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Curriculum Structure and Curriculum Content for the Batch 2022-26
Department of Automation & Robotics
Bachelor of Engineering (Automation & Robotics)

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Vision and Mission of KLE Technological University

Vision

KLE Technological University will be a national leader in Higher Education–recognised globally for innovative culture, outstanding student experience, research excellence and social impact.

Mission

KLE Technological University is dedicated to teaching that meets highest standards of excellence, generation and application of new knowledge through research and creative endeavors.

The three-fold mission of the University is:

- To offer undergraduate and post-graduate programs with engaged and experiential learning environment enriched by high quality instruction that prepares students to succeed in their lives and professional careers.

- To enable and grow disciplinary and inter-disciplinary areas of research that build on present strengths and future opportunities aligning with areas of national strategic importance and priority.

- To actively engage in the Socio-economic development of the region by contributing our expertise, experience and leadership, to enhance competitiveness and quality of life.

As a unified community of faculty, staff and students, we work together with the spirit of collaboration and partnership to accomplish our mission.

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Vision and Mission Statements of the Department of Automation & Robotics

Vision

To develop into a research-oriented department educating engineers to serve the diverse needs of our changing society.

Mission

The mission of the Automation & Robotics Program is to prepare undergraduate students with in-depth technical knowledge in the fields of mechanical, electronics, computer, control systems, and applications.

Program Educational Objectives/Program Outcomes and Program-Specific Objectives

Program Educational Objectives -PEO's
PEO1: Our graduates will provide innovative and state-of-the-art solutions to solve complex problems in automation, robotics, and allied fields and design high-quality systems for diverse applications.
PEO2: Our graduates will work in diverse, multi-disciplinary teams and possess leadership skills, ethical standards, environmental concerns, and social awareness.
PEO3: Our graduates will continue life-long learning and pursue professional development opportunities like graduate degrees or professional studies to adapt to the evolving technological changes.
Program Outcomes-PO's
PO1. Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3. Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4. Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research- based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi- disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural,
language, and learning differences
PO10. Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in Multidisciplinary environments.
PO11. Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and ii) Critical thinking in the broadest context of technological change. (WK8)
Program Specific Objectives -PSO's
PSO1 - Foundations of Robotics: Identify the needs, analyze, design, and develop simple robotic systems and programs for diverse applications.
PSO 2 - Integration and Applications of Automation and Robotics: Identify the needs, design, select, and integrate appropriate automation and robotic subsystems for diverse applications.

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Curriculum Structure-Overall

Semester							Total Program Credits: 177
Course with course code	I	II	III	IV	V	VI	VII	VIII
	Single Variable Calculus 18EMAB101	Multivariable Calculus 18EMAB102	Calculus and Integral Transforms 15EMAB231	Vector Calculus and Differential Equations 15EMAB241	Numerical Methods and Statistics 24EMAB301	Hydraulics & Pneumatics 18EARC308	Industrial Data Networks 24EARC401	Smart Manufacturing 17EARE404
	Engineering Physics 22EPHB102	Engineering Chemistry 22ECHB101	Statistics and Integral Transforms 15EMAB201	Numerical Methods and Partial Differential Equations 19EMAB206	Machine Learning 23EARC301	AI for Autonomous Robots 17EARE301	Mobile Robotics & Perception 17EARE401	Open Elective
	C Programming for Problem Solving 18ECSP101	Engineering Mechanics 15ECVF102	Analog & Digital Electronic Circuits 18EARF201	Machine Design 18EARC206	Real-time Embedded Systems 18EARC303	Computer Vision & Digital Image Processing 15EARE302	Design of Automatic Machinery 17EARE402	Capstone Project 18EARW402
	Engineering Exploration 22ECRP101	Computer-Aided Engineering Drawing 15EMEP101	Kinematics of Machinery 19EARF202	Control Systems Design and Practice 22EARC201	Mechatronics System Design 24EARC302	Robot Dynamics & Control 17EARE302	Industrial Internet of Things 25EARE401	OR
	Basic Electrical & Electronics Engineering 21EEXF101	Problem-Solving with Data Structures 18ECSP102	Object Oriented Programming 22EARC202	Microcontrollers Programming & Interfacing 22EARC208	Measurement Systems 18EARC305	Power Electronics, Motors & Drives 16EARE301	Research Experience for Undergraduates 17EARE490	Industry Internship – Training 17EARI493
	Basic Mechanical Engineering 22EMEF101	Design Thinking for Social Innovation 20EHSP101	Mechanics of Materials 18EARF204	Database Management System and Application Development 22EARC203	Programming Industrial Automation Systems Practice 24EARC301	Operation Research with Evolutionary Algorithms 24EARE301	Institutional Research Project 17EARE491	Industry Internship - Project Work 17EARW494
	Applied Physics Lab 21EPHP102	Professional Communication 15EHSH101	Manufacturing Technology & Processes 23EARC205	Robot Analysis & Design 18EARC210	Machine Learning & ROS Lab 18EARP301	Hydraulics and Pneumatics Lab 16EARP302	Senior Design Project 25EARW401	

			Analog & Digital Electronic Circuits Lab 18EARP201	Manufacturing & Metrology Lab 16EARP205	Industrial Robotics Lab 18EARP303	Mechatronics & Measurements Lab 18EARP304	Constitution of India, Professional Ethics and Environmental Studies 15EHSA401	
			Kinematics of Machinery Lab 18EARP202	Microcontrollers Programming & Interfacing Lab 22EARP208	Mini Project - (Engineering Design Project) 18EARW301	Real-Time Embedded Systems Lab 16EARP307		
			Machine Drawing, Modelling & Analysis Laboratory 22EARP201	Problem Solving and Analysis 22EHSH202	Arithmetical Thinking and Analytical Reasoning 22EHSH301	Minor Project 17EARW302		
			Corporate Communication 22EHSC201			Professional Aptitude & Logical Reasoning 16EHSC301		
						Industry Readiness and Leadership Skills 22EHSH302		
Credits	22	22	26.5	26.5	22.5	25.5	15	17

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Curriculum Structure-Semester wise

Semester - I

No.	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	18EMAB101	Single Variable Calculus	BS	4-1-0	5	6	50	50	100	3 Hrs
2	22EPHB102	Engineering Physics	BS	3-0-0	3	3	50	50	100	3 Hrs
3	18ECSP101	C Programming for Problem Solving	ES	0-0-3	3	6	80	20	100	3 Hrs
4	22ECRP101	Engineering Exploration	ES	0-0-3	3	6	80	20	100	3 Hrs
5	21EEXF101	Basic Electrical & Electronics Engineering	ES	4-0-0	4	4	50	50	100	3 Hrs
6	22EMEF101	Basic Mechanical Engineering	ES	2-1-0	3	4	50	50	100	3 Hrs
7	21EPHP102	Applied Physics Lab	BS	0-0-1	1	2	80	20	100	3 Hrs
		TOTAL		**13-2-7**	**22**	**31**				

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Semester - II

No.	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	18EMAB102	Multivariable Calculus	BS	4-1-0	5	6	50	50	100	3 Hrs
2	22ECHB101	Engineering Chemistry	BS	3-0-0	3	3	50	50	100	3 Hrs
3	15ECVF102	Engineering Mechanics	ES	4-0-0	4	4	50	50	100	3 Hrs
4	15EMEP101	Computer-Aided Engineering Drawing	ES	0-0-3	3	6	80	20	100	3 Hrs
5	18ECSP102	Problem-Solving with Data Structures	ES	0-0-3	3	6	80	20	100	3 Hrs
6	20EHSP101	Design Thinking for Social Innovation	HSS	0-1-1	2	4	80	20	100	3 Hrs
7	15EHSH101	Professional Communication	HSS	1-1-0	2	3	50	50	100	3 Hrs
		TOTAL		**12-3-7**	**22**	**32**				

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Semester- III

No.	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	15EMAB231	Calculus And Integral Transforms	BS	4-0-0	4	4	50	50	100	3 Hrs
2	15EMAB201	Statistics And Integral Transforms	BS	4-0-0	4	4	50	50	100	3 Hrs
3	18EARF201	Analog & Digital Electronic Circuits	ES	4-0-0	4	4	50	50	100	3 Hrs
4	19EARF202	Kinematics of Machinery	ES	4-0-0	4	4	50	50	100	3 Hrs
5	22EARC202	Object Oriented Programming	PSC	2-0-3	5	8	80	20	100	2 Hrs
6	18EARF204	Mechanics of Materials	ES	3-0-0	3	3	50	50	100	3 Hrs
7	23EARC205	Manufacturing Technology & Processes	PSC	2-1-0	3	4	80	20	100	2 Hrs
8	18EARP201	Analog & Digital Electronic Circuits Lab	PSC	0-0-1	1	2	80	20	100	3 Hrs
9	18EARP202	Kinematics Of Machinery lab	PSC	0-0-1	1	2	80	20	100	3 Hrs
10	22EARP201	Machine Drawing, Modelling & Analysis Laboratory	PSC	0-0-1	1	2	80	20	100	3 Hrs
11	22EHSH201	Corporate Communication	HSS	0.5-0-0	0.5	0.5	100	0	100	3 Hrs
		TOTAL		**19.5-1-6**	**26.5**	**33.5**				

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Semester- IV

No.	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	15EMAB241	Vector Calculus and Differential Equations	BS	4-0-0	4	4	50	50	100	3 Hrs
2	19EMAB206	Numerical Methods and Partial Differential Equations	BS	3-1-0	4	4	50	50	100	3 Hrs
3	18EARC206	Machine Design	PSC	3-0-0	3	3	50	50	100	3 Hrs
4	22EARC201	Control Systems Design and Practice	PSC	2-1-1	4	6	80	20	100	3 Hrs
5	22EARC208	Microcontrollers Programming & Interfacing	PSC	4-0-0	4	4	50	50	100	3 Hrs
6	22EARC203	Database Management System and Application Development	PSC	2-0-3	5	8	80	20	100	3 Hrs
7	18EARC210	Robot Analysis & Design	PSC	4-0-0	4	4	50	50	100	3 Hrs
8	16EARP205	Manufacturing & Metrology Lab	PSC	0-0-1	1	2	80	20	100	3 Hrs
9	22EARP208	Microcontrollers Programming & Interfacing Lab	PSC	0-0-1	1	2	80	20	100	3 Hrs
10	22EHSH202	Problem Solving and Analysis	HSS	0.5-0-0	0.5	0.5	100	0	100	3 Hrs
		TOTAL		**19.5-1-6**	**26.5**	**33.5**				

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Semester- V

No.	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	24EMAB301	Numerical Methods and Statistics	BS	3-0-0	3	3	50	50	100	3 Hrs
2	23EARC301	Machine Learning	PSC	3-0-0	3	3	50	50	100	3 Hrs
3	18EARC303	Real-time Embedded Systems	PSC	4-0-0	4	4	50	50	100	3 Hrs
4	24EARC302	Mechatronics System Design	PSC	0-0-3	3	6	80	20	100	3 Hrs
5	18EARC305	Measurement Systems	PSC	3-0-0	3	3	50	50	100	3 Hrs
6	24EARC301	Programming Industrial Automation Systems Practice	PSC	2-0-2	4	6	50	50	100	2 Hrs
7	18EARP301	Machine Learning & ROS Lab	PSC	0-0-1	1	2	80	20	100	3 Hrs
8	18EARP303	Industrial Robotics Lab	PSC	0-0-1	1	2	80	20	100	3 Hrs
9	18EARW301	Mini Project - (Engineering Design Project)	PRJ	0-0-3	3	6	80	20	100	3 Hrs
10	22EHSH301	Arithmetical Thinking and Analytical Reasoning	HSC	0.5-0-0	0.5	0.5	100	0	100	3 Hrs
		TOTAL		**12.5-0-10**	**22.5**	**32.5**				

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Semester- VI

No.	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	18EARC308	Hydraulics & Pneumatics	PSC	4-0-0	4	4	50	50	100	3 Hrs
2	17EARE301	AI for Autonomous Robots	PSE	3-0-0	3	3	50	50	100	3 Hrs
3	15EARE302	Computer Vision & Digital Image Processing	PSE	3-0-0	3	3	50	50	100	3 Hrs
4	17EARE302	Robot Dynamics & Control	PSE	3-0-0	3	3	50	50	100	3 Hrs
5	16EARE301	Power Electronics, Motors & Drives	PSE	3-0-0	3	3	50	50	100	3 Hrs
6	24EARE301	Operation Research with Evolutionary Algorithms	PSE	3-0-0	3	3	50	50	100	3 Hrs
7	16EARP302	Hydraulics and Pneumatics Lab	PSC	0-0-1	1	2	80	20	100	3 Hrs
8	18EARP304	Mechatronics & Measurements Lab	PSC	0-0-1	1	2	80	20	100	3 Hrs
9	16EARP307	Real-Time Embedded Systems Lab	PSC	0-0-1	1	2	80	20	100	3 Hrs
10	17EARW302	Minor Project	PRJ	0-0-6	6	12	80	20	100	3 Hrs
11	16EHSC301	Professional Aptitude & Logical Reasoning	HSC	3-0-0	3	3	50	50	100	1.5 Hrs
12	22EHSH302	Industry Readiness and Leadership Skills	HSC	0.5-0-0	0.5	0.5	100	0	100	3 Hrs
		TOTAL		**16.5-0-9**	**25.5**	**34.5**				

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Semester- VII

No.	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	24EARC401	Industrial Data Networks	PSC	3-0-0	3	3	50	50	100	3 Hrs
2	17EARE401	Mobile Robotics & Perception	PSE	3-0-0	3	3	50	50	100	3 Hrs
3	17EARE402	Design of Automatic Machinery	PSE	3-0-0	3	3	50	50	100	3 Hrs
4	25EARE401	Industrial Internet of Things	PSE	3-0-0	3	3	50	50	100	3 Hrs
5	17EARE490	Research Experience for Undergraduates	PRJ	0-0-6	6	12	50	50	100	3 Hrs
6	17EARE491	Institutional Research Project	PRJ	0-0-6	6	12	50	50	100	3 Hrs
7	25EARW401	Senior Design Project	PSC	0-0-6	6	12	50	50	100	3 Hrs
8	15EHSA401	Constitution of India, Professional Ethics and Environmental Studies	HSC	0-0-0	0	0	50	50	100	3 Hrs
		TOTAL		**9-0-6**	**15**	**21**				

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Semester- VIII

No.	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	17EARE404	Smart Manufacturing	PSE	3-0-0	3	3	50	50	100	3 Hrs
2	XXXXX	Open Elective	OE	3-0-0	3	3	50	50	100	3 Hrs
3	18EARW402	Capstone Project	PRJ	0-0-11	11	22	50	50	100	3 Hrs
		TOTAL		**6-0-11**	**17**	**28**				
				OR						
4	17EARI493	Industry Internship - Training	IE	0-0-6	6	12	50	50	100	3 Hrs
5	17EARW494	Industry Internship - Project Work	IEPRJ	0-0-11	11	22	50	50	100	3 Hrs
		TOTAL		**0-0-17**	**17**	**28**				

Semester	I	II	III	IV	V	VI	VII	VIII	**Total**
Credits	22	22	26.5	26.5	22.5	25.5	15	17	177

List of Open Electives

Sr. No	Name of the Course	Course Code
1	Nano Composite Materials	15ECVO401
2	Nanotechnology	15EMEO402
3	Design of Experiments	15EMEO403
4	Artificial Intelligence	17EEEO402
5	Automotive Electronics	18EECO403
6	Embedded Systems	18EECO404
7	Big data and Analytics	18ECSO401
8	Industrial Waste Management	19EBTO401
9	Management Theory & Practice	15EHSO402
10	Accounting & Financial Management	15EHSO403
11	Technical Writing	18EHSO402
12	Advanced Mathematics	22EMAO401
13	Applied Numerical Methods	15EMAO401

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List of Program Electives

Sr. No	Name of the Course	Course Code
1	AI for Autonomous Robots	17EARE301
2	Computer Vision & Digital Image Processing	15EARE302
3	Robot Dynamics & Control	17EARE302
4	Power Electronics, Motors & Drives	16EARE301
5	Operation Research with Evolutionary Algorithms	24EARE301
6	Mobile Robotics & Perception	17EARE401
7	Design of Automatic Machinery	17EARE402
8	Industrial Internet of Things	23EARE403
9	Research Experience for Undergraduates	17EARE490
10	Institutional Research Project	17EARE491
11	Smart Manufacturing	17EARE404

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Curriculum Content- Course wise

Program: Automation & Robotics Engineering		**Semester: I**
Course Title: Single Variable Calculus		**Course Code: 18EMAB101**
L-T-P: 4-1-0	**Credits: 5**	**Contact Hours: 6 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: ---	**Examination Duration: 3 hrs**	

Unit I

Chapter 1: Functions, Graphs and Models

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

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

Chapter 2: Functions, Graphs and Models

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

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

Chapter 2: Calculus of Functions and Models

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

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

MATLAB: optimization problems. Curvature problems

Unit II

Chapter 4: Infinite Series

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

MATLAB: Convergence of series

Chapter 5: Integral Calculus

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

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

Unit III

Chapter 6: Ordinary Differential Equations of First Order

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

Applications of first order differential equations-Orthogonal trajectories growth and decay problems, mixture problems, Electrical circuits, falling bodies. **MATLAB**: Solve differential equations
Text Books 1. Early Transcendental Calculus- James Stewart, Thomson Books, 7ed 2010.
Reference Books: 1. Calculus Single and Multivariable, Hughues-Hallett Gleason, Wiley India Ed, 4ed, 2009. 2. Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010

BACK

Program: Automation & Robotics Engineering		Semester: I
Course Title: Engineering Physics		Course Code: 22EPHB102
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Concept of Motion- Kinematics in One Dimension: Introduction, motion diagrams, particle model,osition and time, linear velocity and acceleration, uniform motion, instantaneous velocity, findingposition from velocity, motion with constant acceleration, free fall motion on an inclined plane,instantaneous acceleration, numericals.

Chapter 2Kinematics in Two Dimensions: Introduction to vectors, properties of vectors, co-ordinate systemsand vector components, vector algebra. Position, velocity and acceleration vectors, projectile motion,relative motion, uniform circular motion, velocity and acceleration in uniform circular motion, non-uniform circular motion and angular acceleration, numericals.

Chapter 3: Force and Motion: Concept of force, identifying forces, a virtual experiment, Newton's first law,Newton's second law, free-body diagrams, applications.

Unit II

Chapter 4: Dynamics I: Equilibrium using Newton's second law, friction, drag, Newton's third law, analyz ing**i**nteracting objects, Newton's third law, applications.

Chapter 5: Dynamics II: Motion in a plane, dynamics in two dimension, velocity and acceleration in uniformcircular motion, dynamics of uniform circular motion, fictitious forces, non-uniform circular motion,numericals.

Chapter 6:Impulse and Momentum: Momentum and impulse, problems, conservation of momentum,inelastic collisions, explosion, momentum in two dimensions, numericals**.**

.

Unit III

Chapter 7: Quantum Mechanics: Introduction, dual nature of matter waves, De-Broglie concept of matterwaves, Davission and Germer Experiment, Heisenberg's uncertainty principle, 1-D Schrodinger waveequation (qualitative). Physical significance of wave function, particle in a box (qualitative), Eigen functions and Eigen values, discretization of energy.

Chapter 8: Nanoscience and its applications: Introduction, length scales, scaling effect (surface-volume ratio,quantization, dandling bonds, defects and self-assembly-qualitative), density of states andconfinement of electron energy states in 3D, 2D, 1D and 0D systems (qualitative treatment), change inmaterial properties from bulk to nanostructures, variation of physical properties (mechanical, optical,electric, magnetic, chemical) from bulk to thin films to nano-materials, nano-particle examples: metal(magnetic and non-magnetic), Graphene, carbon nanotubes, biological nanoparticles.

Text Books:

1. Randall D Knight, Physics for Scientists and Engineers, Pearson publication, 3e (2008)
2. Aurther Beiser, Concepts of Modern Physics, 6e, Tata McgrawHills, (2003)
3. . Sulbha Kulkarni, Nanotechnology Principles and practices, 3e, Springer.

Reference Books:

1. John W Jewett and Raymond A Serway, Physics for Scientists and Engineers with modern physics, Cengage publication, India Edition, 9e (2014)
2. Hans C Ohanian & John T Markert, Physics for Engineers and Scientists, W W Norton and Company, Vol-1, 3e (2006)
3. A.K. Bandopadhya, Nanomaterials, New Age Publishers, (2004)
4. S.K. Prasad, Advanced nano technology, Discovery publishing house Pvt. Ltd New Delhi

BACK

Program: Automation & Robotics Engineering		Semester: I
Course Title: C Programming for Problem Solving		Course Code: 18ECSP101
L-T-P: 0-0-3	Credits: 3	Contact Hours: 6 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 78 hrs	Examination Duration: 3 hrs	

1	**Introduction to Problem solving** Introduction to algorithms / flowcharts and its notations, top down design, elementary problems.
2	**Basics of C programming language** Characteristics and uses of C, Structure of C program, C Tokens: Keywords, Identifiers, Variables, Constants, Operators, Data-types, Input and Output statements.
3	**Decision control statements** Conditional branching statements: if statement, if else statement, else if ladder, switch statement, unconditional branching statements**:** break, continue. Introduction to Debugging Skills Introduction to Test Driven Programming.
4	**Iterative statements** while, do while, for, nested statements
5	**Functions** Introduction, Function declaration, definition, call, returns statement, passing parameters to functions, introduction to macros.Introduction to Coding Standards
6	**Arrays and Strings** Introduction, Declaration, Accessing elements, Storing values in arrays, Operations on one dimensional array, Operations on two dimensional arrays, Introduction to Code Optimization and refactoring
7	**Pointers** Introduction, declaring pointer, pointer variables, pointer expression and arithmetic, passing arguments to functions using pointers, pointers and arrays, passing an array to a function.
8	**Structures and Unions** Introduction, passing structures to functions, Array of structures, Unions

Text Books:

1. R.G.Dromey, How to Solve it by Computer, 1ed, PHI, 2008.
2. Yashvant Kanetkar, Let us C,15th ed, BPS Publication, 2016

Reference Books:

1. B W Kernighan, D M Ritchie, The Programming language C, 2ed, PHI, 2004.
2. B S Gottfried, Programming with C, 2ed, TMH, 2006.
3. B.A. Forouzan, R.F. Gilberg, A Structured Program Approach Using C, 3ed, CENGAGE Learning, 2008

BACK

Program: Automation & Robotics Engineering		Semester: I
Course Title: Engineering Exploration		Course Code: 22ECRP101
L-T-P: 0-0-3	Credits: 3	Contact Hours: 6 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 78hrs	Examination Duration: 3 hrs	

Module 1: Introduction to Engineering and Engineering Study
Introduction to Engineering and Engineering Study: Difference between science and engineering, scientist and engineer needs and wants, various disciplines of engineering, some misconceptions of engineering, Expectation for the 21 st -century engineer, and Graduate Attributes.

Module 2: Engineering Design
Engineering Design Process, Problem definition formulation process, Concept generation- Function tree, Functional structure, Morphological chart, and Concept selection- Pugh Chart, Product Architecture. Prototyping and testing.

Module 3: Mechanisms and Resource Specifications (MRS)
Mechanism, types of mechanisms, degree of freedom, linkages, four-bar linkage mechanism, actuators & their types, torque, governing equations, FOS, motor sizing, motor selection, mass acquisition using software, power adapters, types of adapters, power calculations & adapter selection.

Module 4: Platform-Based development
Introduction to various platform-based development (Arduino) programming and its essentials, Introduction to sensors, transducers, and actuators and its interfacing with Arduino.

Module 5. Project Management
Introduction to Project Management, Significance of teamwork, Significance of Agile practices, Significance of documentation.

Module 6. Engineering Ethics
Identifying Engineering as a Profession, Significance of Professional Ethics, Code of Conduct for Engineers, Identifying Ethical Dilemmas in different tasks of engineering, Applying Moral Theories and codes of conduct for resolution of Ethical Dilemmas.

Module 7. Sustainability in Engineering
Introduction to sustainability, Sustainability leadership, Life cycle assessment, carbon foot print.

BACK

Program: Automation & Robotics Engineering		Semester: I
Course Title: Basic Electrical & Electronics Engineering		Course Code: 21EEXF101
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 47hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction to Electrical & Electronics Technology

Electrical Power Generation (convention and renewable energy sources, with PV elaborated), transmission, distribution, utilization (Electric Vehicle as a case study), Electrical and Electronic Systems, concept and power of abstraction, lumped circuit abstraction, and its limitation.

Chapter 2: The Circuit Abstraction

Energy storage and dissipating elements (RLC), Ideal and practical sources, series and parallel circuits, concept of order of the system, voltage dividers, RC, RL, RLC with KCL and KVL, Mesh and Nodal analysis with an example.

Chapter 3: Introduction to Transformer and Electric Drive

Electromagnetic principles, classification of electric machines – static and rotary, transformers, motors, PMDC, stepper, BLDC, single and three-phase induction motors, selection of motors for various applications. Safety measures.

Unit II

.

Chapter 4: Semiconductor Devices and its Applications

Fundamentals of semiconductors, PN junction diode, BJT, FET, Thyristors, Integrated circuits, Linear application – Transistors and Operational amplifiers, oscillators (Op-Amp based), Nonlinear application – Power electronics converters.

Chapter 5: Digital Abstraction

Concept of digital abstraction, Number systems, base conversion – binary, decimal, hexadecimal, BCD, Gray code, Boolean algebra, logic gates, combinational circuits, - half adders, full adders, half subtractor and full subtractor using k-maps for 2 or 3 variables, sequential circuits – registers, counters.

Chapter 6: Mechatronic Subsystem

Power supply, Introduction to sensors and actuators, signal conditioning and interfacing, Control logic design for mechatronic applications.

Text Books

1. Anant Agarwal and Jefferey H. Lang, Foundations of Analog and Digital Electronic Circuits, Morgan Kaufmann -Elsevier, 2005
2. Hughes, Electrical and Electronic Technology, 12th Edition, Pearson, 2016.

Reference Books:

1. N.P.Mahalik, Mechatronics - Principles, Concepts and Applications, Tata McGraw-Hill, 2011
2. K.A Krishnamurthy and M.R.Raghuveer, Electrical, Electronics and Computer Engineering for Scientist and Engineers, 2, New Age International Publishers, Wiley Eastern, 2001
3. George Kennedy, Electronic Communication Systems, 4, Tata McGraw Hill, 2000
4. Morris Mano, Digital Logic and Computer Design, 21st Indian print Prentice Hall India, 2000
5. Boylestead Nashelsky, Electronic devices & Circuit theory, 6, Prentice Hall India, 2000
6. David A Bell, Electronic Devices and Circuits, PHI New Delhi, 2004
7. Ramakant Gayakwad, Operational Amplifiers & applications, 3, PHI, 2000
8. W.Bolton, Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, 3, Pearson Education, 2005
9. Ernest O Doeblin, Dhanesh N Manik, Measurement Systems, 6th Edition, McGraw Hill Education; 2017

BACK

Program: Automation & Robotics Engineering		Semester: I
Course Title: Basic Mechanical Engineering		Course Code: 22EMEF101
L-T-P: 2-1-0	Credits: 3	Contact Hours: 4hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40 hrs	Examination Duration: 3 hrs	

UNIT I

Chapter 1:.Introduction to Mechanical Engineering

Mechanical Engineering, Mechanical Engineers' top ten achievements, Branches Mechanical Engineering, Mechanical product Example: Pressure Cooker.

Chapter. 2:Power Transmission Drives

Overview Design Application: • Belt Drives (Flat belt), Length of Belt. Velocity Ratio, Initial Tension. Ratio of Tensions. Power Transmitted, Numerical Problems. • Gears. Spur Gear, Rack and Pinion, Worm Gear, Bevel Gear, Helical Gears and Elliptical gear. Speed, Torque, and Power in Gear pair. Simple and Compound Gear trains. Numerical Problems. Hydraulic transmission system.

UNIT II

Chapter. 3:Manufacturing Engineering:

What is manufacturing? Classification of Manufacturing Processes, Metal joining processes- Soldering,brazing, and welding (Arc and gas welding). Machine tools- Lathe, Milling, Drilling Grinding (working principle and operations). CNC machines, Robotics and its applications. Additive manufacturing techniques.

Chapter. 4:IC engines and Electric powertrains

Internal Combustion Engines: Classification, IC engine parts, 4 Stroke SI and CI Engine, Comparison of 2strokeand 4 stroke engine, comparison of CI and SI engine, Problems on Engine Performance. Electric drives. Hybriddrives- series and parallel layout.

UNIT III

Chapter. 5:Refrigeration and Air conditioning

Refrigeration system, vapour compression refrigeration system, vapour absorption system, refrigerants and their properties. Air conditioning system.

Chapter. 6:Fluid movers

Pumps, Blowers and Compressors and their working principle

Tutorial Content

Virtual Prototyping: 2D sketching, 3D modelling-Extrude, Revolve, Pattern and Sheet Metal Assembly.

Visit to workshop: welding shop, sheet metal shop, machine Shop.
 Demonstration of various machine tools such as lathe, milling, drilling and grinding machines and safety
precautions in workshop.
 Assembly and disassembly of bicycle and demonstration on welding (electric arc welding, gas welding).
 Demonstration and exercise on sheet metal work.

Text Books

1. Jonathan Wickert and Kemper Lewis, An Introduction to Mechanical Engineering, Third Edition, Cengage Learning, 2013
2. K.R. Gopalkrishna, Sudhir Gopalkrishna, S.C. Sharma, A Text Book of Elements of Mechanical Engineering, 30th Edition, Subhash Publishers, Bangalore, 2010
3. Dr. N. Krishnamurthy, Dr. H. S. Manohar, Mr. Sagar M. Baligidad, Elements of Mechanical Engineering, First Edition, Sunstar Publisher, 2014

Reference Books:

1. 1. SKH Chowdhary, AKH Chowdhary, Nirjhar Roy, The Elements of Workshop Technology, Vol I & II, 11th edition, Media Promoters and Publishers, 2001
2. Roger Timings, Basic Manufacturing, Third edition, Newnes, An imprint of Elsevier, 2010

BACK

Program: Automation & Robotics Engineering		Semester: I
Course Title: Applied Physics Lab		Course Code: 21EPHP102
L-T-P: 0-0-1	Credits: 1	Contact Hours: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 20hrs	Examination Duration: 3 hrs	

LIST OF EXPERIMENTS

1. Experimental data error analysis.
2. Centripetal force.
3. Young's modulus.
4. Coefficient of friction.
5. V-I Characteristics of pn- Junction diode and plotting DC load line.
6. Hysteresis loss.
7. Verification of Kirchoff's KVL and KCL (DC Circuits)
8. Use of measuring instruments (RPS & FG) and calibration of oscilloscope
9. Realization of basic gates (Using IC's)
10. Zener diode characteristics and voltage regulation (line and load regulation).

BACK

Program: Automation & Robotics Engineering		Semester: II
Course Title: Multivariable Calculus		Course Code: 18EMAB102
L-T-P: 4-1-0	Credits: 5	Contact Hours: 6 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Partial differentiation

Function of several variables, Partial derivatives, Level curves, Chain rule, Errors and Approximations. Extreme value problems. Lagrange's multipliers.

Chapter 2: Double integrals

Double integrals- Rectangular and polar coordinates, Change the order of integration. Change of variables, Jacobian. Application of double integrals

Unit II

Chapter 3: Triple integrals

Triple integrals, Cartesian, change to Cylindrical and Spherical coordinates Application of Triple integrals

Chapter 4: Calculus of Vector Fields

fields, Gradient and directional derivatives. Line and Surface integrals. Independence of path and potential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem.

MATLAB: application of Triple integrals, Vector calculus problems

Unit III

Differential equations of higher orders

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

MATLAB: application of differential equations

Text Books

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

Reference Books:

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

BACK

Program: Automation & Robotics Engineering		Semester: II
Course Title: Engineering Chemistry		Course Code:22ECHB101
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1 Chemical Bonding

Chemical bonding – Types, Ionic bond: Formation of NaCl molecule, factors influencing the formation of ionic bond – ionization energy, electron affinity and lattice energy, Born–Haber's cycle, calculation of lattice energy of NaCl molecule and properties of ionic compounds; Covalent bond: Atomic orbital theory – formation of H2 molecule, polar and nonpolar covalent bonds – H2 and HCl molecules, dipole moment, calculation of percentage of ionic character and properties of covalent compounds.

Chapter 2: . Pure Substances

Properties of pure substance (steam), two property rule, T-H diagram: Formation of steam at constant pressure. Different states of steam: Wet steam, dry saturated steam and superheated steam. Quality of wet steam: dryness fraction – determination by combined separating-throttling calorimeter. Thermodynamic parameters of steam, Steam Table and numerical problems. P-T, T-V and P-V diagrams of pure substance by taking water as an example

Chapter 3:. Ideal and Real Gases

Vander Waal's equation: Vander Waal's constants in terms of critical properties, numerical problems. Compressibility factor, compressibility chart and law of corresponding states. Ideal gas: Equation of state, specific heat of ideal gas, internal energy and enthalpy as a function of temperature. Ideal gas mixture: Dalton's law of partial pressure and Amagat's law of additive volumes; Terms used in the analysis of mixture of gases and numerical problems

.

Unit II

Chapter 4: . Fuel Chemistry

Fuels: classification, determination of calorific value of a solid/liquid fuel by Bomb calorimeter, numerical problems; Coal analysis - Proximate method. Petroleum: Cracking – fluidized bed catalytic cracking, reforming, octane number, cetane number and mechanism of knocking. Renewable energy sources: power alcohol and biodiesel**.**

Chapter 5: Energy Storage and Conversion Systems

Electrode potential, Nernst equation; Formation of a cell; Reference electrodes: Calomel electrode - determination of electrode potential; Numerical problems on E, E_{cell} and E^0_{cell}. Batteries: classification, characteristics, Lead - acid battery and Lithium ion battery. Fuel cells: Types of fuel cells; Methanol - Oxygen fuel cell

Chapter 6: Surface Chemistry

Corrosion: Electrochemical theory of corrosion by taking Iron as an example; Metal Finishing: Electroplating: Definition, electroplating of Chromium, determination of Throwing Power of

plating bath by Haring Blum cell and numerical problems; Electroless plating: advantages of electroless plating over electroplating, electroless plating of Nickel; Hot dipping coating: Galvanization and Tinning.

Unit III

Chapter 7: Polymer Chemistry

Polymers, properties, classification, free radical mechanism of addition polymerization by taking ethylene as an example. Commercial polymers: plexi glass and polyurethane. Polymer composites: carbon fibre and epoxy resin – synthesis, properties and applications. Conducting polymers: Polyaniline – synthesis, mechanism of conduction in doped polyaniline and its applications

Chapter 8: .Water Chemistry

Water: sources, impurities in water, potable water: meaning and specifications (as per WHO standards). Hardness: determination of total hardness of water by EDTA method and numerical problems; Sewage: BOD - determination of Biological Oxygen Demand by Winkler's method and numerical problems; COD - determination of Chemical Oxygen Demand by redox reaction and numerical problems

Text Books:

1. A text Book of Engineering Chemistry, 1st edition, Dara. S. S, S. Chand and Co. Ltd., 2009, New Delhi.
2. A text Book of Engineering Chemistry, 16th edition, Jain P.C and Jain M, Dhanpat Rai Publications, 2006, New Delhi.
3. 3. Engineering Chemistry, 3rd Edition, Krishnamurthy. N., Vallinayaga. P. and Madhavan. D., PHI/ E-Books Premium, 2014..

Reference Books:

1. Text book of Inorganic Chemistry, P. L. Soni, Sultan Chand, 1999, New Delhi.
2. Inorganic chemistry: Principles of structure and reactivity, , 4th Edition, James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Dorling Kindersley (India) Pvt. Ltd., 2006, New Delhi.
3. Concise Inorganic Chemistry ELBS, 5th Edition, J.D. Lee, Wiley, 2008, New York.
4. An introduction to Thermodynamics, Revised Edition, Y V C Rao, University Press, 2009, Hyderabad.
5. Principles of Physical Chemistry, 33rd Edition, Puri B. R., Sharma L.R. and Pathania M. S., S Nagin Chand and Co., 1992, New Delhi.
6. Hand book of batteries, 3rd edition, David Linden, Thomas B Reddy, McGraw Hill publications, 2001, New York.
7. Corrosion Engineering, 3rd edition, Fontana M G, McGraw Hill Publications, 1986, New York.
8. Materials Science and Engineering: An introduction, 7th, Edition William D Callister, John

Wiley and Sons, 2007, New York.

9. Text Book of Polymer Science, 3rd edition, Fred W. Billmeyer, John Wiley and Son's, 1984, New York.
10. Principles of Polymer Chemistry, A. Ravve, Plenum Press, 2012, New York and London.

BACK

Program: Automation & Robotics Engineering		Semester: II
Course Title: Engineering Mechanics		Course Code: 15ECVF102
L-T-P: 4-0-0	Credits: 4	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1:Overview of Civil Engineering

Evolution of Civil Engineering Specialization, scope and role. Impact of Civil Engineering on National economy, environment and social & cultural fabric. Challenges and Opportunities for Civil Engineers, Civil Engineering Marvels, Future challenges, Higher education and Research.

Chapter 2:Coplanar concurrent force system

Introduction to Engineering Mechanics: Basic idealizations – Particle, Continuum, Body, Rigid body, Deformable body, Definition of force and its elements; Laws of Mechanics – Parallelogram law of forces, Principle of transmissibility, Law of Superposition, Newton's laws of motion.

Classification of force systems Resultant of coplanar concurrent force system: Definitions – Resultant, composition & Resolution of a force, Equilibrium, Equilibrant, Formulae for resultant of forces and resolution of a force. Numerical problems on resultant of forces.

Equilibrium of coplanar concurrent force system: Conditions of equilibrium, Action & Reaction, Free body diagram, Lamis' theorem. Numerical problems on equilibrium of forces.

Chapter 3: Coplanar non-concurrent force system

Resultant of a force system: Moment, moment of a force, couple, moment of a couple, Characteristics of couple, Equivalent force-couple system, Numerical problems on moment of forces and couples, on equivalent force-couple system. Varignons principle of moments, Resultan

t of coplanar- non-concurrent force systems and numerical problems.

Unit II

Chapter 4: Equilibrium of a force system (Chapter 3 contd.)
Conditions of equilibrium, types of support and loading for a statically determinate beam, Reactions at support connections, Numerical problems on equilibrium of force systems and support reactions for a statically determinate beam.

Chapter 5: Static Friction
Introduction, types of friction, definition, limiting friction, coefficient of friction, laws of Coulomb friction, angle of friction and angle of repose, cone of friction. Wedge and belt friction theory. Derivation of belt friction formula. Numerical problems on, impending motion on horizontal and inclined planes (including connected bodies); wedge friction; Ladder friction and Belt friction

Chapter 6: Centroid of Plane Figures
Introduction, Definition, Methods of determining the centroid, axis of reference, axis of symmetry, Locating the centroid of simple plane figures (triangle, semicircle, quarter of a circle and sector of a circle, etc.) using method of integration, Numerical problems on Centroid of simple built up sections

Unit III

Chapter 7: Second moment of area (Plane figures)
Introduction, Definition, Method of determining the second moment of area, Section Modulus, Radius of gyration, perpendicular and Parallel axis theorems, Polar second moment of area, second moment of area of simple plane figures (triangle, rectangle, semicircle, circle etc.) using method of integration, Numerical problems on MI of simple built up sections

Chapter 8: Kinetics of a particle- Work, Power, Energy
Introduction – Kinematics and Kinetics, Definitions – work, power and energy. Work done by a force (constant, gravitational and spring forces) in rectilinear motion. Numerical problems, Kinetic energy of a particle, principle of work and energy. .

Text Books:

1. Beer, F.P. and Johnston, R., Mechanics for Engineers: Statics, McGraw Hill Company, New York, 1988.
2. Bhavikatti, S.S., and Rajasshekarappa K.G., Engineering Mechanics, 3Ed., New Age International Pub. Pvt. Ltd., New Delhi, 2008.
3. Kumar, K.L., Engineering Mechanics, 3ed., Tata McGraw Hill Publishing Company, New Delhi, 2003.
4. Punmia, B.C., Jain, A. and Jain, A., Mechanics of Materials, Lakshmi Publications, New Delhi, 2006

Reference Books:

1. Jagadeesh, T.R. and Jayaram, Elements of Civil Engineering, Sapna Book House, Bangalore, 2006.
2. Ramamrutham, S., Engineering Mechanics, Dhanpat Rai Publishing Co., New Delhi, 1998.
3. Singer, F.L., Engineering Mechanics, 3rd edition Harper Collins, 1994.
4. Timoshenko, S.P. and Young, D.H., Engineering Mechanics, 4th edition, McGraw Hill

Publishing Company, New Delhi, 1956.
5. Irving H Shames, Engineering Mechanics, 3rd edition, Prentice-Hall of India Pvt. Ltd, New Delhi- 110 001, 1995

BACK

Program: Automation & Robotics Engineering		Semester: II
Course Title: Computer-Aided Engineering Drawing		Course Code: 15EMEP101
L-T-P: 0-0-3	Credits: 3	Contact Hours: 6 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 72 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction to engineering drawing and orthographic projections (Manual Drafting)

1. Introduction to engineering drawing – BIS conventions.
2. Orthographic projections: first angle projection and third angle projection – symbolic representation.
3. Projections of points.
4. Projections of lines inclined to both the planes and determination of true length by rotating the view method (Problems on traces of a line and mid-point problems are not included). However application problems are included.
5. Projection of planes: Planes parallel to one plane and perpendicular to other plane or perpendicular to one plane and inclined to other plane (Two stage problems).
6. Projection of simple solids such as prisms, pyramids, cylinders, cones and sphere and their frustums in simple positions (Base parallel to or in one of the three planes).

Chapter 2: Development of lateral surfaces of solids. (MANUAL)

1. Development of lateral surface of prisms and cylinders (Either full or truncated using parallel line development method)
2. Development of lateral surface of pyramids and cones (Either full or truncated or of their frustums using radial line development method)
3. Development of lateral surfaces of spheres using both the methods and development of transition pieces

Chapter 3: Conversion of pictorial views into orthographic projections using CAD software.

Drawing orthographic projection of objects shown in pictorial views by first angle method of projection using CAD software. (2D drafting only)

Chapter 4: Isometric projection or view using CAD software.

Drawing isometric projections or views of objects shown in orthographic projections using CAD software

Text Books:

1. Text Book of Engineering Drawing by K R Gopalakrishna
2. Text Book of Engineering Drawing by N D Bhatt and V M Panchal

BACK

Program: Automation & Robotics Engineering		**Semester: II**
Course Title: Problem-Solving with Data Structures		**Course Code: 18ECSP102**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours: 6 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 40hrs	**Examination Duration: 3 hrs**	

Chapter 1: Pointers, Structures and Files

Recap of basics: Pointers ,Structures; Self-referential structures, dynamic memory management Files – File manipulation programs

. Chapter 2: Stacks and Recursion

Stack: Definition, Operations, Stack ADT Implementation of stack operations. Applications of stack.

Recursion- Need for Recursion and problems on Recursion.

Chapter 3: Queues

Queue: Definitions of Linear, Circular queues, Queue ADT Linear and circular queue operations Definition and working of Priority queue, Double ended queue; Applications of queues.

Chapter 4: Lists

Concept of lists and dynamic memory management lists, definitions and representations: singly, doubly, circular lists. Dynamic Implementation of lists and its operations, Applications of linked lists

Chapter 5: Binary trees

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

Text Books

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

Reference Books:

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

BACK

KLE Technological University | Creating Value, Leveraging Knowledge

Program: Automation & Robotics Engineering			**Semester: II**
Course Title: Design Thinking for Social Innovation			**Course Code: 20EHSP101**
L-T-P: 0-1-1	**Credits: 2**		**Contact Hours: 4 hrs/week**
ISA Marks: 80	**ESA Marks: 20**		**Total Marks: 100**
Teaching Hours: 24 hrs	**Examination Duration: 3 hrs**		

Module		Topics	Assignments	Support activities / Tools
		1. Introduction to Social Innovation: • Awakening social consciousness **(www.yourstory.com)** • Social Innovation and Leadership • Engineering& Social innovation (EPICS) **(Connecting SI Course to Mini Project, Capstone Project, Campus Placements)** • Course Overview • **Students' Self Introduction Activity** • Group formation **Activity**	**Reading assignments** • Read the handout on "The Process of Social Innovation" by Geoff Mulgan • Design thinking for Social Innovation **Written Assignments** • **Writing about Akshaya Patra in class.** **(Background information about Akshaya patra and the Social Cuase it is addressing)** • **Brainstorming Session on Social Innovators in Class**	• Class activity on Behavioral Blocks to Innovation **Discussion on the behavioural blocks.** • **Introducing oneself with three Adjectives- Appreciating diversity and discovering self** • **Group Formation Activity** **(Forming square)** **(Making four equilateral triangles out of popsicle sticks to enhance group cohesiveness amongst the group mates)**
	Create Mindsets	**Seven Mindsets:** 1. Empathy **(Example of The Boy and the Puppies)** 2. Optimism **(Person Paralyzed waist down / Glass Halh full Half Empty)** 3. Iteration **(Thomas Alva Edison)** 4. Creative Confidence **(Origamy – Josef Albers)** 5. Making it 6. Embracing Ambiguity **(Confusion is the Welcome doormat at the door of Creativity)** 7. Learning from Failure **(Designing Website first and then asking the stakeholders about the website)** **(Spending one lakh for the business which is never launched)**	**Reading assignments** • Handout on " Create Mindsets"	• **(How to train the Dragon? Common Video for all the mindsets)** • **Watching in Class TED Talk on "How to build youir Creative Confidence by David Kelley – IDEO Founder)**

	Process of Social Innovation	**Engage** Community study and Issue Identification	**Reading assignments** • Handout on Community Study and Issue Identification • Case Study on "EGramSeva" • Case Study on "Janani Agri Serve" **Class Presentations** • Initial observations being made by the group **(Literature Survey of Places of Hubli- Dharwad)** **www.readwhere.com** • Detailed interaction / engagements with the society and finalize the social issue for intervention **Use template 1: Frame your Design Challenge**	• Activity on Observation skills To know how to use one's observation skills in understanding the social conditions • Experience sharing by senior students • Brainstorming Deliberations on the initial observations and arrive at the "Social Issue" • Familiarization of the respective templates with the help of sample case study
		PEER REVIEW		
		2. Inspiration • Plan for the Research • Development of Interview guide Capture your Learnings	**Reading assignments** • Handout on Overview of Inspiration **Class Presentations** • Entirety of the Social Issue • Identification of the Stake Holders **(Examples on Fluoroscent Curtain and Students' Punctuality for Class)** • Interview Questions **(Role Play on Interview with Stakeholders)** • Category wise Learnings capture **Use template 2: Plan your Research** **Template 3. Development of Interview Guide** **Template 4. Capture your Learning**	Familiarization of the respective templates with the help of sample case study

		3. Ideation **3.1 Synthesis** • Search for meaning Create "How might we" question	**Reading assignments** • Handout on Overview of Ideation-Synthesis **Class Presentations** • Create insights • "How might we" questions **Use template 5: Create Insights Template 6: Create "How Might We' Questions**	Familiarization of the respective templates with the help of sample case study
		3.0 Ideation **3.2 Prototyping** • Generate Ideas • Select Promising Ideas • Determine what to prototype • Make your prototype Test and get feedback	**Reading assignments** • Handout on Overview of Ideation-Prototyping **Class Presentations** • Story board-demonstrating the possible solutions **Use template 7: Select your best ideas** **Template 8: Determine what to prototype**	• Brain storming • Familiarization of the respective templates with the help of sample case study • Activity on Risk management • Activity on Resource management Structure building games
		PEER REVIEW		
		4.0 Implementation • Create an action plan • Community Partners (if any) • Budgeting & Fundraising 1. Peer to Peer 2. Crowd Funding 3. Giving Kiosks 4. Donation 5. Envelop Funding 6. Marathons/ Walkathons 7. Conducting Yoga Classes (www.causevox.com / www.blog.fundly.com) • Duration • Ethical concerns • Launch your solution • Feedback (Impact)	**Reading assignments** • Handout on Overview of Implementation **Class Presentations** Pilot implementation plan with required resources and Budget indicating stake holders & their enagement	• Familiarization of the respective templates with the help of sample case study
		5.0 Reflect Reflection of the overall learning	**Reading assignments** • Handout on Overview of	• Familiarization of the respective templates with the help of

		by the students	students Reflection **Use template 9: Reflection on the Process** **Class Presentations** Final Presentation- After Implementation	sample case study

BACK

Program: Automation & Robotics Engineering		**Semester: II**
Course Title: Professional Communication		**Course Code: 15EHSH101**
L-T-P: 1-1-0	**Credits: 2**	**Contact Hours: 3 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 42hrs	**Examination Duration: 3 hrs**	
Chapter 1: Basics- English Communication Course Introduction, Explanation of template mix-ups with correct usages & necessity of grammar in error detection, Usage of tenses		
Chapter 2: Vocabulary and grammar Vocabulary, Word Formation and Active and Passive Voice		
Chapter 3: Bouncing Practice Definition and types of bouncing and its practice with examples, reading skills, free style speech. Individual presentation.		
Chapter 4: Rephrasing and Structures Comprehension and Rephrasing, PNQ Paradigm and Structural practice		
Chapter 5: Dialogues Introduction of dialogues, Situational Role plays,		
Chapter 6: Business Communication Covering letter, formal letters, Construction of paragraphs on any given general topic.		
Reference Books: 1. Collins Cobuild Advanced Learner's English Dictionary 2. Raymond Murphy - Intermediate English Grammar, Cambridge University Press 3. Martin Hewings- Advanced English Grammar, Cambridge University Press.		

BACK

Program: Automation & Robotics Engineering		Semester: III
Course Title: Calculus And Integral Transforms		Course Code: 15EMAB231
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Differential Calculus

Differentiation of standard functions of first and higher orders, Taylor's and Maclaurin's series expansion of simple functions for single variable.

Chapter 2: Integral Calculus

Evaluation of integrals, properties, Beta and Gamma functions, relation between Beta and Gamma functions simple problems, Approximate integration- Trapezoidal rule, Simpson's 1/3 rule.

Chapter 3: Fourier Series

Fourier series, Evaluation of Fourier coefficients, Waveform symmetries as related to Fourier co-efficient, Exponential form of the Fourier series, half range Fourier series. Practical Harmonic Analysis.

Unit II

Chapter 4: Fourier Transform

Exponential Representation of non-periodic signals, Existence of Fourier transforms properties of Fourier Transform: symmetry, scaling, shifting, Fourier transform of Sine and Cosine Convolution theorem

Chapter 5: Laplace Transforms

Definition, transforms of elementary functions- transforms of derivatives and integrals- Properties. Periodic functions, Unit step functions and Unit impulse functions. Inverse Transforms- properties- Initial and final value theorems and examples; Convolution Theorem. Applications to differential equations.

Unit III

Chapter 6: Ordinary Differential Equations of First Order

Introduction, order and degree of equation, Solution of first order first-degree differential equations –variable separable methods, Linear differential equations, Bernoulli's equations, Initial value problems.

Chapter 7: Complex Analysis

Function of complex variables. Limits, continuity and differentiability. Analytic functions, C-R equations in Cartesian and polar forms, construction of Analytic functions (Cartesian and polar forms).

Text Books:

1. Grewal B S, Higher Engineering Mathematics, 38, Khanna Pub, 2001
2. Bali and Iyengar, A text book of Engineering Mathematics, 6, Laxmi Publ, 2003

Reference Books:

1. James Stewart, Early Transcendental Calculus, 5, Cengage Le, 2007.

BACK

Program: Automation & Robotics Engineering		Semester: III
Course Title: Statistics And Integral Transforms		Course Code: 15EMAB201
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Laplace Transforms

Definition, transforms of elementary functions- transforms of derivatives and integrals- Properties. Periodic functions, Unit step functions and Unit impulse functions.

Inverse Transforms- properties- Initial and Final value theorems, examples, Convolution Theorem. Applications to differential equations.

Chapter 2: Curve Fitting and Regression

Introduction to method of least squares, fitting of curves $\boldsymbol{y = a + bx}$, $\boldsymbol{y = ab^x}$, $\boldsymbol{y = a + bx + cx^2}$ Correlation and regression. Applications to Engineering problems: fluid flow through a pipe problem-using curve.

Chapter 3: Probability

Definition of probability, addition rule, conditional probability, multiplication rule, Baye's rule. (no proof)

Unit II

Chapter 4: Random variable and Probability Distributions

Discrete and continuous random variables- PDF-CDF- Binomial, Poisson and Normal distributions (Problems only).

Chapter 5: Tests of Hypothesis

Sampling, Sampling distribution, Standard error, Null and alternate hypothesis, Type -I and Type- II errors, Level of significance. Confidence limits, testing of hypothesis for single mean and difference of means (large samples). t-test (test for single mean, paired t-test), Chi Squared distribution, analysis of variance (one-way and two-way classifications). Case studies of designs of experiments (CRD, RBD). Applications to civil Engineering problems

Unit III

Chapter 6: Fourier Series

Fourier series representation of a function, Derivation of Complex coefficients of Exponential Fourier Series and its relationship with coefficients of trigonometric Fourier series, examples. Convergence of Fourier Series, properties. Even and odd functions and examples. Fourier half range series and examples

Chapter 7: .Fourier Transform

Exponential Representation of non-periodic functions and Existence of Fourier transforms and simple examples

Text Books:

1. Gupta S C and Kapoor V K, Fundamentals of Mathematical Statistics, 9th edition, Sultan Chand and sons, 2002
2. J. Susan Milton, Jesse C. Arnold, Introduction to Probability and Statistics: Principles and Applications for Engineering and the Comp, 4th edition, TATA McGraw, 2007
3. Kreyszig. E, Advanced Engineering Mathematics, 8th edition, John Wiley, 2003

Reference Books:

1. Kishor S Trivedi, Probability and statistics with reliability queuing and computer science applications, 1st edition, PHI, 2000
2. Miller, Freud and Johnson, Probability and Statistics for Engineering, 5th edition, PHI, 2000
3. Potter.M.C, Jack Goldberg and Aboufadel.E. F, Advanced Engineering Mathematics, 3rd edition, Oxford Ind, 2005

BACK

Program: Automation & Robotics Engineering		Semester: III
Course Title: Analog & Digital Electronic Circuit		Course Code: 18EARF201
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction of PN junctions and analog electronics

Diode theory, forward and reverse biased junctions, reverse- bias breakdown, load line analysis, diode applications – limiters, clippers, clampers, voltage multipliers, half wave and full wave rectification, voltage regulators, voltage dividers, pull up, pull down, optocoupler, special purpose diodes – Zener diode, varactor, light emitting diodes, photodiodes. Network theorems and applications: KVL, KCL,

Node Method, Loop Method, Superposition, Thevenin's Theorem and Norton's Theorem.

Chapter 2: Transistors

Bipolar Junction Transistors and introduction to MOSFET:

Operating point, Fixed bias circuits, Emitter stabilized biased circuits, Voltage divider biased, Bias stabilization, BJT transistor modeling, , Emitter follower, CB configuration, Collector feedback configuration, analysis of CE configuration using h- parameter model; Relationship between h-parameter model of CE,CC and CB configuration, Introduction to MOSFETs, MOSFET as a switch.

Chapter 3: Operational Amplifiers

Op-Amp Basics, practical Op-Amp circuits, differential and Common mode operation, Inverting & Non- Inverting Amplifier, differential and cascade amplifier, Op-Amp applications: Voltage follower, Comparator, summing, integrator, differentiator, instrumentation amplifiers, Schmitt trigger, Op-amp based oscillators.

Unit II

Chapter 4: Number system and digital logic gates

Decimal, binary, octal, hexadecimal number system and conversion, binary weighted codes, signed numbers, 1s and 2s complement codes, Binary arithmetic.

Logical Operators, Logic Gates-Basic Gates, Other gates, Active high and Active low concepts, Universal Gates and realization of other gates using universal gates, Gate Performance Characteristics and Parameters.

Chapter 5: Boolean algebra and combinational logic circuits

Binary logic functions, Boolean laws, truth tables, half adder, full adder, subtractor, associative and distributive properties, DE Morgan's theorems, realization of switching functions using logic gates.

Switching equations, canonical logic forms, sum of product & product of sums, Karnaugh maps, two, three and four variable Karnaugh maps, simplification of expressions.

Chapter 6 :

Design of combinational logic circuits and sequential logic

Introduction to combinational circuits, code conversions, decoder, encoder, priority encoder, multiplexers as function generators, binary adder, subtractor, BCD adder, Binary comparator, arithmetic logic units.

Sequential circuits, flip-flops, clocked and edge triggered flipflops, timing specifications, asynchronous

and synchronous counters, counter design with state equations, Registers, serial in serial out shift registers, tristate register, timing considerations.

Unit III

Chapter 7: Data conversions

Introduction to data conversions, R/2nR DAC, R/2R, Flash, Digital ramp ADC, Successive approximation ADC, Slope (integrating) ADC, Delta-Sigma (ΔΣ) ADC, Practical considerations of ADC circuits.

Chapter 8: Digital integrated circuits

Logic levels, propagation delay time, power dissipation fan-out and fan-in, noise margin, logic families and their characteristics TTL, LSTTL CMOS and ECL integrated circuits and their performance comparison, open **collector and tristate gates and buffers.**

Text Books:

1. Anant Agarwal, Foundations of Analog and Digital Electronic Circuits, 1, Morgan Kau, 2005
2. Thomas L. Floyd, Digital fundamentals, 9, Pearson Ed, 2006
3. Robert L. Boylestad, Electronic Devices and Circuit Theory, 10, Pearson Ed, 2008

BACK

Program: Automation & Robotics Engineering		Semester: III
Course Title: Kinematics of Machinery		Course Code: 19EARF202
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction to Kinematics

The subject of Kinematics and Dynamics of Machines, Kinematics and Dynamics as Part of the Design Process, Is It a Machine, a Mechanism, or a Structure? Examples of Mechanisms; Terminology, Mobility of Mechanisms, Kinematic Inversion, Grashof's Law for a Four-Bar Linkage.

Chapter 2: Position Analysis

Kinematic Requirements in Design, The Process of Kinematic Analysis, Kinematic Analysis of the Slider-Crank Mechanism, Solutions of Loop-Closure Equations, Applications to Simple Mechanisms, Applications to Compound Mechanisms, Trajectory of a Point on a Mechanism.

Chapter 3: Velocity & Acceleration Analysis

Velocity Vector, Equations for Velocities, Applications to Simple Mechanisms, Applications to Compound Mechanisms. Acceleration Vector, Equations for Accelerations, Applications to Simple Mechanisms, Applications to Compound Mechanisms.

Unit II

Chapter 4: Static Force Analysis

Forces, Moments and Torques, Laws of Motion, Free-Body Diagrams, Drawing a Free-Body Diagram, Characterizing Contact Forces, Static Equilibrium, Analysis of a Two-Force Member, Sliding Friction Force

Chapter 5: CAMS: Design and Kinematic Analysis

Types of Cam, Types of Followers, Prescribed follower motion, Follower motion schemes, Graphical disk cam profile design, Pressure angle, Design Limitations, Analytical disk cam profile design.

Chapter 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.

Unit III

Chapter 7:BELTS AND CHAIN DRIVES

Types of Belt, Belt drive geometry, Belt drive kinematics, Types of Chains, Chain drive geometry, Chain drive kinematics.

Chapter 8: Screw Mechanisms

Thread features, Thread forms, Ball screws, Lead Screw kinematics, Screw forces and torques, Differential screws, Auger screws.

Text Books:

1. Fundamentals of Kinematics and Dynamics of Machines and Mechanism, Oleg Vinogradov, CRC Press-2000.
2. Machines and Mechanisms-Applied Kinematic Analysis, David H. Myszka, Fourth Edition, Pearson Education.

Reference Books:

1. Kinematics, Dynamics and Design of Machinery, Kenneth J. Waldron, Wiley India Pvt Ltd; Second edition.

BACK

Program: Automation & Robotics Engineering		Semester: III
Course Title: Object Oriented Programming		Course Code:22EARC202
L-T-P: 2-0-3	Credits: 5	Contact Hours: 8hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 50hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1. INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING WITH C++

Introduction to Object-Oriented Programming, Data-Type, Variables, Strings, Functions, Functions with Default Values, Recursion, Namespaces, Operators, Flow Control, Arrays, Pointers.

Chapter 2. CLASSES AND OBJECTS

Structure vs. Class, Components of a Class, UML – Class Diagram, Encapsulation, Access Specifiers, Member Functions, Instance of a Class, Default Constructors, Destructors, Accessing Data Fields, Constructors with Parameters, Static Class Members - Data Members and Member Functions, Scope Resolution Operator, Nested Classes, Local Classes, Passing Objects to Functions, Return Objects, Object Assignment, Friend Function, Operator Overloading, Function Overloading, Copy Constructors

Unit II

Chapter 3: INHERITANCE AND POLYMORPHISM

Inheritance, Derived Class, Calling the Base Class Constructor, Overriding Member Functions, Polymorphism, Class Inheritance Hierarchies, Abstract Classes, Run-Time Information, Early vs. Late Binding, Virtual Base Classes, Multiple Inheritance, Interfaces, Stream Handling.

Chapter 4: EXCEPTION HANDLING AND TEMPLATE

Exception Handling, Try, Catch, Throw, User-Defined Exceptions, Class Template-Implementing class template, Implementing class template and its members, Using a class template, Function template-Implementing template functions, Using template functions.

Unit III:

Chapter 5 **GRAPH DATA STRUCTURE**

Terminologies, Representation, Graph Traversal - Breadth First Search and Depth First Search, Shortest Path Problems - Dijkstra's Algorithm, Minimal Cost Spanning Trees -Kruskal's Algorithm

Chapter 6: DYNAMIC PROGRAMMING

The Knapsack Problem, The Travelling Salesperson Problem, Longest Common Subsequence

Text Books:

1. Herbert Schildt, “C++: The Complete Reference”, Tata McGraw-Hill, 2003.
2. Grady Booch, James Rumbaugh and Ivar Jacobson, “Unified Modeling Language User Guide,” Addison-Wesley, 1999.
3. 3.Johan Sannemo, “Principles of Algorithmic Solving Problems”, 2018

BACK

Program: Automation & Robotics Engineering		Semester: III
Course Title: Mechanics of Materials		Course Code: 18EARF204
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Stress & Strain

Introduction, Normal Stress Under Axial Loading, Direct Shear Stress, Bearing Stress, Stresses on Inclined Sections, Equality of Shear Stresses on Perpendicular Planes, Strain, Displacement, Deformation, and the Concept of Strain, Normal Strain, Shear Strain

Chapter 2: Mechanical Properties of Materials

The Tension Test, The Stress-Strain Diagram, Hooke's Law, Poisson's Ratio, Design Concepts, Types of Loads, Safety, Allowable Stress Design, Load and Resistance Factor Design

Chapter 3: Axial Deformation

Introduction, Saint-Venant's Principle, Deformations in Axially Loaded Bars, Deformations in a System of Axially Loaded Bars, Statically Indeterminate Axially Loaded Members

Unit II

Chapter 4: Torsion

Introduction, Torsional Shear Strain, Torsional Shear Stress, Stresses on Oblique Planes, Torsional Deformations, Torsion Sign Conventions, Power Transmission, Statically Indeterminate Torsion Members.

Chapter 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

Chapter 6: Bending

Introduction, Flexural Strains, Normal Stresses in Beams, Analysis of Bending Stresses in Beams, Introductory Beam Design for Strength, Flexural Stresses in Beams of Two Materials, Bending Due to Eccentric Axial Load, Un symmetric Bending

Unit III

Chapter 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

Chapter 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
Text Books: 1. Timothy .A. Philpot, Mechanics of Materials, An Integrated Learning System, Third edition, Wiley
Reference Books: 1. Roy R., Craig, JR. Mechanics of Materials, Third edition, JOHN WILEY & SONS.

BACK

Program: Automation & Robotics Engineering		**Semester: III**
Course Title: Manufacturing Technology & Processes		**Course Code: 23EARC205**
L-T-P: 2-1-0	**Credits: 3**	**Contact Hours: 4 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 40 hrs	**Examination Duration: 2 hrs**	

Unit I

Chapter 1: Lathe Machining

Classification of Machining, construction of lathe, driving mechanisms of lathe, different operations on lathe, nomenclature of cutting tools, parameters. Numerical related to machining operations. Material Properties, Selection of materials based on properties, grain size, bonding process. (Tutorial: Simulation of the cutting process using any CAM software, refining parameters through literature study, Process sheets).

Chapter 2: Milling Machining

Need, constructional features of milling machines, types of milling cutters, operations & milling cutter profiles. Milling processes, up milling and down milling concepts, indexing- Simple, compound, differential and angular indexing concepts. Numericals

Chapter 3: Drilling & Abrasive processes

Classification, constructional features of drilling machine & related operations. Types of drill & drill bit nomenclature, drill materials. Numericals. Classification, constructional features of grinding machines (Center less, cylindrical and surface grinding). Selection of grinding wheel grade and structure of grinding wheels, grinding wheel types.(Tutorial: Simulation of the drilling process using any CAM software, selection and application of materials, develop operation process sheet)

Unit II

Chapter 4: Non-Traditional Machining

Need for non-traditional machining, principles, utilization of Abrasive Jet Machining, Water Jet Machining, Electro-Chemical Machining, Electrical Discharge Machining, Wire EDM, Electron Beam Machining, Laser Beam Machining & Plasma Arc Machining

Chapter 5: Welding and Joining Processes

Welding Technology, methods of welding, Gas Welding, Electric Arc Welding, Welding designs, Resistance Welding and Friction welding. Brazing, soldering and fastening technique.(Tutorial: Illustration of the welding process and GD&T terminologies, Welding process

Chapter 6: Advanced Manufacturing

Introduction to CNC machines- Principles of operation, coordinate systems of CNC machine, construction and elements of a CNC system, manual part programming methods, G & M codes, Selection of CNC machine tool. CNC programming (Tutorials: Building and simulation of CNC codes for various machining operations)

Unit III

Chapter 7: Additive Manufacturing

Basics of Additive Manufacturing, classifications, principles, Material and binder, Powder Bed Fusion, Extrusion based systems, Stereolithography, Design for Additive Manufacturing (DFAM) concepts & Applications. (Tutorials: Developing a model using DFAM concept)

Chapter 8: Dimensional Metrology

Definition, need for inspection, standards of measurement-line standards, end standards & wavelength standards, terminologies, methods of measurement. Limits & Fits- Introduction, tolerances, limits of size, fit and tolerances, Limit gauges classification, Co-ordinate Measuring Machine, important features of CMM, Precision instruments based on laser.

Text Books:

1. Manufacturing Technology- Foundry, Forming and Welding, 5e (Volume 1), PN RAO (Call No.- 669 Rao)
2. Manufacturing Technology- Metal Cutting and Machine Tools, PN RAO. (Call No.- 669 Rao, D68-)
3. CNC Machines, ADITHAN (M) AND PABLA (BS), (Call No.- 629.892 ADI)

Reference Books:

1. Rapid prototyping, 3D printing and additive manufacturing principles and applications, CHUA (CK) AND LEONG (KF). (Call No. - 629.892 ADI)
2. Engineering Dimensional Metrology, MILLER. (Call No. - 669 MIL)

BACK

Program: Automation & Robotics Engineering		Semester: III
Course Title: Analog & Digital Electronic Circuits Lab		Course Code: 18EARP201
L-T-P: 0-0-1	Credits: 1	Contact Hours: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 28 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Demonstration of lab equipment and components

CRO, Multimeter, Function Generator, Power supply- Active/Passive Components & Bread Board.

Demonstration of Software – Matlab.

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.

Chapter 2: Demonstration of Lab Equipments and Components

While this experiment may not be directly simulated in MATLAB, MATLAB can be used for educational simulations or virtual labs to introduce students to the functioning of lab equipment and components before they work with physical equipment

Learning Objectives:

The students should be able to:

1. Simulate circuits using Matlab software

Chapter 3: Design and Implementation of Rectifiers with and without Filters: MATLAB can simulate the output waveform of rectifiers and help students understand the effects of filtering on the output signal

Learning Objectives:

The students should be able to:

1. Draw and understand the use of diodes in half wave and fullwave rectifiers without filter and with filter
2. Calculate the ripple and efficiency
3. Calculate the peak value of the output voltage of the rectifiers given the rms input value
4. The process of AC to DC conversion

Chapter 4: **Network Theoresm**:

Verification of Superposition, Thevenin's. MATLAB can assist in verifying these network theorems using circuit simulations and comparing the results with theoretical calculations

Learning Objectives:

The students should be able to:

1. Explain and Learn circuit analysis using these theorems
2. How to solve linear circuit problems and short circuit current
3. Verifification of Network theorems using Matlab software

Unit II

Structured Enquiry

Design and Implementation of Code Converters, Encoder, and Decoder using Logic Gates: MATLAB can simulate logic gates and code converters, enabling students to analyze their functioning.

Learning Objectives:

The students should be able to:

1. Design and implementation of converters using logic gates
2. Learn how to design and implementation of encoders and decoders
3. Learn how and where to use encoders and decoders

Design an 8-bit ADC Circuit that Utilizes LEDs to Indicate its Binary Output Value: MATLAB/Multisim can simulate the ADC circuit's performance and help students understand its behavior with varying input signals

Learning Objectives:

The students should be able to:

1. Learn how to design and implement 8 bit ADC circuit that to indicate its binary output values
2. Understands why to use Analog to Digital converter

Chapter 6: Demonstrate the Characterization of Ultrasonic Sensor: MATLAB/Multisim can assist in the analysis of ultrasonic sensor data and calibration

Learning Objectives:

The students should be able to:

1. Learn how to measure distance from ultrasonic sensor
2. Understands how to calibrate data from ultrasonic sensor.

Viva, Journal and Attendance Learning Outcomes:

The students should be able to:

1. Command of appropriate communication skills such as technical reports, viva and presentations through the lab.
2. Maintaining the punctuality to all the lab sessions.

Project Learning Outcomes :

The students should be able to:

1. Carryout a project in a team.
2. Come up with PCB design using Eagle software

BACK

Program: Automation & Robotics Engineering		Semester: III
Course Title: Kinematics of Machinery lab		Course Code: 18EARP202
L-T-P: 0-0-1	Credits: 1	Contact Hours: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 28 hrs	Examination Duration: 3 hrs	

Experiments	
1	Introduction to Matlab
2	Introduction to Multibody Simulation
3	Visualizing Co-ordinate frames
4	Simple Pendulum
5	Double Pendulum
6	Pendulum on cart
7	Crane Base
8	Pendulum waves
9	Four bar linkage
10	Inline –Three Engine
11	Crank & Flywheel
12	Importing CAD model in Mat lab
13	Project

BACK

Program: Automation & Robotics Engineering		**Semester: III**
Course Title:Machine Drawing, Modeling & Analysis Laboratory		**Course Code: 22EARP201**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 28 hrs	**Examination Duration: 3 hrs**	
Unit I- Demonstration		
Develop Free Hand Sketches for the specified set of products.		
Understand & list the standard organizations and societies worldwide contributing to the design sector.		
Understand and develop the GD&T drawings for the production unit.		
Unit II- Exercise		
Generate 2D sketches using the Solidworks part tool.		
Develop 3D models and drawings using the tool.		
Build assemblies & drafts using Solidworks Assembly-drafting tool.		
Simulate the electrical connections for the model/assembly.		
Analyze the model using the Solidworks simulation tool.		
Unit III - Enquiry		
Examine the sustainability and production requirements for the designed model.		
Design and analyze a product involving all the design standards and principles.		
Text Books: 1. Bowman, Understanding CAD-CAM, MH. (Call No.- 004.SCH) 2. Groover (MP) and Zimmer's (EW), CAD/CAM Computer Aided Design and Manufacturing, PHI. (Call No.- 670.427 GRO) 3. P N Rao, CAD-CAM Principles and Applications, TMH. (Call No.- 670.427 RAO)		
Reference Books: 1. ebook1- Introducing Solidworks, weblink-files.solidworks.com/pdf/introsw.pdf. 2. ebook2- An Introduction to Stress Analysis with SolidWorks Simulation, Student Guide, www.solidworks.com/sw/images/content/Training/SolidWorks_Simulation_Student_Guide-ENG.pdf		

BACK

Program: Automation & Robotics Engineering		Semester: IV
Course Title: Vector Calculus and Differential Equations		Course Code: 15EMAB241
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: .Partial Differentiation

Function of several variables, Partial derivatives, Chain rule, Errors and approximations

Chapter 2: Multiple Integrals

Double integral, Evaluation by change of order, change of variables, simple problems, Triple integrals simple problems.

Chapter 3: Vector Algebra and Calculus

Vector addition, multiplication (Dot and Cross products), Triple products, Vector functions, Vector differentiation, Velocity and Acceleration of a vector point function, Vector fields, Gradient and directional derivatives.

Unit II

Chapter 4: .Vector Calculus-continued

Line and Surface integrals. Independence of path and potential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem

Chapter 5: Differential equations of second order

Differential equations of second and higher orders with constant coefficients, method of variation of parameters.

Unit III

Chapter 6: Partial differential equations

Introduction, classification of PDE, Formation of PDE, Solution of equation of the type Pp + Qq = R. Solution of partial differential equation by direct integration methods, method of separation of variables

Text Books:

1. Grewal B S, Higher Engineering Mathematics, 38ed, Khanna Publication, New Delhi, 2001.
2. Bali and Iyengar: A text book of Engineering Mathematics, 6ed, Laxmi Publications (p) Ltd, New Delhi, 2003

Reference Books:

1. Early Transcendental Calculus by James Stewart, Thomson Books, 5ed, 2007

BACK

Program: Automation & Robotics Engineering		Semester: IV
Course Title: Numerical Methods and Partial Differential		Course Code: 19EMAB206
L-T-P: 3-1-0	Credits: 4	Contact Hours: 4hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Interpolation Techniques

Finite differences, Forward, Backward and central difference operators. Newton Gregory forward and backward interpolation formulae. Sterling's and Bessel's formulae for central difference, Newton's divided difference formula for un equal intervals. Heat transfer problem, gas law problem-shear stress problem-using interpolation. Applications to Mechanical engineering problems.

Chapter 2: Matrices and System of Linear Equations Hours

Introduction to system of linear equations, Rank of a matrix by elementary row transformations. Consistency of system of linear equations, solution of system by (i) Direct methods-Gauss elimination, Gauss Jordon method (ii) Iterative methods- Guass-Seidal method. Eigenvalues and Eigenvectors of a matrix. Largest Eigenvalue and the corresponding Eigenvector by power method. Spring mass system Falling parachutist using system of equations.

Unit II-

Chapter 3: Partial Differential Equations

Introduction, classification of PDE, Formation of PDE, Solution of equation of the type Pp + Qq = R, Solution of partial differential equation by direct integration methods, method of separation of variables. Modeling: Vibration of one-dimensional string-wave equation and heat equation. Laplace equation. Solution by method of separation of variables

Chapter 4: Finite Difference Method

Finite difference approximations to derivatives, finite difference solution of parabolic PDE explicit and implicit methods, hyperbolic PDE-explicit method, Elliptic PDE-initial-boundary value problems. Engineering Problems: Temperature distribution in a heated plate, vibration of a stretched string, steady-state heat flow

Unit III –

Chapter 5: Complex Analysis

Function of complex variables. Limits, continuity and differentiability. Analytic functions, C-R equations in Cartesian and polar forms, construction of Analytic functions (Cartesian and polar forms).

Chapter 6: Complex Integration

Line integral, Cauchy's theorem-- corollaries, Cauchy's integral formula. Laurent's Series, Singularities, Poles, Residue theorem – problems.

Text Books:

1. Kreyszig E., Advanced Engineering Mathematics, 8ed, John Wiley & sons, 2003.
2. Potter M C, Jack Goldberg and Aboufadel E F, Advanced Engineering Mathematics, 3ed, Oxford Indian Edition, 2005.

3. Grewal B S, Higher Engineering Mathematics, 38ed, TATA McGraw-Hill, 2001

Reference Books:

1. Burden R L and Douglas Faires J, Numerical Analysis, 7ed, Thomson publishers, 2006.
2. Simmons G F and Krantz S G, Differential Equations, TATA McGraw-Hill, 2007.
3. Sastry S S, Introductory method for numerical analysis, 3ed, PHI, 2003
4. Chapra S C and Canale R P, Numerical methods for Engineers, 5ed, TATA McGraw-Hill, 2007.

BACK

Program: Automation & Robotics Engineering		Semester: IV
Course Title: Machine Design		Course Code: 18EARC206
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: The Design Process

Introduction, Materials in Design, The Evolution of Engineering Materials, The Evolution of Materials in Products, the Design Process, Types of Design, Design Tools and Materials Data, Function, Material, Shape, and Process.

Chapter 2: Material Property Charts

Exploring Material Properties, Modulus–density chart Strength–density chart, Modulus–strength chart, Maximum service temperature chart, Cost bar charts, The modulus–relative cost chart, and The strength–relative cost chart.

ENGINEERING MATERIALS, THEIR PROPERTIES AND MATERIAL SELECTION

The Families of Engineering Materials, Materials Information for Design, Material Properties and Units

Chapter 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.

Unit II –

Chapter 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

Chapter No. 5. Linear Motion Elements, Springs, Fasteners

Power screws, ball screws, application considerations for power screws and ball screws, bolt materials and strength, externally applied force on a bolted joint, thread stripping strength, other means of fastening and joining. Kinds of springs, helical compression springs, stresses and deflection for helical compression springs, analysis of spring characteristics, design of helical compression springs, helical torsion springs, improving spring performance by shot

peening, spring manufacturing.

Chapter 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.

Unit III

Chapter.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.

Chapter 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.

Text Books:

1. Robert L. Norton, Machine Design, Pearson Education edition, Prentice Hall, 2005
2. Robert L. Mott, Machine Elements in Mechanical Design, Fourth edition, PEARSON Prentice Hall, 2004.

Reference Books:

1. Shigley J.E. and Mischke C.R, Mechanical Engineering Design, McGraw Hill Publication Co. Ltd
2. Michael F. Ashby, Materials Selection in Mechanical Design, Fourth Edition, 2014, 2014

BACK

Program: Automation & Robotics Engineering		Semester: IV
Course Title: Control Systems Design and Practice		Course Code: 22EARC201
L-T-P: 2-1-1	Credits: 4	Contact Hours: 6hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 50 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction to Control System and System Modeling in Frequency Domain
System Configurations (open-loop & closed loop systems), Analysis and Design Objectives, The Design Process. Mathematical modeling of physical Systems: Electrical networks, Mechanical systems, Electro mechanical systems, Analogous systems.

Chapter 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.

Chapter 3: Time –Domain Analysis
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.

Unit II

Chapter 4: Stability Analysis
Concepts of stability, Necessary conditions for Stability, Routh- stability criterion, Relative stability analysis; More on the Routh stability criterion.

Chapter 5: Root Locus Techniques
Introduction, The root locus concepts, Construction of root loci.

Chapter 6: Frequency Domain Analysis
Stability analysis, Bode plot, Nyquist Stability Criterion, Relative Stability – Gain and Phase Margins.

Unit III

Chapter 7: Design Via Frequency Response
Control System Design via Frequency Response – Lead, Lag and Lag-Lead Compensation

Chapter 8: Design Via Root Locus
Improving Transient Response and Steady-State Error via Cascade Compensation, Feedback Compensation, Physical Realization of Compensation

Text Books:

1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons, Inc, Sixth edition, 2011.

Reference Books:

1. Benjamin C. Kuo, Automatic Control Systems by,PHI/ 7th edition.

2. https: //ocw.mit.edu/courses/2-04a-systems-and-controls-spring-2013.
3. K.Ogata “Modern Control Engineering”, Pearson Education Asia/ PHI, 4th Edition, 2002.

BACK

Program: Automation & Robotics Engineering		**Semester: IV**
Course Title: Microcontrollers Programming & Interfacing		**Course Code: 22EARC208**
L-T-P: 4-0-0-	**Credits: 4**	**Contact Hours: 4hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50 hrs	**Examination Duration: 3 hrs**	

Unit I

Chapter 1: Introduction to Microcontroller

Introduction To Microprocessor and Microcontroller: History and Evolution, types of microprocessors, Difference between Microprocessors and Microcontrollers. CPU architectures: RISC/CIS, Overview of PIC Microcontroller family, Introduction to different microcontroller families (8051, ATMEL/AVR, and ARM).

Chapter 2: Microcontroller Architectures and System Design

The architecture of microcontrollers (Harvard vs von Neumann), STM 32 ARM Architecture, ESP Microcontroller Architecture, Memory organization (ROM, RAM, EEPROM, Flash), Input/output ports (GPIO, ADC, DAC, PWM), System design considerations (power, timing, interfacing)

Chapter 3: Introduction to the STMicroelectronics Line of Microcontrollers

Overview of STMicroelectronics microcontroller families (STM32, STM8), Features and specifications of STM32 microcontrollers, Advantages of using STMicroelectronics microcontrollers, Comparison with other microcontroller brands.

Unit II

Chapter 4: HAL, GPIO and Interrupt Management, A/D Conversions

STM32 peripherals mapping and HAL handlers, GPIO configuration, GPIO Modes. GPIO Alternate functions, GPIO Speeds, Driving a GPIO and De-initializing GPIOs. NVIC Controller, Vector table in STM32, Enabling Interrupts, Interrupt lifecycle, Interrupt priority levels, Interrupt re-entrancy, masking Interrupts. HAL_ADC Module, Conversion modes, HAL_DAC Module and DAC peripherals.

Chapter 5: Communication with STM32

Universal Asynchronous serial communication – UART ad USARTs, URAT communication in polling mode, URAT in Interrupt mode, Error Management and I/O retargeting, I2C- Specs and Protocols, Start Stop Conditions, I2C peripherals in STM32 MCUs, HAL_I2C Module. SPI Interface, HAL_SPI Module.

Chapter 6: Clock Tree and Timers

Clock distribution in STM32, Overview of HAL_RCC module, Introduction to Timers, Timers

Unit III –

Chapter 7: Application Development and Setting Up the Tool Chain

Embedded systems design and development, Real-time operating systems (RTOS), sensor and actuator interfacing, Robotics and automation applications, Tool chain in different environments, STM32 Cube IDE, Eclipse, GCC ARM, ST Tools and drivers.

Chapter 8: Case studies: Microcontrollers in robotics and automation. Microcontroller-based robot control systems, Microcontroller-based automation systems, Design and implementation of microcontroller-based control systems for various applications, Integration of microcontrollers with other hardware and software platforms.
Text Books: 1. Carmine Noviello, “Mastering STM32”, Lean Pub publications, 2018 Edition. 2. Donald Norris, “Programming with STM32 getting started with Nucleo board and C/C++”, McGraw-Hill Education
Reference Books: 1. Ramesh Gaonkar, Fundamentals of microcontrollers and Applications in Embedded Systems. Penram International Publishing(India) Pvt. Ltd. 2. Ajay V Deshmukh, “Microcontroller: Theory and Applications” 3. M Krishnakumar, “Microprocessors and Microcontrollers”.

BACK

Program: Automation & Robotics Engineering		Semester: IV
Course Title: Database Management System and Application Development		Course Code: 22EARC203
L-T-P: 2-0-3	Credits: 5	Contact Hours: 8hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 50hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: INTRODUCTION TO DBMS

Introduction, Characteristics of Database Approach, Actors on the Scene, Workers Behind the Scene, Advantages and Disadvantages of using DBMS Approach, Data models, Schemas and Instances, Three-Schema Architecture and Data Independence, Database Languages and Interfaces, Database System Environment.

Chapter 2: ENTITY RELATIONSHIP (ER) MODEL

High-Level Conceptual Data Models for Database Design, Entity Types, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, Relationship Types of Degree Higher than Two, ER Notations, Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, First Normal Form (1NF), Second Normal Form (2NF) and Third Normal Form (3NF), Boyce-Codd Normal Form (BCNF).

Chapter 3: STRUCTURED QUERY LANGUAGE

Relational Model Concepts, Relational Model Constraints, Relational Database Schemas, Update Operations, SQL Data Definition and Data Types, Specifying Basic Constraints in SQL, Insert, Delete and Update Statements in SQL, Specifying Constraints as Assertion and Trigger, Views in SQL, Basic Queries in SQL.

Unit II

Chapter 4: UNIFIED MODELING LANGUAGE (UML) AND SDLC

Unified Modeling Language (UML), Static and Dynamic Diagrams, Class Diagram, Use Case Diagram, State Chart Diagram, Activity Diagram, Sequence Diagram, SDLC models, Waterfall Model, V-Model, Spiral Model

Chapter 5:WEB APPLICATION DESIGNAND DEPLOYMENT

JavaScript Introduction, Language Syntax, Client-Side Scripting, JavaScript Design Principles, JavaScript Objects, JavaScript Events, Forms, JSON objects, JSON Arrays.

Unit III:

Chapter 6: NOSQL DATABASE

Why NoSQL? The Value of Relational Databases. Distribution Models; Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication. Consistency, Update Consistency, Read Consistency, Relaxing Consistency.

Chapter 7: PYTHON PROGRAMMING

Python Basics, Flow Control, Functions, Lists, Tuples, Sets and Dictionaries, Classes and Objects, Inheritance, File Handling, Exception Handling.

Text Books:

1. Ramez Elmasri and Shamkant B. Navathe, “Fundamentals of Database Systems,” Pearson Education, 5th Edition, 2008.
2. Ian Sommerville, “Software Engineering,” Pearson Publication, 9th edition, 2010.
3. Grady Booch, James Rumbaugh and Ivar Jacobson, “Unified Modeling Language User Guide,” Addison-Wesley, 1999.
4. Pramod Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Pearson Addison Wesley, 2012.
5. Randy Connolly, Ricardo Hoar, "Fundamentals of Web Development”, 1st Edition, Pearson Education India.
6. Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, Create Space Independent Publishing Platform, 2016

BACK

Program: Automation & Robotics Engineering		**Semester: IV**
Course Title: Robot Analysis & Design		**Course Code: 18EARC210**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50hrs	**Examination Duration: 3 hrs**	

Unit I

Chapter 1: Introduction to Robotics and Applications

Introduction, Classifications of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, and Robot Applications.
Representing Position and Orientation Coordinate frames, representing Pose in 2-Dimensions, representing Pose in 3-Dimensions, representing Orientation in 3-Dimensions, orthonormal Rotation Matrix, three-Angle Representations, combining Translation and Orientation.

Chapter 2: Position Analysis of Serial Manipulators

Describing a Robot Arm, Link Parameters and Link Coordinate systems, Homogeneous transformation Matrices, Denavit-Hartenberg, Product of Exponential formula in space frame, Forward Kinematics, Inverse Kinematics, A 2-Link Robot, A 6-Axis Robot.

Chapter 3: Introduction to Robotics and Applications

Introduction, Classifications of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, and Robot Applications.
Representing Position and Orientation Coordinate frames, representing Pose in 2-Dimensions, representing Pose in 3-Dimensions, representing Orientation in 3-Dimensions, orthonormal Rotation Matrix, three-Angle Representations, combining Translation and Orientation.

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.

Unit II-

Chapter 5: Statics and Dynamics of Serial Manipulators

Types of gears/ motor/ drives/ encoders, Motion controller (Motion control software),Statics of Serial Manipulators, Transformations of Forces and Moments, mass properties, momentum, transformation of inertia matrix, kinetic energy. Newton-Euler Laws, Recursive Newton-Euler Formulation

Chapter 6: Trajectory planning

Path versus Trajectory, Joint-Space versus Cartesian-Space Descriptions, Basics of Trajectory Planning, Joint-Space Trajectory Planning, Third-Order Polynomial Trajectory Planning, Fifth-Order Polynomial Trajectory Planning, Linear Segments with Parabolic Blends, Linear Segments with Parabolic Blends and Via Points, Higher-Order Trajectories, Other Trajectories, Cartesian-Space Trajectories, Continuous Trajectory Recording.

Unit III

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.

Text Books:

1. Saeed B. Niku, "Introduction to Robotics, Analysis, Systems, Applications, PHI Learning private limited. 2009.
2. Lung-Wen Tsai, “Robot Analysis”, A Wiley-Interscience Publications, John Wiley & Sons, Inc., 1999.
3. S.K. Saha, “Introduction to Robotics”, Tata McGraw Hill Education Private Limited, 2008.

Reference Books:

1. Fu K.S., Gonzalez R.C., and Lee C.S.G., "Robotics control, Sensing, Vision and Intelligence”, McGraw-Hill Book Co.
2. Groover M.P., “Industrial Robotics, programming and applications ", McGraw-Hill Book Co., 1995.
3. AshitaviaGhoshal, “Robotics Fundamental Concepts & Analysis”, Oxford University Press.
4. John J. Craig, “Introduction to Robotics-Mechanics & Control”, Pearson Education, Inc., 2005.
5. T. Bajd, M. Mihelj, J. Lenarcic, A. Stanovnik, M. Munih., “Robotics”, Springer, Vol 43.
6. Peter Corke, “Robotics, Vision and Control: Fundamental Algorithms In MATLAB, Second, Completely Revised, Extended and Updated Edition: 118 (Springer Tracts in Advanced Robotic

BACK

Program: Automation & Robotics Engineering		Semester: IV
Course Title: Manufacturing & Metrology Lab		Course Code: 16EARP205
L-T-P: 0-0-1	Credits: 1	Contact Hours: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 24 hrs	Examination Duration: 3 hrs	
Experiment 1- Material Removal Operation		
Experiment 2- Metrology		
Experiment 3- Additive Manufacturing		
Experiment 4- Measurement for linear and angular dimensions		
Experiment 5- Fabrication of XY positioning table		

BACK

Program: Automation & Robotics		Semester: **IV**
Course Title: Microcontrollers Programming & Interfacing Lab		**Course Code:22EARP208**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 24 hrs	**Examination Duration: 3 hrs**	

Exp. No.	List of Experiments
1	Write a program to demonstrate the blinking of LED for ATMEGA 328 on a bread board implementation – barebone MCU development.
2	Write a program to demonstrate the interfacing of sensors with MSP430 microcontroller development board with Energia/ Code composer studio.
3	Write a program to read the values from the temperature sensor (LM35) and display the temperature in degree Celsius on LCD display using MSP430 development board.
4	Write a program to interface and display state of GPIO pins on a remote dashboard with an Expressif-ESP microcontroller board – IoT dashboard.
5	Write a program to measure the distance of an object using ultrasonic Sensors and display the distance in terms of centimeters and inches with STM32 microcontroller. Make the connections as per the schematic and develop the flowchart and the code to perform the required operation.
6	Write a program to control the speed and direction of DC, stepper and servo motors with ESP32 microcontroller and micro python
7	Design and develop an interconnected connection of controllers to communicate and transfer data between them. Use Bluetooth module and controller.
8	Design and develop an IOT (Internet of Things) system to collect data from multiple sensors – Temperature, Humidity and store the data in the cloud. Use Wi-Fi-module and controller.
9	Write a program to program interrupt functions on STM32 microcontroller.
10	Develop a simple data logger for recording data through sensors and store on external media. Also, develop a logic of detecting anomalies if the incoming data surpasses predefined upper and lower trigger points
11	Develop an IoT system using ESP/STM32 microcontroller for developing a weather station to display and record parameters like temperature, humidity, pressure and sunlight intensity.

BACK

Program: Automation & Robotics Engineering		Semester: V
Course Title: Numerical Methods and Statistics		Course Code: 24EMAB301
L-T-P: 3-0-0	Credits: 3	Contact Hours: 5hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Numerical Methods

Introduction to numerical methods. Roots of equations using Bisection Method, Newton-Raphson Method, Finite differences, Forward, Backward Operators. Newton Gregory forward and backward interpolation formulae. Newton's divided difference formula for unequal intervals. Numerical solution of first order ODE, Euler's and Modified Euler's method, Runge-Kutta 4^{th} order method.

Python: Interpolation problems related to Mechanical engineering/Civil/AR

Chapter 2: Matrices and System of Linear Equations

Introduction to the system of linear equations, Rank of a matrix by elementary row transformations. Consistency of system of linear equation solution of system by (i) Direct methods-Gauss elimination, Gauss Jordon method (ii) Iterative methods- Gauss-Seidel method. Eigenvalues and Eigenvectors of a matrix. Largest Eigen value and the corresponding Eigenvector by power method.

Python: Matrices, system of linear equations by Gauss elimination, Gauss Jordon and eigenvalue problems

Unit II

Chapter 3: Curve Fitting and Regression

Introduction to method of least squares, fitting of curves $\boldsymbol{y = a + bx}$, $\boldsymbol{y = ab^x}$, $\boldsymbol{y = a + bx + cx^2}$, correlation and regression.

Python: Fitting of curves, correlation and regression

Chapter 4: Probability

Definition of probability, addition rule, conditional probability, multiplication rule, Baye's rule. (no proof) Discrete and continuous random variables- PDF-CDF- Binomial, Poisson and Normal distributions (Problems only).

Python: Probability distributions

Unit III –

Chapter No. 5. Sampling Distribution-I

Sampling, Sampling distribution, Standard error, Null and alternate hypothesis, Type-I and Type- II errors, Level of significance. Confidence limits for means (large sample).

Chapter No. 6. Sampling Distribution-II

Testing of hypothesis for means. Large and small samples and student's t- distribution and Confidence limits for means (small sample).

Python: Sampling distributions

Text Books:

1. Bali and Iyengar, A text book of Engineering Mathematics, 6ed, Laxmi Publications(p) Ltd, New Delhi,2003.
2. Chapra S C and Canale R P, Numerical methods for Engineers, 5ed, TATA McGraw-Hill, 2007.
3. Gupta and Kapoor V K, Fundamentals of Mathematical Statistics, 9, Sultan and Chand, 2002

Reference Books:

1. Sastry S S, Introductory method for numerical analysis, 3ed, PHI, 2003.
2. J. Susan Milton, Jesse C. Arnold, Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, 4th Ed, TATA McGraw-Hill Edition 2007

BACK

Program: Automation & Robotics Engineering		Semester: V
Course Title: Machine Learning		Course Code: 23EARC301
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: The Machine Learning Landscape

Introduction to machine learning and its applications, Types of machine learning: supervised, unsupervised, reinforcement learning.The main challenges of machine learning: data quality, overfitting, underfitting, bias, etc.The machine learning workflow: data preparation, model training, model evaluation, deployment.

The Python ecosystem for machine learning: NumPy, Pandas, Matplotlib, Scikit-Learn, Keras, TensorFlow. Setting up your machine learning environment: Anaconda, Jupyter Notebook, virtual environments.

Chapter 2: End-to-End Machine Learning

Understanding and analyzing the problem, Gathering and exploring the data, Preparing the data for machine learning: data cleaning, feature engineering, feature scaling, handling missing values. Selecting a model and training it, Fine-tuning the model: hyperparameter tuning, cross-validation, Evaluating the model and making predictions, Documenting the project and presenting the results.

Chapter 3: Classification

The classification task and its applications, Binary classification and multiclass classification, Evaluating classification models: accuracy, precision, recall, F1 score, confusion matrix, Common algorithms for classification: Logistic Regression, k-Nearest Neighbors, Decision Trees, Random Forests, Support Vector Machines. Using Scikit-Learn for classification.

Unit II-

Chapter 4: Training Models

The linear regression model and its assumptions, Training linear regression models with Scikit-Learn, Gradient descent and its variants, Polynomial regression and other nonlinear models, Regularization techniques (L1, L2, Elastic Net), Logistic regression and softmax regression, Using Keras and TensorFlow for deep learning.

Chapter 5: Support Vector Machines

Introducing SVMs and their applications, Linear SVM classification and regression, Nonlinear SVM classification and regression, SVM optimization and the dual problem, Kernel tricks for SVMs.

Chapter 6: Decision Trees and Random Forests

The decision tree model and its advantages and disadvantages, Training decision trees with Scikit-Learn, Regularization techniques for decision trees (max_depth, min_samples_split, etc.), The random forest model and its advantages over decision trees, Training random forests with Scikit-Learn.

Unit III

Chapter 7: Ensemble Learning and Gradient Boosting

Introducing ensemble learning and its advantages, Combining weak learners into strong learners (bagging, boosting, stacking), The AdaBoost algorithm for boosting
Gradient boosting and its variants (XGBoost, LightGBM), Using ensemble methods with Scikit-

Chapter 8: Neural Networks and Deep Learning

The basics of neural networks and their architecture, Activation functions and loss functions, Training neural networks with backpropagation and stochastic gradient descent, Convolutional neural networks (CNNs) for image recognition, Recurrent neural networks (RNNs) for sequence prediction, Generative models (GANs, VAEs) for image and text generation, Using Keras and TensorFlow for deep learning.

Text Books:

1. Aurélien Géron " Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems" O'Reilly Media, October 2019, 2nd edition. ISBN-13: 978-1492032649
2. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective" The MIT Press, August 2012, ISBN-13: 978-0262018029

Reference Books:

1. Shai shalev-scwartz and Shai Ben David "Understanding Machine Learning" First Edition, Cambridge Press, USA, 2014.
2. Tom Mitchell "Machine Learning" McGraw-Hill Science/Engineering/Math (March 1, 1997).

BACK

Program: Automation & Robotics Engineering		Semester: V
Course Title: Real-time Embedded Systems		Course Code: 18EARC303
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction to System Structures and Real-time Embedded System

System Structures types, Real-time systems & basics, Classification, Example case studies, namely, Process control system, Avionics system, Multimedia systems, Intensive Care Computing, Modern car, Digital Flight control system, Embedded system purpose, Quality attributes, Challenges and characteristics of Embedded Computing System Design, Embedded System Design Process, Core and Supporting components of the embedded system, Embedded firmware, discussion on real-time case studies and block diagram representation of systems, Embedded design cycle-case study- Engine Control Unit, GPS Moving Map, Automatic Chocolate Vending Machine (ACVM) using Finite State machine(FSM), Unified Modeling Language(UML), state charts etc.

Chapter 2: Target Architectures: ARM Cortex M3 processors & its Programming

Introduction to embedded computing with examples and arm processors, The architecture of ARM Cortex M3, Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming. Advanced Programming Features. Memory Protection. Debug Architecture. Digital Signal Processor (DSP), Field Programmable Generic Array (FPGA).Examples to demonstrate each of its architectural and programmable features. A case study on the Antilock Brake System(ABS) and stability control system

Chapter 3: Real-Time Kernels and Operating Systems

Introduction to Real-Time Kernels, Tasks, process and threads, Introduction to RTOS, key characteristics of RTOS, its kernel, components in RTOS kernel, objects, scheduler, services, context switch, Task scheduling, Task communication and synchronization, Multiprocessing and multitasking, Multi-Threading, Hyper-threading, State diagrams, timing diagrams, examples for each, Scheduling types: Preemptive priority-based scheduling, Round-robin and preemptive scheduling. First come first served scheduling, shortest job first scheduling, Device drivers and selection of an RTOS. Examples for each of the scheduling technique, objects, context switching, synchronization, and device drivers, Case study on Mars Pathfinder mission

Unit II

Chapter 4: 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., Demonstration of each of the objects of Inter-process communication, namely, semaphore, Message Queue,

MUTEX, Mailbox, etc. Case-study on Magnetic Resonance Imaging (MRI)

Chapter 5: Tasks and Task Management

RTOS - task creation and Management, task scheduling, kernel services, inter-task-communication, Micro C/OS-II- task creation and Management, task scheduling, kernel services, inter-task-communication, Demo on Task creation and management functions. Case studies on Industrial Robot, Weapons Defence System, Adaptive Cruise control

Chapter 6: Handling Deadlocks

Sharing Resources, Deadlock Model- Necessary Conditions, A Graph-Theoretic Tool—The Resource Allocation Graph, Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Demonstration on Handling of deadlocks, identification through a case study, The Dynamic Dining Philosopher problem

Unit III

Chapter 7: Performance Analysis and Optimization

Performance or Efficiency Measures, Complexity Analysis—A High-Level Measure, The Methodology, Analyzing Code, algorithms, Response Time, Time Loading, Memory Loading, Evaluating Performance, Performance Optimization, optimizing for Power Consumption. Demonstration of concepts of Performance Analysis and Optimization through a case-study.

Chapter 8: Wired and Wireless Protocols used in Real-Time Embedded System

Bus communication protocol (USB, I2C, SPI), Wireless and mobile system protocol (Bluetooth, 802.11 and its variants, ZigBee), Examples of block diagrams to explain the working of each protocol for a specified application.

Text Books:

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

Reference Books:

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

BACK

Program: Automation & Robotics Engineering		Semester: V
Course Title: Mechatronics System Design		Course Code: 24EARC302
L-T-P: 0-0-3	Credits: 3	Contact Hours: 6 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 50hrs	Examination Duration: 3 hrs	

Chapter 1: Introduction to Mechatronics

Introduction to Mechatronics, Evolution of Mechatronics systems, Key elements of Mechatronics, Role of Mechatronics in Industrial Automation, Design methodology for Mechatronics systems-VDI2206.

Chapter 2: Requirements Collection

What is requirement, types of requirements, Steps and techniques of requirement gathering, importance requirement gathering, Mind map.

Chapter 3: Writing Specifications

What is specification, Tips for writing technical specification, what are product Specifications, Steps to write product specifications.

Chapter 4: System Design

What is system? System design, System Architecting Using Function Behavior-State Modelling, Method to Develop Product Architectures, Example of Vacuum Cleaning Robot, Autonomous Vacuum cleaning Robot (VC robot), Method to Develop Product Architectures, System Architecting Using Function Behavior State Modelling, Multidisciplinary Product Decomposition and Structure Analysis.

Chapter 5: Modelling and Simulation

What is Model? Types of Models, Theoretical Model, Practical Model, Mathematical Model, Example of Automobile system, Need for Modelling & Simulation, what is simulation? Real-time simulation, Hardware in loop simulation, Hardware in Loop Simulation of a Diesel Engine with Turbocharger.

Chapter 6 Components Design

Mechatronics module design, Model of mechatronics system at three levels, Process of basic mechatronic model development, Model based method for the design of actuation system.

Chapter 7: Prototype

What is Prototyping? Need of prototyping, Traditional Design vs Modern Design, Virtual prototyping, Stages in Virtual prototyping, The virtual prototyping process

Chapter 8: System Integration

Introduction, Mechatronics Design Approach, Model of Mechatronic Module Design Process,

Control Algorithm Selection, Control Stage Components, Microcontroller Based Control Subsystem (Embedded), Digital Signal Processor (DSP), Application Specific Integrated Circuits (ASICS), Computer Based Control Subsystem, Digital Communications,

Chapter 9: Testing

Mechatronics system testing, what is testing? What exactly is user testing and why is it so important? Why conduct user testing? User testing methods, testing guidelines, what is NPS? What is considered to be a good NPS? Test plan, User-experience feedback, and iteration process, Identify limitations and scope for further improvement.

Text Books:

1. Mechatronics system design by Devdas Shetty, Richard A. Kolk, Second edition.
2. Practical Model-Based Systems Engineering by Jose L. Fernandez, Carlos Hernandez (z-lib.org) (1).

Reference Books:

1. Mechatronics system fundamentals by Rolf Isermann**.**

BACK

Program: Automation & Robotics Engineering		Semester: V
Course Title: Measurement Systems		Course Code: 18EARC305
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40hrs	Examination Duration: 3 hrs	

Unit I

Chapter 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.

Chapter 2: Sensors and Signal conditioning

Sensor characterization, Relations between physical quantities, Sensor Classification, Specifications, Error reduction techniques, Loading errors, Signal conditioning processes, The operational amplifier, Filtering, Wheatstone bridge, Pulse modulation.

Chapter 3: Motion Measurement

Fundamental Standards, Relative Displacement: Translation and Rotational, Relative Velocity: Translation and Rotational, Relative-Acceleration Measurements, Displacement Pickups, Velocity Pickups, Acceleration Pickups, Calibration and Vibration Pickups, Jerk Pickups

Unit II

Chapter 4: Force, Torque, and Shaft Power Measurement

Standards and Calibration, Basic Methods of Force Measurement, Characteristics of Elastic Force Transducers, Torque measurement on Rotating shaft, Shaft Power Measurement (Dynamometers), Vibrating Wire Force Transducers.

Chapter 5: Pressure & Sound Measurement

Standards and Calibration, Basic Methods of Pressure Measurement, Deadweight Gages and Manometers, Elastic Transducers, Vibrating-Cylinder and Other Resonant Transducers, Dynamic Testing of Pressure-Measuring Systems, High-Pressure Measurement, Low-Pressure Measurement, Sound Measurement.

Chapter 6: Flow and Temperature Measurement

Local Flow Velocity, Magnitude and Direction, Gross Volume Flow Rate, Standards and Calibration of Temperature Measurement, Thermal-Expansion methods, Thermoelectric Sensors, Electrical-Resistance Sensors, Junction Semiconductor Sensors, Digital Thermometers, Radiation Methods.

Unit III

Chapter No.7. Data Acquisition Systems

Data conversion devices, Signal sampling and aliasing, Sampling theorem, Quantization,

Encoding, Digital to analog conversion methods, Analog to digital conversion methods, Sample & Hold circuit, Flash ADC, Successive approximation ADC, Dual slope ADC, Sigma Delta ADC, Multiplexers.

Chapter 8: Transmission and Recording of Data

Cable Transmission of Analog Voltage and Current Signals, Cable Transmission of Digital Data, Fiber-Optic Data Transmission, Analog Voltmeters and Potentiometers, Electrical Instruments, Digital Voltmeters and Multimeters, Signal Generation, Electromechanical XT and XY Recorders, Fiber Optic Sensors.

Text Books:

1. Ernest O. Doebelin and Dhanesh N. Manik, “Measurement Systems”, Sixth Edition, McGraw Hill Education Pvt Ltd, 2011.
2. W. Bolton, “Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering”, Fourth Edition, PEARSON, 2010.

References:

1. Sabri Cetinkunt “Mechatronics with Experiments”, WILEY, Second Edition, 2015.
2. J. P. Holman, “Experimental Methods for Engineers”, Eighth Edition, McGraw Hill Education Pvt Ltd, 2012

BACK

Program: Automation & Robotics Engineering		Semester: V
Course Title: Programming Industrial Automation Systems Practice		Course Code: 24EARC301
L-T-P: 2-0-2	Credits: 4	Contact Hours: 72
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 24	Examination Duration: 2 hrs	

Unit I

Chapter 1: Introduction to Programmable Logic Controllers (PLCs)
Automation Pyramid, Internal Architecture of PLCs, Input/Output Devices, PLC Program, Memory Organization, I/O Processing, Signal Conditioning, Scan Time/Cycle

Chapter 2: Industrial Networks and Field Devices
Open System Interconnection (OSI) Standards, Network Protocol Concepts, Network Topologies, Media Access Control Mechanisms, RS-232, Foundation FIELDBUS, PROFIBUS, Ethernet, PLC Programming Standards

Chapter 3: PLC Programming Languages - I
IEC 61131-3: Building Blocks, Goals, benefits, Programming Languages of IEC 61131-3, Data Types, Variables, Program Organization Unit (POU), Ladder Diagram, Basic of PLC Programming – AND Logic, OR Logic, Counters, Sequencers, Timers, Oscillators, Flip Flops, One Shot, Arithmetic Instructions, Data handling Instructions, Data Transfer Instructions

Unit II

Chapter 4: PLC Programming Languages - II
Functional Block (FB), Structured Text (ST), Instruction Lists (IL), Sequential Function Charts (SFC), PLC Sequencer, Shift registers, Arithmetic Instructions, Data handling Instructions like FIFO, FAL, ONS, Data Transfer Instructions PLC MOVE, Network Communication Instructions, Analog PLC operation, PID control of continuous processes

Chapter 5: SCADA, HMI, and DCS
SCADA Introduction, SCADA Systems, SCADA Functions, Human Machine Interface (HMI), Distributed Control Systems (DCS), Elements of DCS, Programmable Automation Controllers (PACs)

Unit III

Chapter 6: OPC (Open Platform Communications)
OPC DA, OPC UA, OPC Features, OPC Server, OPC Client, Tags, Mapping Tags onto PLC Memory, OPC Aggregation, OPC Tunneling, OPC Bridging, Inter-Process Communication

Chapter 7: PLC Selection Guidelines and 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, Precautions, Safety Standards like NEMA & NEC, Electrical wiring diagrams PLC Start-Up and Checking Procedures, PLC System Maintenance & Troubleshooting**.**
Text Books: 1. W. Bolton, Programmable Logic Controllers, Fourth Edition, ELSEVIER, 2009. 2. John W. Webb & Ronald A Reis, Programmable Logic Controllers: Principles and Applications, Fifth Edition, PHI, 2012.
Reference Books: 1. Frank D. Petruzella, Programmable Logic Controllers, McGraw- Hi, 1989

BACK

Program: Automation & Robotics		Semester: V
Course Title: Machine Learning & ROS Lab		Course Code: 18EARP301
L-T-P: 0-0-1	Credits: 1	Contact Hours: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 24 hrs	Examination Duration: 3 hrs	

Exp. No.	List of Experiments
1	Set up ROS on the system and create a ROS package. Write a minimal ROS publisher and subscriber. Compile and run the nodes, examining the output.
2	Define custom messages and services in ROS. Implement ROS service nodes and interact with them manually. Create a custom action server and client for more complex tasks.
3	Demonstrate obstacle detection, avoidance, and navigation on a simulation environment using python programming in your controller.
4	Explore a machine learning dataset and handle missing values. Perform data cleaning, feature engineering, and feature scaling.
5	Implement binary and multiclass classification models. Evaluate models using metrics like accuracy, precision, and recall.
6	Train a linear regression model using Scikit-Learn. Explore different variants of gradient descent.
7	Implement polynomial regression and other nonlinear models. Apply L1, L2, and Elastic Net regularization techniques.
8	Implement Linear SVM for classification and regression tasks. Explore Nonlinear SVM using kernel tricks.
9	Train decision trees using Scikit-Learn and examine their advantages and disadvantages. Implement Random Forests and compare their performance.
10	Implement ensemble learning techniques like bagging and stacking. Apply the AdaBoost algorithm and explore its impact on model performance.
11	Implement neural networks for image recognition using CNNs. OR Explore RNNs for sequence prediction tasks. Implement GANs OR VAEs for image or text generation.

BACK

Program: Automation & Robotics		Semester: **V**
Course Title: Industrial Robotics Lab		**Course Code: 18EARP303**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 28 hrs	**Examination Duration: 3 hrs**	

Unit I

Chapter 1: Matlab Introduction

Millions of engineers and scientists worldwide use MATLAB to analyze and design the systems and products transforming our world. The matrix-based MATLAB language is the world's most natural way to express computational mathematics. Built-in graphics make it easy to visualize and gain insights from data. The desktop environment invites experimentation, exploration, and discovery. These MATLAB tools and capabilities are all rigorously tested and designed to work together.

MATLAB helps you take your ideas beyond the desktop. You can run your analyses on larger data sets, and scale up to clusters and clouds. MATLAB code can be integrated with other languages, enabling you to deploy algorithms and applications within web, enterprise, and production systems.

Topics:

Basic commands

Vectors and Matrices

Importing Data

Plotting Data

Technically speaking, MATLAB is not a programming language but it is a tool with which you can find engineering solutions based on mathematics. Robotic developers need to learn MATLAB if they want to analyze data, produce advanced graphs or implement control systems. MATLAB, and its open source relatives, such as Octave, is very popular with some robotic engineers for analyzing data and developing control systems.

Programming for a robot requires designing the controller that governs robot behavior. Modeling and simulation became vital to understand how the controller interacts with the robot's environment perception, mobility, and interaction.

Chapter 2: Robotics Toolbox

The Toolbox has always provided many functions that are useful for the study and simulation of classical arm-type robotics, for example such things as kinematics, dynamics, and trajectory

. **Chapter 3: RoboAnalyzer**

Explaining the concepts in a course on Robotics typically requires a 3D model of a serial-robot/manipulator, either in the form of a physical robot or a virtual robot in software environment, for a better understanding. With the experience of handling Robotics courses and the feedback received so far, we have come up with a list of Virtual Experiments using RoboAnalyzer.

List of Virtual Experiments using RoboAnalyzer

Sl No.	Practical Assignments using RoboAnalyzer	Topics Covered
1	Introduction to RoboAnalyzer	Usage of RoboAnalyzer
2	Virtual Models of Industrial Robots	Industrial Robots
3	Understanding coordinate frames and transformations	DH Parameters, Robot Geometry
4	Forward kinematics of robots	Robot Kinematic Analysis
5	Inverse kinematics of robots	Robot Kinematic Analysis
6	Case Study: Kinematics of MTAB Mini Robot	Robot Kinematic Analysis
7	Case Study: Workspace Analysis of a 6-axis robot	Workspace Analysis
8	Inverse and Forward dynamics of robots	Robot Dynamics
9	Creating robot joint trajectories	Trajectory Planning

Chapter 4: Simulation/Offline Programming (Robotstudio)

Topics to be covered:

1. Create mechanism
2. AutoPath
3. Set Task Frame
4. Collision control
5. Reachability
6. Create MultiMove System from Layout

Chapter 5: Online Programming

To perform a particular action, robots are programmed either by guiding or by off-line programming. Most of the industrial robots are programmed by guiding a robot from point to point through the phases of an operation, with each point stored in the robotic control system. Robots receive instructions through computer commands and this is referred to as manipulator level off-line programming. Usage of off-line programming involves higher-level languages, in which robotic actions are defined by tasks or objectives.

Robotic programmers must have knowledge on different types of programming languages as switching from computers to robots is not the smooth transition that many developers/programmers may think.

Chapter 6: Simulation/Offline Programming (Robotstudio)

Topics to be covered:

1. Create mechanism
2. AutoPath
3. Set Task Frame
4. Collision control
5. Reachability
6. Create MultiMove System from Layout

Online Programming

To perform a particular action, robots are programmed either by guiding or by off-line programming. Most of the industrial robots are programmed by guiding a robot from point to point through the phases of an operation, with each point stored in the robotic control system. Robots receive instructions through computer commands and this is referred to as manipulator level off-line programming. Usage of off-line programming involves higher-level languages, in which robotic actions are defined by tasks or objectives.
Robotic programmers must have knowledge on different types of programming languages as switching from computers to robots is not the smooth transition that many developers/programmers may think.

Chapter 7: Introduction to ABB Robotstudio

Ofline programming is the best way to maximize return on investment for robot systems. ABB's simulation and ofline programming software, RobotStudio, allows robot programming to be done on a PC in the office without shutting down production.
RobotStudio provides the tools to increase the profitability of your robot system by letting you perform tasks such as training, programming, and optimization without disturbing production. This provides numerous benefits including:
Risk reduction
Quicker start-up
Shorter change-over
Increased productivity
RobotStudio is built on the ABB VirtualController, an exact copy of the real software that runs your robots in production. This allows very realistic simulations to be performed, using real robot programs and configuration files identical to those used on the shop floor.

Unit III

Chapter 8: Structured Enquiry

Project
Students should form a team of 4 in numbers and select a problem or need statement in industrial robotics area.
The project should consists of following requirements:
Minimum 3 to 6 DOF robot arm
DH Parameters
Students are free to choose the software to complete the project

BACK

Program: Automation & Robotics		Semester: **V**
Course Title: Mini Project - (Engineering Design Project)		**Course Code: 18EARW301**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours: 6 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30 hrs	**Examination Duration: 3 hrs**	

Theme: Product development through Engineering Design and Rapid Prototyping

Course Objective: To apply engineering design process to develop a simple product and build it using rapid prototyping.

Task Details:

The project should include usage of engineering design principles, agile methodology and rapid prototyping. The product should be used to automate a process or perform a set of useful tasks.

Course Outcomes - CO

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

1. Carry out need analysis and identify suitable problems.
2. Apply the principles of engineering design to scope, plan and implement the project, continuously evaluate progress, navigate uncertainty and adversity, and iterate as needed.
3. Think critically while analyzing, evaluating, synthesizing, and applying diverse information and experiences to support decision-making during the design process.
4. Develop and apply creativity to generate novel ideas taking into account real constraints that lead to innovative outcomes.
5. Develop schematics and select appropriate components.
6. Prototype the product using rapid prototyping and test it.
7. Collaborate successfully with other team members to achieve the desired outcome.
8. Consider the individual, social and environmental impacts of their decisions to produce positive transformations while minimizing unintended consequences.
9. Communicate effectively through oral, written, and visual media and listen actively to

Experiment wise plan

List of activities planned to meet the requirements of the syllabus

Week No	Activities	Deliverables
1&2	Need analysis, Identification of problem	Problem statement, Project plan,
3&4	Product development	Component designs & Integration,
5,6,7&8	Rapid prototyping, Testing and validation	Prototype (hardware and software)
9&10	Reporting	Test reports and Conclusion

BACK

Program: Automation & Robotics Engineering		Semester: VI
Course Title: Hydraulics & Pneumatics		Course Code: 18EARC308
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction to Hydraulic Power and Hydraulic Pumps

Pascal's law, Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, Variable displacement pumps, pump performance, pump selection. Problems on determining the pump flow rate, pump efficiency and pump power.

Chapter 2: Hydraulic Actuators: Cylinders and Motors

Linear Hydraulic Actuators (cylinders), Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic Motor Performance. Problems on determining motor speed, torque, power, motor efficiency

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.

Unit II

Chapter 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.

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.

Chapter No. 6. Pneumatic Circuit Design and Hydraulic Control Systems

Pneumatic Circuit Design: Direct and indirect control of single acting cylinder, control of single acting cylinder using “or”, “and”, “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, Proportional valves: Force control, force position control, spool position control, proportional pressure control, proportional flow control, electrical control of proportional valve, Applications of proportional control valves.

Unit III

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.

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.

Text Books:

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

Reference Books:

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

BACK

Program: Automation & Robotics Engineering		Semester: VI
Course Title: AI for Autonomous Robots		Course Code: 17EARE301
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction to Artificial Intelligence and Autonomous Systems Foundation of artificial intelligence, robotics and the AI approach, Semi-autonomous control, Seven areas of AI, The Concept of Rationality The Nature of Environments, The Structure of Agents, Problem-Solving Agents, Searching for Solutions, Uninformed Search Strategies, Informed Search Strategies, Knowledge representation in AI, knowledge based agents, propositional logic, predicate calculus, inference rules

Chapter 2: Robotic Software Architectures
Subsumption architecture, Three-layer architecture, Pipeline architecture, Hierarchical Paradigm- Attributes of the Hierarchical Paradigm, Reactive Paradigm- Attributes of Reactive Paradigm, Hybrid Deliberative/Reactive Paradigm-Attributes of Hybrid Paradigm, Architectural Aspects, Managerial Architectures-Autonomous Robot Architecture (AuRA), Sensor Fusion Effects (SFX), State-Hierarchy Architectures, Model-Oriented Architectures, Interleaving Deliberation and Reactive Control.

Chapter 3: Biological Foundations of the Reactive Paradigm
Agency and computational theory, Animal Behaviors, Reflexive behaviors, Coordination and Control of Behaviors, Innate releasing mechanisms, Concurrent behaviors, Perception in Behaviors, Action-perception cycle, Two functions of perception Gibson: Ecological approach, Neisser: Two perceptual systems, Schema Theory, Behaviors and schema theory, Principles and Issues in Transferring Insights to Robots

Unit II

Chapter 4: Capturing Intelligence - Designing a Reactive Implementation with Common Sensing Techniques for Robotics Perception
Behaviors as Objects in OOP, Steps in Designing a Reactive Behavioral System, Case Study: Unmanned Ground Robotics Competition, Assemblages of Behaviors, Logical sensors, Behavioral Sensor Fusion, Designing a Sensor Suite, Proprioceptive Sensors, Proximity Sensors, Computer Vision, Range from Vision, Case Study: Hors d'Oeuvres, Anyone?

Chapter 5: Multi-Agents and Navigation in Robotics
Heterogeneity, Control, Cooperation, Emergent Social Behavior, Topological Path Planning, Relational Methods, Associative Methods, Case Study of Topological Navigation with a Hybrid Architecture

Unit III

Chapter 6: Localization and Map Making
Sonar Sensor Model, Bayesian, Conditional probabilities, Conditional probabilities, Updating

with Bayes' rule, Dempster-Shafer Theory, Shafer belief functions Belief function for sonar Dempster's rule of combination Weight of conflict metric, HIMM sonar model and Comparison of Methods, Example computations, Performance Errors due to observations from stationary robot, Tuning, Localization, Continuous localization and mapping, Feature-based localization Exploration, Frontier-based exploration, Generalized Voronoi graph methods .

Chapter 7: Deep Learning and Natural Language Processing

Deep Learning Improvement of the Deep Neural Network Vanishing Gradient Over fitting Computational Load. Language models, text classification, information retrieval

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence,A Modern Approach" Third Edition, Pearson Education, Inc.2010
2. R. Murphy "Introduction to AI Robotics", Second edition, The MIT Press Cambridge, Massachusetts,2000

Reference Books:

1. Elaine Rich, Kevin Knight: "Artificial Intelligence", 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709
2. Sebastian Thrun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics" MIT Press; Intelligent Robotics and Autonomous Agents series edition,2005

BACK

Program: Automation & Robotics Engineering		Semester: VI
Course Title: Computer Vision & Digital Image Processing		Course Code: 15EARE302
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Fundamentals of Computer Vision and Digital Image Processing

Introduction to computer vision system, Geometric Camera Models- Pinhole Perspective, Cameras with Lenses, the Human Eye, Intrinsic and Extrinsic Parameters, Geometric Camera Calibration. Digital image processing system, application of computer vision and digital image processing. Design of machine vision system.

Chapter 2: Light and Shading, Color

Modeling Pixel Brightness, Reflection at Surfaces, Sources and Their Effects, the Lambertian+SpecularModel, Inference from Shading, Radiometric Calibration and High Dynamic Range Images, the Shape of specularities, Inferring Lightness and Illumination, Color-Human Color Perception, The Physics of color, representing Color, Inference from Color Finding specularities Using Color Shadow removal, using Color Constancy: Surface Color from Image Color.

Chapter 3: Image Formation and Processing

Image Acquisition – Sampling and Quantization- Pixel Relationships, image enhancement Spatial Domain Gray level Transformations Histogram Processing Spatial Filtering – Smoothing and Sharpening, Introduction to the Fourier Transform and the Frequency Domain, DFT, FFT

Unit II

Chapter 4: Image Segmentation and Feature Analysi

Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation, A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only–Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering.

Chapter 5: Color Image Processing and Image Compression

Color Fundamentals, Color Models, Pseudo color Image Processing, Basics of Full-Color Image Processing Color Transformations, Smoothing and Sharpening, Color Segmentation, Noise in Color Images Color Image Compression, Image Compression-Fundamentals, Image Compression Models, Elements of Information Theory, Error-Free Compression, Lossy Compression.

Unit III

Chapter 6: Morphological Processing

Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms.

Chapter 7: Recognition and 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.

Text Books:

1. David A. Forsyth and Jean Ponce- Computer vision A modern approach, 2nd Edition, Pearson publication, 2003.
2. Rafael C. Gonzalez and Richard E. Woods- Digital Image Processing-2nd Edition, Prentice Hall publication,2002

Reference Books:

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

BACK

Program: Automation & Robotics		Semester: **VI**
Course Title: Robot Dynamics & Control		**Course Code: 17EARE302**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40 hrs	**Examination Duration: 3 hrs**	

Unit I

Chapter 1: Dynamics of Open Chains

Introduction to robot dynamics, Lagrangian Formulation, Basic Concepts and examples, General Formulation, Mass Matrix, Gravity terms, Inertia Matrix, Coriolis Matrix, Friction, Effect of Payload.

Chapter 2: Actuation, Gearing, & Friction

Introduction, Characteristics of actuating systems robot, Comparison of actuating systems dynamics, Motors and Gearing, Apparent Inertia, Independent joint control, Motor Inertias, Friction, Joint and Link Flexibility, Robot Dynamics in the URDF format.

Unit II

Chapter 3: Motion Control

Introduction to robot motion control, trends in robotic research, motion control, types of manipulator control, robust & adaptive control, motion and model-based control, kinematic and dynamic control schemes, Feedforward and feedback control.

Chapter 4: Trajectory Planning

Introduction to trajectory generation, Cubic polynomial schemes, Higher-order polynomial function, cycloidal function, parabolic blends, joint-space, and task-space schemes.

Unit III

Chapter 5: Motion Planning

Overview of Motion Planning, Types of Motion Planning Problems, Motion planning- arms vs. mobile robots, Motion Planning Schemes – Graph-based methods, Motion Planning Schemes – Analytical approaches**.**

Chapter 6: Manipulator-Mechanism Design

Introduction, Basing the design on task requirements, Kinematic configuration, Quantitative measures of workspace Attributes, Stiffness and deflections, Position sensing, Force sensing**.**

Text Books

1. Modern Robotics: Mechanics, Planning, and Control, K. M. Lynch and F. C. Park, Cambridge University Press, 2017
2. Introduction to Robotics: Mechanics and Control, John J. Craig, Pearson; 3rd edition (27 July 2004)
3. Robotics, Vision and Control Fundamental Algorithms in MATLAB, Peter Corke, Springer Berlin Heidelberg, Springer, Cham, 978-3-319-54413-7

Reference Books:

1. Robot Modeling and Control, M. W. Spong, S. Hutchinson, and M. Vidyasagar, Wiley, 2020**.**

BACK

Program: Automation & Robotics Engineering		Semester: VI
Course Title: Power Electronics, Motors & Drives		Course Code: 16EARE301
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction to PE and Electric Drive Systems

Power Electronics, Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switches. Basic components of an Electric drive system: Mechanical loads, electric motors, power sources, converters and controllers.

Chapter 2: Power Diodes, BJT, MOSFET and Rectifiers

Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Freewheeling Diodes with Switched RL Load. Power BJT, structure of BJT, MOSFET and IGBT, characteristics of BJT, MOSFET and IGBT, comparison of power devices. Introduction, Single-Phase Full-Wave Rectifiers, Single-Phase Full-Wave Rectifier with RL Load, Single-Phase Full-Wave Rectifier with a Highly Inductive Load.

Chapter 3: Thyristors and Commutation Theory

Introduction, Principle of Operation of SCR, Static Anode-Cathode Characteristics of SCR, two transistor model of SCR, Gate Characteristics of SCR, Firing circuits for SCRs, Turn-On Methods, Turn-Off Mechanism, Turn-Off. Natural and Forced Commutation – Class A and Class B types, Gate Trigger Circuit: Resistance Firing Circuit, Resistance capacitance firing circuit.

Unit II

Chapter 4: Static Switches and Power Supplies

Single phase ac static switches, three phase ac static switches, three phase reversing switches, Solid state relays, Design of static switches, DC power supplies, DC Switched Mode DC power supplies, bidirectional power supplies, Switched Mode AC power supplies.

Chapter 5: DC-DC Converters

Introduction, principle of step-down operation and its analysis with RL load, principle of step-up operation, Step-up converter with a resistive load, Performance parameters, Converter classification, Switching mode regulators: Buck regulator, Boost regulator, Buck-Boost Regulators.

Chapter 6: Power Electronics for Motor and Drive Applications

DC and AC motor control, Single phase SCR drive, Three phase SCR drive, Reversible SCR drive, Speed control of DC motor, chopper-controlled DC drives, Microprocessor-Controlled DC drives, AC motor characteristics, speed control methods of induction motor, commutator less DC motor and Electronic commutation.

Unit III

Chapter 7: Stepper Motor

Principle of Stepper motor, Classification of Stepper motor, Principle of variable reluctant stepper motor, Principle of Permanent magnet stepper motor, Principle of hybrid stepper motor, driver for stepper motor, Applications of Stepper motor

Chapter 8: Drives for Industrial Applications

Rolling mill drives, cement mill drives, electric traction drives, textile mill drives and machine tool drives.

Text Books:

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

Reference Books:

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

BACK

Program: Automation & Robotics		Semester: **VI**
Course Title: Operation Research with Evolutionary Algorithms		**Course Code: 24EARE301**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 40 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40hrs	**Examination Duration: 3 hrs**	

Unit I

Chapter 1:Introduction to Simplex Method

Introduction to Linear Programming, Basic Concepts of the Simplex Method, Formulating and Solving Linear Programming Problems, and Advantages of the Simplex Method. Scheduling, Role of scheduling, framework and notations.
Transportation Problems

Chapter 2: Transportation Problems

Introduction to Transportation Problems, Formulating Transportation Problems, Solution Methods (Northwest Corner, Least Cost, Vogel's Approximation), and Applications

Unit II

- **Chapter 3: Traveling Salesman Problem**

Introduction to TSP, Mathematical Formulation, Types of TSP (Symmetric and Asymmetric), Heuristic Solution Methods (Nearest Neighbor, 2-Opt), and Applications.

Chapter 4:Knapsack Problems

Introduction to Knapsack Problems, Mathematical Formulation, Dynamic Programming Solution, Solution Methods (Greedy Algorithms, Approximation Algorithms), Computational Complexity, and Case Studies.

Unit III

Chapter 5:- Evolutionary Algorithms

Introduction to Evolutionary Algorithms, Fundamental Principles (Population, Fitness Function, Selection, Crossover, Mutation), Types of Evolutionary Algorithms (Genetic Algorithms, Evolution Strategies, Genetic Programming), and Applications in Operations Research, Parameters and parameter tuning

Chapter 6:Constraint Handling in Evolutionary Algorithm

Introduction to Constraint Handling Two Main Types of Constraint Handling, Approaches to Handling Constraints, Penalty Functions, Repair Functions

Text Books

1. Operations Research: An Introduction by Hamdy A. Taha, Pearson, 10th Edition.
2. Introduction to Operations Research by Frederick S. Hillier, Gerald J. Lieberman, McGraw-Hill, 10th Edition.
3. Introduction to Evolutionary Computing by A. E. Eiben, J. E. Smith, Springer, 2nd Edition.
4. Evolutionary Computation: A Unified Approach by Kenneth A. De Jong, MIT Press, 1st Edition.

5. Scheduling: Theory, Algorithms, and Systems, Michael L. Pinedo, Springer, 5th Edition.

Reference Books:

1. NPTEL - Operations Research by Professor G. Srinivasan, IIT Bombay.
2. Swayam - Operations Research by Professor Manoj K. Singh, IIT Kharagpur.
3. Coursera - Operations Research Specialization by Professor Michael C. Ferris, University of Wisconsin-Madison.
4. Stanford University - Operations Research by Professor Yinyu Ye, Stanford University

BACK

Program: Automation & Robotics		Semester: **VI**
Course Title: Hydraulics and Pneumatics Lab		**Course Code: 16EARP302**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 24 hrs	**Examination Duration: 3 hrs**	

Expt. No.	Types of laboratory work	Name of the Experiment
1	Demonstration (20 Marks)	To study hydraulic pump, its characteristics and calculate the hydraulic power
2		Study of direct and indirect control of a double-acting cylinder with a pneumatically operated 5/2 directional control valve.
3		A. Study of speed control of Single Acting Cylinder - Slow Speed Extension and Rapid Retraction. B. Stop control, double-acting cylinder with 5/3 directional control valve, tensile load
4		To study position dependent control of a double acting cylinder using mechanical limit switches.
5	Exercise (30 Marks)	To study concepts of Meter-in and Meter-out circuits using Single-rod cylinder and 4/2 DCV.
6		To study pressure intensification of a single rod cylinder.
7		Study of Hydraulic Motor with 4/3 DCV.
8		To study the application of different center configuration of 4/3 DCV. (Tandem and closed center)
9		To study the application of Regenerative Circuit.
10		Experiments on AND, OR, Latch and Electric limit Switch
11	Structured Enquiry (20 Marks)	Several stations on a rotary machining station are driven by a hydraulic power pack. As individual stations are Switched on and off, they produce pressure fluctuations throughout the hydraulic circuit. Practice is obtained in using a flow control valve to control feed rate and pressure relief valve as a counter-holding valve to compensate for the tractive forces
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

13	Open Ended Enquiry (10 Marks)	A double-acting cylinder is used to press together glued components. Upon pressing a push-button, the clamping cylinder is to extend and trip the roller valve. Once the fully extended position of the cylinder has been reached and sufficient clamping force has been developed, the cylinder is to retract to the initial position. Develop a control circuit using a pressure sequence valve.

BACK

Program: Automation & Robotics		Semester: VI
Course Title: Mechatronics & Measurements Lab		Course Code: 18EARP304
L-T-P: 0-0-1	Credits: 1	Contact Hours: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 22 hrs	Examination Duration: 3 hrs	

Expt. No.	Category	List of Experiments
1	Demonstration	Demo of Quanser Mechatronics Sensor kit, DAQ card, DC Motor Control Trainer module, Inverted Pendulum Trainer module with NI ELVIS Platform.
2		Investigation of time-response and frequency-response. i. Time-Response Identification of Resistor Capacitor (RC) Circuit. ii. Frequency-Response Identification of Resistor Capacitor (RC) Circuit iii. Control of a Resistor Capacitor (RC) Circuit iv. Investigation of time response of LRC Circuit v. Investigation of loading in circuits in series.
3	Exercise	Sensor characterization using sensor modules, namely, Accelerometer, Ultrasonic sensor, Temperature sensor, Strain gauge
4		Sensor fusion of IMU and compass
5		Model Based Design Experiments: i. Modeling Systems using Simulink. (Hydroplane) ii. System Identification of Disk Head Assembly. iii. Estimating Simulink model parameters from measured data.
6	Structured Enquiry	System identification of DC motor
7		Control of an Inverted Pendulum on a Cart.
8	Open Ended	Control of a Linear Electric Actuator

BACK

Program: Automation & Robotics		Semester: VI
Course Title: Real-Time Embedded Systems Lab		Course Code: 16EARP307
L-T-P: 0-0-1	Credits: 1	Contact Hours: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 28 hrs	Examination Duration: 3 hrs	

Expt. No.	List of Experiments
1	TIVA C Series Microcontroller Board Introduction and Advanced Features Learning Objectives: The students should be able to work with Energia IDE and TM4c1294NCPDT, TIVA C series microcontroller • Gain familiarity with TIVA C series microcontroller board architecture and features. • Understand the development environment setup for TIVA C series microcontroller boards. • Learn advanced functionalities and capabilities offered by TIVA C series microcontrollers.
2	MSP430 LED and Switch Interfacing with Energia & CCS IDE Learning Objectives: The students should be able to work with Code Composer Studio(CCS) and TIVA C series TM4C1294NCPDT microcontroller: • Develop proficiency in interfacing LEDs and switches with MSP430 microcontrollers using Energia and Code Composer Studio IDEs. • Understand GPIO configuration and control techniques. • Learn to write firmware for controlling LEDs based on switch input
3	STM32 LED and Switch Interfacing with Cube IDE Learning Objectives: • Develop expertise in interfacing LEDs and switches with STM32 microcontrollers using Cube IDE. • Explore advanced GPIO configuration options available in STM32 microcontrollers. • Master firmware development for controlling LEDs based on switch input.
4	MSP430 Analog Sensor Interfacing with Signal Conditioning Techniques Learning Objectives: • Learn analog sensor interfacing principles with MSP430 microcontrollers. • Understand signal conditioning techniques for accurate analog sensor data acquisition. • Develop skills in calibrating and processing analog sensor data for various applications.

5	MSP430Sensor Data Acquisition and Processing Techniques Learning Objectives: • Implement advanced techniques for sensor data acquisition and processing with MSP430 microcontrollers. • Explore multiple sensor integration and multiplexing methods. • Learn firmware development for real-time sensor data processing and analysis.
6	Advanced MSP430 Communication Protocols: Serial and I2C Learning Objectives: • Master serial communication protocols (UART) and I2C protocol implementation on MSP430 microcontrollers. • Develop skills in establishing communication with external devices using serial and I2C interfaces. • Learn firmware development for data transmission and reception via serial and I2C protocols.
7	STM32 Advanced Pulse Width Modulation (PWM) Implementation Learning Objectives: • Understand pulse width modulation (PWM) principles and applications. • Learn advanced PWM configuration and control techniques on STM32 microcontrollers. • Develop skills in using PWM for motor control, LED dimming, and other applications.
8	Real-Time Clock (RTC) Implementation with Advanced Features Learning Objectives: • Gain proficiency in real-time clock (RTC) implementation on MSP430 and STM32 microcontrollers. • Explore advanced RTC features and functionalities. • Learn firmware development for timekeeping, scheduling, and alarm functionalities using RTC.
9	Raspberry Pi Advanced OS Installation and GPIO Control with Python Programming Learning Objectives: • Master advanced techniques for Raspberry Pi OS installation and configuration. • Develop expertise in GPIO control using Python programming on Raspberry Pi. • Learn to interface external devices and sensors with Raspberry Pi GPIO pins for various applications.
10	Advanced IoT Application Development with Raspberry Pi Learning Objectives: • Gain comprehensive understanding of IoT application development principles. • Develop skills in designing and deploying advanced IoT applications using Raspberry Pi. • Learn to integrate sensors, actuators, and communication modules for real-world IoT solutions.

BACK

Program: Automation & Robotics		**Semester: VI**
Course Title: Minor Project		**Course Code: 17EARW302**
L-T-P: 0-0-6	**Credits: 6**	**Contact Hours: 12 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30 hrs	**Examination Duration: 3 hrs**	

Task Details:

The project should include mechatronics system design (hardware and software co-design), modeling and co-simulation using MATLAB tools, Machine components design, Logic development, selection of controller, interfacing devices like robots, CNC machine tools with sensors and actuators.

Course Learning Objectives-CLO

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

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

Experiment wise plan

List of activities planned to meet the requirements of the syllabus

Week No	Activities	Deliverables	CIE Marks out of 80
1&2	Engineering Design	Problem statement, Project plan	20
3&4	Mechatronics System Design	Component designs & Integration	20
5,6,7&8	Fabrication	Prototype	20

Experiment wise plan

List of activities planned to meet the requirements of the syllabus

Sl. No	Activity	SEE Marks out of 20

1	Project Report & Presentation	10
2	*Demo of Project*	10

BACK

Program: Automation & Robotics		**Semester: VI**
Course Title: Professional Aptitude & Logical Reasoning		**Course Code: 16EHSC301**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40 hrs	**Examination Duration: 3 hrs**	
Unit I **Arithmetical Reasoning and Analytical Thinking** Chapter 1. – Arithmetical Reasoning Chapter 2. – Analytical Thinking Chapter 3. – Syllogistic Logic		
Unit II **Verbal and Non–Verbal Logic** Chapter 1. – Verbal Logic Chapter 2. – Non-Verbal Logic		
Unit III **Lateral Thinking** Chapter 1. - Lateral Thinking		
Text Books: 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		
Reference Books: 1. Verbal and Non – Verbal Reasoning – Dr. Ravi Chopra, MacMillan India 2. Lateral Thinking – Dr. Edward De Bono, Penguin Books, New Delhi		

BACK

Program: Automation & Robotics Engineering		Semester: VII
Course Title: Industrial Data Networks		Course Code: 24EARC401
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3hrs	

Unit I

Chapter 1. Data Network Fundamentals and Industrial Ethernet

Modern Instrumentation and Control Systems, Open Systems Interconnection (OSI) Model, Concepts of Parallelization, Sequential, Framing, Bit Encoding, Media Access Control, Error Correction, Time Division, Bit Rate, and Baud Rate, EIA-232, EIA-485, Fiber Optics Overview, Circuit Switching and Packet Switching, Network Topologies, Ethernet, Ethernet Topology, 10 Mbps Ethernet, 1 Gigabit Ethernet, Internetwork Connections Devices (Repeaters, Bridges, Hubs, Switches, Routers and Gateways)

Chapter 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)

Chapter 3. MODBUS

MODBUS: Protocol Structure, Function Codes

Unit II

Chapter 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

Chapter 5. ETHERCAT, Ethernet POWERLINK and SERCOS III

ETHERCAT: Architecture Model, Protocol, Topology, Distributed Clocks, Device Profiles, EtherCAT Master, EtherCAT Slave
Ethernet POWERLINK: Slot Communication Network Management, Physical Layer, Data Link Layer, Transport and Application Layer of Ethernet POWERLINK, Ethernet POWERLINK Addressing, Frame Structures
SERCOS III: OSI Layers of SERCOS III, Communication Cycle, Protocol Structure, Topology, Communication Network Infrastructure

Chapter 6. HART and OPC

HART: HART Protocol, Physical Layer, Data Link Layer and Application Layer of HART
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)

Unit III

Chapter 7. CAN, and CAN FD

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

Text Books

1. Steve Mackay, Edwin Wright, Deon Reynders, John Park, "Practical Industrial Data Networks: Design, Installation and Troubleshooting," First edition, Newnes publication, Elsevier, 2004.
2. John Park, Steve Mackay, Edwin Wright, "Practical Data Communications for Instrumentation and Control," First edition, Newnes publication, Elsevier, 2003

Reference Books:

1. Modbus, http: //www.Modbus.org.
2. FOUNDATION Fieldbus, http: //www.fieldbus.org.
3. FOUNDATION Fieldbus, https: //www.fieldcommgroup.org/technologies/foundation-fieldbus/foundation-technology-overview.
4. ProfiBus, https: //www.profibus.com.
5. AS-Interface, http: //www.as-interface.net.
6. HART, https: //www.fieldcommgroup.org/technologies/hart/hart-technology.
7. EtherCAT, https: //www.ethercat.org.
8. Ethernet POWERLINK, https: //www.ethernet-powerlink.org.
9. SERCOS, https: //www.sercos.org.
10. OPC Foundation, https: //opcfoundation.org.
11. CAN, https: //www.can-cia.org/can-knowledge.
12. CAN FD, https: //www.can-cia.org/can-knowledge/can/can-fd.

BACK

Program: Automation & Robotics Engineering		Semester: VII
Course Title: Mobile Robotics & Perception		Course Code: 17EARE401
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3hrs	

Unit I

Chapter 1. Introduction to Mobile robots

Intelligence and embodiment, A roboticist's problem, challenges of mobile autonomous robots, Locomotion, static and dynamic stability, degrees of freedom. Coordinate systems and frames of reference, forward kinematics, inverse kinematics, inverse kinematics using feedback control

Chapter 2. Path Planning

Map representations, path planning algorithms, sampling based path planning, path smoothing, planning at different length scales. Uncertainty and error propagation in robotics, probabilistic robotics, basic concepts in probability.

Chapter 3. Recursive State Estimation

Robot environment interaction, Bayes filter, representation and computation. Gaussian filters, Kalman filter, extended kalman filter, information filter, histogram filter, particle filter

Unit II

Chapter 4. Robot Motion

Kinematic configuration, probabilistic kinematics, velocity motion model, odometry motion model.

Chapter 5. Robot Perception

Maps, Beam models of range finders, likelihood fields for range finders, correlation-based sensor models, feature-based sensor models.

Unit III

Chapter 6. Mobile Robot Localization: Markov and Gaussian

Mobile robot localization, Markov localization, EKF localization, Estimating correspondences, multi-hypothesis tracking, grid localization, Monte Carlo localization.

Chapter 7. Occupancy Grid Mapping

Occupancy grid mapping, Simultaneous localization and mapping, RGB-D SLAM.

Text Books:

1. Sebastian Thrun, Wolfram Burgard & Dieter Fox, " Probabilistic Robotics", The MIT Press

Reference Books:

1. Eugene Kagan, Nir Shvalb & Irad Ben-Gal, "Autonomous Mobile Robots and Multi-Robot Systems ", First Edition, John Wiley & Sons Ltd, 2020.
2. Nikolaus Correll, Introduction to Autonomous Robots, 1st edition

BACK

Program: Automation & Robotics Engineering		Semester: VII
Course Title: Design of Automatic Machinery		Course Code: 17EARE402
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3hrs	

Unit I

Chapter 1: Introduction and Steps to Automation

What is Automation, An Automation design process, examples of automation, problems and project assignments?

Justifying Automation

Traditional Project Cost Justification for a Purchase, Traditional Costing Estimating for Building and Selling Automation, Win–Win Purchasing Philosophy, Maximum Profit Cost Estimating for Building and Selling Automation, Justifying Flexible Automation over Hard Automation, Intellectual Property, Patents, Trade Marks, Copyrights, and Trade Secrets.

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.

Chapter 3: Workstations

Workstation Basics, Drive Mechanisms, Case Study Number 1: TBBL Workstation Design, Case Study Number 2: Automated Screwdriver Workstation Design, Machine Design and Safety.

Feeders

Feeders, Automatic Feeding and Orienting — Vibratory Feeders, Escapement Feeders, Vibratory Bowl Feeder, Centripetal Feeder, Flexible Feeders, Gravity Feed Tracks, Powered Feed Tracks, Escapements, Parts-Placing Mechanisms, Assembly Robots, Case Study Number 1: Dropping Cookies, Case Study Number 2: Feeding of TBBL Cases.

Unit II

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 Machi**ne.**

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.

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 Introduction to flexible manufacturing system, flexible manufacturing systems components, flexible manufacturing systems applications and benefits, flexible manufacturing system planning and implementation issues, quantitative

Unit III

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**.**

Chapter 8: Packaging Machines

Liquid Filling Machines, Cartoning and Boxes, Labeling, Cases, Palletizing, Forming Pouche, Blister Packs and Bags.

Text Books

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

Reference Books:

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

BACK

Program: Automation & Robotics Engineering		Semester: VII
Course Title: Industrial Internet of Things		Course Code: 25EARE401
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3hrs	

Unit I

Chapter 1: Introduction to IoT and IIoT

Various definitions of IoT and IIoT, concept of smart hyperconnected devices and their role in IIoT, IoT conceptual framework and architectural views, technology underlying IoT systems, RFIDs and wireless sensor networks, wearable watches, smart homes, and smart cities, communication modules and protocols. Evolution of IIoT from Industry 3.0 to 5.0, Human-centric IIoT, Sustainability in IIoT..

Chapter 2: Design Principles for Connected Devices

IoT architectural layers and their importance in design, IETF six-layered design for IoT applications and components, ITU-T reference model and its relevance to IoT design, ETSI M2M domains, architectural layers, wireless and wired communication protocols, and functionalities. Device Edge Computing Concepts, Power-aware Design Principles, Real-time constraints

Chapter 3: Design Principles for Web Connectivity

Fundamental principles of web connectivity design in IoT, JSON, TLV, and MIME data format standards, CoAP, CoAP-SMS, CoAP-MQ, MQTT, and XMPP protocols, SOAP, REST, HTTP RESTful, and WebSockets methods, web connectivity design principles and protocols to IoT scenarios. Security considerations in web connectivity (TLS, DTLS, JWT Tokens)

Unit II

Chapter 4: Internet Connectivity Principles

Significance of Internet connectivity for IoT applications, IPv4 and IPv6 addressing schemes, concept of 6LowPAN and its relevance, components of the TCP/IP suite, IP addressing in IoT devices and its practical implications. IoT-specific network stacks (Thread, Matter, OPC-UA over TSN)

Chapter 5: Data Acquisition, Organization, and Analytics in IoT

Data generation, acquisition, and validation in IoT applications, functions of data center and server management, methods for organizing data, spatial and time series databases, SQL and NoSQL methods and their application, principles of queries processing, transactions, and events, IoT/M2M analytics using databases and big data. Introduction to Edge Analytics, Stream Processing (Apache Kafka, AWS IoT Analytics).

Chapter 6: Cloud Computing for IoT Applications

Concept of cloud computing in IoT and its significance, cloud deployment models: SaaS, IaaS, PaaS, DaaS, concept of "Everything-as-a-Service", cloud service models and their applications, role of cloud platforms in device collection, data storage, and computing. Fog Computing,

Hybrid Cloud models, Open-source IIoT platforms (ThingsBoard, Node-RED).

Unit III

Chapter 7: Sensors, Actuators, and Embedded Platforms

Concept of sensors, their types, and their importance in IoT applications, working principles of various sensors and their usage, participatory sensing and its role in Industrial IoT, concept of Automobile IoT and its implementation through Vehicle-to-Infrastructure (V2I) technology, role of actuators, RFID, and wireless sensor networks, prototype embedded IoT devices. Sensor Interoperability (OPC-UA), IIoT Edge Device examples (Raspberry Pi CM4, NVIDIA Jetson)

Chapter 8: IoT Project Design and Case Studies

design levels involved in IoT prototype and product development, complexity levels in designing IoT systems, concept of Connected Platform-as-a-Service (PaaS) cloud, PaaS platforms such as AWS IoT and TCS Connected Universe Platform, applications of PaaS platforms in IoT and Industrial IoT scenarios. Case studies in Industry 4.0 (Digital Twins, Condition Monitoring, AGV Management).

Text Books

1. INTERNET OF THINGS, Architecture and Design Principles, Dr. Raj Kamal, McGraw Hill Education (India) Private Limited. 2017, ISBN-13: 978-93-5260-522-4

Reference Books:

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

BACK

Program: Automation & Robotics Engineering		**Semester: VII**
Course Title: Research Experience for Undergraduates		**Course Code: 17EARE490**
L-T-P: 0-0-6	**Credits: 6**	**Contact Hours: 12hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: ---	**Examination Duration: 3hrs**	

Course Outcomes (COs):

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

1. Identify the scope of the problem based on the literature survey bringing out the contemporary issues in the defined area.
2. Learn and use the tools required for the defined problem.
3. Define process/methodology/steps towards solving the defined problem.
4. Establish flowchart/test bench/block diagram etc towards solving the defined problem.
5. Conduct/simulate, analyze and interpret the data/input for the defined problem.
6. Communicate effectively in written and oral form of the research findings

BACK

Program: Automation & Robotics Engineering		Semester: VII
Course Title: Institutional Research Project		Course Code: 17EARE491
L-T-P: 0-0-6	Credits: 6	Contact Hours: 12hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 72	Examination Duration: 3hrs	

Course Outcomes (COs):

At the end of the course, the student should be able to:

1. Carry out literature survey and review for the identified statement of work and formulate a research project plan.
2. Identify and follow a systematic design process and design components and processes to build the required platform, generate and collect data and use research-based knowledge and methods to analyze and interpret the data to reach appropriate conclusions.
3. Use various software tools and techniques to create algorithms and analyze conceptual designs through modelling, analysis and simulation and to create detailed designs.
4. Apply engineering and management principles to scope, plan and implement the project, continuously evaluate progress, navigate uncertainty and adversity, and iterate as needed.
5. Function effectively as an individual and collaborate successfully with other members in the team to achieve the desired outcomes.
6. Prepare effective design documentation, project report, and technical paper and make

BACK

Program: Automation & Robotics Engineering		**Semester: VII**
Course Title: Senior Design Project		**Course Code: 25EARW401**
L-T-P: 0-0-6	**Credits: 6**	**Contact Hours: 12 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3hrs**	

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.

BACK

Program: Automation & Robotics Engineering		Semester: VII
Course Title: Constitution of India, Professional Ethics and Environmental Studies		Course Code: 15EHSA401
L-T-P: 0-0-0	Credits: 0	Contact Hours: ---
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: **Features of Indian Constitution**
Features of Indian Constitution, Preamble to the constitution of India, Fundamental rights under Part III – details of Exercise of rights, Limitations & Important cases. Berubari Union and Exchange of Enclaves, Kesavanand Bharati vs. UOI, Maneka Gandhi vs. UOI, Air India Ltd. vs. Nargees Meerza, T.M.A. Pai Foundation v. St. of Karnataka, M.C. Mehta vs. UOI etc.

Chapter 2: **Relevance of Directive principles of State Policy**
Relevance of Directive principles of State Policy under Part IV, Fundamental duties & their significance. Sarla Mudgal v. UOI

Chapter 3: **Union**
Union – President, Vice President, Union Council of Ministers, Prime Minister, Parliament & the Supreme Court of India.

Chapter 4: **State**
State – Governors, State Council of Ministers, Chief Minister, State Legislature and Judiciary.

Chapter 5: Constitutional Provisions for Scheduled Castes & Tribes
Constitutional Provisions for Scheduled Castes & Tribes, Women &Children & Backward classes, Emergency Provisions.

Chapter 6: Electoral process
Electoral process, Amendment procedure, 42nd, 44th and 86th Constitutional amendments**.**

Unit II

Chapter 7: Scope & Aims of Engineering Ethics
Scope & Aims of Engineering Ethics: Meaning and purpose of Engineering Ethics, Responsibility of Engineers, Impediments to responsibility, Honesty, Integrity and reliability, risks, safety & liability in engineering. Bhopal Gas Tragedy, Titanic case.

Chapter 8: Intellectual Property Rights
Intellectual Property Rights (IPRs)- Patents, Copyright and Designs

Chapter 9: Ethical perspectives of professional bodies
Ethical perspectives of professional bodies- IEEE, ASME, NSPE and ABET, ASCE etc

Unit III

Chapter10: Effects of Human Activities on Environment

Effects of human activities on environment - Agriculture, Housing, Industry, Mining, and Transportation activities, Environmental Impact Assessment, Sustainability and Sustainable Development.

Chapter 11: Environmental Protection

Environmental Protection – Constitutional Provisions and Environmental Laws in India

Text Books

1. Dr. J. N. Pandey, "Constitutional Law of India", Central Law Agency, 2005
2. Dr. M.K. Bhandari, "Law relating to Intellectual Property Rights", Central Law Publicaitons, Allahabad, 2010.
3. Charles E. Harris and others, "Engineering Ethics: Concepts and Cases", Thomson Wadsworth, 2003

Reference Books:

1. Durga Das Basu, "Introduction to the Constitution of India", Prentice-hall EEE, 2001
2. Mike Martin and Ronald Schinzinger, "Ethics in Engineering", Tata McGraw-Hill Publications.

BACK

Program: Automation & Robotics		Semester: VIII
Course Title: Smart Manufacturing		Course Code: 17EARE404
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40 hrs	Examination Duration: 3 hrs	

Unit I

Chapter 1: Introduction to Smart Manufacturing

Introduction to Smart Manufacturing, Smart Manufacturing Ecosystem, Product Development Lifecycle, Production Systems Lifecycle, Business Cycle, Manufacturing Pyramid, Integration, Production Planning and Control, Examples, Standards

Chapter 2: Supply Chain Management (SCM)

Introduction to Supply Chain, SCOR model, Virtual/Extended Enterprise, Delivery Channel, Decision Phases in a Supply Chain, Production Approaches, Supply Chain Process, Push & Pull Production Systems, Push-Pull Boundary, Lack of Coordination and Bullwhip Effect, Order-to-Cash Process, Procure-to-Pay Process, Call-off, Replenishment, Sourcing, Uncertainties, Responsiveness vs Cost, Supply Chain Performance Drivers – Facilities, Inventory, Transportation, Information, Sourcing, and Pricing

Chapter 3: Enterprise Resource Planning (ERP)

Business Processes, Process Modeling and Data Modeling, Business Process Reengineering, Event Process Chains (EPC), ERP Functionalities, Financial Accounting, Cost Accounting and Managerial Accounting, Cost Assignment Techniques, Cost Drivers, Purchasing, Receiving, Inventory Management, Warehouse Management, Shipping and Transportation, Billing, Material Requirement Planning (MRP), Manufacturing Resource Planning (MRP II)

Unit II

Chapter 4: Product Development Lifecycle

Product Development Lifecycle, Digital Thread, PLM Overview, Background for PLM, Scope, PLM Grid, PLM Paradigm - Concepts, Business Process in the PLM Environment, Product Data in the PLM Environment, Information Systems in the PLM Environment, Organization Change Management in the PLM Environment, CAD, CAE, CAM, CAPP, Simulations, NC Programming, CMM Programming, Introduction to Digital Twin, Standards

Chapter 5: Production System Lifecycle

Production System Lifecycle, Revisit Production Planning and Control, Manufacturing Pyramid, Manufacturing Execution Systems (MES), MES Functionalities, MES Models, Functional Control Model, MES in Discrete Industry, MES in Process Industry, Data Collection, Traceability, Performance Measurement and Management, Real-Time Enterprise, Revisit Digital Twin, Standards

Unit III

Chapter 6: Cloud Computing

Introduction to Cloud Computing, Virtualization Concepts, Main Players, Types of Cloud – Public, Private and Hybrid, Cloud Services – CaaS, SaaS, PaaS, and IaaS, Service Level Agreement, Cloud Security, Leveraging Cloud Services for Smart Manufacturing, Cloud Computing at Enterprise Systems Level, Hybrid Cloud Options

Chapter 7: Key Focus Areas

Knowledge Management, Case-Based Reasoning (CBR), Big Data Analytics, Smart Maintenance, Smart Product, Smart Supply Chain, Intelligent Machines, Smart Services, Blockchain

Text Books:

1. Sunil Chopra, and Peter Meindl, “Supply Chain Management – Strategy, Planning, and Operation,” Pearson Education, Sixth Edition, 2016.
2. Ellen Monk, and Bret Wagner, “Concepts in Enterprise Resource Planning,” Fourth Edition, Course Technology CENGAGE Learning, 2009.
3. Stark John, "Product Lifecycle Management: 21st Century Paradigm for Product Realization," Springer, Third Edition, 2015.
4. Sachin Karadgi, “A Reference Architecture for Real-Time Performance Measurement,” Springer, 2014.
5. Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter, “Cloud Computing – A Practical Approach,” McGraw Hill Education, 2010.

Reference Books:

1. Y. Lu, K.C. Morris, S. Frechette, “Current Standards Landscape for Smart Manufacturing Systems,” National Institute of Standards and Technology (NIST), (2016).
2. MESA International, "Three Functional Dimensions Converge on Smart Manufacturing," Whitepaper #59, 2018.
3. MESA International, "Smart Manufacturing and Cloud Computing," Whitepaper #60, 2018.

BACK

Program: Automation & Robotics		Semester: VIII
Course Title: Capstone Project		**Course Code: 18EARW402**
L-T-P: 0-0-11	**Credits: 11**	**Contact Hours:** ---
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: ---	**Examination Duration: 3 hrs**	
Prerequisites: Subjects learnt up to VII 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**.**		

BACK

Program: Automation & Robotics		Semester: VIII
Course Title: Industry Internship - Training		Course Code: 17EARI493
L-T-P: 0-0-6	Credits: 6	Contact Hours: 12
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: ---	Examination Duration: 3 hrs	

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.

BACK

Program: Automation & Robotics		**Semester: VIII**
Course Title: Industry Internship - Project Work		**Course Code: 17EARW494**
L-T-P: 0-0-11	**Credits: 11**	**Contact Hours: 22**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: ---	**Examination Duration: 3 hrs**	

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

BACK