microcontroller.* 2. *Write function to read values from LM35 and display it on LCD.*			
Category: Exercise		**Total Weightage: 20**		**No. of lab sessions: 8**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
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.	2	5	
	Learning Objectives: The students should be able to: 1. *Connect Keypad, LCD with microcontroller.* 2. *Write logic to read key press event from keypad*			

5	There is a need to develop a microcontroller based in an automobile to estimate the exact distance of an object from the car. Develop a system using Ultrasonic Sensors to find the distance of an object and inform the driver. The schematic of the system with all the connections are shown in the diagram below. Make the connections as per the schematic and develop the flowchart and the code to perform the required operation.	2	5	
	Learning Objectives: The students should be able to: 1. *Connect Ultrasonic Distance Sensor and microcontroller* 2. *Logic to find distance in CM and Meters.*			
6	There is a need to develop a microcontroller based system to do control the speed and direction of a wheeled autonomous mobile robot. Develop an add-on to autonomous robot using sensors to control the speed control of a DC motor hence control the robot movement.	2	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.*			

7	Write a program to sensor based control of a stepper motor	2	5	
	Learning Objectives: The students should be able to: 1. *Connect stepper motor to microcontroller using driver.* 2. *Understand different types of stepper motors.*			
Category: Structured Enquiry		**Total Weightage: 25**		**No. of lab sessions: 4**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
8	There is a need to develop a microcontroller based system to continuously monitor and check products for defect which are moving on a conveyer belt using sensors and kick out the defect product from the queue.	2	5	
	Learning Objectives: The students should be able to: 1. *Connect Push button, LED and microcontroller*. 2. *Logic to control ON/OFF of LED using push button.*			
9	People sitting in a car have the tendency of keeping their hand out of window and when driver closes the window their hand may get struck in between. Implement an Anti-Pinch System for Power Window which helps in avoiding such accidents.	2	20	
	Learning Objectives: The students should be able to:			

	1. Understand difference between software and hardware interrupts. 2. *Write interrupt programs*			
Category: Open Ended		**Total Weightage: 20**		**No. of lab sessions: 4**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
11	Develop a system to create Liquid flow rate measurement using any microcontroller.	4	20	
	Learning Objectives: The students should be able to: 1. *Identify the problem and solve.* 2. *Apply the knowledge of electronics and programming to measurement Liquid flow rate.*			

Laboratory Plan

Laboratory Course Plan: B Ein A&R 2014-2018

Laboratory Title: **Kinematics of Machinery lab**	Lab. Code:15EARP206
Total Hours: **24**	Duration of SEE Hours: 3
SEE Marks: **20**	CIE Marks: **80**

Experiment wise Plan

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

Category: Demonstration		**Total Weightage: 15.00**		**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	5.00	
	Learning Outcomes: The students should be able to: 1. Demonstration of commands used in SolidWorks Motion interface. Demonstration of advanced mates and mechanical mates The students should be able to: 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? 4. What is analysis? 5. Why analysis is important? 6. What does SolidWorks Motion analysis calculate?			UNIT – I
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. 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 should be able to: 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: 45.00**		**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. 1. Applying motors to simulate the movement. 2. Setting 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. 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			UNIT-I

	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			
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. Students should modify the geometry of Link3 so that the 4Bar mechanism looks like 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?			UNIT-I
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. 1. Compute the torque and power analytically 2. Obtaining the results in solidworks			UNIT-I
6	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 1. Design CAM & Follower 2. Applying motors to simulate the movement 3. Setting the time flow			UNIT-II

	and frame rate			
7	Gears: Motion study of spur gears & Planetary gear.	1.00	5.00	
	Learning Outcomes: The students should be able to: 1. Importing Standard Gears from solidworks toolbox. Meshing of Gears (Spur gear, Rack and Pinion and Planetary Gear)			UNIT-II
8	Simulation of Belt and Chain Drive Mechanism.	2.00	10.00	
	Learning Outcomes: The students should be able to: 1. Silmulation of 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 simulate the effect of: • Forces • Springs • Dampers • Gravity • Contact between components • Bushings			UNIT-3

Course Content

Course Code: 15EARC301	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.	6
2	Chapter 2:**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
3	Chapter 3:**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
	UNIT - II	
4	Chapter 4:**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
5	Chapter 5: **Staticsand Dynamics of Serial Manipulators** 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, Lagrangian Formulation, Inertia Effects of the Rotors, End-Effectors Space Dynamical Equations.	7

6	Chapter 6: **Trajectoryplanning** 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
UNIT - III		
7	Chapter 7:**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.	5
8	Chapter 8:**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

Course Content

Course Code: **15EARC302**	Course Title: **Hydraulics and Pneumatics**	
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 - 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.	7hrs
Chapter No. 2. Hydraulic Actuators: Cylinders and Motors Linear Hydraulic Actuators (cylinders), Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic Motor Performance	6hrs
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.	7hrs
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.	6hrs
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 and Hydraulic Control Systems **Pneumatic Circuit Design:** Direct and indirect control of single acting cylinder, control of	9hrs

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. **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.	
Unit - 3	
Chapter No. 7. 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
Chapter No. 8. Hydraulic System Maintenance Common faults in a hydraulic systems, contamination, Filter and filter maintenance, pump maintenance, Hydraulic system maintenance, fault diagnosis of Hydraulic system.	5 hrs

Course Content

Course Code: 15EARC303	Course Title: Mechatronic Systems 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 - 1	
Chapter No. 1. Mechatronic Systems Design , Engineering & Modeling Introduction to mechatronic systems design, structure of mechatronic systems, Traditional approach to mechatronic systems design, Mechatronics design methodology (V-model) – VDI 2206, Model based design, Bond graph approach to modeling State charts, UML &SysML , Case studies.	**10**
Chapter No. 2. Design of Mechatronic control systems in State space Controller Design,Alternative Approaches toController Design,Observer Design,Alternativeapproaches toObserver Design, Steady-State Error Design ViaIntegral Control, Robust Control System Design, The z-Transform: Transfer Functions, Block Diagram Reduction, Stability, Steady-State Errors, Transient Response on the z-Plane, Gain Design on the z-Plane, Cascade Compensation via the s-Plane, Implementing the Digital Compensator.	**10**
Unit - 2	
Chapter No.3. Mechanisms for motion transmission Characteristics of motion transmission mechanism, Rotary to rotary motion transmission mechanisms, Rotary to translational motion mechanisms, Cyclic motion transmission mechanisms, Shaft misalignments and flexible couplings, Actuator sizing.	**6**
Chapter No. 4: Motion control systems Design Methodology for Programmable motion control Systems, Motion Controller Hardware and Software, Basic Single-Axis Motions, Coordinated Motion Control Methods, Point-to-point Synchronized Motion, Electronic Gearing Coordinated Motion, CAM Profile and Contouring Coordinated Motion, Sensor Based Real-time Coordinated Motion, Coordinated Motion Applications.	**7**
Chapter No. 5 : Sensors Principles & characteristics of measurement devices, Signal conditioning, Sensor characterization, Relations between physical quantities, Sensor Classification, Specifications, Error reduction techniques, Loading errors, Wheatstone bridge circuit, Sensors for position, Velocity , Acceleration , Strain, Force, Torque, Pressure, Temperature, Flow rate, Humidity, Vision systems, Sensor fusion.	**7**

Unit - 3	
Chapter No.6. Actuators Principle and characteristics of electric motors, Solenoids, DC motors & drives, AC induction motors & drives, Step motors, Linear motors.	**7**
Chapter No.7. Data Acquisition Systems Data conversion devices, Filters, 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.	**7**

Course Content

Course Code: 15EARC304	Course Title: Programming Industrial Automation Systems	
L-T-P-SS: 3-0-0-0	Credits: 3	Contact Hrs: 40
CIE Marks: 50	SEE 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 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,	8 hrs

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

Laboratory Course Plan: B E in A&R 2014-2018

Laboratory Title: **Automation Lab**	Lab. Code: 15EARP303
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: 20.00**		**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. Introduction to SELEC Hardware and instruction set, demo programs.	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* 2. Solve the problems on interfacing by using Selec PLC, sensor and actuators.			UNIT I
2	Introduction to Panasonic PLC Hardware and FPWinPro software , Instruction set, Demo Programs	1.00	5.00	
	Learning Outcomes: 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*			UNIT I

	logic, Function block and Structured Text programming			
3	Introduction to Bosch Rexroth PLC Hardware, Indra Works, Instruction set and Demo Programs	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	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	1.00	5.00	
	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: 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**
5	Simulation Exercises on FPWINPro Software & Panasonic PLC a. Car safety system b. Solving Boolean Expressions c. Sequential Logic Control	1.00	5.00	
	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	Exercises using Panasonic PLC hardware interfaced with sensors and actuators &FPWinPro software	1.00	5.00	
	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	simulate exercises using Rexroth PLC software using ladder diagram, function block and structured text programming for the given case studies	1.00	5.00	
	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	Solve case study problems using Rexroth PLC hardware interfaced with sensors, actuators and process indicators	1.00	5.00	
	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*			
9	Exercises using Rexroth PLC software and hardware Building ALU , Timer and Counter b. Motor Control c.Burglar Alarm . d. Conveyor Control e. To explore PID control	1.00	5.00	
	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: 15.00**		**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	Case studies on A. Automatic stamp B. Vehicle control system C. Process control system	2.00	15.00	
				UNIT III
Category: Open Ended		**Total Weightage: 20.00**		**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	20.00	UNIT III

Laboratory Plan

Laboratory Course Plan: B E in A&R 2015-2019

Laboratory Title: **Mechatronics Laboratory**	Lab. Code: **15EARP304**
Total Hours: **30**	Duration of ESA Hours: 2hrs

Experiment wise Plan

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

<table>
<tr><th colspan="2">Category: Demonstration</th><th colspan="2">Total Weightage: 10</th><th>No. of lab sessions: 2</th></tr>
<tr><th>Expt./ Job No.</th><th>Experiment / Job Details</th><th>No. of Lab Session(s) per batch (estimate)</th><th>Marks / Experiment</th><th>Correlation of Experiment with the theory</th></tr>
<tr><td rowspan="2">1</td><td>Demo on Quanser Mechatronics Sensor kit, DC Motor Control Trainer module, Inverted Pendulum Trainer module with NI ELVIS Platform.</td><td>1</td><td>05</td><td rowspan="2">Unit - 2</td></tr>
<tr><td colspan="3">Learning Objectives:
The students should be able to:
1. Demonstrate the working of Quanser, Mechatronics Sensor kit, DC Motor Control Trainer module, Inverted Pendulum Trainer module with NI ELVIS Platform.</td></tr>
<tr><td rowspan="2">2</td><td>1. Model physical systems using bond graph techniqueusing Model-20Sim software/Open modelica/ /Hopsansoftware.
2. Discretization(S→Z) (Simulation) using Labview.</td><td>1</td><td>05</td><td rowspan="2">Unit - 1</td></tr>
<tr><td colspan="3">Learning Objectives:
The students should be able to:
1. Model physical systems using bond graph technique using Model-20Sim software/Open modelica software.
2. Realize discretizition methods and compare the results.</td></tr>
</table>

	3. Make basic calculation using Laview Virtual Instrument.			
Category: Exercise		**Total Weightage: 20**		**No. of lab sessions: 3**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
3	A/D and D/A (Simulation) using Labview.	1	05	Unit - 3
	Learning Objectives: The students should be able to: 1. Measure and characterize Analog to Digital Converter (ADC). 2. Measure and characterize Digital to Analog Converter (DAC). 3. Make basic calculation using LabVIEW Virtual Instrument.			
4	Implementing a Level Control System in LabVIEW.	1	05	Unit - 1
	Learning Objectives: The students should be able to: 1. Implement a level control system using PID controller.			
5	Ultrasonic Transducer Characterization and Motor Control on starter kit 2.0	1	10	Unit - 2
	Learning Objectives: The students should be able to: 1. Realize the characteristics of an ultrasonic transducer using Starter kit 2 and LABVIEW. 2. Discover how to control motors using motor drivers, PWM, and PID techniques. 3. Realize the characteristics of an encoder using Starter kit 2 and LABVIEW. 4. Apply conversions between motor command units and user preferred units.			
Category: Structured Enquiry		**Total Weightage: 40**		**No. of lab sessions: 6**
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 (DC motor, Inverted pendulum)	2	20	Unit - 2
	Learning Objectives: The students should be able to: 1. Derive analytically the mathematical model of a DC motor and identify experimentally its physical parameters. 2. Measure the resistance and the back-electromotive force (back-EMF) constant of the DC motor and derive the voltage-to-motor speed transfer function. 3. Investigate various physical principles of the rotary pendulum and experimentally determine its moment of inertia.			
7	Design a Lag controller for a DC motor using the frequency response method.	2	10	Unit – 1, 2
	Learning Objectives: The students should be able to: 1. Design a Lag controller for a DC motor 2. Derive and simulate a digital equivalent controller using emulation.			
8	Design a PI controller for a DC motor using the Ziegler Nichols method, and then use this controller to build the discrete equivalent controller using emulation, investigating the effect of the discretization method and sampling frequency.	2	10	Unit – 1, 2
	Learning Objectives: The students should be able to: 1. Design a PI controller using the Ziegler Nichols method 2. Derive and simulate a digital equivalent controller using emulation.			

Category: Open Ended		**Total Weightage: 10**		**No. of lab sessions: 2**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
9	Select any one of these following experiments and	2	10	Unit – 1, 2 and 3

	perform the experiment: 1. Kinematics, Perception with PING))) and Localization using starter kit 2.0. 2. Pole placement using state feedback (PPSF emulation) for the inverted pendulum 3. Use DSC module in LabVIEW software and SbRIO/ CRIO to build control system. 4. Build SCADA and Cam profile applications using Rexroth Win-studio and MLD-CAM builder software tools.			
	Learning Objectives: The students should be able to: 1. Discover the steering frame. Add motor control of turning and rotating to provide the capability to drive from point A to point B. 2. Learn about hierarchical programming and state machine architectures to build more sophisticated programs to sequence control tasks like rotate and drive to navigate from point A to point B. 3. Calibrate PING)))'s orientation and file IO 4. Displayperception data with an XY Graph 5. Communicate perception data to the host with network Streams 6. Write a program to identify edges using feature extraction method to identify an obstacle, avoid obstacle and follow a wall. 7. Determine DaNI's location in the environment with odometric localization (dead reckoning). 8. Build an occupancy grid map using LABVIEW. 9. Design a state feedback controller for the inverted pendulum using pole placement. 10. Derive and simulate a digital equivalent controller using emulation. 11. Study the effect of sampling rate on the system. 12. Implement the selected control system prototype and develop the user interface using SCADA features of LabVIEW software and SbRIO/ CRIO.			

Semester: V *Year: 2017*

Laboratory Title: **Mini project**	*Lab. Code*: 15EARW301
Total Hours: **30**	*Total Credits*: **3**
Total ESA Marks: 5**0**	*Total ISA. Marks*: **50**

Experiment wise plan

List of activities planned to meet the requirements of the syllabus

Week No	***Activities***	***Deliverables***	***CIE Marks out of 50***
1&2	*Need analysis, Identification of problem statement, Engineering Design process*	*Problem statement, Project plan*	*10*
3&4	*Control System Design*	*Component designs & Integration, Modeling and simulation*	*10*
5,6,7&8	*Fabrication, Testing and validation*	*Prototype (hardware and software)*	*20*
9&10	*Report generation*	*Test reports and Conclusion*	*10*

Course Content

Course Code: 15EARC305	Course Title: Real Time Embedded Systems		
L-T-P-SS: 4-0-0-0	Credits: 4	Contact Hrs: 50	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100	
Teaching Hrs: 50		Exam Duration: 3 hrs	

Content	Hrs
Unit - 1	
1.0 Introduction to System Structures, Embedded System and Operating System System Structures types, Real time systems & basics, Operating system definition, operations, types,Embedded system purpose, Quality attributes, Core and Supporting components of embedded system, Embedded firmware	5
2.0 Target Architectures : ARM Cortex M3 processors & its Programming: 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).	8
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, 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.	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 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.	7
5.0 Tasks and Task Management VxWorks- 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.	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.	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.	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), Embedded design cycle-case study-ACVM	5

Laboratory Plan **FMTH0303-3.0**

Semester: VI *Year:* **2018 - 2019**

Laboratory Title: **OOP & Python Practice**	Lab Code: **15EARC306**
Total Hours: **48**	Duration of SEE 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: 2**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	Write programs using the concept of OOP (C++/Java) Language Fundamentals and concept of command line arguments.	1	10	
	Learning Objectives: The students should be able to: 1. Demonstrate how to compile and run a program in command prompt. 2. Write programs using operators and control statements. 3. Write programs for accepting command line arguments and process them in program. 4. Demonstrate how to compile and run a Java program using different IDE's like eclipse, Net beans etc.			Object Oriented Programming -I
2	Write programs using the concept of arrays, Strings and String Buffer class and exception Handling.	1	10	
	Learning Objectives: The students should be able to: 1. Write programs using different types of arrays and			Object Oriented Programming -I

	strings. 2. Write a program to catch different types of exceptions. 3. Demonstrate how the String Buffer is used in a program.			
Category: Exercise		**Total Weightage: 20**		**No. of lab sessions: 2**
3	Develop a swing based GUI using swing components and containers and connect it to database .	1	10	Object Oriented Programming -I
	Learning Objectives: The students should be able to: 1. Develop a GUI using swing components and containers. 2. Demonstrate how to insert, update and retrieve data from a database by using a simple swing based program. 3. Demonstrate the procedure of database connection.			
4	Write programs using the concept of Generic class, Inheritance, Interface and Package.	1	10	
	Learning Objectives: The students should be able to: 1. Write a program to create base class and derived class and demonstrate the inheritance concept using the same program. 2. Write a program to create interface and demonstrate how to use the interface for other programs also. 3. Use the built in packages to write programs for defined task. 4. Create the user packages and demonstrate how to use the user package in other programs or other classes. 5. Demonstrate how to create parameterized constructors and how to use different types of access specifies in a program.			Object Oriented Programming -I
Category: Exercise		**Total Weightage: 30**		**No. of lab sessions: 3**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**

5	Write a program using the concepts of python scripting elements python constructs, data structures.	1	10	Python programming-II
	Learning Objectives: The students should be able to: 1. Demonstrate how to compile and run a program in command prompt. 2. Write programs using operators and control statements. 3. Write programs for accepting command line arguments and process them in program. 4. Demonstrate how to compile and run a python program using different IDE's like anaconda ,ipython etc.			
6	Write programs using the concept of functions, modules, packages and regular expressions	1	10	Python programming-II
	Learning Objectives: The students should be able to: 1. Write programs using functions and modules. 2. Write a program to use packages and regular expressions			
7	Write a python program to use the language scripting elements and constructs, data structures, and repository of standard library, to develop real world applications.	1	10	Python programming-II
	Learning Objectives: The students should be able to: 1. Write a program using scripting elements and data structures. 2. Create the user packages and demonstrate how to use the user package in other programs or other classes. 3. Write a program to create interface and demonstrate how to use the interface for other programs also			

Category: Structured Enquiry		**Total Weightage: 10**		**No. of lab sessions: 3**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
8	Solving a Maze: Program a robot to solve a maze by finding the goal position in the maze starting from a starting position. You will need a data structure to keep track of positions found in the maze that are yet to be explored, starting with positions around the starting position. You will compare the maze solutions found using a Stack versus a Queue for storing unexplored positions.	2	10	
	Learning Objectives: The students should be able to: 1. Select fundamentals concepts of object oriented programming concepts/python, based on the problem scenario to implement programs.			Object Oriented Programming –I/ Python programming-II
Category: Open Ended		**Total Weightage: 20**		**No. of lab sessions: 2**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
9	Implement a project using C++/Java/python concepts, for automation and robotics applications. (FOR SEE)	2	20	

	Learning Objectives: The students should be able to: 1. Use the C++/Java/python concepts to implement the project. 2. Select the appropriate tool/software to implement the project. 3. Write a technical report using IEEE standard. 4. Present the technical report for the implemented project. 5. Demonstrate the learning experiences of working in a team.	Object Oriented Programming –I/ Python programming-II

Laboratory Plan **FMTH0303-3.0**

Semester: VI *Year:* **2018-2019**

Laboratory Title: **DBMS Lab**	Lab. Code: : 15EARC307
Total Hours: **24**	Duration of ESA Hours: 3
ESA Marks: **20**	ISA 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: 4**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	Preparing an ER diagram for given database	2	10	
	Learning Objectives: The students should be able to 1. Demonstrate how structure of a database can beexpressed graphically by an ER diagram. 2. Demonstrate how torepresent attributes,relationships among entity sets, link attribute to entity sets and entity sets to relationships			
2	Execute basic SQL queries on a given database. (DDL, DML, DCL commands)	2	10	
	Learning Objectives: The students should be able to: 1. Demonstrate how to use DDL, DML and DCL commands on a database. 2. Demonstrate how to specify different types of constraints on a table while creating a table.			
Category: Exercise		**Total Weightage: 40**		**No. of lab sessions: 4**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
3	Execute nested, correlated queries using exist, like,	1	10	

	union, intersection and joins on a given database.			
	Learning Objectives: The students should be able to: 1. Write SQL queries to retrieve the required data, using correlated queries, nested queries, joins, and using keywords exist, like, union and intersection. 2. Demonstrate how to join two tables using different types of joins and use keywords exist, like, union, and intersection to retrieve data.			
4	Execute SQL queries on - group by, having clauses and aggregate functions on a given database to retrieve the required data.	1	10	
	Learning Objectives: The students should be able to: 1. Write SQL queries using group by, having clauses and aggregate functions to retrieve the required data.			
5	Specifying views in SQL	1	10	
	Learning Objectives: The students should be able to 1. Write SQL queries to create & update Views			
6	Design a database for the given schema using normalization concept and execution of given queries on the database and execution of queries.	1	10	
	Learning Objectives: The students should be able to: 1. Design the database for the given schema using normalization concepts and use the given RDBMS software and implement the database.			
Category: Structured Enquiry		**Total Weightage: 20**		**No. of lab sessions: 2**
Expt./	**Experiment / Job Details**	**No. of Lab**	**Marks /**	**Correlation of Experiment**

Job No.		**Session(s) per batch (estimate)**	**Experiment**	**with the theory**
7	Design a database for the given specifications & implement the database and write and execute the queries for the given statements.	2	20	
	Learning Objectives: The students should be able to: 1. Draw the ER diagram for a given specifications. 2. Design a database based on the specifications given and create tables by specifying different types of constraints on database and write SQL queries for given statements and execute them. 3. Select the proper RDBMS software to implement the database.			
Category: Open Ended		**Total Weightage: 20**		**No. of lab sessions: 2**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
8	Implement a project using Java/database management systems concepts, for automation and robotics applications. (FOR SEE)	2	20	
	Learning Objectives: The students should be able to: 1. Use the java /database management concepts to implement the project. 2. Select the appropriate tool/software to implement the project. 3. Write a technical report using IEEE standard. 4. Present the technical report for the implemented project. 5. Demonstrate the learning experiences of working in a team.			

Course Content

Course Code: 15EARE301	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: 40		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1.Elements and Dynamics of Electric Drive Systems Basic components of an Electric drive system: Mechanical loads, electric motors, power sources, converters and controllers. Moment of inertia , basic concept of Traveling time, gears and belts, traveling time of dc motors and traveling time of induction motors.(Book-1,3)	3 hrs
Chapter No. 2.Power electronic devices Ratings of power electronic devices, Characteristics of : power diodes, power transistors, power mosfets, triac and IGBT. Thyristors (SCR): static VI characteristics, turn on methods, switching characteristics, gate characteristics, two transistor model, di/dt and dv/dt protection. Firing circuits for SCRs. .(Book-2,5)	6 hrs
Chapter No. 3.Solid state switching circuits Single- phase , half-wave, ac/dc conversion for resistive loads, Single- phase , full-wave, ac/dc conversion for resistive loads, Single- phase , half-wave, ac/dc conversion for inductive loads without/with freewheeling diode, single phase dc/ac converter, voltage, frequency and sequence control and PWM,. Current source Inverter. .(Book-2,5)	6 hrs
Unit - 2	
Chapter No. 4. Power Amplifiers Definitions and amplifier types, series fed class A amplifier, Transformer coupled Class A amplifiers, Class B amplifier operations, Class B amplifier circuits, Amplifier distortions. Designing Power amplifiers: Heat flow calculations using analogous circuit. Calculation of actual power handling capacity of transistors with and without heat sink. Heat sink design.(Book-4)	6 hrs
Chapter No. 5.Speed –torque characteristics &Speed Control of Electric motors Joint Speed-Torque Characteristics of Electric Motors and Mechanical Loads, DC motors: separately excited motors, shunt motors, series motors and compound motors, Speed control of shunt or separately excited DC motors: by adding resistance, adjusting armature voltage, adjusting field voltage and solid-state control, Speed control of DC series motor: by adding resistance to armature circuit, adjusting armature voltage, and by adjusting field current, **Induction motors:** equivalent circuit, power flow, torque characteristics, starting procedure ,Damage to electric machines. speed control of induction motors: by rotor resistance, by slip energy recovery method, by adjusting the stator voltage, adjusting the supply frequency, voltage/frequency (V/F) control. .(Book-1,3)	9hrs
Unit - 3	

Chapter No. 6.Braking of electric motors DC shunt and series motors: Regenerative, dynamic, and concurrent braking. Induction motors: Regenerative , dynamic and concurrent braking. (Book-1,3)	5 hrs
Chapter No. 7.Drives for industrial Applications Rolling mill drives, cement mill drives, electric traction drives, textile mill drives drives and machine tool drives. .(Book-1,3)	5 hrs

Course Content

Course Code: 15EARE302	Course Title: **Computer vision & digital image processing**	
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

Content	Hrs
Unit - 1	
CHAPTER 1: FUNDAMENTALS OF COMPUTER VISION &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 & digital image processing. Design of machine vision system.	6 hrs
CHAPTER 2:LIGHT & 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. .	6hrs
CHAPTER 3: IMAGE FORMATION &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 ANALYSIS 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 & IMAGE COMPRESSION	6hrs

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	
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 &BAYESIAN 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

Course Content

Course Code: **15EARE303**	Course Title: **Computer-Integrated Manufacturing**	
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

Unit –I

1. Geometric Modelling and Computer-Aided Design, CAD Data Exchange and CAD Standards • Introduction to Geometric Modelling • Geometric Modelling Approaches: Wire-Frame Modelling, Surface Modelling, Solid Modelling • Computer-Aided Design, CAD System Architecture • Computer Hardware for CAD • CAD Kernels • Data Interoperability: Different Types of Data Translation/Conversion, Dual Kernel CAD Systems, Direct Data Translators, Common/Neutral Translators	05 hours
2. Group Technology and Flexible manufacturing system • Group Technology: Part Families, Part Classification and Coding, Production flow analysis, Machine Cell Design, Benefits of Group Technology • Flexible Manufacturing Technology: Introduction, FMS workstations, Material Handling and storage Systems, Computer Controls Systems, Planning the FMS, Analysis Methods for FMS	05 hours
3. Computer-Aided Process Planning and Manufacturing • Computer-Aided Process Planning: Basic Steps in Developing a Process Plan, Principal Process Planning Approaches • Computer-Aided Manufacturing: Computer Applications in a Manufacturing Plant , Key Aspects of CAM in a Manufacturing System , Manufacturing Control	05 hours
Unit –II	

4. Integration of CAD/CAPP/CAM/CNC , Integration Based on STEP Standards, Function Block-Enabled Integration
• Models of Integrating CAD/CAPP/CAM/CNC
• A Case Study of Integrating CAD/CAPP/CAM: Concurrent Product Modelling in a CAD/CAM System, A Bird's-Eye View of the Case Study, CAD/CAM Enabling a Concurrent Environment, Reflections
• Limited Efforts to Integrate CAM and CNC, Post-Processor: A Source of Vexation, Challenges, The APT Effort, The BCL Effort , The BNCL Effort, Intermediate Languages for CNC Programming
• Data Exchange Using STEP and STEP-NC
  ○ Data Exchange between CAD Systems
  ○ Data Flow between CAD, CAPP, CAM and CNC Systems
	05 Hours

○ Features as a Common Thread ○ Integration through STEP AP Harmonization ○ Integrate CAD with CAPP ○ Integrate CAPP with CAM ○ Integrate CAM with CNC ○ STEP-NC Data Model ○ Data Access Implementation Methods	
5. Integrating CAD/CAPP/CAM/CNC with Inspections • Closed-Loop Machining and On-Machine Inspection • Past Research • A Data Model for OMI • An Integrated Machining and Inspection System • Implementation	05 Hours
6. Internet-Based Integration • A Collaborative Framework • System Model ○ Client Tier: User Interface ○ Business Logic Tier: CAPP Server ○ Data Tier: Data Model • Framework Development ○ Client Tier Implementation ○ Business Logic Tier Implementation ○ Data Tier Implementation	05 Hours
Unit –III	
7. From CAD/CAPP/CAM/CNC to PDM, PLM and Beyond • PDM's Capabilities • Benefits of PDM Systems • Web-Based PDM • PDM Standardization • Integrated and Extended PDM • Product Lifecycle Management • Looking Forward to "Grand" Integration	05 Hours
8. Key Enabling Technologies • Knowledge-Based Systems • Artificial Neural Network Methods • Genetic Algorithm • Agent-Based Technology • Other Technologies	05 Hours

Laboratory Plan **FMTH0303-3.3**

Semester: VI *Year: 2018*

Laboratory Title: Robotics Lab	Lab. Code: 15EARP301
Total Hours: 28	Duration of Exam: 3
Total ESA Marks: 20	Total ISA Marks: 80

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: 4***

Learning Outcomes :

The students should be able to:

1. *Demonstrate the knowledge about the basic principles and laws of robot.*
2. *Demonstrate the knowledge about the basic principle of operation, coordinates and parts of robot.*
3. *Demonstrate the knowledge about Mat lab and Robot studio software based tools.*

Expt./Job No.	***Experiment/job Details***	***No. of Lab. Session/s per batch (estimate)***	***Marks/ Experiment***	***Correlation of Experiment with the theory***	***CLO***	***PI Code***
1	Demonstration on working with Mat Lab software.	*1*	*10*	Chapter 1-3	1	4.1.1
2	Demonstration of operations of ABB Robot and Robot Studio Software.	*1*	*10*	Chapter 1-3	1	4.1.1
3	Demonstration of controlling the robot using Flex pendant.	*1*	*10*	Chapter 1-3	2	5.1.1
4	Demonstration on working with ROS. **Description:** This tutorial introduces ROS filesystem concepts, and covers using the roscd, rosls, and	*1*	*10*	Chapter 1-3	2	5.1.1

	rospackcommandline tools.					
Category: Exercises		***Total Weightage: 20 No. of lab sessions: 4***				
Learning Outcomes: *The students should be able to:* 1. *Demonstrate the robot programming methods.* 2. *Demonstrate the operation of robot using robot controller.* 3. *Simulate the robot using Mat lab and Robot studio software.*						
Expt./Job No.	***Experiment/job Details***	***No. of Lab. Session/s per batch (estimate)***	***Marks/ Experiment***	***Correlation of Experiment with the theory***	***CLO***	***PI Code***
5	Create dynamic simulation of a simple robot with flexible transmission using the toolbox with Mat lab Simulink.	*1*	*20*	Chapter 3-5	2	5.1.1
6	Obtain the kinematic equation of the 3 DOF articulated arm with three revolute joints and simulate the same using ABB robot.	*1*	*20*	Chapter 7, 8	2	5.1.1
7	Obtain the position & orientation of the tool point P with respect to the base for the 2 DOF, RP planar manipulator using ABB robot studio software. Example: Path Tracing, Collision Detection.	*1*	*20*	Chapter 2-8	3	5.1.1
8	Creating a ROS Package. **Description:** This exercise covers using roscreate-pkg or catkin to create a new package, and rospack to list package dependencies.	*1*	*20*	Chapter 2-8	3	5.1.1

Category: Structured Enquiry	***Total Weightage: 20***	***No. of lab sessions: 4***				
Learning Outcomes : *The students should be able to:* 1. *Demonstrate the knowledge of solid modeling software tools.* 2. *Demonstrate the knowledge of industrial applications of robot.* 3. *Demonstrate the knowledge about the mapping of sensors and end effectors with the robot.*						
Expt./Job No.	***Experiment/job Details***	***No. of Lab. Session /s per batch (estimate)***	***Marks/ Experiment***	***Correlation of Experiment with the theory***	***CLO***	***PI Code***
9	Design an end effector for a particular application using Robot Studio and Solid work software.	*2*	*20*	Chapter 1-8	4 and 6	4.2.1
10	Writing a Simple Publisher and Subscriber (Python). i. Writing the Publisher Node ii. Writing the Subscriber Node iii. Building your nodes	*2*	*20*	Chapter 1-8	3	4.2.1
Category: Open Ended	***Total Weightage: 20***	***No. of lab session: 2***				
Learning Outcomes : *The students should be able to:* 1. *Demonstrate the knowledge about the commands used in simulating the robot.* 2. *Demonstrate the knowledge about work stations and conveyors.*						
Expt./Job No.	***Experiment/job Details***	***No. of Lab. Slots per batch (estimate)***	***Marks/ Experiment***	***Correlation of Experiment with the theory***	***CLO***	***PI Code***

12	Design a complete process for welding, assembly, drilling, gluing or sorting using Robot Studio and DELMIA software.	*2*	*20*	Chapter 1-8	5	4.2.1 10.1.1 12.1.1

Laboratory Plan

Laboratory Course Plan: B E in A&R 2015-2019

Laboratory Title: **Hydraulics And Pneumatics Lab**	Lab. Code: **15EARP302**
Total Hours: **24**	Duration of SEE Hours: 2
ESA Marks: **20**	ISA Marks: **80**

Experiment wise Plan

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

Category: Demonstration		**Total Weightage: 25.00**		**No. of lab sessions: 5.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	To study hydraulic pump, its characteristics and calculate the hydraulic power	1.00	4.00	
	Learning Objectives: The students should be able to: 1. Differentiate between types of pumps. 2. Plot and infer characteristic curve of the Pump.			Unit - I
2	**A.** To study concepts of Meter-in and Meter-out circuits using Single-rod cylinder and 4/2 DCV **B.** Automation Studio Exercises	1.00	6.00	
	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.			Unit II

3	To study pressure intensification of a single rod cylinder.	1.00	4.00	
	Learning Objectives: The students should be able to: 1. Demonstrate how the speed of a cylinder is controlled using 4/2 directional valve. 2. Demonstrate the pressure intensification of the single-rod cylinder.			Unit - II
4	Study of Hydraulic Motor with 4/3 DCV	1.00	5.00	
	Learning Objectives: The students should be able to: 1. Discuss the operating features of a hydraulic motor. 2. Explain how a 4/3 directional valves can be used to implement clockwise and counter-clockwise running of the hydraulic motor.			Unit – I
5	**A.** Study of indirect control of a double-acting cylinder with a pneumatically operated 5/2 directional control valve. **B.** Automation Studio Exercises	1.00	6.00	
	Learning Objectives: The students should be able to: 1. Demonstrate how a 5/2 DCV can be used control a double acting cylinder.			Unit - II
Category: Exercise		**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**
6	To study position dependent control of a double acting cylinder using mechanical limit switches.	1.00	5.00	
	Learning Objectives: The students should be able to:			Unit - II

	1. Identify switches and push buttons and use them to build the circuits.			
7	To study the application of different center configuration of 4/3 DCV. (Tandem and closed centre)	1.00	5.00	
	Learning Objectives: The students should be able to: 1. Demonstrate how a hydraulic cylinder is controlled by a 4/3 directional valve with different spool shapes (blocked and circulation position).			Unit - I
8	Study of Speed Control of Single Acting Cylinder - Slow Speed Extension and Rapid Retraction.	1.00	5.00	
	Learning Objectives: The students should be able to: 1. Explain how the speed of a single acting cylinder is controlled using a quick-exhaust valve.			Unit I and II
9	Stop control, double-acting cylinder with 5/3 directional control valve, tensile load	1.00	5.00	
	Learning Objectives: The students should be able to: 1. Explain the use of a 5/3 directional control valve with closed mid-position for stopping a double-acting cylinder.			Unit - II
Category: Structured Enquiry		**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**
10	To study the application of Regenerative Circuit	1.00	8.00	
	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 - II

11	By using a 3/2 directional control valve with adjustable minimum pressure of response, a pressure-dependent (and in addition displacement) control of a double acting cylinder is put into effect.	1.00	6.00	
	Learning Objectives: The students should be able to: 1. Use double acting cylinder, appropriate DCVs, flow control valves and push buttons and construct the circuit diagram for the given application.			Unit - II
12	The sequential control with two pneumatic drives. The signal overlapping occurring during this exercise is constructively solved by use of rollers with idle return. Practice is obtained in developing sequential diagrams and pneumatic circuit diagrams.	1.00	6.00	
	Learning Objectives: The students should be able to: 1. Use double acting cylinders, appropriate DCVs, flow control valves and push buttons and construct the circuit diagram for sequential control of two pneumatic drives.			Unit - II
Category: Open Ended		**Total Weightage: 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**
13	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	2.00	10.00	

	clamping force has been developed, the cylinder is to retract to the initial position. Develop a control circuit using a pressure sequence valve.			
	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 **FMTH0303-3.0**

*Semester:***VII** *Year: **2017***

Laboratory Title: **Real Time Embedded Systems Lab**	*Lab. Code*: 15EARP305
Total Hours: **28**	*Duration of ESA Exam*: **3hrs**
Total ESA Marks: 2**0**	*Total ISA. Marks*: **80**

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	**10**
2	Demo on Code Composer Studio(CCS) and TIVA C series TM4C1294NCPDT microcontroller board and problem solving on ADC,TIMERS,INTERRUPTS	**10**
3	Demo on LABVIEW on multitasking to implement Semaphores, Queue Demo on Introduction to Keiluvision 4 problem solving	**10**
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 Keiluvision 4.	**10**
7	Structured Query : Implementing Communication Protocols like I2C / SPI / UART /CAN / ETHERNET with Energia /CCS & TM4C1294 TIVA board	**10**
8	Synopsis for ESA Project	**10**
9	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**

Semester: VI Year: 2015-16(Even)

Course Title: Professional Aptitude and Logical Reasoning	Course Code:HSC301
Total Contact Hours: 40	Duration of SEE: 90 mins
SEE Marks: 50	CIE Marks: 50

Unit –I - Arithmetical Reasoning and Analytical Thinking

Chapter 1. – ArithmeticalReasoning	**10hrs**
Chapter 2. – AnalyticalThinking	**4hrs**
Chapter 3. – SyllogisticLogic	**3hrs**

Unit – II – Verbal and Non – Verbal Logic

Chapter 1. – Verbal Logic	**9hrs**
Chapter 2. – Non-Verbal Logic	**6hrs**

Unit – III - Lateral Thinking

Chapter 1. - Lateral Thinking	**8hrs**

Text Book

1. A Modern Approach to Verbal and Non – Verbal Reasoning – R. S. Aggarwal, Sultan Chand and Sons, New Delhi

2. Quantitative Aptitude – R. S. Aggarwal, Sultan Chand and Sons, New Delhi

References:

1. Verbal and Non – Verbal Reasoning – Dr. Ravi Chopra, MacMillan India

2. Lateral Thinking – Dr. Edward De Bono, Penguin Books, New Delhi

Semester: VI *Year: 2017-18*

Laboratory Title: **Minor project**	*Lab. Code*: **15EARW302**
Total Hours: **30**	*Duration of Exam*: **3 Hrs**
Total ESA Marks: 5**0**	*Total ISA. Marks*: **50**

Design Process

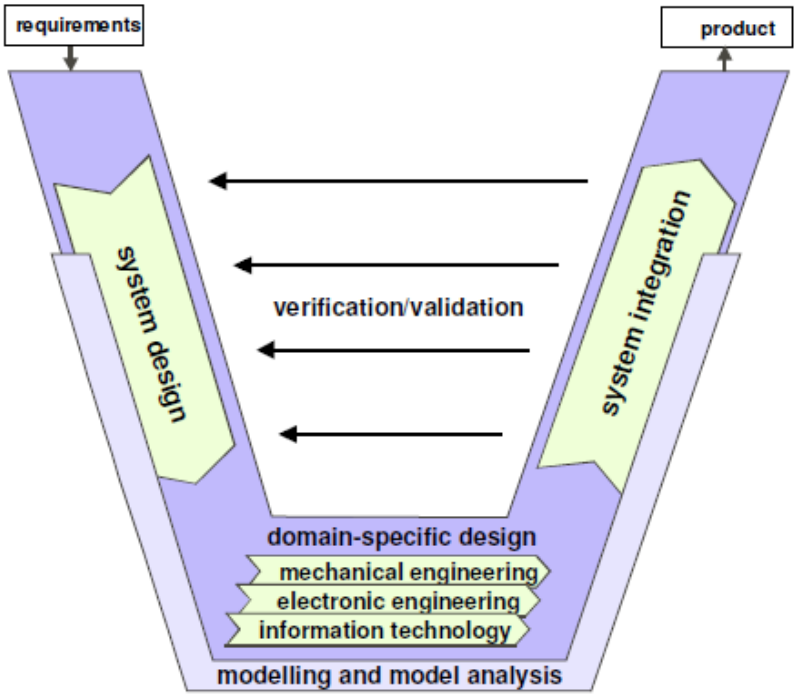
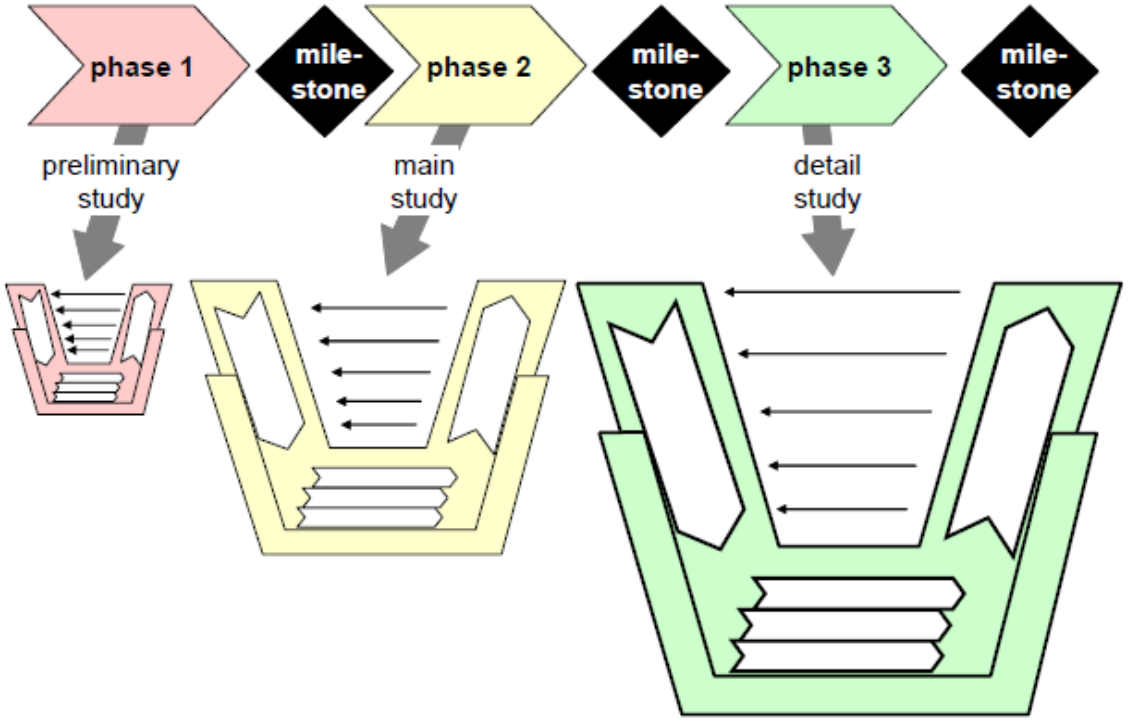


Figure 2. V-shaped model on the macro-level



Combination of V-model and project plan

Experiment wise plan

1. *List of activities planned to meet the requirements of the syllabus (Demonstration only)*

Week No	***Activities***	***Deliverables***	***ISA Marks out of 50***
1&2	*Engineering Design*	*Problem statement, Project plan*	*10*
3&4	*Mechatronics System Design*	*Component designs & Integration*	*10*
5,6,7&8	*Fabrication*	*Prototype*	*20*
9&10	*Testing, Validation an Improvements*	*Test reports and Recommendations*	*10*

Course Content

Course Code: 15EARC401	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		Duration of ESA: 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, EIA-232, EIA-485, Fiber Optics Overview, Local Area Networks (LANs), Metropolitan Area Networks (MANs), Wide Area Networks (WANs), 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 Protocol, Application Profiles, PROFIBUS PA (Process Automation) AS-Interface: AS-Interface, Physical Layer, Data Link and Application Layer of the AS-Interface	7
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 ofEthernet 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: 15EARE401	Course Title: MeasurementSystems	
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 – 1	
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 and Problems.	7hrs
Chapter No. 2. Motion Measurement Fundamental Standards , Relative Displacement: Translation and Rotational, Relative Velocity: Translation and Rotational, Relative-Acceleration Measurements, Seismic-Displacement Pickups, Seismic-Velocity Pickups, Seismic-Acceleration Pickups,Calibration and Vibration Pickups, Jerk Pickups, Problems.	4hrs
Chapter No. 3. 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, Problems.	4hrs
Unit – 2	
Chapter No. 4. 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, Problems.	7hrs
Chapter No. 5. 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, Problems.	5hrs
Chapter No. 6.Manipulation, Transmission, and Recording of Data Bridge Circuits, Amplifiers , Filters, Integration and Differentiation, Problems	3hrs

Unit – 3	
Chapter No. 7. Data Transmission and Instrument Connectivity Cable Transmission of Analog Voltage and Current Signals, Cable Transmission ofDigital Data, Fiber-Optic Data Transmission, Radio Telemetry, Pneumatic Transmission, Synchro Position Repeater Systems, Slip Rings and Rotary Transformers, Instrument Connectivity, Data Storage with Delayed Playback, Problems.	5 hrs
Chapter No. 8. Voltage-Indicating and Recording Devices Standards and Calibration, Analog Voltmeters and Potentiometers, Electrical Instruments, Digital Voltmeters and Multimeters, Signal Generation, Electromechanical XT and XY Recorders, Thermal-Array Recorders and Data Acquisition Systems, Analog and Digital Cathod-Ray Oscilloscopes/Displays and Liquid-Crystal Flat-Panel Displays, Displays, Virtual Instruments, Magnetic Tape and Disk Recorders/Reproducers, Fiber Optic Sensors.	5 hrs

Course Content

Course Code: 15EARE402	Course Title: **Advanced Microcontrollers**	
L-T-P : 3-0-0	Credits: **3**	Contact Hrs:**40**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40**		Duration of ESA: **3hours**

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 SetArchitectural 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 peripheral libraries .	7
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: 15EARE403	Course Title: Machine Learning	
L-T-P:**3- 0- 0**	Credits:3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Total Teaching Hrs.: 40		Duration of ESA: 3 hrs

UNIT-I

No	Content	Hrs
1	**Chapter 1**: **Introduction** Machine Learning Applications, 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
2	**Chapter 2**: **Decision Tree learning** Representation, decision tree algorithm, hypotheses space search in decision tree algorithm inductive bias in decision tree algorithm, issues in DTL,Bayesian decision theory classification.	5hrs
3.	**Chapter 3: Computational Learning theory** Motivation, Estimating hypotheses accuracy, Basics of sampling theory, general approach for deriving confidence intervals, difference in error of two hypotheses, 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	5 hrs
	UNIT-II	
4.	**Chapter 4: Artificial neural network** Feed forward neural networks, Learning neural network ,the expressive power of neural network, the sample complexity of neural networks, the runtime of learning neural networks,SGD and back-propogation.	5hrs
5	**Chapter 5: Clustering** Linkage–Based clustering algorithms-means and other cost minimization clusterings,spectral clustering, high level view of clustering	5 hrs

6	**Chapter 6:Kernel methods & Graphical models** Embeddings into feature spaces,the kernel trick, Multiple kernel learning, Kernel dimensionality reduction,Implementating soft SVM with kernels, Canonical Cases for Conditional Independence, Example Graphical Models, Naive Bayes' Classifier, Hidden Markov Model, Linear Regression, d-Separation Belief Propagation	5hrs
	UNIT-III	
7	**Chapter 7:Reinforcement Learning** The learning task,Q-learning,Nondeterministic rewards & actions, temporal difference learning, generalizing from examples, relationship to dynamic programming**.**	5 hrs
8	**Chapter 8:Design and Analysis of Machine Learning Experiments** Factors, Response, and Strategy of Experimentation, Response Surface Design, Randomization, Guidelines for Machine Learning Experiments, Cross-Validation and Re sampling Methods, Measuring Classifier Performance, Interval Estimation, Hypothesis Testing, Assessing a Classification Algorithm's Performance, Comparing Two Classification Algorithms, Comparison over Multiple Datasets.	5hrs

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, AnAutomation 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.	5

	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 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.** **Flexible Manufacturing Systems**	6

	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, FormingPouche, Blister Packs and Bags.	5

TEXT BOOKS:

1. Stephen J. Derby., "Design of Automatic Machinery", 2005
2. Patrick M. McGuire, P.E., "Conveyors", CRC Press, 2010.

REFERENCE:

3. Geoffrey Boothroyd., "Assembly Automation and Product Design", Taylor & Francis Group, CRC Press, 2005.

CourseContent

Course Code:15EARO401	CourseTitle:HomeandBuildingAutomation		
L-T-P:3-0-0	Credits:3	ContactHrs:40	
ISAMarks:50	ESAMarks:50	TotalMarks:100	
TeachingHrs:50		ExamDuration:3hrs	
Content			**Hrs**
Unit- 1			
CHAPTERNO.1.INTRODUCTIONConceptandapplicationofBuildingManagementSystem(BMS)andAutomation,requirementsanddesignconsiderationsanditseffectonfunctional efficiencyofbuildingautomation system,architectureandcomponentsofBMS.			5hrs
CHAPTERNO.2.FIREALARMSYSTEMFUNDAMENTALS: What is Fire? Fire modes, History, Components, and Principles of Operation. FAS Components:Different fire sensors, smoke detectors and their types, Fire control panels, design considerations forthe FA system. Field Components, Panel Components, Applications. FAS Architectures: Types ofArchitectures,Examples.FASloops:Classificationofloops,Examples.FireStandards:FASDesignprocedureinbrief,NFPA72A,BS5839,ISConceptofIPenabledfire&alarmsystem,designaspects andcomponents ofPAsystem			5hrs
CHAPTER NO. 3. ACCESS CONTROL SYSTEM: Access Components, Access control systemDesign. CCTV: Camera: Operation & types, Camera Selection Criteria, Camera Applications, DVRBasedsystem,DVM,Networkdesign,Storagedesign.ComponentsofCCTVsystemlikecameras, typesoflenses,typicaltypesofcables,controllingsystem.CCTVApplications:CCTVApplications.			5hrs
Unit-2			
CHAPTER NO. 4. SECURITY SYSTEMS FUNDAMENTALS: Introduction to Security Systems,Concepts.PerimeterIntrusion:Concept,Components,Technology,AdvancedApplications.SecurityDesign: Security system design for verticals. Concept of automation in access control system forsafety,Physicalsecuritysystemwithcomponents,RFIDenabledaccesscontrolwithcomponents, Computersystemaccesscontrol–DAC,MAC,RBAC.			5hrs
CHAPTERNO.5.LIGHTING-CONTROLSYSTEMS Purposeoflighting-controlsystems,Basiccomponentsoflightingandlighting-controlsystems,Systemsbasedonstandardlighting-controlprotocols,Systemsbasedoncommonautomation protocols,Strategiesforenergymanagementandlightingcontrol			5hrs
CHAPTERNO.6.Processcontrol,PIDandadaptivecontrolw.r.t automationsystem Closedcontrolloops,Proportionalcontrol,Integralcontrol,Derivativecontrol,Proportional,integralandderivative functions, Tuning of PID control loops, Digital PID and direct digital control (DDC),Introductionto adaptive control			5hrs

Unit-3	
CHAPTERNO.7.BUILDINGMANAGEMENTSYSTEM:IBMS(HVAC,Fire&Security)project cycle,ProjectstepsBMS.Verticals:Advantages&ApplicationsofBMS,ExamplesIntegration:IBMSArchitecture, Normal&Emergencyoperation.Advantages ofBMS	5hrs
CHAPTERNO.8.PRACTICALAUTOMATIONSYSTEM:DesignconsiderationofAutomationsystem,RapsberryPi, PLC, IoTbased systems.	5hrs

Laboratory Plan **FMTH0303-3.3**

Semester: VIII Year: 2018-19

Laboratory Title: **Project**	Lab Code: 17EARW401
Total Hours: **30**	Duration of Exam:**3 Hrs**
Total ESA Marks: 5**0**	Total ISA. Marks: **50**
Lab. Plan Author: Rakesh Tapaskar	Date: 29**/12/2018**
Checked By: Arun C Giriyapur	Date: 29**/12/2018**

Prerequisites:

Subjects learnt up to VI semester.

Course Outcomes-CO

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

1. Carry out market survey, do need analysis and identify suitable problems.
2. Write a project proposal which will involve developing a complete solution for the identified problem from the real world.
3. Apply the principles of engineering design to plan and manage the project.
4. Apply suitable design processes and develop the best possible solution.
5. Develop proof of concepts and models for verification.
6. Prepare production drawings, bill of materials and process plans.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Program outcomes (PO)

Laboratory (Course) Title:**Project** Laboratory (Course) code: 15EARW401Semester:VIII Year:2018-19

Course Outcomes (CO) / Program Outcomes (PO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
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.														

Degree of compliance **L**: Low **M**: Medium **H**: High

Design Process

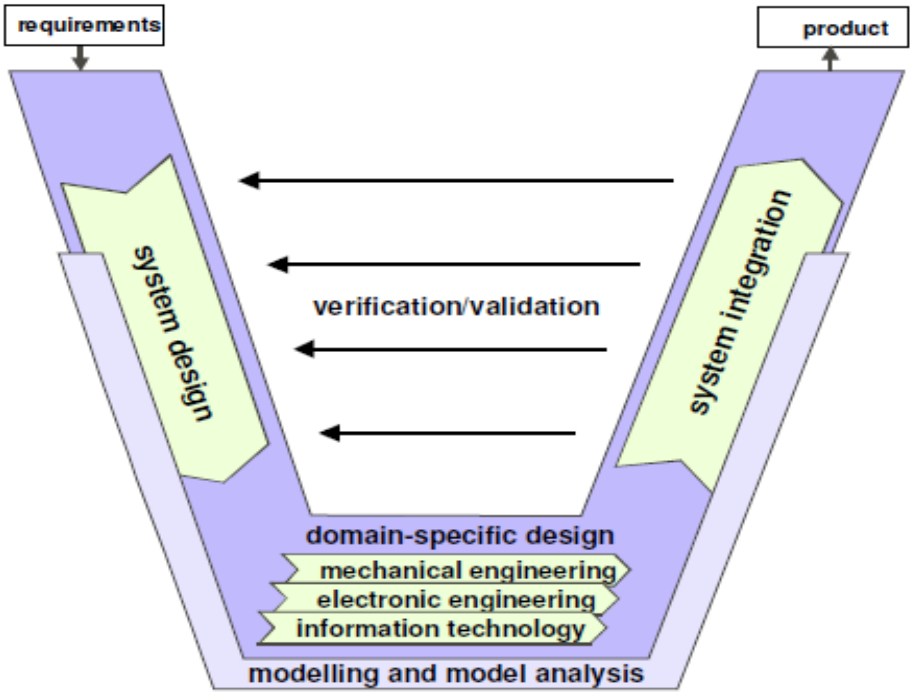
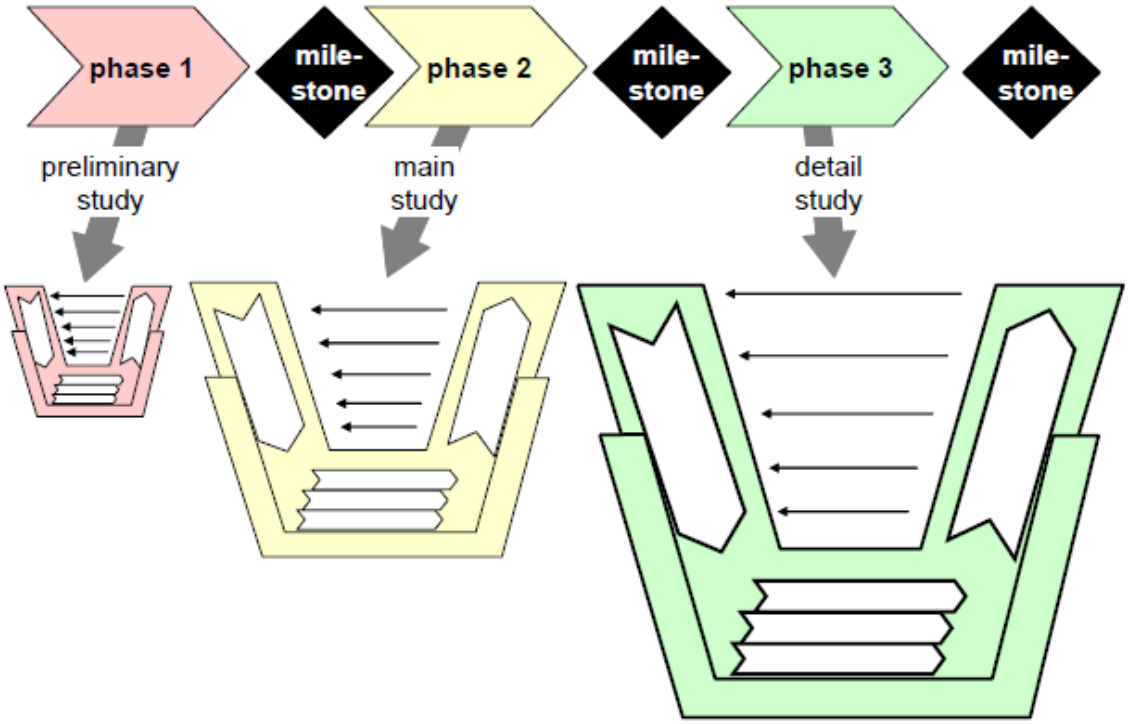


Figure 2. V-shaped model on the macro-level



Combination of V-model and project plan

Experiment wise plan

2. *List of activities planned to meet the requirements of the syllabus*

Week No	***Activities***	***Deliverables***	***CIE Marks out of 50***
1&2	*Need analysis, Problem identification and market survey*	*Project proposal*	*10*
3&4	*Project management*	*Project plan, gantt chart, WBS, Budget*	*10*
5,6,7&8	*Engineering design*	*Component designs & Integration, Proof of concept, modeling and simulation (hardware and software)*	*20*
9&10	*Detailed design*	*Bill of materials, production drawings*	*10*

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

Prerequisites:

-

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.

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

Preamble:

The aim of this project work is to enable students to develop their engineering skills and practice by co-working with industry mentors on an industry relevant problem.

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.

Course Content

Course Code: **16EARE403**	Course Title: **Machine learning and ROS**	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration : 3 hours

Content	Hours
UNIT – 1	
Chapter 1:Introduction to Robot operating system ROS concepts, creating ROS packages writing a minimal ROS publisher, compiling ROS nodes, running ROS nodes, examining running minimal publisher node, scheduling node timing, writing a minimal ROS subscribercompiling 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	8hrs

learning, locally weighted regression, Representation, decision tree algorithm, hypotheses space search in decision tree algorithm inductive bias in decision tree algorithm, issues in DTL,Bayesian decision theory classification.	
Chapter 5:Kernel methods and Graphical models Embedding's into feature spaces, the kernel trick, Multiple kernel learning, Kernel dimensionality reduction Canonical Cases for Conditional Independence, Example Graphical Models, Naive Bayes' Classifier, Hidden Markov Model, Linear Regression, d-Separation Belief Propagation, Linkage–Based clustering algorithms-means and other cost minimization clustering.	7hrs
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	5hrs

Course Content

CourseCode:17EARE301	Course Title: **Artificial Intelligence For Autonomous Systems**	
L-T-P:3-0-0	Credits:3	ContactHrs:40
ISAMarks:50	ESAMarks:50	TotalMarks: 100
TeachingHrs:40		ExamDuration:3hours

Content	Hours
UNIT–1	
Chapter1:**IntroductiontoArtificialintelligenceand autonomoussystems**Foundationofartificialintelligence,roboticsandtheAIapproach,Semi-autonomouscontrol,SevenareasofAI**,**TheConceptofRationalityTheNatureofEnvironments, TheStructure of Agents,Problem-SolvingAgents,Searching forSolutions, UninformedSearchStrategies,InformedSearchStrategies,KnowledgerepresentationinAI,knowledge	5hrs
Chapter2:Roboticsoftwarearchitectures Subsumptionarchitecture,Three-layerarchitecture, Pipelinearchitecture,HierarchicalParadigm-AttributesoftheHierarchicalParadigm,ReactiveParadigm-AttributesofReactiveParadigm,HybridDeliberative/ReactiveParadigm-AttributesofHybridParadigm,ArchitecturalAspects,ManagerialArchitectures-AutonomousRobotArchitecture(AuRA),SensorFusionEffects(SFX),State-HierarchyArchitectures,Model-	5hrs.
Chapter3:BiologicalFoundationsoftheReactiveParadigm Agencyandcomputationaltheory,AnimalBehaviors,Reflexivebehaviors ,CoordinationandControlofBehaviors,Innatereleasingmechanisms,Concurrentbehaviors,PerceptioninBehaviors,Action-perceptioncycle,TwofunctionsofperceptionGibson:Ecologicalapproach,Neisser:Twoperceptualsystems,SchemaTheory,Behaviorsandschematheory,PrinciplesandIssuesinTransferringInsightstoRobo	5hrs
UNIT–2	
Chapter4:Capturingintelligence-Designingareactiveimplementationwithcommonsensingtechniquesforroboticsperception Behaviors asObjects inOOP,Steps inDesigningaReactiveBehavioralSystem,CaseStudy:UnmannedGroundRoboticsCompetition,AssemblagesofBehaviors,Logicalsensors,BehavioralSensorFusion,DesigningaSensorSuite,ProprioceptiveSensors,ProximitySensors,ComputerVision,RangefromVision,CaseStudy:Horsd'Oeuvres,Anyone?	8hrs
Chapter5: Multi-agentsandnavigation inrobotics Heterogeneity,Control,Cooperation,EmergentSocialBehavior,TopologicalPathPlanning,RelationalMethods,AssociativeMethods,CaseStudyofTopologicalNavigationwithaHybridArchitecture	7hrs

UNIT–3	
Chapter6:LocalizationandMapMaking SonarSensorModel,Bayesian,Conditionalprobabilities,Conditionalprobabilities,UpdatingwithBayes'rule,Dempster-ShaferTheory,ShaferbelieffunctionsBelieffunctionforsonarDempster'sruleofcombinationWeightofconflictmetric,HIMMsonarmodelandComparisonofMethods,Examplecomputations,PerformanceErrorsduetoobservationsfromstationaryrobot,Tuning,Localization,Continuouslocalizationandmapping,Feature-basedlocalizationExploration,Frontier-basedexploration,GeneralizedVoronoigraphmethods .	6hrs
Chapter7: Deeplearningandnaturallanguageprocessing DeepLearningImprovementoftheDeepNeuralNetworkVanishingGradientOverfittingComputationalLoad.Languagemodels, textclassification,informationretrieval	4hrs