ERODE SENGUNTHAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University)

PERUNDURAI, ERODE - 638 057

UG Curriculum and Syllabus

(1 to 8 Semesters)

B.E – ROBOTICS AND AUTOMATION ENGINEERING

Choice Based Credit System (CBCS)

REGULATION 2019

R.A

ERODE SENGUNTHAR ENGINEERING COLLEGE (AUTONOMOUS), ERODE

DEPARTMENT OF ROBOTICS AND AUTOMATION

REGULATIONS – 2019 CHOICE BASED CREDIT SYSTEM

I TO VIII SEMESTERS CURRICULUM

Induction Program (Mandatory)	**3 weeks duration**
Induction program for students to be offered right at the start of the first year	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lecture by Eminent People • Visits to local Areas • Familiarization to Dept. / Branch & Innovations

B.E. ROBOTICS AND AUTOMATION
Minimum credits to be earned: 164

SEMESTER I

THEORY

Code No.	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	Pos	PSOs					CA	ES	Total	
19BS101	Calculus and its Applications	I, II	1, 2,3,4,12	1	3	1	0	4	40	60	100	BS
19BS102	Engineering Physics (Laboratory Embedded)	I, II	1,2,4,5,6,8,9	1,2	2	0	2	3	40	60	100	BS
19BS103	Engineering Chemistry	I, II	1, 2,3,4, 5, 7, 12	-	3	0	0	3	40	60	100	BS
19HS101	Communicative English	IV	2,3,8,9,10, 12	-	3	0	0	3	40	60	100	HS
19ES101	Python Programming	I, II, III	1, 2,3,4,12	2	3	0	0	3	40	60	100	ES
19TPS01	Soft Skill – I	IV	8,9,10,12	-	1	0	1	1.5	40	60	100	EEC
PRACTICAL												
19ES104	Python Programming Laboratory	I, II, III	1, 2, 3, 4, 5, 12	2	0	0	2	1	60	40	100	ES
19BS105	Chemistry Laboratory	I, II	1,2,3,4,5,12	-	0	0	4	2	60	40	100	BS
19ES107	Workshop Practices	II	1,3,9,12	-	0	0	2	1	60	40	100	ES
TOTAL					**15**	**1**	**11**	**21.5**	**420**	**480**	**900**	-

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SEMESTER II												
THEORY												
Code No.	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	Pos	PSOs					CA	ES	Total	
19BS201	Vector Calculus and Complex Variables	I, II	1, 2, 3, 4,12	1	3	1	0	4	40	60	100	BS
19BS206	Engineering Materials	I, II	1,2,3,4,5,7	-	3	0	0	3	40	60	100	BS
19MC201	Environmental Science and Engineering	I, II	1, 2, 3, 4, 5, 6, 7, 8, 12	-	3	0	0	0	40	60	100	MC
19ES206	Semiconductor Devices and Circuits	I,II	1,2,3,4,12	-	3	0	0	3	40	60	100	ES
19ES225	Basics of Engineering Mechanics	I,II, III	1,2,6,7,12	2,3	3	1	0	4	40	60	100	ES
	Language Elective	IV	2,3,6,9,10, 12	-	3	0	0	3	40	60	100	HS
19TPS02	Soft Skill - II	IV	8,9,10,12	-	1	0	1	1.5	40	60	100	EEC
PRACTICAL												
19ES223	Electronics Devices and Circuits Laboratory	I,II, III	1, 9	-	0	0	4	2	60	40	100	ES
19ES221	Engineering Drawing	I	1,2,3,5,10, 12	-	0	0	4	2	60	40	100	ES
TOTAL					19	2	9	22.5	400	500	900	-

SEMESTER III												
THEORY												
Code No.	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BS304	Transform Techniques and their Applications	I, II	1, 2,3,4	-	3	1	0	4	40	60	100	BS
19RA301	Sensors and Instrumentation	I, II	1, 3, 5	-	3	0	0	3	40	60	100	PC
19RA302	Kinematics and Dynamics of Machinery	II, III	1,3	3	3	1	0	4	40	60	100	PC
19ES304	Electrical Machines	I,II	1,2	-	3	0	0	3	40	60	100	ES
19ME305	Strength of Materials	II	1,2,3,4,6,7,12	-	3	1	0	4	40	60	100	PC
19TPS03	Quantitative Aptitude and Logical Reasoning – I	IV	1,2,9,10,12	-	2	0	0	0	40	60	100	EEC
PRACTICAL												
19ES305	Sensors and Electrical Machines Laboratory	I, II, III	1, 2, 3, 4, 5 9	-	0	0	4	2	60	40	100	ES
19ME307	Strength of Materials Laboratory	I, II, III	1,2,3,4,6,7,12	-	0	0	4	2	60	40	100	PC
19RA303	Dynamics Laboratory	II, III	1, 3	-	0	0	4	2	60	40	100	PC
TOTAL					17	3	12	24	420	480	900	-

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SEMESTER IV												
THEORY												
Code No.	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	Pos	PSOs					CA	ES	Total	
19BS403	Numerical Methods and Statistics	I, II	1,2,3,4	-	3	1	0	4	40	60	100	BS
19ES403	Object Oriented Programming	II, III	1,2,3,4,12	-	3	0	0	3	40	60	100	ES
19EI401	Linear Integrated Circuits and Applications	II	1,2	-	3	0	0	3	40	60	100	ES
19EI402	Digital Principles and System Design	I,II	1, 2,3,4,12	-	2	1	0	3	40	60	100	ES
19EI403	Industrial Internet of Things	I,II	1, 2,3,4,12	-	2	0	2	3	40	60	100	ES
19TPS04	Quantitative Aptitude and Logical Reasoning – II	IV	1,2,9,10,12	-	2	0	0	0	40	60	100	EEC
19MC401	Indian Constitution	IV	6,8,10,11,12	-	2	0	0	0	40	60	100	MC
PRACTICAL												
19ES404	Object Oriented Programming Laboratory	II,III	1, 2, 5, 9	-	0	0	4	2	60	40	100	ES
19ES407	Digital and Integrated Circuits Laboratory	I,II	1, 2, 3, 4, 9	-	0	0	4	2	60	40	100	ES
19HS401	Language Skills	IV	5, 9,10,12	-	0	0	2	0	100	0	100	EEC
				TOTAL	**17**	**2**	**12**	**20**	**500**	**500**	**1000**	-

SEMESTER V												
THEORY												
Code No.	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	Pos	PSOs					CA	ES	Total	
19RA501	CNC Machine and Metrology	II, III	2, 3, 4, 12	-	3	0	0	3	40	60	100	PC
19RA502	Principles of Robotics	II, III	3, 4, 5, 6, 7	-	3	0	0	3	40	60	100	PC
19RA503	Hydraulics and Pneumatics	II, III	1, 3	-	3	0	0	3	40	60	100	PC
19EI501	Automatic Control Systems	II,III	2, 3, 4, 12	1, 3	3	0	0	3	40	60	100	ES
19ES501	Design of Machine Elements and Transmission Systems	II, III	3, 4, 5, 6, 7	1,3	3	2	0	4	40	60	100	ES
19HS505	Universal Human Values 2 : Understanding Harmony	I, II, III, IV	1, 6, 7, 10,12	3	2	1	0	3	40	60	100	HS
19TPS05	Quantitative Aptitude and Logical Reasoning – III	I, II, III	1,2,9,10,12	3	2	0	0	0	40	60	100	EEC
PRACTICAL												
19RA504	Robotics Laboratory	II, III	3, 4, 5, 6, 9,10	3	0	0	2	1	60	40	100	PC
19RA505	CNC and Metrology Laboratory	II, III	2, 3, 4, 9, 10	-	0	0	2	1	60	40	100	PC
19RA506	Hydraulics and Pneumatics Laboratory	II, III	2, 3, 4, 5, 6, 9, 10	1, 3	0	0	2	1	60	40	100	PC
19RA507	Internship/ Industrial Training	I,IV	1,2,3,4,5,6,11,12	1,2	0	0	2	0	100	0	100	EEC
				TOTAL	**14**	**1**	**14**	**22**	**480**	**420**	**900**	-

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SEMESTER VI												
THEORY												
Code No.	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	Pos	PSOs					CA	ES	Total	
19RA601	Machine Vision Systems	II,III, IV	1, 3, 5	1, 2, 3	3	0	0	3	40	60	100	PC
19RA602	Automation System Design	II,III	1, 2, 3, 4, 5,6	1, 3	3	0	0	3	40	60	100	PC
19RA603	Industrial Automation	II,III, IV	1,3,5	1, 2, 3	3	0	0	3	40	60	100	PC
	Professional Elective – 1	-	-	-	3	0	0	3	40	60	100	PE
	Open Elective – 1	-	-	-	3	0	0	3	40	60	100	OE
19TPS06	Quantitative Aptitude and Logical Reasoning – IV	I, II, III	1,9,10,12	3	2	0	0	0	40	60	100	EEC
PRACTICAL												
19RA604	Automation System Design Laboratory	II, III	1, 2, 3, 4, 5, 6	1, 3	0	0	2	1	60	40	100	PC
19RA605	Industrial Automation Laboratory	II,III, IV	1, 2, 3, 5, 9	1, 2, 3	0	0	2	1	60	40	100	PC
19HS602	Professional Skills for Automation Engineers	IV	1,5,7,8,9,12	-	0	0	2	0	100	0	100	EEC
				TOTAL	17	0	10	17	460	440	900	-

SEMESTER VII												
THEORY												
Code No.	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	Pos	PSOs					CA	ES	Total	
19HS701	Research Methodology	IV	2,4,8,10,12	-	3	0	0	3	40	60	100	HS
19RA701	Modeling and Simulation	IV	2, 4, 8, 10, 12	-	3	0	0	3	40	60	100	PC
19RA702	Field and Service Robotics	II, III	1, 2, 3, 4, 5	1, 2, 3	3	0	0	3	40	60	100	PC
19RA703	Design of Machine Elements and Transmission Systems	II, III	1,2,8	1, 3	3	1	0	4	40	60	100	PC
	Professional Elective – 2	-	-	-	3	0	0	3	40	60	100	PE
	Open Elective – 2	-	-	-	3	0	0	3	40	60	100	OE
PRACTICAL												
19RA704	Modeling and Simulation Laboratory	II, III	1, 2, 3, 4, 5, 9	1, 2, 3	0	0	4	2	60	40	100	PC
19RA705	Design and Fabrication Project	II, III, IV	3,4,5,9,10	1, 3	0	0	2	1	100	0	100	EEC
19RA706	Comprehensive Review	I, IV	1,2,3,4,5,6,7,8,9 ,10,11,12	-	0	0	2	0	100	0	100	EEC
				TOTAL	18	1	8	22	500	400	900	-

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SEMESTER VIII													
THEORY													
Code No.	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	Pos	PSOs					CA	ES	Total	
19RA801	Artificial Intelligence for Robotics	II, III	2,3,4,5,7,8,10, 11	1, 3	3	0	0	3	40	60	100	PC
	Professional Elective – 3	-	-	-	3	0	0	3	40	60	100	PE
	Professional Elective – 4	-	-	-	3	0	0	3	40	60	100	PE
PRACTICAL												
19RA802	Project Work	II,III,IV	1,2,3,4,5,6,7,8 ,9,10,11,12	1, 3	0	0	12	6	60	40	100	EEC
TOTAL					**9**	**0**	**12**	**15**	**180**	**220**	**400**	-

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ELECTIVES:

LANGUAGE ELECTIVES								
Code No.	Course	Objective & Outcomes			L	T	P	C
		PEOs	POs	PSOs				
19HX201	English for Engineers	IV	2,3,6,9,10,12	-	3	0	0	3
19HX202	Hindi	IV	2,3,6,9,10,12	-	3	0	0	3
19HX203	Japanese	IV	2,3,6,9,10,12	-	3	0	0	3
19HX204	French	IV	2,3,6,9,10,12	-	3	0	0	3

PROFESSIONAL ELECTIVES								
Code No.	Course	Objective & Outcomes			L	T	P	C
		PEOs	Pos	PSOs				
PROFESSIONAL ELECTIVE – I								
19RAX01	System Software	II, III	1, 3	-	3	0	0	3
19RAX02	Automobile Engineering	II, III	1, 2, 3, 4	-	3	0	0	3
19RAX03	Virtual Instrumentation Systems	II, III	2, 3, 4, 12	3	3	0	0	3
19RAX04	Professional Ethics in Engineering	II, III	2, 3, 4	-	3	0	0	3
PROFESSIONAL ELECTIVE – II								
19RAX05	Lean Manufacturing	II, III	1, 2, 3, 5	-	3	0	0	3
19RAX06	Industrial Design and Applied Ergonomics	II, III	1, 3, 4, 12	1	3	0	0	3
19RAX07	Process Planning and Cost Estimation	II, III	1, 2, 3, 4, 5,6, 7 8, 9,10,11	1, 3	3	0	0	3
19RAX08	Disaster Management	II, III	1, 2, 3, 4,5,6, 9, 12	3	3	0	0	3
PROFESSIONAL ELECTIVE – III								
19RAX09	VLSI Design	II, III	1, 2, 3, 5	1, 3	3	0	0	3
19RAX10	Virtual Instrumentation	II, III	1, 3, 5	1, 3	3	0	0	3
19RAX11	Special Machines and Controllers	II, III	1, 2, 3, 4, 5	1, 3	3	0	0	3
19RAX12	Process control	II, III	1, 2, 3, 4, 5,6, 7, 12	1, 3	3	0	0	3
PROFESSIONAL ELECTIVE – IV								
19RAX13	Maintenance and Safety Engineering	II, III	1, 2, 3, 4, 5,6	-	3	0	0	3
19RAX14	Neural Networks and Fuzzy Systems	II, III	1,3,4,5,7	-	3	0	0	3
19RAX15	Industrial Robotics and Material Handling Systems	II, III	1,3,4,5,8	-	3	0	0	3
19RAX16	Micro Electro Mechanical Systems	II, III	1, 2, 3, 4, 5,6	-	3	0	0	3

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OPEN ELECTIVES								
Code No.	Course	Objective & Outcomes			L	T	P	C
		PEOs	Pos	PSOs				
19RAY01	Principles of Robotics	II, III	3,4,5,6,7	-	3	0	0	3
19RAY02	Totally Integrated Automation	II, III	2, 3, 4	-	3	0	0	3
19RAY03	Air Pollution and Control Engineering	II, III	2, 3	-	3	0	0	3
19RAY04	Industrial Safety Engineering	II, III	2, 3, 4, 12	-	3	0	0	3
19RAY05	Intellectual Property Rights	II, III	1, 3, 7	-	3	0	0	3

ADDITIONAL ONE CREDIT COURSES								
Code No.	Course	Objective & Outcomes			L	T	P	C
		PEOs	POs	PSOs				
19RAZ01	CAD Tools for Industrial Automation	IV	10, 11	-	1	0	0	1
19RAZ02	Design Concepts and Realization	III	1, 2, 3, 6, 7,8	3	1	0	0	1
19RAZ03	Dynamic Modelling Simulations and Control of Robots	II, III	1, 2, 3, 5, 6	3	1	0	0	1
19RAZ04	Modelling and Simulation of Dynamic Systems Using Adams	II, III	1, 2, 3, 7	3	1	0	0	1
19RAZ05	Robot Operating Systems	II, III	1, 2, 3	2, 3	1	0	0	1
19RAZ06	Computer Vision with Open CV	II, III, IV	1, 2, 5	2, 3	1	0	0	1
19RAZ07	Underwater Robotics	II,III,IV	1, 2, 3, 5, 7	1, 2, 3	1	0	0	1
19RAZ08	Industrial Drives for Automation	II, III,V	1, 2, 3, 7	3	1	0	0	1
19RAZ09	PC Based Industrial Automation	II, III	1, 2, 3, 5,6,7	3	1	0	0	1

S.No.	Category	Credits Per Semester								Total Credit	Credits in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	12	7	4	4	-	-	-	-	27	16	15	20
2	HS	3	3	-	-	3	-	3	-	12	7	5	10
3	ES	5	11	5	16	4	-	-	-	41	23	15	20
4	PC	-	-	15	-	15	11	12	3	56	37	35	45
5	PE	-	-	-	-	-	3	3	6	12	7	5	10
6	OE	-	-	-	-	-	3	3	-	6	4	4	10
7	EEC	1.5	1.5	-	-	0	-	1	6	10	6	5	10
Total		21.5	22.5	24	20	22	17	22	15	164	100		

BS-Basic Science
HS-Humanities and Social Science
OE-Open Elective
MC-Mandatory Course
ES- End Semester Examination
ES-Engineering Science
PE- Professional Elective
PC- Professional Core
CA – Continuous Assessment
EEC-Employability Enhancement Course

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester I	BS
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS101	CALCULUS AND ITS APPLICATIONS	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is to

- Interpret the introductory concepts of Limit and continuity
- Interpret the introductory concepts of calculus, this will enable them to model and analyze physical phenomena involving continuous change of variables
- Find eigen values and eigen vectors which is one of the powerful tools to handle practical problems arising in the field of engineering.
- Summarize and apply the methodologies involved in solving problems related to functions of several variables.
- Develop enough confidence to identify surface and area there by solving using integration

Course Outcomes: At the end of this course, learners will be able to:

- Apply differentiation to solve maxima and minima problems use both the limit definition and rules of differentiation to differentiate functions
- Identify and model the real time problems using first order linear differential equations. Recognize and solve the higher order ordinary differential equations.
- Analyze the characteristics of a linear system with Eigen values and Eigenvectors.
- Characterize the functions of several variables and get the solutions of the same.
- Integrate the functions for evaluating the surface area and volume.

UNIT I	LIMITS AND CONTINUITY	12

Representation of a function-Limit of a function-Continuity-Derivatives-Differentiation rules-Maxima and Minima of one variable

UNIT II	ORDINARY DIFFERENTIAL EQUATIONS	12

Linear differential equations of second and higher order with constant coefficients. Linear differential equations of higher order with variable coefficients: Cauchy's linear differential equation - Method of variation of parameters for second order differential equations-Vibrating string-Electrical circuits

UNIT III	MULTIVARIABLE CALCULUS	12

Functions of Two Variables - Total Differential - Derivative of implicit functions- Jacobian's- constrained maxima and minima

UNIT IV	MULTIPLE INTEGRALS	12

Double integration with constant and variable limits-Region of integration -Change the order of integration -Area as double integral in cartesian coordinates. Triple integral in Cartesian coordinates.

UNIT V	EIGEN VALUES AND EIGEN VECTORS	12

Eigen Values and Eigen Vectors of a real matrix - Properties of Eigen Values- Cayley - Hamilton Theorem Orthogonal matrix- Diagonalisation-Quadratic form: Reduction of a quadratic form to a canonical form.

REFERENCE(S):

1. Thomas Calculus, 14th Edition by Pearson
2. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2015.
3. Peter V. O Neil , Advanced Engineering Mathematics, Eight Edition , Cengage Learning India Private Limited, 2018
4. C. Ray Wylie and C Louis Barrett Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
5. Glyn James Advanced Engineering Mathematics, Third Edition, Wiley India, 2014.

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Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS102	ENGINEERING PHYSICS (Laboratory Embedded)	2	0	2	3	60	100	

Course Objective (s): The purpose of learning this course are

- To enhance the fundamental knowledge in different materials.
- To intensify the information regarding the ultrasonic sound and its applications.
- To reveal the needs of fiber optics and laser application in the modern technology.
- To upgrade the knowledge in quantum mechanics.
- To analysis the role of thermal properties in the materials and applications.

Course Outcomes: At the end of this course, learners will be able :

- To gain knowledge on the basics of properties of matter and its applications
- To acquire knowledge on the concepts of Ultrasonics and their applications
- To have adequate knowledge on the concepts of fiber & Laser and their applications
- To get knowledge on advanced Physics concepts of quantum theory and its applications in tunneling microscopes
- To understand knowledge on the concepts of thermal properties of materials and their applications in expansion of joints and heat exchangers

UNIT I PROPERTIES OF MATTER — 6

Elasticity – Stress-strain diagram and its uses - torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders.

UNIT II ULTRASONICS — 6

Introduction–Classification of Sound- Ultrasonics Production - Magnetostriction generator - Piezo electric generator-cavitations-ultrasonic cleaning-Non Destructive Testing- Pulse echo system through transmission and reflection modes-A, B and C – scan displays- Engineering Applications-Cutting, welding and drilling.

UNIT III LASER AND FIBRE OPTICS — 6

Lasers: population of energy levels, Einstein's A and B coefficients derivation – Semiconductor lasers: homojunction and heterojunction – Industrial applications of laser. Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – fibre optic sensors: pressure and displacement.

UNIT IV QUANTUM PHYSICS — 6

Black body radiation – Planck's theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box.

UNIT V THERMAL PHYSICS — 6

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation – heat conductions in solids – thermal conductivity - Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – applications: heat exchangers, ovens and solar water heaters.

TEXT BOOK(S):

1. Bhattacharya, D.K. & Poonam, T. —Engineering Physics‖. Oxford University Press, 2015
2. Gaur, R.K. & Gupta, S.L. —Engineering Physics‖. Dhanpat Rai Publishers, 2012
3. Pandey, B.K. & Chaturvedi, S. —Engineering Physics‖. Cengage Learning India, 2012

REFERENCE(S):

1. Halliday, D., Resnick, R. & Walker, J. —Principles of Physics‖. Wiley, 2015
2. Serway, R.A. & Jewett, J.W. —Physics for Scientists and Engineers‖. Cengage Learning, 2010
3. Tipler, P.A. &Mosca, G. - Physics for Scientists and Engineers with Modern Physics'.W.H.Freeman, 2007

Exp No.	Name of Experiments (Any Five) - 30 Hours
1	Determination of rigidity modulus – Torsion pendulum
2	Determination of Young's modulus by non-uniform bending method
3	Determination of Young"s modulus by uniform bending method
4	Determination of wavelength and particle size using Laser
5	Determination of acceptance angle and numerical aperture in an optical fiber
6	Determination of thermal conductivity of a bad conductor – Lee"s Disc method
7	Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer

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8	Determination of wavelength of mercury spectrum – spectrometer grating
9	Determination of band gap of a semiconductor
10	Determination of thickness of a thin wire – Air wedge method

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester I	BS
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS103	ENGINEERING CHEMISTRY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the basic concepts of water characterization and treatment methods.
- Know the fundamental concepts of electrochemistry and corrosion.
- Understand the principles and generation of energy in batteries and nuclear reactors.
- Gain knowledge on polymers.
- Know the types of fuels and the manufacture of solid, liquid and gaseous fuels.

Course Outcomes: At the end of this course, learners will be able to:

- Make the students conversant with water treatment techniques
- Know the reaction involved in corrosion and corrosion protection methods
- Impart knowledge on renewable energy sources like nuclear and to impart knowledge on energy storage devices
- Aware the synthesis & industrial application of polymers
- Impart knowledge on different types of fuels (solid liquid, gas, primary, secondary and synthetic) and combustion process.

UNIT I WATER CHEMISTRY 9

Hardness of water – types – Estimation of hardness of water by EDTA method– – Domestic water treatment-boiler troubles (scales,sludge,priming,foaming,caustic embrittlememt) – Internal conditioning (carbonate,phosphate, sodium aluminate and calgon) .External treatment – Demineralization process – Reverse Osmosis

UNIT II ELECTROCHEMISTRY AND CORROSION 9

Electrochemical cell - redox reaction, electrode potential- Nernst equation (derivation and problems). Electro Chemical series-Standard hydrogen electrode-Calomel Electrode. Corrosion: chemical & electrochemical corrosion (galvanic, differential aeration) - types-factors influencing corrosion rate corrosion control - sacrificial anode and impressed current cathodic protection method.

UNIT III ENERGY SOURCES 9

Introduction- nuclear energy- nuclear fission- nuclear fusion- nuclear chain reactions- light water reactor- breeder reactor. Batteries and fuel cells:Types of batteries- alkaline battery- lead storage battery- lithium ion battery.Fuel cell :H2 -O2 fuel cell.

UNIT IV POLYMER CHEMISTRY 9

Monomers - polymers - polymerization - functionality - degree of polymerization - classification of polymers based on source and applications. Types of polymerization: addition, condensation and copolymerization. Preparation, properties and applications of thermosetting (epoxy resin and bakelite) and thermoplastics (poly vinyl chloride, poly tetrafluoroethylene and PMMA). Rubber: SBR. Compounding of plastics (blow moulding, injection, extrusion) .

UNIT V FUELS AND COMBUSTION 9

Fuel: Introduction- classification of fuels- solid fuels-coal- proximate and ultimate analysis- manufacture of metallurgical coke (Otto Hoffmann method) – Liquid fuels: Refining of petroleum- synthetic petrol Fischer-Trophs and Bergius processes- knocking- octane number- cetane number – Gaseous fuels: liquefied petroleum gases(LPG)- water gas- bio diesel. Combustion- flue gas analysis (ORSAT Method).

TEXT BOOK(S):

1. Jain P.C.andMonicaJain, "EngineeringChemistry",DhanpatRaiPublishing Company (P) Ltd., New Delhi, 2019.
2. Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2019

REFERENCE(S):

1. Dara S.S, Umare S.S, "Engineering Chemistry", S. Chand & Company Ltd., New Delhi 2016
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2017.
3. GowarikerV.R,Viswanatha.N.V,Jayadev Sreedhar-"Polymer Science'',Publishing company New Age International Publishers,New Delhi,2015.
4. Ozin G. A. and Arsenault A. C., "Nanochemistry: A Chemical Approach to Nanomaterials", RSC Publishing, 2017.
5. Ashima Srivastava and Janhavi N N., "Concepts of Engineering Chemistry", ACME Learning Private Limited., New Delhi, 2015.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester I	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS101	COMMUNICATIVE ENGLISH	3	0	0	3	45	100	

Course Objective (s):

- To acquire Basic English grammar.
- To develop listening skills to listen lectures and basic videos.
- To enhance the reading skill to comprehend technical writings.
- To improve writing skills to express thoughts freely.
- To develop speaking skills to speak fluently in real contexts.

Course Outcomes: At the end of this course, learners will be able to:

- Improve language usage in LSRW skills.
- Develop listening skills to comprehend general / technical talks.
- Acquire the ability to understand different written texts.
- Enhance the writing skills to express the ideas of the learners.
- Communicate fluently in real time context.

UNIT I	LANGUAGE FOCUS	9

Parts of speech - Word formation - Sentence types (declarative, imperative, exclamatory & interrogative) - Tense forms - Subject - Verb agreement

UNIT II	LISTENING	9

Listening for specific information: Short conversations / monologues - Gap filling - Telephone conversations - Telephone etiquette - Note-taking - Listening for gist / interviews - Listening to songs and completing the lyrics - Clear individual sounds - Word stress

UNIT III	READING	9

Completing the sentences - Prediction - Skimming for gist - Scanning for specific information - Understanding text and sentence structure - Close reading

UNIT IV	WRITING	9

Paragraph writing (descriptive, narrative, expository & persuasive) - Letter (formal and informal) - Dialogue writing E-mail - Instructions

UNIT V	SPEAKING	9

Self-introduction - Giving personal and factual information - Talking about present circumstances, pastexperiences and future plans - Mini-presentation - Expressing opinions and justifying opinions - Agreement / disagreement - Likes and dislikes

TEXT BOOK(S):

1. Communicative English by KN Shoba, Lourdes JoavaniRayenPublised by Cambridge University 2017.

REFERENCE(S):

1. Murphy, Raymond. English Grammar in Use – A Self-Study Reference and Practice Book for Intermediate learners of English .Ived. United Kingdom: Cambridge University Press.2012.
2. Seely, John. Oxford Guide to Effective Writing and Speaking. Indianed. New Delhi: Oxford University Press.2005.
3. Anderson, Kennethetal. Study Speaking: A Course in Spoken English for Academic Purposes. United Kingdom: Cambridge University Press1992.
4. Wren and Martin, High school English Grammar and Composition, Publisher: S.Chand.2019.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester I	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES101	PYTHON PROGRAMMING	3	0	0	3	45	100	

Course Objective (s):

The purpose of learning this course is to

- Understand problem solving concepts
- UnderstandwhyPythonisausefulscriptinglanguagefordevelopersandtoreadandwritesimplePython programs.
- Develop Python programs with conditionals and loops
- Use Python data structures — lists, tuples, dictionaries.
- Do input/output with files in Python

Course Outcomes:

At the end of this course, learners will be able to

- Apply problems solving techniques to real world problems.
- Recognize and construct common programming idioms: variables, loop, branch, and input/output.
- Design, code, and test Python programs using List, Tuples and Strings
- Write code using dictionaries and functions
- Read and write data from/to files in Python Programs.

UNIT I	COMPUTATIONAL THINKING	9

Introduction to Computational Thinking –From abacus to machine – The first Software –First Modern Computer Information and data - Converting information into data -Data Capacity Problem Solving Techniques: Genera problem Solving concepts-: Algorithm, Pseudo-code and Flowchart Problem Solving with Sequential Logic Structure Problem Solving with Decisions - Problem Solving with Loops Case Study: Raptor and Scratch Tools.

UNIT II	INTRODUCTION TO PYTHON	9

History- Features - Setting up path - Working with Python- Basic Syntax - Variable and Data Types –Operator Conditional Statements – Looping – Control Statements

UNIT III	STRING MANIPULATION, LIST AND TUPLES	9

Creating String - Accessing Strings- Basic Operations - String slices - Function and Methods – Creating List - Accessing list - Operations on List - Working with lists - Function and Methods – Creating tuple – Tuple Operations Functions and Methods

UNIT IV	DICTIONARIES AND FUNCTIONS	9

Creating Dictionaries - Accessing values in dictionaries - Working with dictionaries - Properties – Functions Defining a function - Calling a function - Types of functions - Function Arguments - Anonymous functions - Globa and local variables

UNIT V	MODULES, FILES AND EXCEPTION HANDLING	9

Modules - Importing module - Math module - Random module - Packages - Composition Files - Opening and closing file- File Opening Modes - Reading and writing files – Functions Exception Handling - Exception - Exception Handling - Except clause - Try , finally clause User Defined Exceptions

TEXT BOOK(S)

1. David Riley and Kenny Hunt, "Computational Thinking for the Modern Problem Solver", Chapman &Hall/ CRC,2014.
2. M.Sprankle," Problem Solving and Programming Concepts", 9thEdition, Pearson Education, New Delhi, 2011.

REFERENCE(S)

1. Brian Heinold, "Introduction to Programming Using Python ",Mount St. Mary's University,2013.
2. Michael Dawson, "Python Programming for the Absolute Beginner" , 3rd Edition,2010.
3. Allen Downey, Green Tea Press Needham," Think Python, Howto Think Like a Computer Scientist", Massachusetts.
4. Cunningham, Sams teach yourself python in 24 hours, Second edition Pearson,2014

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester I	EEC
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS01	SOFT SKILL- I	1	0	1	1.5	30	100	

Course Objective (s): The purpose of learning this course is to

- Develop basic grammar knowledge in English.
- Enhance Speaking Skills in English
- Improve Verbal and Non-verbal Communication Skills
- Develop Confidence and Emotional Intelligence
- Develop Inter Personal Skills.

Course Outcomes: At the end of this course, learners will be able to:

- Have competent knowledge of grammar
- Speak fluent English by enriching Vocabulary Knowledge.
- Have good Presentation Skills through verbal and non verbal communication.
- Handle any Situation with confidence by being emotionally stable.
- Work in a team by having team coherence and dealing with people.

UNIT I	EFFECTIVE ENGLISH – WRITTEN ENGLISH	6

Basic rules of Grammar - Parts of Speech – Tenses – Verbs.Sentence Construction.Dialogues and Conversations – Writing. Exercises to practice and improve these skills.

UNIT II	EFFECTIVE ENGLISH – SPOKEN ENGLISH	6

Vocabulary – Idioms& Phrases – Synonyms – Antonyms.Dialogues and Conversations –Writing. Exercises to practice and improve these skills.

UNIT III	ART OF COMMUNICATION & THE HIDDEN DATA INVOLVED	6

Verbal Communication - Effective Communication - Active listening –Paraphrasing – Feedback.
Non Verbal Communication - Body Language of self and others.Importance of feelings in communication - dealing with feelings in communication.

UNIT IV	WORLD OF TEAMS – PART -01	6

Self Enhancement - importance of developing assertive skills- developing self confidence – developing emotional intelligence.

UNIT V	WORLD OF TEAMS – PART -02	6

Importance of Team work – Team vs. Group - Attributes of a successful team – Barriers involved Working with Groups – Dealing with People- Group Decision Making

REFERENCES:

1. The Seven Habits of Highly Effective People - Stephen R. Covey.
2. All the books in the "Chicken Soup for the Soul" series.
3. Man's search for meaning – Viktor Frankl
4. The greatest miracle in the world – OgMandino
5. Goal - Eliyahu Goldratt.
6. Working with Emotional Intelligence - David Goleman.
7. Excel in English – Sundra Samuel, Samuel Publications
8. Developing Communication Skills by Krishna Mohan and Meera Banerji; MacMillan India Ltd., Delhi
9. Essentials of Effective Communication, Ludlow and Panthon; Prentice Hall of India.
10. Effective Presentation Skills (A Fifty-Minute Series Book) by Steve Mandel
11. "Strategic interviewing" byRichaurd Camp, Mary E. Vielhaber and Jack L. Simonetti – Published by Wiley India Pvt. Ltd
12. "Effective Group Discussion: Theory and Practice" by Gloria J. Galanes, Katherine Adams , John K. Brilhart.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester I	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES104	PYTHON PROGRAMMING LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries
- Read and write data from/to files in Python.

Course Outcomes: At the end of this course, learners will be able to

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

List of Experiments

1. Find the Greatest among three numbers without using third variable
2. Sum of the Digits of a Number
3. Generation of Prime Numbers
4. Implement a sequential search
5. Create a calculator program
6. Explore string functions
7. Implement Selection Sort and Stack
8. Read and write into a file
9. Demonstrate usage of basic regular expression
10. Demonstrate use of advanced regular expressions for data validation.
11. Demonstrate use of List and Dictionaries
12. Demonstrate use of Create Comma Separate Files (CSV), Load CSV files into internal Data Structure

PLATFORM NEEDED

Python 3 interpreter for Windows/Linux

TEXT BOOK(S)

13. DavidRileyandKennyHunt,"ComputationalThinkingfortheModernProblem Solver", Chapman & Hall/CRC,2014.
14. M. Sprankle, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, NewDelhi, 2011.

REFERENCE(S)

1. Brian Heinold, "Introduction to Programming Using Python", Mount St. Mary's University,2013.
2. Michael Dawson, "Python Programming for the Absolute Beginner", 3rd Edition, 2010.
3. Allen Downey, Green Tea Press Needham, "Think Python, How to Think Like a Computer Scientist", Massachusetts.
4. Cunningham, Sams teach yourself python in 24 hours, 2nd edition Pearson, 2014.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester I	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS105	CHEMISTRY LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Determination of total, temporary & permanent hardness of water by EDTA method.
- Determination of chloride content of water sample by Argentometric method.
- Estimation of iron content of the given solution using potentiometer.
- Determination of strength of given hydrochloric acid using pH meter
- Conductometric titration of strong acid vs strong base.

Course Outcomes: At the end of this course, learners will be able to

- Make the student to acquire practical skills in the determination of water quality parameters through volumetric analysis.
- Acquire the knowledge about chloride content in water sample.
- Make the student to acquire practical skills about strength of iron using potentiometric titrations.
- Understand the how to estimate hydrochloric acid in water sample using pH meter.
- Gain the knowledge about conductance of ions.

List of Experiments

CHEMISTRY (ANY TEN)

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of chloride content of water sample by argentometric method.
3. Determination of Dissolved oxygen content in water sample using Winklers Method
4. Determination of Alkalinity in Water Sample
5. Determination of strength of given hydrochloric acid using pH meter.
6. Determination of strength of acids in a mixture of acids using conductivity meter.
7. Conductometric titration of strong acid vs strong base
8. Estimation of iron content of the given solution using potentiometer.
9. Conductometric titration of strong acid vs strong base
10. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer
11. Estimation of iron content of the water sample using spectrophotometer
12. Estimation of Copper in Brass

LIST OF EQUIPMENT (CHEMISTRY)

S.No	Description of Equipment	Quantity required	Quantity available
1	Potentiometer	10 Nos.	10 Nos.
2	pH meter	10 Nos.	10 Nos.
3	Conductivity meter	10 Nos.	10 Nos.
4	Spectrophotometer	2 Nos.	2 Nos.
5	Oswald viscometer	30 Nos.	30 Nos.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester I	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES107	WORKSHOP PRACTICES	0	0	2	1	30	100	

Course Objectives: The purpose of learning this course is to

- Provide hands-on training in fabrication of components using carpentry, sheet metal and welding equipment / tools.
- Acquire the skill for making fitting joints and household pipe line connections using suitable tools.
- Develop the skill for preparing the green sand mould.
- Provide hands-on training in assembling and dismantling of petrol engines, gear boxes and pumps.
- Develop the skill for making wood/sheet metal models using suitable tools.

Course Outcomes: At the end of this course, learners will be able to:

- Fabricate simple components using carpentry, sheet metal and welding equipment/tools.
- Make fitting joints and household pipe line connections using suitable tools.
- Prepare green sand mould.
- Assemble and dismantle petrol engines, gear boxes and pumps.
- Make simple models using wood and sheet metal.

Exp. No.	Name of Experiments
1	Forming of simple object in sheet metal using suitable tools (Example: Dust Pan / Soap Box)
2	Fabrication of a simple component using thin and thick plates. (Example: Book rack)
3	Making a simple component using carpentry power tools. (Example: Pen stand/Tool box/ Letter box)
4	Prepare a "V", Half-round or Square joint from the given mild steel flat plate.
5	Construct a household pipe line connections using pipes, Tee-joint, Four-way joint, elbow, union, bend, gateway and taps (or) Construct a pipe connection for domestic application (centrifugal pump) using pipes, bend, gate valve, flanges and foot valve.
6	Prepare a green sand mould using solid pattern/split pattern.
7	Dismantling and assembly of Centrifugal Gear Pump / Gear box.
8	Dismantling and assembly of two-stroke and four-stroke petrol engine.
9	a) Preparation of butt joints, lap joints and T- joints by ElectricArcWelding. b) Gas Welding practice.
10	Mini-Project (Fabrication of small components).

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings	15 sets
2.	Carpentry Vice (fitted to work bench)	15 Nos.
3.	Standard woodworking tools	15 Sets.
4.	Models of industrial trusses, door joints, furniture joints	5 each
5.	Power Tools: (a) Rotary Hammer	2 Nos.
	(b) Demolition Hammer	2 Nos.
	(c) Circular Saw	2 Nos.
	(d) Planer	2 Nos.
	(e) Hand Drilling Machine	2 Nos.
	(f) Jigsaw	2 Nos.
6.	Arc welding transformer with cables and holders	5 Nos.
7.	Welding booth with exhaust facility	2 Nos.
8.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
9.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfits	2 Nos.
10.	Centre lathe	2 Nos.
11.	Hearth furnace, anvil and smithy tools	2 Sets.
12.	Moulding table, foundry tools	2 Sets.
13.	Power Tool: Angle Grinder	2 Nos.
14.	Study-purpose items: Centrifugal pump, Air-conditioner	One each.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	BS
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS201	VECTOR CALCULUS AND COMPLEX VARIABLES	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is to

- Summarize problems related to fundamental principles of Vector Calculus
- Apply the methodologies involved in solving problems related to fundamental principles Vector Differentiation and Vector Integration.
- Implement the Complex Analysis, an elegant method in the study of heat flow, fluid dynamics and electrostatics.
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.
- Defining a complex function and solving through complex integration

Course Outcomes: At the end of this course, learners will be able to:

- Characterize the calculus of vectors.
- Apply the theoretical aspects of vector integral calculus in their core areas.
- Recognize the differentiation properties of complex functions.
- Identify the complex functions and their mapping in certain complex planes.
- Use the concepts of integration to complex functions in certain regions.

UNIT I	DIFFERENTIATION OF VECTORS	12

Vector point function- Directional derivative - Gradient -Divergence -Curl - Solenoidal – Irrotational vector fields –Scalar potential

UNIT II	INTEGRATION OF VECTORS	12

Work done - Line Integral - Surface integral- Green's theorem in a plane- Stoke's Theorem- Gauss divergence theorem- Applications involving cubes and parallelepiped.

UNIT III	ANALYTIC FUNCTIONS	12

Analytic Functions- Necessary and Sufficient conditions of Analytic Function- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method -Applications to the problems of Potential Flow.

UNIT IV	MAPPING OF COMPLEX FUNCTIONS	12

Conformal mapping- Application of transformation: translation, rotation, magnification and inversion of multi valued functions - Linear fractional Transformation (Bilinear transformation).

UNIT V	COMPLEX INTEGRATION	12

Cauchy's Fundamental Theorem - Cauchy's Integral Formula - Taylor's and Laurent's series-Classification of Singularities - Cauchy's Residue Theorem

REFERENCE(S):

1. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2015
2. C. Ray Wylie and C. Louis Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill Publishing Company Ltd,2003
3. J. A. Brown and R. V. Churchill, Complex Variables and Applications , Sixth Edition, McGraw Hill, New Delhi,1996
4. PeterV.O.Neil,AdvancedEngineeringMathematics,SeventhEditicn,CengageLearningIndiaPrivate Limited,2012
5. Glyn James, Advanced Engineering Mathematics, Third Edition,WileyIndia,2007

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	BS
Course Code	Course Name	Hours /Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS206	ENGINEERING MATERIALS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To introduce the essential principles of materials science for mechanical and related engineering.
- Learn about the Fe-Fe3C phase diagram, various microstructures and alloys
- Knowledge on mechanical properties of materials and their measurement
- Gain knowledge on magnetic and dielectric properties of materials
- Understand the basics of ceramics, composites and nano materials.

Course Outcomes: At the end of this course, learners will be able:

- To have knowledge on the various phase diagrams and their applications
- To acquire knowledge on Fe-Fe3C phase diagram, various microstructures and alloys
- To get knowledge on mechanical properties of materials and their measurement
- To gain knowledge on magnetic and dielectric properties of materials
- To understand the basics of ceramics, composites and nano materials.

UNIT I PHASE DIAGRAMS 9

Solid solutions - Hume Rothery's rules – the phase rule - single component system - one-component system of iron - binary phase diagrams - isomorphism systems - the tie-line rule - the lever rule - application to isomorphism system - eutectic phase diagram - paratactic phase diagram - other invariant reactions – free energy composition curves for binary systems - micro structural change during cooling

UNIT II FERROUS ALLOYS 9

The iron-carbon equilibrium diagram - phases, invariant reactions - microstructure of slowly cooled steels - eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - diffusion in solids - Fick's laws - phase transformations - T-T-T-diagram for eutectoid steel – pearlitic, baintic and martensitic transformations - tempering of martensite – steels – stainless steels, Cast iron.

UNIT III MAGNETIC MATERIALS 9

Magnetism in materials-magnetic field and induction-magnetic permeability and susceptibility -Classification of Magnetic Materials- Dia, Para and Ferro magnetic materials-Ferromagnetism – domain theory – types of energy – hysteresis – hard and soft magnetic materials – Anti ferro magnetic Materials- ferrites - Application of Ferrites

UNIT IV DIELECTRIC MATERIALS 9

Dielectric materials- Dipole moment- Polarization vector- Dielectric Constant- Polar and Non-polar Molecules- Electric Susceptibility-Polarization-Types of polarization – Langevin-Debye equation – frequency effects on polarization – Internal Field- Clausius mosotty equation-dielectric breakdown- Types of dielectric breakdown- Dielectric Loss– Insulating materials – Ferroelectric materials - Applications of Dielectric Materials- Dielectrics in Capacitors- Insulating materials in transformers.

UNIT V NEW MATERIALS 9

Ceramics – types and applications – composites: classification, role of matrix and reinforcement, processing of fiber reinforced plastics – metallic glasses: types, glass forming ability of alloys, melt spinning process, applications - shape memory alloys: NiTi alloy, applications – nonmaterial's: preparation (bottom up and top down approaches), properties and applications – carbon nano tubes: structures, preparation and applications.

TEXT BOOK(S):

1. Raghavan, V. —Physical Metallurgy: Principles and Practice. PHI Learning, 2015.
2. Balasubramaniam, R. "Callister's Materials Science and Engineering". Wiley India Pvt. Ltd. 2014.
3. Raghavan, V. —Materials Science and Engineering: A First course. PHI Learning, 2015.

REFERENCE(S):

1. Askeland, D. "Materials Science and Engineering". Brooks/Cole, 2010.
2. Wahab, M.A. —Solid State Physics: Structure and Properties of Materials. Narosa Publishing House, 2009.
3. Smith, W.F., Hashemi, J. & Prakash. R. "Materials Science and Engineering". Tata Mcgraw Hill Education Pvt. Ltd., 2014.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	MC
		Hours/Week			Credit	Total Hours	Maximum Marks	
Course Code	Course Name	L	T	P	C			
19MC201	ENVIRONMENTAL SCIENCE AND ENGINEERING	3	0	0	0	45	100	

Course Objective (s): The purpose of learning this course is to

- Study the nature and facts about environment.
- Finding and implementing scientific, technological and economic solutions to environmental problems.
- Know the types of natural resources and the individual role in conserving the resources.
- Apply the knowledge to various social issues by understanding the environmental legislation laws.
- Study the integrated themes and biodiversity, natural resources, pollution control and waste management.

Course Outcomes: At the end of this course, learners will be able to:

- Extend their knowledge in maintaining ecological balance and make use of their knowledge in the preservation of biodiversity.
- Outline the role of human being in maintaining a clean environment and useful environment for the future generations.
- Explain the constituents of environment, precious resources in the environment and conservation of natural resources.
- Find the role of government and Non-Government organization and explain the various rain water harvesting techniques.
- Develop their awareness about population growth, Family planning programme and HIV/AIDS and extend their knowledge in role of information technology in environment & human health.

UNIT I ECOSYSTEMS AND BIODIVERSITY | **10**

Environment: Scope – importance - need for public awareness -Concepts of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Food chains- food webs - types of ecosystem - structure and functions of forest ecosystem and river ecosystem – Biodiversity - value of biodiversity - consumptive use-productive use - social - ethical - aesthetic values - Hotspots of biodiversity -Threats to biodiversity - Habitat loss - poaching of wildlife and man wildlife conflicts.Conservation of biodiversity - In-situ and Ex-situ conservation.

UNIT II ENVIRONMENTAL POLLUTION | **8**

Pollution: Causes - effects and control measures of Air pollution - Water pollution - Soil pollution and Noise pollution - Solid waste management - Causes - effects -control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Disaster managements - Floods - cyclone- landslides.

UNIT III NATURAL RESOURCES | **9**

Forest resource - Use-over exploitation -deforestation - Water resource - use-over utilization of surface and ground water - conflicts over water - Mineral resource - use-exploitation-environmental effects of extracting and using mineral resource - Food resources - world food problems changes caused by agriculture - Effects of modern agriculture - fertilizer- pesticide problems - Energy resource - Renewable energy sources - solar energy - wind energy. Land resources - land degradation - soil erosion - Role of an individual in conservation of natural resources.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT | **9**

Sustainable & Unsustainable development-Water conservation - rain water harvesting (roof top method)- climate change- global warming - acid rain - ozone layer depletion - Environment protection act - Air (Prevention and control of pollution) Act - Water (prevention and control of pollution) Act - Green Chemistry – 12 Principles of Green chemistry – Application of Green chemistry

UNIT V HUMAN POPULATION AND THE ENVIRONMENT | **9**

Population growth - variation among nations - Population explosion & its consequences – Family,child, women welfare programmes - Human rights - HIV/AIDS – Human health and environment - Role of information technology in environment and human health

TEXT BOOK(S):

1. Anubha Kaushik and C.P. Kaushik, Environmental Science and Engineering, New Age International Publishers, New Delhi (2015)
2. Dr. A.Ravikrishan, Envrionmental Science and Engineering., Sri Krishna Hitech Publishing co. Pvt. Ltd., Chennai,12th Edition (2016)

REFERENCE(S):

1. Masters, Gilbert M, —Introduction to Environmental Engineering and Science‖, Second Edition, Pearson Education, New Delhi (2012).
2. Santosh Kumar Garg, Rajeshwari garg, smfRanjni Garg —Ecological and Environmental Studies‖ Khanna Publishers, NaiSarak, Delhi (2014).
3. .K. Trivedi, "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standard", Vol. I and II,

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Enviro Media.
4. Dharmendra S. Sengar, "Environmental law", Prentice Hall of India PVT LTD, New Delhi, 2007. 4. Rajagopalan, R, "Environmental Studies-From Crisis to Cure", Oxford University Press 2005
5. Cunningham, W.P. Cooper, T.H. Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2015.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES225	BASICS OF ENGINEERING MECHANICS	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is :

- To familiarizes basic concepts and force systems in real-world environment.
- To provide knowledge on statics of practices in space with moment & equilibrium of rigid bodies.
- To study the moment of inertia of surfaces and solids.
- To determine the solution for the problems related to kinematics of particles and forces associated with work, energy, impulse and momentum.
- To learn the concepts of static friction & geometric motion of rigid bodies.

Course Outcomes: At the end of this course, learners will be able to:

- Illustrate the scalar and Vectorial representation of forces and moments.
- Analyze the rigid bodies in equilibrium.
- Evaluate the properties of surface and solids.
- Calculate dynamic forces exerted in rigid bodies.
- Determine the friction characteristics of rigid bodies.

UNIT I	STATICS OF PARTICLES	10

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space (basics).

UNIT II	EQULIBRIUM OF RIGID BODIES	8

Free body diagram – Types of supports – Action and reaction forces – stable equilibriym – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Vargnon's theorem – Single quivalent force – Equilibrium of Rigid bodies in tow dimensions.

UNIT III	PROPERTIES OF SURFACES AND SOLIDS	9

Centroids and centre of mass – Cemtroids of areas – Rectangular, circular, triangular areas by integration – T-section, I-section, Angle section Hollow section by using standard formula – Theorems of Pappus – Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T-section, I-section, Angle section Hollow section by using standard formula – Parallel axis and Perpendicular axis theorems.

UNIT IV	DYNAMICS OF PARTICLES	9

Displacement, velocity and acceleration – Relative motion – Rectilinear & Curvilinear motions – Newton's second law of motion – Work – Energy Equation – Impulse and Momentum _ Law of Conservation of Momentum.

UNIT V	FRICTION	9

Friction force – Static and Dynamic friction – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – friction in connected bodies – wedge friction – ladder friction – belt friction – rolling resistance.

TEXT BOOK(S):

1. Dr. N. Kottiswaran, "Engineering Mechanics – Statics & Dynamics ", Latest Edition, Sri Balaji Publications.
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010).
3. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.

REFERENCE(S):

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004)

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	ES
Course Code	Course Name	Hours /Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES206	SEMICONDUCTOR DEVICES AND CIRCUITS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the structure of basic electronic devices.
- Be exposed to active and passive circuit elements.
- Familiarize the operation and applications of transistor like BJT and FET.
- Explore the characteristics of amplifier gain and frequency response.
- Learn the required functionality of positive and negative feedback systems.

Course Outcomes: At the end of this course, learners will be able to:

- Explain the structure and working operation of basic electronic devices.
- Identify and differentiate both active and passive elements
- Analyze the characteristics of different electronic devices such as diodes and transistors
- Choose and adapt the required components to construct an amplifier circuit.
- Employ the acquired knowledge in design and analysis of oscillators.

UNIT I	PN JUNCTION DEVICES	9

PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers – Half Wave and Full Wave Rectifier,– Display devices- LED, Laser diodes, Zener diode characteristics- Zener Reverse characteristics – Zener as regulator

UNIT II	TRANSISTORS AND THYRISTORS	9

BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristors and IGBT - Structure and characteristics

UNIT III	AMPLIFIERS	9

BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response – MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

UNIT IV	MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER	9

BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages– Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers –Types (Qualitative analysis).

UNIT V	FEEDBACK AMPLIFIERS AND OSCILLATORS	9

Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

TEXT BOOK(S):

1. David A. Bell,"Electronic devices and circuits", Oxford University higher education, 5th edition2008.
2. Sedra and smith, "Microelectronic circuits", 7th Ed., Oxford University Press.

REFERENCE(S):

1. Balbir Kumar, Shail.B.Jain, "Electronic devices and circuits" PHI learning private limited, 2nd edition2014.
2. Thomas L.Floyd, "Electronic devices" Conventional current version, Pearson prentice hall, 10th Edition, 2017.
3. Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rd Edition, 2003.
4. Robert L.Boylestad, "Electronic devices and circuit theory", 2002.
5. Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, 2004.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	EEC
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS02	SOFT SKILL - II	1	0	1	1.5	30	100	

Course Objective (s): The purpose of learning this course is to

- Train the Students on Group Discussion Do's and Don'ts.
- Coach the students on Interview Skills.
- Develop Presentation Skills.
- Develop Business Etiquette.
- Teach importance of Ethics and Values.

Course Outcomes: At the end of this course, learners will be able to:

- Participate Group Discussion with Confidence by knowing the tips and Tricks.
- Attend the interview with positive attitude by having Mock Interviews.
- Present them very well by enhancing their Presentation Skills.
- Behave very well in official gathering and Meeting by knowing Etiquette.
- Have good ethics and values in their Personal and Professional Life.

UNIT I	GROUP DISCUSSION	6

GD skills – Understanding the objective and skills tested in a GD – General types of GDs – Roles in a GD – Do's & Don'ts – Mock GD & Feedback

UNIT II	INTERVIEW SKILLS	6

Interview handling Skills – Self preparation checklist – Grooming tips: do's & don'ts – mock interview & feedback

UNIT III	PRESENTATION SKILLS	6

Presentation Skills – Stages involved in an effective presentation – selection of topic, content, aids – Engaging the audience – Time management – Mock Presentations & Feedback

UNIT IV	BUSINESS ETIQUETTE	6

Grooming etiquette – Telephone & E-mail etiquette – Dining etiquette – do's & Don'ts in a formal setting – how to impress.

UNIT V	ETHICS	6

Ethics – Importance of Ethics and Values – Choices and Dilemmas faced – Discussions from news headlines

REFERENCE BOOKS

1. The Seven Habits of Highly Effective People - Stephen R. Covey.
2. All the books in the "Chicken Soup for the Soul" series.
3. Man's search for meaning – Viktor Frankl
4. The greatest miracle in the world – OgMandino
5. Goal - Eliyahu Goldratt.
6. Working with Emotional Intelligence - David Goleman.
7. Excel in English – Sundra Samuel, Samuel Publications
8. Developing Communication Skills by Krishna Mohan and Meera Banerji; MacMillan India Ltd., Delhi
9. Essentials of Effective Communication, Ludlow and Panthon; Prentice Hall of India.
10. Effective Presentation Skills (A Fifty-Minute Series Book) by Steve Mandel
11. "Strategic interviewing" byRichaurd Camp, Mary E. Vielhaber and Jack L. Simonetti – Published by Wiley India Pvt. Ltd
12. "Effective Group Discussion: Theory and Practice" by Gloria J. Galanes, Katherine Adams , John K. Brilhart

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES223	ELECTRONICS DEVICES AND CIRCUITS LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Illustrate the VI characteristics semi conductor devices.
- Determine the various parameters of solid state devices by experimentally.
- Analyze the application of solid state devices.
- Learn about rectifiers and filter circuits
- Learn about Astable and Mono stable multivibrators

Course Outcomes: At the end of this course, learners will be ableto:

- Understand the applications of semiconductor devices.
- Analyze the parameters of BJT and FET.
- Apply the concept of UJT and SCR for simple applications
- Design an oscillator circuit using R, L, C components.
- Design an amplifier circuit using Transistors

LIST OF EXPERIMENTS

1. Characteristics of Semi conductor diode and Zener diode
2. Characteristics of a NPN Transistor under common emitter, common collector and common base configurations
3. Characteristics of JFET(Draw the equivalent circuit)
4. Characteristics of UJT and generation of saw tooth waveforms
5. Design and Frequency response characteristics of a Common Emitter amplifier
6. Characteristics of photo diode & photo transistor, Study of light activated relay circuit
7. Design and testing of RC phase shift, LC oscillators
8. Single Phase half-wave and full wave rectifiers with inductive and capacitive filters
9. Differential amplifiers using FET
10. Study of CRO for frequency and phase measurements
11. Astable and Mono stable multivibrators
12. Realization of passive filters

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Semiconductor devices like Diode, Zener Diode, NPN Transistors, JFET, UJT, Photo diode, Phototransistor
2. Resistors, Capacitors and inductors
3. Necessary digital IC8
4. Function Generators10
5. Regulated 3 output Power Supply 5, ± 15V10
6. CRO10
7. Storage Oscilloscope1
8. Bread boards10
9. At least one demo module each for the listed equipments.
10. Component data sheets to be provided

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES221	ENGINEERING DRAWING	0	0	4	2	60	100	

Course Objectives: The purpose of learning this course is to

- Learn conventions and use of drawing tools in making engineering drawings.
- Draw orthographic projection of points and lines.
- Draw the projection of planes and simple solids.
- Draw the section of solids and obtain the development of surfaces of given solids.
- Draw the isometric projection of the given solids.

Course Outcomes: At the end of this course, learners will be able to:

- Recognize the conventions and apply dimensioning concepts while drafting simple objects.
- Draw the orthographic projection of points and lines.
- Draw the projection of planes and simple solids.
- Draw the section of solid drawings and development of surfaces of given solids.
- Draw the isometric projection of the given objects.

CONCEPTS AND CONVENTIONS (Not for Examination)	1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and Specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I	PLANE CURVES	12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of triangle, square and circle – Drawing of tangents and normal to the above curves.

UNIT II	PROJECTION OF POINTS AND LINES	11

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method.

UNIT III	PROJECTION OF PLANES & SOLIDS	12

Projection of planes (polygonal and circular surfaces) inclined to both the principal planes. Projection of simple Solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES	12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V	ISOMETRIC PROJECTIONS	12

Principles of isometric projection – isometric scale –Isometric projections of simple solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions.

TEXT BOOK(S):

1. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2012.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

REFERENCE(S):

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi,2008.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester III	BS
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS304	TRANSFORM TECHNIQUES AND THEIR APPLICATIONS	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is to

- Find the difference between the discrete and continuous signals and formulae usingZ-Transform.
- Find Laplace transform of a continuous function in time space and solve second order differential equations
- Understand the concepts of Fourier series, Transforms and Boundary Conditions, which will enable them to model and analyze the physical phenomena
- Implement the Fourier Transform an elegant method in the study of signals
- Summarize and apply the mathematical aspects that contribute to the solution of one dimensional wave equation

Course Outcomes: At the end of this course, learners will be able to:

- Use the Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation
- Formulate a function in frequency domain whenever the function is defined in time domain
- Recognize the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series.
- Apply the Fourier transform, which converts the time function into a sum of sine waves of different frequencies, each of which represents a frequency component.
- Apply and solve the engineering problems in the area of heat, wave equations.

UNIT I	Z -TRANSFORM	12

Z-Transform - Elementary Properties - Inverse Z-Transform - Convolution Method- Partial fraction method - Solution of Difference Equations using Z-Transform.

UNIT II	LAPLACE TRANSFORM	12

Laplace Transform- Existence Condition -Transforms of Standard Functions - Unit step function, Unit impulse function- Properties- Transforms of Derivatives and Integrals - Initial and Final Value Theorems - Laplace transform of Periodic Functions - Inverse Laplace transforms - Applications of Differential Equations

UNIT III	FOURIER SERIES	12

Dirichlet's conditions - General Fourier series - Odd and even functions - Half range cosine and sine series - Root mean square value

UNIT IV	FOURIER TRANSFORM	12

Fourier Integral Theorem- Fourier Transform and Inverse Fourier Transform- Sine and Cosine Transforms - Properties - Transforms of Simple Functions - Convolution Theorem - Parseval's Identity

UNIT V	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	12

Classification of Second Order Quasi Linear Partial Differential Equations - Fourier Series Solutions of One Dimensional Wave Equation - One Dimensional Heat Equation - Steady State Solution of Two-Dimensional Heat Equation - Fourier Series Solutions in Cartesian Coordinates.

REFERENCE(S):

1. E. Kreyszig, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Sons, Inc, Singapore, 2008
2. Peter V. O. Neil,Advanced Engineering Mathematics, Seventh Edition, Cenage Learning India Private Ltd,2012.
3. C. Ray Wylie and C. Louis Barrett,Advanced Engineering Mathematics, Tata McGraw-Hill Publishing Company Ltd, 2003.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA301	SENSORS AND INSTRUMENTATION	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- To understand the concepts of measurement technology.
- To learn the various sensors used to measure various physical parameters.
- To understand the concepts of motion , Proximity and ranging sensors
- To understand the basic principles of various pressure and temperature, smart sensors.
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.

Course Outcomes: At the end of this course, learners will be able to:

- Familiar with various calibration techniques and signal types for sensors.
- Apply the various sensors in the Automotive and Mechatronics applications
- Describe the working principle and characteristics of force, magnetic and heading sensors.
- Understand the basic principles of various pressure and temperature, smart sensors.
- Ability to implement the DAQ systems with different sensors for real time applications.

UNIT I	INTRODUCTION	9

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types. Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II	MOTION, PROXIMITY AND RANGING SENSORS	9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RFbeacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III	FORCE, MAGNETIC AND HEADING SENSORS	7

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers

UNIT IV	OPTICAL, PRESSURE AND TEMPERATURE SENSORS	11

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V	SIGNAL CONDITIONING AND DAQ SYSTEMS	9

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TEXT BOOK(S):

1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009
2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013

REFERENCE(S):

1. C. Sujatha Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science
4. Publications, 1999.
5. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
6. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA302	KINEMATICS AND DYNAMICS OF MACHINERY	3	1	0	4	60	100	

Course Objectives: The purpose of learning this course is to

- To understand the basic knowledge about kinematics of machines.
- To understand the basic components and layout of linkages in the assembly of a system/ machine.
- To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.

Course Outcomes: At the end of this course, learners will be able to:

- The students be able to understand the basic knowledge of kinematics of machines
- Students can able to apply fundamentals of mechanism for the design of new mechanisms
- Able to know about the linkages, design few linkage & cam mechanisms for specified output motions.
- Impart knowledge about the gears and gear trains.
- Ability to analyze them for optimum design.

UNIT I	KINEMATIC OF MACHINES	12

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles -derivatives of followers motion – circular arc and tangent cams.

UNIT II	GEARS AND GEAR TRAINS	12

Spur gear – law of toothed gearing – involutes gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclical gear trains – automotive transmission gear trains.

UNIT III	FRICTION	12

Sliding and Rolling Friction angle – friction in threads – Friction Drives –Belt and rope drives.

UNIT IV	FORCE ANALYSIS	12

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D□ Alembert□ s principle – superposition principle – dynamic Force Analysis in simple machine members.

UNIT V	BALANCING AND VIBRATION	12

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft

TEXT BOOK(S):

1. Ambekar A.G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi,2007
2. Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press,2003.

REFERENCE(S):

1. Rao.J.S. and Dukkipatti R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi, 1992.
2. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low Prices Student Edition, 1999.
3. V.Ramamurthi, Mechanisms of Machine, Narosa Publishing House, 2002.
4. Robert L.Norton, Design of Machinery, McGraw-Hill, 2004.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ME305	STRENGTH OF MATERIALS	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To study and estimate the mechanical properties of materials and its deformations under different loading conditions through experiments.
- To learn two dimensional stress systems and stresses in thin cylinders and spherical shells.
- To gain knowledge on shear force and bending stress distribution in different beams under various loads.
- To impart knowledge on finding slope and deflection of beams and buckling of columns for various boundary conditions.
- To learn the deformation of shaft under torsion and deflection of closed helical springs.

Course Outcome(s): At the end of this course, learners will be able to:

- Evaluate the stresses and strains in regular and composite structures subjected to axial loads.
- Examine the stresses in two dimensional systems and thin cylinders.
- Examine the shear force, bending moment and shear stress of various beams under different loading conditions
- Evaluate the slope and deflection of beams and buckling loads of columns with different boundary conditions.
- Examine the stresses induced in shaft and closed coil helical springs subjected to torsion.

Unit I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	09
Introduction to material properties. Stresses and strains due to axial force, shear force, impact force and thermal effect-stepped and composite bars-uniformly varying cross section. Stress-strain curve for ductile and brittle materials-Hooke-law-Factor of safety Poisson-ratio. Elastic constants and their relationship.		
Unit II	**ANALYSIS OF STRESSES IN TWO DIMENSIONS**	**09**
State of stresses at a point-Normal and shear stresses on inclined planes-Principal planes and stresses- Plane of maximum shear stress-Mohr's-circle for bi-axial stress with shear stress. Hoop and longitudinal stresses in thin cylindrical and spherical shells-Changes in dimensions and volume.		
Unit III	**LOADS AND STRESSES IN BEAMS**	**09**
Types of beams-Supports and Loads, Shear force and Bending Moment in beams, Cantilever, simply supported and overhanging beams-Point of contra flexure. Theory of simple bending-bending and shear stress-stress variation along the length and section of the beam, Section modulus.		
Unit IV	**DEFLECTION OF BEAMS AND COLUMNS**	**09**
Slope and Deflection of cantilever, simply supported and overhanging beams- Double integration method and Macaulay's method. Columns-types-Equivalent length Euler and Rankine formulae- Slenderness.		
Unit V	**TORSION IN SHAFT AND HELICAL SPRING**	**09**
Analysis of torsion of circular solid and hollow shafts-stepped shaft-compound shaft-Shear stress distribution, angle of twist and torsional stiffness. Closed coil helical spring-stresses and deflection under axial load-Maximum shear stress in spring section including Wahl's Factor problems, applications.		

TEXT BOOK(S):

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India Learning Pvt. Ltd, New Delhi, 2010.
2. S.S.Rattan, Strength of Materials, Tata McGraw Hill, Delhi, Second Edition, 2011.
3. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016

REFERENCE(S):

1. D. K. Singh, Mechanics of Solids, Pearson Education New Delhi, 2006.
2. W.A. Nash, Theory and problems in Strength of Materials, Schaum Outline Series, McGraw- Hill Book Co., New York,1995.
3. F. P. Beer and R. Johnston, Mechanics of Materials, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, Third edition,2002.
4. B. K. Sarkar, Strength of Materials, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, Second Reprint, 2007.
5. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester III	ES
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES304	ELECTRICAL MACHINES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Introduce the principles of operations of DC machines as motor and generator
- Introduce the principles of operations of Transformers
- Introduce the principles of operations of Induction machines
- Introduce the principles of operations of Synchronous machines
- Introduce other special machines

Course Outcomes: At the end of this course, learners will be able to:

- Acquire knowledge to solve problems associated with DC and AC Machines.
- Test and control different machines based on the familiarity of basic concepts and working principle.
- Choose appropriate machines for a given application while carrying out projects.
- Apply the knowledge gained to choose appropriate machines for specific application useful for the society.
- Know about the latest developments related to machines and to learn their concepts even after the completion of the course.

UNIT I	D.C. MACHINES	9

D.C. Machines: – Principle of operation and construction of motor and generator – torque equation – Various excitation schemes – Characteristics of Motor and Generator – Starting, Speed control of D.C.Motor.

UNIT II	TRANSFORMERS	9

Principle, Construction and Types of Transformer - EMF equation - Phasor diagrams - Regulation and efficiency of a transformer-Introduction to three phase transformer Connection. Applications of Current and Potential Transformer.

UNIT III	SYNCHRONOUS MACHINES	9

Principle of Operation, type - EMF Equation and Phasor diagrams - Synchronous motor- Rotating Magnetic field Starting Methods , Torque V- Curves, inverted – Vcurves.

UNIT IV	THREE PHASE INDUCTION MOTORS	9

Induction motor-principle of operation, Types - Torque-slip characteristics - Starting methods and Speed control of induction motors.

UNIT V	SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES	9

Types of single phase induction motors –Double field revolving theory- Capacitor start capacitor run motors – Shaded pole motor – Repulsion type motor – Universal motor – Hysteresis motor - Switched reluctance motor – Brushless D.C motor.- Steppermotor.

TEXT BOOK(S):

1. Fitzgerald A.E, Kingsley C., Umans, S. and Umans S.D., "Electric Machinery", McGraw- Hill, 2002.
2. Theraja, B.L., "A Text book of Electrical Technology", Vol.II, S.C Chand and Co., New Delhi, 2007.

REFERENCE(S):

1. Abhijit Chakrabarti and Sudipta Debnath, "Electrical Machines", McGraw- Hill Education, 2015.
2. Deshpande M. V., "Electrical Machines" PHI Learning Pvt. Ltd., New Delhi,2011
3. B.S.Guru and H.R.Hiziroglu, "Electric Machinery and Transformer', Oxford university Press2007
4. Del Toro, V., "Electrical Engineering Fundamentals", Prentice Hall of India, New Delhi, 1995.
5. Nagrath I. J and Kothari D. P. 'Electric Machines', Fourth Edition, McGraw Hill Education,2010.
6. C.A.Gross, "Electric Machines", CRC Press2010.
7. NPTEL Video Lecture series on "Electrical Machines I" and "Electrical Machines II" by Dr. Krishna Vasudevan, IIT Madras.

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Department	ROBOTICS AND AUTOMATION					R2019	Semester III	EEC
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS03	QUANTITATIVE APTITUDE AND LOGICAL REASONING - I	2	0	0	0	30	100	

Course Objective (s): The objective of this course is to

- Crack aptitude assessment by using speed math concepts.
- Solve problems using fast track method by learning simplification and numbers.
- Learn the basic of ratio and proportion and mixture concepts.
- Calculate different ways of solving problems on average and ages.
- Learn the logical skills by analyzing the objects.

Course Outcomes: At the end of this course, learners will be able to:

- Solve the question with speed and accuracy.
- Crack the quantitative aptitude questions by using simplification and numbers system.
- Solve most of the aptitude topics by knowing ratio and proportion topics with allegation.
- Solve the problems on average and ages by using logical way of approach.
- Develop their logical thinking.

UNIT I	SPEED MATHS AND NUMBER SYSTEMS	6

SPEED MATHS: Square and square roots – Square for numbers from 31 to 50. Finding squares of numbers between 81 to 100. Cubes and cubes roots.
NUMBER SYSTEMS: Numbers and types of Numbers – Properties of Numbers –Face value and place value - Divisibility rules – Concept on unit digit and remainder theorem.

UNIT II	SIMPLIFICATIONS & PROBLEMS ON NUMBERS	6

SIMPLIFICATIONS: BODMAS rule – Application of algebraic formulae –Simplification of decimal fraction & mixed fraction – Continued fraction and its simplification – Recurring decimals.
PROBLEMS ON NUMBERS: Set of numbers – Assume the unknown numbers and form equations

UNIT III	RATIO &PROPORTION ,ALLIGATIONS& MIXTURE	6

RATIO AND PROPORTION: Ratio between two or more persons – Miscellaneous problems.
ALLIGATIONS ANS MIXTURES: Definition – Allegation rule – Mean value (or cost price) of the mixture – Six golden rules to solve problems on mixture – Removal among the quantities more than two.

UNIT IV	AVERAGES &PROBLEM ON AGES	6

AVERAGES: Average from total –Total from the average – Miscellaneous problems.
PROBLEMS ON AGES: Ages - Persons in Past - Present - Future. Miscellaneous problem.

UNIT V	ANALOGY & MIRROR & WATER IMAGES	6

ANALOGY: Study and topic relationship – Worker and tool relationship – Tool and action relationship – Work and working place – Worker and product – Product and raw materials – Instrument and measurement – Quantity and unit – Animals and young ones – Male and female.
MIRROR IMAGES AND WATER IMAGES: Letter inverted – Object inverted.

REFERENCES:

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. R.V.Praveen,"Quantitative Aptitude and Reasoning"Third Edition, PHI Learning ,2016.
4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017.
5. Arun Sharma "How to Prepare for Quantitative Aptitude"Eight Edition, McGraw Hill Education,2018.
6. "Reasoning and Aptitude" for GATE andESE Prelims, Made Easy Publication,2020.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester III	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES308	SENSORS AND ELECTRICAL MACHINES LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Make the students aware of basic concepts of measurement and operation of different types of transducers.
- Make the students conscious about static and dynamic characteristics of different types of transducer.
- Make the students to analyze step response of RTD
- Obtain the no load and load characteristics of D.C machines.
- Obtain the speed characteristics of D.C motor and Find out regulation characteristics of Transformer.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the static and dynamic characteristics of measuring instruments.
- Gain knowledge about the principle of operation and characteristics of different types of resistance, capacitance and inductance transducers.
- Analyze various electronic circuits such as voltage regulators, transistor amplifiers andoscillators.
- Make use of basic concepts to obtain the no load and load characteristics of D.Cmachines.
- Analyze and draw conclusion from the characteristics obtained by conducting experiments onmachines.

LIST OF EXPERIMENTS :

SENSOR LAB:

1. Displacement versus output voltage characteristics of a potentio metric transducer.
2. Characteristics of Strain gauge and Load cell.
3. Characteristics of LVDT, Hall Effect transducer and photoelectric tachometer.
4. Characteristics of LDR, thermistor and thermocouple (J, K, E types).
5. Step response characteristic of RTD and thermocouple.

MACHINES LAB:

1. Open circuit characteristics of D.C. shuntgenerator.
2. Load characteristics of D.C. shuntgenerator.
3. Load test on D.C. seriesmotor.
4. Load test and speed control of D.C. shuntmotor.
5. Open circuit and short circuit tests on single phase transformer (Determination of equivalent circuitparameters).

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

FOR SENSOR LAB:

1. Potentiometric Transducer kit
2. Strain gauge and Load cell
3. LVDT , Thermistor and photoelectric tachnometerThermocouple (J, K, E types).
4. LDR and Thermistor

FOR MACHINES LAB:

S.No.	Name of the Equipment / Components	Quantity Required
1.	DC Shunt Motor with Loading Arrangement	3
2.	Single Phase Transformer	3
3.	Single Phase Induction Motor with Loading Arrangement	1
4.	Single Phase Auto Transformer	3
5.	Single Phase Resistive Loading Bank	2
6.	Sufficient number of Ammeters, Voltmeters, (or multimeters), switches, tachometers, Wattmeters.	2

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA303	DYNAMICSLABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- To supplement the principles learnt in kinematics and Dynamics of Machinery.
- To understand how certain measuring devices are used for dynamic testing.

Course Outcomes: At the end of this course, learners will be able to:

- Ability to demonstrate the principles of kinematics and dynamics of machinery
- Ability to use the measuring devices for dynamic testing.

LIST OF EXPERIMENTS:

1. a) Study of gear parameters.
   b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
   b) Kinematics of single and double universaljoints.
3. a) Determination of Mass moment of inertia of Fly wheel and Axlesystem.
   b) Determination of Mass Moment of Inertia of axisymmetric bodies using TurnTable apparatus.
   c) Determination of Mass Moment of Inertia using bifilar suspension and compoundpendulum.
4. Motorized gyroscope – Study of gyroscopic effect andcouple.
5. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing, Motion curves and study of jumpphenomenon
7. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficientdetermination.
   b) Multi degree freedom suspension system – Determination of influence coefficient.
8. a) Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies. b) Vibration Absorber – Tuned vibrationabsorber.
9. Vibration of Equivalent Spring mass system – undamped and damped vibration.
10. Whirling of shafts – Determination of critical speeds of shafts with concentratedloads.
11. a) Balancing of rotating masses. (b) Balancing of reciprocatingmasses.
12. a) Transverse vibration of Free-Free beam – with and without concentratedmasses.
    b) Forced Vibration of Cantilever beam – Mode shapes and naturalfrequencies.
    c) Determination of transmissibility ratio using vibratingtable.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Cam follower setup.	1 No.
2	Motorised gyroscope.	1 No.
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	1 No.
4	Whirling of shaft apparatus.	1 No.
5	Dynamic balancing machine.	1 No.
6	Two rotor vibration setup.	1 No.
7	Spring mass vibration system.	1 No.
8	Torsional Vibration of single rotor system setup.	1 No.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ME307	STRENGTH OF MATERILAS LABORATORY	0	0	2	1	30	100	

Course Objective(s): The purpose of learning this course is:

- To study the mechanical properties of materials when subjected to different types of loading.

Course Outcome(s): At the end of this course, learners will be able to:

- Perform Tension and Shear stress test on Solid materials.
- Perform Torsion and impact test on Solid materials.
- Perform Hardness test on Solid materials.
- Perform Deformation test on Beams.
- Perform Compression and Tension test on Helical springs.

Exp No.	Name of Experiments
1	Tension test on a mild steel rod.
2	Double shear test on Mild steel and Aluminium rods.
3	Torsion test on mild steel rod.
4	Impact test on metal specimen.
5	Hardness test on metals - Brinnell Hardness Number.
6	Hardness test on metals - Rockwell Hardness Number.
7	Hardness test on metals – Vicker's Hardness Number.
8	Deflection test on beam.
9	Compression test on helical spring.
10	Tension test on helical spring.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
S. No	NAME OF THE EQUIPMENT	Qty.
1	Universal Tensile Testing machine with double 1 shear attachment – 40 Ton Capacity	1 No.
2	Torsion Testing Machine (60 NM Capacity)	1 No.
3	Impact Testing Machine (300 J Capacity)	1 No
4	Brinell Hardness Testing Machine	1 No.
5	Rockwell Hardness Testing Machine	1 No.
6	Vicker's Hardness Testing Machine	
7	Spring Testing Machine for tensile and compressive loads (2500 N)	1 No.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES403	OBJECT ORIENTED PROGRAMMING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand Object Oriented Programming concepts and basic characteristics of Java
- Know the principles of packages, inheritance and interfaces
- Define exceptions and use I/O streams
- Develop a java application with threads and generics classes
- Design and build simple Graphical User Interfaces

Course Outcomes: At the end of this course, learners will be able to:

- Develop Java programs using OOP principles
- Develop Java programs with the concepts inheritance and interfaces
- Build Java applications using exceptions and I/O streams
- Develop Java applications with threads and generics classes
- Develop interactive Java programs using swings

UNIT I | INTRODUCTION TO OOP AND JAVA FUNDAMENTALS | 10

Object Oriented Programming - Abstraction – objects and classes - Encapsulation- Inheritance - Polymorphism- OOP in Java – Characteristics of Java – The Java Environment - Java Source File -Structure – Compilation. Fundamental Programming Structures in Java – Defining classes in Java – constructors, methods -access specifies - static members - Comments, Data Types, Variables, Operators, Control Flow, Arrays , Packages – Java Doc comments.

UNIT II | INHERITANCE AND INTERFACES | 9

Inheritance – Super classes- sub classes –Protected members – constructors in sub classes- the Object class – abstract classes and methods- final methods and classes – Interfaces – defining an interface, implementing interface, differences between classes and interfaces and extending interfaces - Object cloning -inner classes, Array Lists -Strings

UNIT III | EXCEPTION HANDLING AND I/O | 9

Exceptions - exception hierarchy - throwing and catching exceptions – built-in exceptions, creating own exceptions, Stack Trace Elements. Input / Output Basics – Streams – Byte streams and Character streams – Reading and Writing Console – Reading and Writing Files

UNIT IV | MULTITHREADING AND GENERIC PROGRAMMING | 8

Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups. Generic Programming – Generic classes – generic methods – Bounded Types – Restrictions and Limitations.

UNIT V | EVENT DRIVEN PROGRAMMING | 9

Graphics programming - Frame – Components - working with 2D shapes - Using color, fonts, and images - Basics of event handling - event handlers - adapter classes - actions - mouse events - AWT event hierarchy - Introduction to Swing – layout management - Swing Components – Text Fields , Text Areas – Buttons- Check Boxes – Radio Buttons – Lists-choices- Scrollbars – Windows –Menus – Dialog Boxes.

TEXT BOOK(S):

1. Herbert Schildt, "Java The complete reference", 8th Edition, McGraw Hill Education, 2011.
2. Cay S. Horstmann, Gary cornell, "Core Java Volume –I Fundamentals", 9th Edition, Prentice Hall, 2013.
3. Herbert Schildt, "Java The complete reference", 8th Edition, McGraw Hill Education, 2011.

REFERENCE(S):

1. Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3rd Edition, Pearson, 2015.
2. Steven Holzner, "Java 2 Black book", Dreamtech press, 2011.
3. Timothy Budd, "Understanding Object-oriented programming with Java", Updated Edition, Pearson Education, 2000.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester IV	BS
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS403	NUMERICAL METHODS AND STATISTICS	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is to

- By enrolling and studying this course the students will be able to understand the methods to solve polynomial equations.
- Implement the mathematical ideas for interpolation numerically
- Summarize and apply the methodologies involved in solving problems related to ordinary and partial differential equations
- Apply the concepts testing of hypothesis in their core areas
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment

Course Outcomes: At the end of this course, learners will be able to:

- Classify the equations into algebraic, transcendental or simultaneous and apply the techniques to solve them numerically
- Demonstrate and obtain the differentiation and integration of functions using the numerical techniques
- Obtain the solutions of all types of differential equations, numerically.
- Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.
- Design an experiment for an appropriate situation using ANOVA technique.

UNIT I	SOLUTION OF EQUATIONS	12

Solution of algebraic and transcendental equations: Newton- Raphson method - Solution of system of linear equations: Gauss elimination method - Inverse of a matrix: Gauss-Jordan method- Eigen values of a matrix by Power method.

UNIT II	NUMERICAL DIFFERENTIATION AND INTEGRATION	12

Interpolation: Newton's forward and backward interpolation formulae - Numerical differentiation: Newton's forward and backward interpolation formulae. Numerical integration: Trapezoidal rule- Simpson's1/3 rule for single integrals- Two point Gaussian quadrature formula.

UNIT III	NUMERICAL SOLUTIONS OF DIFFERENTIAL EQUATIONS	12

Solution of first order ordinary differential equations: Fourth order Runge- Kutta method - Solution of partial differential equations: Elliptic equations: Poissons equation- Parabolic equations by Crank Nicholson method- Hyperbolic equations by explicit finite difference method

UNIT IV	CORRELATION AND REGRESSION	12

Correlation- Multiple correlation –Regression – Multiple Regression-Linear fit- Quadratic fit

UNIT V	DESIGN OF EXPERIMENTS	12

Completely randomized design - Randomized block design - Latin square design.

REFERENCE(S):

1. Gerald C. F and Wheatley P.O, Applied Numerical Analysis, Seventh Edition, Pearson Education, New Delhi, 2004.
2. Johnson R.A, Miller and Freund, Applied Probability and Statistics for Engineers, Seventh Edition, Prentice Hall of India, New Delhi, 2005.
3. Walpole R.E, Myers R.H, Myers R.S.L and Ye K, Probability and Statistics for Engineers and Scientists, Seventh Edition, Pearsons Education, Delhi, 2002
4. Burden R. L and Douglas Faires J, Numerical Analysis Theory and Applications, Cengage Learning, Ninth Edition, 2005.
5. Steven Chapra , Numerical Methods for Engineers, Tata McGraw Hill seventh Edition, 2015.
6. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19EI401	LINEAR INTEGRATED CIRCUITS AND APPLICATIONS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Learn the IC fabrication procedure.
- Signal analysis using Op-amp based circuits.
- Apply Op-amp for industrial purpose.
- Functional blocks and the applications of special ICs like Timers, PLL circuits, regulator Circuits.
- Know about the linear integrated circuits fabrication and their Application.

Course Outcomes: At the end of this course, learners will be able to:

- Acquire knowledge in IC fabrication procedure
- Analyze the characteristics of Op-Amp
- Understand the importance of Signal analysis using Op-amp based circuits.
- Functional blocks and the applications of special ICs like Timers, PLL circuits, regulator Circuits.
- Understand and acquire knowledge on the Applications of Op-amp

UNIT I IC FABRICATION — 9

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of Impurities. Realization of monolithic ICs and packaging. Fabrication of diodes, capacitance, resistance, FETs and PV Cell.

UNIT II CHARACTERISTICS OF OPAMP — 9

Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Basic applications of op-amp – Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-V/I & I/V converters.

UNIT III APPLICATIONS OF OPAMP — 9

Instrumentation amplifier and its applications for transducer Bridge, Log and Antilog Amplifiers- Analog multiplier & Divider, first and second order active filters, comparators, multivibrators, waveform generators, clippers, clampers, peak detector, S/H circuit, D/A converter (R- 2R ladder and weighted resistor types),A/D Converters using OP-amps.

UNIT IV SPECIAL ICs — 9

Functional block, characteristics of 555 Timer and its PWM application - IC-566 voltage controlled oscillator IC; 565-phase locked loop IC, AD633 Analog multiplier ICs

UNIT V APPLICATION ICs — 9

AD623 Instrumentation Amplifier and its application as load cell weight measurement - IC voltage regulators – LM78XX, LM79XX; Fixed voltage regulators its application as Linear power supply - LM317, 723 Variable voltage regulators, switching regulator- SMPS - ICL 8038 function generator IC.

TEXT BOOK(S):

1. David A. Bell, 'Op-amp & Linear ICs', Oxford, 2013.
2. D. Roy Choudhary, Sheil B. Jani, 'Linear Integrated Circuits', II edition, New Age, 2003.
3. Ramakant A.Gayakward, 'Op-amps and Linear Integrated Circuits', IV edition, Pearson Education, 2003/ PHI.2000.

REFERENCE(S):

1. Fiore, "Opamps& Linear Integrated Circuits Concepts & applications", Cengage, 2010.
2. Floyd, Buchla,"FundamentalsofAnalog Circuits, Pearson,2013.
3. Jacob Millman, Christos C.Halkias, 'Integrated Electronics - Analog and Digital circuits system', McGraw Hill, 2003.
4. Robert F.Coughlin, Fredrick F. Driscoll, 'Op-amp and Linear ICs', Pearson, 6thedition, 2012.
5. Muhammad H. Rashid,' Microelectronic Circuits Analysis and Design' Cengage Learning, 2011.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19EI402	DIGITAL PRINCIPLES AND SYSTEM DESIGN	2	1	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Study various number systems and simplify the logical expressions using Boolean functions
- Study combinational circuits
- Design various synchronous and asynchronous circuits.
- Introduce asynchronous sequential circuits and PLDs
- Introduce digital simulation for development of application oriented logic circuits.

Course Outcomes: At the end of this course, learners will be able to:

- Design combinational and sequential Circuits..
- Study various number systems and simplify the logical expressions using Boolean functions
- Design various synchronous and asynchronous circuits.
- Introduce asynchronous sequential circuits and PLDs
- Introduce digital simulation for development of application oriented logic circuits.

UNIT I	NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES	9

Review of number systems, binary codes, error detection and correction codes (Parity and Hamming code) Digital Logic Families -comparison of RTL, DTL, TTL, ECL and MOS families -operation, characteristics of digital logic family.

UNIT II	COMBINATIONAL CIRCUITS	9

Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps - simplification and implementation of combinational logic – multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders.

UNIT III	SYNCHRONOUS SEQUENTIAL CIRCUITS	9

Sequential logic- SR, JK, D and T flip flops - level triggering and edge triggering - counters - asynchronous and synchronous type - Modulo counters - Shift registers - design of synchronous sequential circuits – Moore and Melay models- Counters, state diagram; state reduction; state assignment.

UNIT IV	ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABILITY LOGIC DEVICES	9

Asynchronous sequential logic circuits-Transition ability, flow ability-race conditions, hazards &errors in digital circuits; analysis of asynchronous sequential logic circuits-introduction to Programmability Logic Devices: PROM PLA –PAL, CPLD-FPGA.

UNIT V	VHDL	9

RTL Design – combinational logic – Sequential circuit – Operators – Introduction to Packages – Subprograms Test bench. (Simulation /Tutorial Examples: adders, counters, flip flops, Multiplexers & De multiplexers).

TEXT BOOK(S):

1. JamesW.Bignel, DigitalElectronics, Cengagelearning, 5thEdition, 2007.
2. M. Morris Mano, 'Digital Design withan introduction to the VHDL', Pearson Education, 2013.
3. Comer "Digital Logic & State Machine Design, Oxford, 2012.

REFERENCE(S):

1. Mandal,"DigitalElectronicsPrinciples&Application,McGrawHillEdu,2013.
2. William Keitz, Digital Electronics-A Practical Approach with VHDL, Pearson, 2013.
3. ThomasL.Floyd, 'Digital Fundamentals', 11thedition, Pearson Education, 2015.
4. CharlesH.Roth, Jr, LizyLizyKurianJohn, 'Digital System Design using VHDL, Cengage, 2013.
5. D.P.Kothari,J.S.Dhillon, 'Digital circuits and Design',PearsonEducation, 2016.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester IV	EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS04	QUANTITATIVE APTITUDE AND LOGICAL REASONING - II	2	0	0	0	30	100	

Course Objective (s): The objective of this course is to

- Learn the basic of partnership and chain rule in simplified way.
- Solve problems using fast track method by learning profit and loss with percentage.
- Teach the angle of elevation and depression.
- Know the relationship, direction concepts in easy way.
- Know about coding and decoding through logical way.

Course Outcomes: At the end of this course, learners will be able to:

- Solve problems by using shortcut in partnership and chain rule.
- Know the tips and tricks of profit and loss with percentage through fast track methods.
- Understand the concepts of angles.
- Evaluate critically the real life situations by resorting and analyzing analytical reasoning of keyissues and factors.
- Enhance the logical way of thinking by solving problems codes and rankings concepts.

UNIT I	PARTNERSHIP & CHAIN RULE	6

PARTNERSHIP: Ratio of division of gains: Simple Partnership – Compound Partnership - Working and sleeping partners.

CHAIN RULE: Definition – Direct proportion and Indirect proportion.

UNIT II	PROFIT &LOSS, PERCENTAGE	6

PROFIT AND LOSS: Basic definition and types of profit and loss – Concept of discount and marked price – Concept of true v/s false value – Application in data interpretation problems.

PERCENTAGE: Percentage – Percentage using shortcuts.

UNIT III	HEIGHT AND DISTANCE	6

HEIGHT AND DISTANCES: Line of sight – Angle of elevation – Angle of depression.

UNIT IV	BLOOD RELATIONSHIP & DIRECTION SENSE TEST	6

BLOOD RELATIONSHIP: Analysis the gender relationship –Relationship diagram - Family tree.

DIRECTION SENSE TEST: Distance between the starting and ending points - Sense the direction correctly.

UNIT V	LOGICAL SEQUENCE OF WORD, CODING AND DECODING, NUMBER RANKING & TIME SEQUENCE TEST	6

LOGICAL SEQUENCE OF WORDS: Sequence of occurrence of events – Sequence of objects in a class or group – Sequence of increasing/decreasing size, value, intensity, etc.

CODING AND DECODING: Introduction – Description of coding method, Coding patterns – Concepts of coding & decoding – Problems involving coding & decoding method.

NUMBER RANKINGS & TIME SEQUENCE TEST: Number test – Ranking test – Time sequence test.

REFERENCES:

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. R.V.Praveen,"Quantitative Aptitude and Reasoning"Third Edition, PHI Learning ,2016.
4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017.
5. Arun Sharma "How to Prepare for Quantitative Aptitude"Eight Edition, McGraw Hill Education,2018
6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication,2020.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19EI403	INDUSTRIAL INTERNET OF THINGS	2	0	2	3	60	100	

Course Objective (s): The purpose of learning this course is to

- Impart knowledge in Internet of Things(IoT)
- Understand the concept of interfacing smart sensors/actuators with internet connectivity
- Illustrate the various protocol standards deployed in Internet of Things (IoT) domain
- Aware of security concerns and challenges in IoT.
- Know about DIY kits and other apps.

Course Outcomes: At the end of this course, learners will be able to:

- Compare the IoT with M2M by analyzing the characteristics, functional blocks and architectural models of IoT
- Examine the various design levels, physical devices and technologies used for IoT
- Analyze the design principles of various connected devices used in IoT
- Analyze the various communication protocols & standards used for IoT design
- Apply IoT design principles in various domain and infer the challenges in real time implementation

UNIT I	INTRODUCTION AND ELEMENTS OF IoT	9

Definition of IoT - Evolution of IoT - IoT and related terms - Business Scope- Introduction to Elements of IoT - Basic Architecture of an IoT Application Sensors & Actuators - Edge Networking (WSN) – Gateways - IoT Communication Model – WPAN & LPWA

UNIT II	COMMUNICATION AND CONNECTIVITY TECHNOLOGIES	9

Cloud Computing in IoT - Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning. IoT Communication Model – Cloud Connectivity

UNIT III	DATA ANALYTICS AND IoT PLATFORMS	9

Big Data Analytics - Evolution of Big data - Best Practices for Big data Analytics - Big data characteristics - Validating-The Promotion of the Value of Big Data - Big Data Use Cases- Characteristics of Big DataApplications - Perception and Quantification of Value -Understanding Big Data Storage – A General Overview of High-Performance Architecture - Data Visualization - IoT Platforms

UNIT IV	CONCERNS AND FUTURE TRENDS	9

Different Players of IoT - Security Concerns and Challenges - Future Trends – Standards

UNIT V	HANDS-ON PROJECTS	9

DIY Kits - IFTTT and other apps

TEXT BOOK(S):

1. Samuel Greengard, The Internet of Things (Essential Knowledge), MIT Press, 2015
2. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, 2015.

REFERENCE(S):

1. ArshdeepBagha& Vijay Madisetti, Internet of Things Ã¢?? A Hands-On Approach,VPT, 2014
2. R G. Moreira, T.P Coultate Automatic Control for Food Processing System. 2001
3. Willard, H.H., L. L. Merrit, J. A. Dean and F. L. Seattle, Instrumental Methods of Analysis, CBS Publishing Co, New York,2010.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester IV	ES
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES404	OBJECT ORIENTED PROGRAMMING LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Understand the fundamentals of object-oriented programming in Java, including defining classes, objects, invoking methods etc and exception handling mechanisms.
- Understand the principles of inheritance, packages and interfaces.
- Understand the basics of Exception Handling &Multi threading
- Know how to handle events

Course Outcomes: At the end of this course, learners will be able to:

- Write program using object classes
- Apply inheritance and Interface to write program
- Able to handle I/O with exception handling
- Develop multi threaded program
- Develop GUI with event handling

List of Experiments

1. Programs using class and methods
2. Inheritance implementation
3. Inheritance via Interface and Abstract class
4. Programs on Package implementations
5. Applications using Generic collections
6. Program using IO Streaming
7. Create user defined exception
8. Develop application to demonstrate multi threading
9. Program using Applet with event handling
10. Program to demonstrate event handing using AWT/ Swing
11. Program to demonstrate Layout Managers
12. Program to demonstrate file handling

TEXT BOOK(S)

1. The Complete Reference, Java 2, 10th Edition , Herbert Schildt, TMH, 2017
2. Core Java Volume-I Fundamentals, 10th Edition, Horstmann& Cornell, Pearson Education, 2016

REFERENCE(S)

1. Bert Bates, Kathy Sierra, Head First Java, 2nd Edition, OReilly Media, 2005.
2. Kathy Sierra, Bert Bates, OCA/OCP Java SE 7 Programmer I and II Study Guide, First edition, McGraw Hill Education, 2014.

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Department	ROBOTICS AND AUTOMATION				R 2019	Semester IV	MC
Course Code	Course Name	Hours /Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19MC401	INDIAN CONSTITUTION	2	0	0	0	30	100

Course Objective (s): The purpose of learning this course is to

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- Address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes: At the end of this course, learners will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

UNIT I	**HISTORY OF MAKING OF INDIAN CONSTITUTION**	**5**
History of Indian Constitution - Drafting Committee, (Composition & Working)		
UNIT II	**PHILOSOPHY OF THE INDIAN CONSTITUTION**	**5**
Preamble - Salient Features		
UNIT III	**CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES**	**5**
Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation -Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties.		
UNIT IV	**ORGANS OF GOVERNANCE**	**5**
Parliament - Composition - Qualifications and Disqualifications - Powers and Functions Executive - President - Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions.		
UNIT V	**LOCAL ADMINISTRATION**	**5**
District's Administration head: Role and Importance, - Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation - Pachayati raj: Introduction, PRI: ZilaPachayat - Elected officials and their roles, CEO ZilaPachayat: Position and role- Block level: Organizational Hierarchy (Different departments) -Village level: Role of Elected and Appointed officials - Importance of grass root democracy.		
UNIT VI	**ELECTION COMMISSION**	**5**
Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women		

TEXT BOOK(S):

1. "The Constitution of India", 1950 (Bare Act), Government Publication
2. Dr. S. N. Busi, "Dr. B. R. Ambedkar Framing of Indian Constitution", 1st Edition, 2016. Ava Publishers
3. M. P. Jain, "Indian Constitution Law", 7th Edn., Lexis Nexis, 2014.

REFERENCE (s)

1. D.D. Basu , Introduction to the Constitution of India, Lexis Nexis, 2015.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester IV	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS401	LANGUAGE SKILLS	0	0	2	0	30	100	

Course Objective (s): The purpose of learning this course is to

- Involve the students in effective listening activities.
- Improve the oral communication skills in proper manner.
- Focus the effective reading of general and technical text.
- Enhance and comprehend the written text.
- Integrate LSRW skills.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the technical talks.
- Communicate to his peer group properly.
- Comprehend the general and technical text.
- Write the reports and job application in clear manner.
- Integrate LSRW skills.

UNIT I	LISTENING	6

Listening as a key skill- its importance - Listen to a process information- give information, as part of a simple explanation - Being an active listener: giving verbal and non-verbal feedback - taking lecture notes - preparing to listen to a lecture

UNIT II	SPEAKING	6

Give personal information - ask for personal information - express ability - enquire about ability - ask for clarification - Improving pronunciation - pronunciation basics - conversation starters: small talk – stressingsyllables and speaking clearly - summarizing academic readings and lectures

UNIT III	READING	6

Strategies for effective reading- Read and recognize different text types - Predicting content using photos and title- Read for details-Use of graphic organizers to review and aid comprehension - Understanding pronoun reference and use of connectors in a passage- speed reading techniques-

UNIT IV	WRITING	6

Plan before writing - Develop a paragraph: topic sentence, supporting sentences, concluding sentence -Write aDescriptive paragraph - Write a paragraph with reasons and examples - Write an opinion paragraph – E-mail writing - Types of essays - descriptive-narrative- issue-based-argumentative-analytical.

UNIT V	INTEGRATION OF LSRW	6

Task based Instruction :Listing Task- Sorting and ordering-comparing - Problem solving-sharing Personal Experience Content based instruction : Texts, Articles, Advertisements ,Videos)

TEXT BOOK(S):

1. Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press: Oxford, 2011
2. Brooks,Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford2011
3. Richards,C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010

REFERENCE(S):

1. Davis, Jason and Rhonda LIss.Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006
2. E. Suresh Kumar and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan:
3. Anderson, Kenneth et al. Study Speaking: A Course in Spoken English for Academic Purposes. United Kingdom: Cambridge University Press 1992.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES407	DIGITAL AND INTEGRATED CIRCUITS LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Learn design, testing and characterizing of circuit behavior with analogICs.
- Learn digital electronics circuits adder / subtractor
- Know about counters and shift register functions
- Write the VHDL Code for counters, adder / subtractor and multiplexer
- Learn about Different Application of Op-Amp

Course Outcomes: At the end of this course, learners will be able to:

- Design and implement counters using specific counterIC.
- Understand about the code converter
- Understand the concepts of counters and shift register functions
- Practice the VHDL Code for counters, adder / subtractor and multiplexer
- Acquire knowledge on Application of Op-Amp.

LIST OF EXPERIMENTS

1. Implementation of Boolean Functions, Adder/ Subtractor circuits.
2. Code converters: Excess-3 to BCD and Binary to Gray code converter and vice-versa
3. Parity generator and parity checking
4. Counters: Design and implementation of 4-bit modulo counters as synchronous and Asynchronous types using FF IC's and specific counter IC.
5. Shift Registers: Design and implementation of 4-bit shift registers in SISO, SIPO, PISO,PIPO modes using suitable IC's.
6. HDL based design entry and simulation of simple counters, adder (min 8 bit) and subtractor (4 bit min).
7. HDL based design entry and simulation of Encoders and Decoders
8. HDL based design entry and simulation of Multiplexer and Demultiplexer
9. Timer IC application: Study of NE/SE 555 timer in Astable, Monostable operation.
10. Application of Op-Amp: inverting and non-inverting amplifier, Adder, comparator, Integrator &Differentiator.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No	Name of the equipments / Components	Quantity Required	Remarks
1	Dual ,(0-30V) variability Power Supply	10	-
2	CRO	9	30MHz
3	Digital Multimeter	10	Digital
4	Function Generator	8	1 MHz
5	IC Tester (Analog)	2	
6	Bread board	10	
7	Computer (PSPICE installed)	1	
8	Xilinx software	10 User License	
	Consumabilites (sufficient quantity)		
1	IC 741/ IC NE555/566/565		
2	Digital IC types		
3	LED		
4	LM317		
5	LM723		
6	ICSG3524 / SG3525		
7	Transistor – 2N3391		
8	Diodes, IN4001,BY126		
9	Zener diodes		
10	Potentiometer , Capacitor, Resistors 1/4 Watt Assorted		

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA502	PRINCIPLES OF ROBOTICS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

Course Outcomes: At the end of this course, learners will be able to:

- Ability to understand basic concept of robotics.
- To analyze Instrumentation systems and their applications to various
- To know about the differential motion add statics in robotics
- To know about the various path planning techniques.
- To know about the dynamics and control in robotics industries

Unit I	BASIC CONCEPTS	9

Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and control issues-Various manipulators – Sensors - work cell - Programming languages.

Unit II	DIRECT AND INVERSE KINEMATICS	9

Mathematical representation of Robots - Position and orientation – Homogeneous transformation- Various joints-Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics-SCARA robots- Solvability – Solution methods-Closed form solution.

Unit III	MANIPULATOR DIFFERENTIAL MOTION AND STATICS	9

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.

Unit IV	PATH PLANNING	9

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

Unit V	DYNAMICS AND CONTROL	9

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

TEXT BOOK(S):

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. John J.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009
3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.

REFERENCE(S):

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
6. S.Ghoshal, " Embedded Systems & Robotics" – Projects using the 8051 Microcontroller", Cengage Learning, 2009.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA501	CNC MACHINE AND METROLOGY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand evolution and principle of CNC machine tools
- Write simple programs for CNC turning and machining centres
- Generate CNC programs for popular CNC controllers
- Describe about linear and angular measurements in metrology
- Study about the advancement in metrology

Course Outcomes: At the end of this course, learners will be able to:

- Ability to know about the basic in CNC machineries
- Evolution and principle of CNC machine tools and different measurement technologies
- Able to write simple programs for CNC machinery
- To impart knowledge about linear and angular measurements in metrology
- Ability to know about the advancement in metrology

Unit I	INTRODUCTION TO CNC MACHINE TOOLS	9

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways.

Unit II	DRIVES AND WORK HOLDING DEVICES	9

Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosysn, laser interferometer, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines.

Unit III	CNC PROGRAMMING	9

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre for well known controllers such as Fanuc, Heidenhain, Sinumerik etc., generation of CNC codes from CAM packages.

Unit IV	LINEAR AND ANGULAR MEASUREMENTS	9

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

Unit V	ADVANCES IN METROLOGY	9

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

TEXT BOOK(S):

1. Mechatronics", HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
2. Warren S.Seamers, "Computer Numeric Control", Fourth Edition, Thomson Delmar, 2002.
3. Jain R.K. "Engineering Metrology", Khanna Publishers, 2005.
4. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.

REFERENCE(S):

1. Charles Reginald Shotbolt, "Metrology for Engineers", 5th edition, Cengage Learning EMEA, 1990.
2. Backwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education , 2006. 3.Peter Smid, "CNC Programming Hand book", Industrial Press Inc., 2000
4. Berry Leathan – Jones, "Introduction to Computer Numerical Control", Pitman, London, 1987.
5. Radhakrishnan P "Computer Numerical Control Machines", New Central Book Agency, 2002.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA503	HYDRAULICS AND PNEUMATICS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is:

- To impart knowledge on various types of hydraulic pumps and actuators.
- To learn about various hydraulic components and its functions.
- To provide knowledge about the selection of hydraulic components.
- To study about various types of pneumatic components and servo systems.
- To learn fluid power circuit design methods and its applications.

Course Outcomes: At the end of this course, learners will be able to:

- Identify suitable hydraulic pumps and actuators for different applications.
- Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
- Select the suitable types of Hydraulic circuits and systems.
- Choose the suitable pneumatic components for different applications.
- Identify various trouble shooting methods and applications of hydraulic and pneumatic systems.

Unit I	FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS	09

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

Unit II	HYDRAULIC ACTUATORS AND CONTROL COMPONENTS	09

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

Unit III	HYDRAULIC CIRCUITS AND SYSTEMS	09

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

Unit IV	PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS	09

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

Unit V	TROUBLE SHOOTING AND APPLICATIONS	09

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

REFERENCE(S):

1. Anthony Esposito, Fluid power with applications, Pearson Education, New Delhi, 2011
2. S.R Majumdar, Oil hydraulics, Tata McGraw Hill publishing company Pvt. Ltd. New Delhi,2004
3. S.R.Majumdar, Pneumatic systems-Principles and maintenance, Tata McGraw Hill publishing company Pvt. Ltd., New Delhi, 2008.
4. S.Ilango Introduction to Hydraulics and Pneumatics, Prentice Hall of India Pvt. Ltd., New Delhi, 2007.
5. Andrew Parr, Hydraulics and Pneumatics, Jaico Publishing House, 2006.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester V	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES501	DESIGN OF MACHINE ELEMENTS AND TRANSMISSION SYSTEMS	3	2	0	4	75	100	

Course Objective (s): The purpose of learning this course is to

- To introduce the design concepts for various machine elements
- To impart knowledge on temporary and Permanent joints
- To design the shafts and couplings
- To educate the Gear trains and various types of Belts
- To import knowledge on design of springs and couplings

Course Outcomes: At the end of this course, learners will be able to:

- To formulate and analyze stresses and strains in machine elements subjected to various loads
- To analyze and design structural joints such as Riveted joints, welded joints, Bolts
- To analyze and design the components for power transmission like shaft and couplings.
- To analyze and design different types of gears and belts for engineering applications.
- To analyze and design mechanical springs and bearings.

Unit I	INTRODUCTION	9+6

Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Consideration - Standards and Codes - Selection of Materials –Design against Static and Dynamic Load –Modes of Failure, Factor of Safety, Principal Stresses, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

Unit II	DETACHABLE AND PERMANENT JOINTS	9+6

Design of Bolts under Static Load, Design of Bolt with Tightening/Initial Stress, Design of Bolts subjected to Fatigue – Keys -Types, Selection of Square and Flat Keys-Design of Riveted Joints and Welded Joints

Unit III	SHAFTS AND COUPLING	9+6

Design of Shaft –For Static and Varying Loads, For Strength and Rigidity-Design of Coupling-Types, Flange, Muff and Flexible Rubber Bushed Coupling

Unit IV	GEARS AND BELT DRIVES	9+6

Design of Spur and Helical Gear drives-Design of Belt drives-Flat and V Belts

Unit V	SPRINGS AND BEARINGS	9+6

Design of Helical Spring-Types, Materials, Static and Variable Loads-Design of Leaf Spring-Design of Journal Bearing -Antifriction Bearing-Types, Life of Bearing, Reliability Consideration, Selection of Ball and Roller Bearings

TEXT BOOK(S):

1. Joseph Edward Shigley, Charles R. Mischke " Mechanical Engineering Design", McGraw Hill, International Edition, 1992
2. Sharma. C.S. and Kamlesh Purohit, " Design of Machine Elements", Prentice Hall of India Private Limited, 2003

REFERENCE(S):

1. Bhandari. V.B., "Design of Machine Elements", Tata McGraw-Hill Publishing Company Limited, 2003.
2. Robert L.Norton, "Machin Design – An Integrated Approach", Prentice Hall International Edition, 2000.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19EI501	AUTOMATIC CONTROL SYSTEMS	3	1	0	4	45	100	

Course Objective (s): The purpose of learning this course is:

- To study the basics of control system and its response stability of mechanical and electrical systems . Use of MATLAB to design a stable control system.
- To introduce the elements of control system and their modeling using various Techniques.
- To introduce methods for analyzing the time response.
- To impart knowledge about the frequency response and the stability of systems
- To introduce the state variable analysis method

Course Outcomes: At the end of this course, learners will be able to:

- To understand the basic of the control system
- Ability to know about the time and frequency domain analysis
- To know about the different stability of the systems
- To expose students to the state space representation and its analysis.
- To introduce non-linear systems and their control and to impart knowledge on advanced control techniques

Unit I	INTRODUCTION	09

Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function Modeling of physical systems – Mechanical, Thermal, Hydraulic systems and Electric Networks - Transfer function of DC generator, DC servomotor, AC servomotor ,Potentiometer, Synchros, Tacho- generator, Stepper motor - Block diagram - reduction techniques, Signal flow graph – Mason gain formula. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

Unit II	TIME DOMAIN ANALYSIS	09

Standard Test signals – Time response of second order system - Time domain specifications - Types of systems - Steady state error constants - Introduction to P, PI and PID modes of feed back control. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

Unit III	FREQUENCY DOMAIN ANALYSIS	09

Frequency domain specifications - Time and frequency response correlation – Polar plot – Bode plot – All pass minimum phase and non-minimum phase systems. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

Unit IV	SYSTEM STABILITY	09

Characteristic equation - Routh Hurwitz criterion of stability - Absolute and Relative stability - Nyquist stability - Nyquist stability criterion - Assessment of relative stability – Gain and Phase Margin. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

Unit V	ROOT LOCUS METHOD	09

Root locus concepts - Construction of root loci – Root contours. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions) STATE SPACE ANALYSIS: Limitations of conventional control theory - Concepts of state, state variables and state model – state model for linear time invariant systems - Introduction to state space representation using physical - Phase and canonical variables. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

REFERENCE(S):

1. Nagrath I J, and Gopal, M, 'Control Systems Engineering" Prentice Hall of India, New Delhi, 2008.
2. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley -2007
3. Ogata K, "Modern Control Engineering", Pearson Education, New Delhi, 2006.
4. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
5. Norman C. Nise S, "Control system Engineering", John Wiley & Sons, Singapore, 2004.

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Department	ROBOTICS AND AUTOMATION				R 2019		Semester V HS
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19HS505	UNIVERSAL HUMAN VALUES 2 : UNDERSTANDING HARMONY	2	1	0	3	45	100

Course Objective (s): The purpose of learning this course is to

- To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Course Outcomes: At the end of this course, learners will be able to:

- Students are expected to become more aware of themselves, and their surroundings (family, society, nature)
- Students would become more responsible in life, and in handling problems with sustainable solutions.
- Students become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
- Students would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.
  Students would have better critical ability.

Unit 1 – Introduction to Value Education **6+3**

Lectures - Understanding Value Education - Self-exploration as the Process for Value Education - Continuous Happiness and Prosperity – the Basic Human Aspirations - Right Understanding, Relationship and Physical Facility - Happiness and Prosperity – Current Scenario - Method to Fulfill the Basic Human Aspirations

Tutorials *[Practice Session] - Sharing about Oneself - Exploring Human Consciousness - Exploring Natural Acceptance*

Unit 2 – Harmony in the Human Being **6+3**

Lectures - Understanding Human being as the Co-existence of the Self and the Body - Distinguishing between the Needs of the Self and the Body – The Body as an Instrument of the Self - Understanding Harmony in the Self - Harmony of the Self with the Body - Programme to ensure self-regulation and Health

Tutorials *[Practice Session] - Exploring the difference of Needs of Self and Body - Exploring Sources of Imagination in the Self - Exploring Harmony of Self with the Body*

Unit 3 – Harmony in the Family and Society **6+3**

Lectures - Harmony in the Family – the Basic Unit of Human Interaction - Values in Human-to-Human Relationship – 'Trust' – the Foundational Value in Relationship - 'Respect' – as the Right Evaluation - Understanding Harmony in the Society - Vision for the Universal Human Order

Tutorials *[Practice Session] - Exploring the Feeling of Trust - Exploring the Feeling of Respect - Exploring Systems to fulfil Human Goal*

Unit 4 – Harmony in the Nature/Existence **4+2**

Lectures - Understanding Harmony in the Nature - Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature – Realizing Existence as Co-existence at All Levels - The Holistic Perception of Harmony in Existence

Tutorials *[Practice Session] - Exploring the Four Orders of Nature - Exploring Co-existence in Existence*

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Unit 5 – Implications of the Holistic Understanding **6+3**

Lectures - Natural Acceptance of Human Values - Definitiveness of (Ethical) Human Conduct – A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order - Competence in Professional Ethics - Holistic Technologies, Production Systems and Management Models-Typical Case Studies - Strategies for Transition towards Value-based Life and Profession

Tutorials *[Practice Session] - Exploring Ethical Human Conduct - Exploring Humanistic Models in Education - Exploring Steps of Transition towards Universal Human Order*

TEXT BOOK(S):

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978- 93-87034-53-2

REFERENCE BOOK(S):

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004
3. The Story of Stuff (Book)
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester V	EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS05	QUANTITATIVE APTITUDE AND LOGICAL REASONING - III	2	0	0	0	30	100	

Course Objective (s): The purpose of learning this course is to

- Design to help people make sense of numerical data.
- Calculate the calendars and series in simplified way.
- Understand the concept of the interest amount in SI and CI.
- Know the procedure to deal with a situation and sufficient to determine the answer.
- Teach seating arrangements in rows or in small groups.

Course Outcomes: At the end of this course, learners will be able to:

- Demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken to solve Aptitude Questions.
- Solve the question based on calendar, odd man out and series by using shortcut methods.
- Calculate the interest by using shortcut methods instead of traditional methods.
- Induce their critical thinking by solving the syllogism and course of action.
- Analyze the conditions and do interpretation.

UNIT 1	DATA INTERPRETATION & CLOCKS	6

DATA INTERPRETATION: Tabulation – Bar graphs – Pie charts – Line graphs.
CLOCKS: Definition – important points – Angular difference between two hands at different timings- Incorrect clock.

UNIT 2	CALENDARS, ODDMAN OUT & SERIES	6

CALENDARS: Odd days – Leap year – Ordinary year – Counting of odd days – Day of the week.

ODDMAN OUT & SERIES: Odd man out – Power series – Number series-Sequence of real numbers.

UNIT 3	SIMPLE & COMPOUND INTEREST	6

SIMPLE INTEREST: Principal – Rate of interest – Number of years – Using formulae and shortcuts methods.
COMPOUND INTEREST: Compounded Annually – Compounded Half-Yearly – Compounded Quarterly – Compounded annually – Rates are different for different years.

UNIT 4	STATEMENT & COURSE OF ACTION, SYLLOGISM	6

STATEMENT AND COURSE OF ACTION: Courses of action - Decision taken - Improvement, Follow-up or further action in regard to the given statement.
SYLLOGISM/ LOGICAL VENN DIAGRAMS: Relationship between the two things or not - Classification of propositions – Immediate deductive inference – Immediate deductive inference.

UNIT 5	SEATING ARRANGEMENTS & DATA SUFFICIENCY	6

SEATING ARRANGEMENTS: Persons seating in the circular – Rectangular – Square.
DATA SUFFICIENCY: Reasoning ability using a set of directions.

REFERENCES:

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. R.V.Praveen,"Quantitative Aptitude and Reasoning"Third Edition, PHI Learning ,2016.
4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017.
5. Arun Sharma "How to Prepare for Quantitative Aptitude"Eight Edition, McGraw Hill Education,2018.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA504	ROBOTICS LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- To introduce different types of robotics and demonstrate them to identify different parts and components.
- To write programming for simple operations

Course Outcomes: At the end of this course, learners will be able to:

- Use of any robotic simulation software to model the different types of robots and calculate work volume for different robots

LIST OF EXPERIMENTS:

1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place
5. Robot programming and simulation for Colour identification
6. Robot programming and simulation for Shape identification
7. Robot programming and simulation for machining (cutting, welding)
8. Robot programming and simulation for writing practice
9. Robot programming and simulation for any industrial process (Packaging, Assembly)
10. Robot programming and simulation for multi process.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

- ROS (Robotic Operating System)
- 30 Systems with server
- Verification of direct kinematics equations and inverse kinematics equations of 1DOF "R- configuration" robot.
- Verification of direct kinematics equations and inverse kinematics equations of 2DOF "R-R-configuration" robot.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA505	CNC AND METROLOGY LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- To impart knowledge in CNC programming for turning and milling operations
- To use measuring systems for the geometrical measurements of gears and threads.
- To know the measurement of Taper Angle using Sine Bar

Course Outcomes: At the end of this course, learners will be able to:

- Ability to understand the features and operation of CNC machines.
- Ability to prepare CNC program from the component drawings
- Understanding the usage of profile projectors and tool maker's microscopes.

LIST OF EXPERIMENTS:

1. Study of the CNC machine
2. Programming and simulation of a lathe using any CAM package
3. Programming and simulation of a machining centre using any CAM package
4. Programming and operation of a CNC Lathe
5. Programming and operation of a CNC machining centre
6. Measurement of Taper Angle using Sine Bar
7. Optical profile projector – study of profile of gear tooth, screw threads.
8. Tool maker's microscope – to study cutting tool geometry, screw threads.
9. Tool wear and surface finish measurement.
10. Dimensional measurement of machined components using, bore gauge, air gauge and Height master

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	CNC lathe	1 no
2.	CNC milling machine	1 no
3.	Production type CNC machining centre	1 no
4.	CNC lathe and milling programming software (FANUC controller)	10 Licenses
5.	CNC lathe and milling programming software (Heidenhain controller)	5 Licenses
6.	Optical profile projector	1 no
7.	tool makers microscope	1 no
8.	Measuring gauges for hole depth and height.	
9.	Sine Bar0	1 no

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA506	HYDRAULICS AND PNEUMATICS LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is:

- To impart knowledge on modeling and simulation of Mechatronics system.
- To provide knowledge on design of fluid power circuit in Mechatronic system.
- To understand the working of microcontroller and PLC in Mechatronic systems through Experiments.
- To expose knowledge on force, acceleration and displacement measurements.
- To gain the knowledge for controlling the position, velocity and force in Mechatronics system.

Course Outcomes: At the end of this course, learners will be able to:

- Developmathematical model of Mechatronics system.
- Simulate fluid power circuit using Simulation software.
- Develop Mechatronics system using microcontroller & PLC.
- Measure the force, acceleration and displacement of a system using microcontroller program.
- Control the position, velocity and force of Mechatronics system.

Exp No.	Name of Experiments
1	Modeling and simulation of Mechatronics system using MATLAB.
2	Modeling and design of PID controller for Mechatronics system.
3	Study and simulation of various hydraulic and pneumatic components using FLUIDSIM software.
4	Design and testing of fluid power circuits for automatic opening and closing for doors and to control its velocity and direction.
5	Position and speed control of DC Motor using Microcontroller Board
6	Speed control of Stepper Motor using Microcontroller Interface Board
7	Measurement of force, acceleration and displacement using Virtual instrumentation.
8	Design of Programmable logic Controller based timer controller for multiple pneumatic cylinder Sequencing in assembly operations.
9	Position and velocity control of pick and place robot arm for loading and unloading Application using Robot Programming language.
10	Measurement and control of temperature of an application using Virtual instrumentation

REFERENCE(S):

1. W. Bolton, Mechatronics, Pearson Education, New Delhi, 2012.
2. Godfrey Onwubolu, Mechatronics: Principles and Applications Butterworth-Heinemann Ltd,2005.

REFERENCE(S):

1. Nitaigour Premchand Mahalik, Mechatronics : Principles, Concepts and Applications, TataMcGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2008
2. Krishna Kant, Microprocessors & Microcontrollers, Prentice Hall of India, 2007.
3. K. P. Ramachandran, G. K. Vijayaraghavan, and M. S. Bala-Sundram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi 2008.

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LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
S. No	**NAME OF THE EQUIPMENT**	**Qty.**
1	Basic Pneumatic Trainer Kit with manual and electrical controls/ PLC Control each	1
2	Basic Hydraulic Trainer Kit	1
3	Hydraulics and Pneumatics Systems Simulation Software	10
4	8051 - Microcontroller kit with stepper motor and drive circuit sets	2
5	Image processing system with hardware & software	1

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester V	EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA507	INTERNSHIP / INDUSTRIAL TRAINING	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Understand one or more practical application of the core courses learned
- Get an inside view of an industry and organization/company
- Gain valuable skills and knowledge
- Make professional connections and enhance networking
- Get experience in a field to allow the student to make a career transition

Course Outcomes: At the end of this course, learners will be able to provide short-term work experience in an Industry/ Company/ Organisation.

Guidelines

1. It is mandatory for every student to undergo this course.
2. Every student is expected to spend a minimum of 15-days in an Industry/ Company/ Organization, during the vacation.
3. The type of industry must be NOT below the Medium Scale category in his / her domain of the degree programme.
4. The student must submit the "Training Completion Certificate" issued by the industry / company / organization as well as a technical report not exceeding 15 pages, within the stipulated time to be eligible for making a presentation before the committee constituted by the department.
5. The committee will then assess the student based on the report submitted and the presentation made.
6. Marks will be awarded out of maximum 100.
7. Appropriate grades will be assigned as per the regulations.
8. Only if a student gets a minimum of pass grade, appropriate credit will be transferred towards the degree requirements, as per the regulations.
9. It is solely the responsibility of the individual student to fulfill the above conditions to earn the credits.
10. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100%, if the credits are transferred, after satisfying the above (1) to (8) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO.
11. The committee must recommend redoing the course, if it collectively concludes, based on the assessment made from the report and presentations submitted by the student, that either the level of training received or the skill and / or knowledge gained is NOT satisfactory.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA601	MACHINE VISION SYSTEMS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- To know about the principles and applications of vision system in modern manufacturing environment
- To learn about the algorithms in vision
- To know about the recognition of object
- To be familiar about the applications regarding vision
- To know about the components used for vision

Course Outcomes: At the end of this course, learners will be able to:

- Knowledge or gadgets of vision systems
- Ability to understand the image capturing and processing techniques
- Ability to apply the vision system in other machines
- Knowledge for recognizing the objects.
- Knowledge in application of vision and image processing in robot operations.

Unit I	VISION SYSTEM	9

Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interfaces

Unit II	VISION ALGORITHMS	9

Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.

Unit III	OBJECT RECOGNITION	9

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values

Unit IV	APPLICATIONS	9

Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.

Unit V	ROBOT VISION	9

Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV - The cv_bridge Package.

TEXT BOOK(S):

1. Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim,2008.
2. Damian m Lyons,"Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011

REFERENCE(S):

1. Rafael C. Gonzalez and Richard E.woods, "Digital Image Processing", Addition - Wesley Publishing Company, New Delhi, 2007.
2. Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2000.
3. R.Patrick Goebel, " ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, 2012.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA602	AUTOMATION SYSTEM DESIGN	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- To know about the basic concepts in industrial automation
- To design automated systems.
- To know about transfer lines and automated assembly
- Be exposed to pneumatic, electric, hydraulic and electronic systems in automation of mechanical operations.
- To know about the advancement in hydraulics and pneumatics

Course Outcomes: At the end of this course, learners will be able to:

- Knowledge of industrial automation by transfer lines and automated assembly lines.
- Ability to design an automated system
- Understanding of automated controls using pneumatic and hydraulic systems
- Ability to understand the electronic control systems in metal machining and other manufacturing processes.
- To understand advancement in hydraulics and pneumatics systems.

Unit I	FUNDAMENTAL CONCEPTS OF INDUSTRIAL AUTOMATION	9

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation.

Unit II	TRANSFER LINES AND AUTOMATED ASSEMBLY	9

General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, modular fixturing. Flow line balancing.

Unit III	DESIGN OF MECHATRONIC SYSTEMS	9

Stages in design, traditional and mechatronic design, possible design solutions. Case studies-pick and place robot, engine management system.

Unit IV	PROGRAMMABLE AUTOMATION	9

Special design features of CNC systems and features for lathes and machining centers. Drive system for CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems.

Unit V	DESIGN FOR HIGH SPEED AUTOMATIC ASSEMBLY	9

Introduction, Design of parts for high speed feeding and orienting, high speed automatic insertion. Analysis of an assembly. General rules for product design for automation.

TEXT BOOK(S):

1. Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing" Pearson Education, New Delhi, 2001.
2. Bolton W, "Mechatronics", Pearson Education, 1999.

REFERENCE(S):

1. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications" , McGraw Hill , New York, USA. 2000.
2. Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001.
3. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press, 2011

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA603	INDUSTRIAL AUTOMATION	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Give an overview of the automation technologies such as PLCs, SCADA used in industries.
- Provide a fundamental understanding of the different languages used for PLC Programming
- Learn about the PLC program in different languages for industrial sequential applications.
- Know about automation technologies such as DCS used in industries.
- Provide insight into some of the advanced principles those are evolving for present and future automation

Course Outcomes: At the end of this course, learners will be able to:

- Understand all the important components such as PLC, SCADA, DCS,
- Understand the concepts of I/O modules and field devices of an industrial automation system.
- Develop PLC program in different languages for industrial sequential applications.
- Select and use most appropriate automation technologies for a given application.
- Gain knowledge on the recent developments in industrial automation.

Unit I	PLC & SCADA	9

PLC: Evolutions of PLCs – Programmable Controllers – Architecture, I/O modules – Comparative study of Industrial PLCs. SCADA: Remote terminal units- Master station - Communication architectures.

Unit II	BASICS OF PLC PROGRAMMING(LADDER)	9

Basics of PLC programming – Ladder Logic – Relay type instructions – Timer/Counter instructions – Program control instructions – Data manipulation and math instructions – Programming Examples.

Unit III	PLC PROGRAMMING (OTHER LANGUAGES)	9

Functional block programming - Sequential function chart – Instruction list – Structured text programming – PLC controlled sequential Process Examples.

Unit IV	DISTRIBUTED CONTROL SYSTEM	9

DCS: Evolution & types – Hardware architecture – Field control station – Interfacing of conventional and smart field devices (HART and FF enabled) with DCS Controller – Communication modules – Operator and Engineering Human interface stations – Study of any one DCS available in market.

Unit V	ADVANCED TOPICS IN AUTOMATION	9

Introduction to Networked Control systems – Plant wide control – Internet of things – Cloud based Automation – OLE for Process Control – Safety PLC – Case studies: PLC - SCADA - DCS.

TEXT BOOK(S):

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2010
2. Michael P. Lukas, Distributed Control Systems: Their Evaluation and Design, Van Nostrand Reinhold Co., 1986
3. D. Popovic and V.P.Bhatkar,' Distributed computer control for industrial Automation' Marcel Dekker,Inc., Newyork ,1990.

REFERENCE(S):

1. Clarke, G., Reynders, D. and Wright, E., "Practical Modern SCADA Protocols: DNP3,4. 60870.5 and Related Systems", Newnes, 1st Edition, 2004.
2. Hughes, T.A., "Programmable Logic Controllers: Resources for Measurements and Control Series", 3rd Edition, ISA Press, 2004.
3. McMillan, G.K., "Process/Industrial Instrument and Controls Handbook", 5thEdition, McGraw- Hill handbook, New York, 1999.
4. NPTEL Notes on, "Programmable Logic Control System" by Department of Electrical Engg., IIT Kharagpur.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	EES
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS06	QUANTITATIVE APTITUDE AND LOGICAL REASONING - IV	2	0	0	0	30	100	

Course Objective (s): The purpose of learning this course is to

1. Ascertains the occurrence of an event on the basis of already present information.
2. Use area models to represent the distributive property in mathematical reasoning.
3. Calculate the work capacity by chocolate based method.
4. Work with time, speed and distance by relative speed concepts.
5. Determine how various phenomena are related.

Course Outcomes: At the end of this course, learners will be able to

1. Know the outcome of an event developed the concept of probability.
2. Calculate the area and surface volume in real time application.
3. Understand the concepts of Times and Work and Pipes and Cistern and Correlating the Concepts of both.
4. Know the concepts of Time, Speed and Distance and concepts of Boats and Streams.
5. Analyze the cause and effect of problems by using critical thinking.

UNIT 1	PROBABILITY , PERMUTATIONS & COMBINATIONS	6

PROBABILITY: Rolling an unbiased dice – Tossing a fair coin – Drawing a card from a pack of well shuffled cards – Picking up balls of certain color from a bag containing balls of different colors.
PERMUTATIONS: Numbers with digits - Words with letters - Arrangements of person in a row - Arrangements of books on a shelf.
COMBINATIONS: Formation of committee – Selection of questions from question papers.

UNIT 2	AREA & VOLUME	6

AREA: Area – Perimeter – Important points about triangle – Quadrilateral – Fast track techniques.
VOLUME: Cuboids – Cube – Cylinder – Cone – Frustum of a cone – Sphere – Hemisphere – Pyramid –their formulas.

UNIT 3	TIME & WORK, PIPE & CISTERNS	6

TIME AND WORK: Introduction – Basic concepts – Leaving and joining – Alternative days – In between days the works starting and ending.
PIPES AND CISTERNS: Introduction - Basic concepts – Capacity of the total liters –Water flow in the tank.

UNIT 4	TIME& DISTANCE, TRAINS, BOATS AND STREAMS	6

TIME AND DISTANCE: Definition – Average speed – Distance covered is same – Distance covered is different – Stoppage time per hour for a train – Time taken with two different modes of transport – Time and distance between two moving bodies.
PROBLEMS ON TRAINS: Basic concepts – Basic formulae – Different types of objects –Two trains crossing each other in both directions – Shortcuts.
BOATS AND STREAMS: Introduction – Speed of man (boat and streams) - Moving same and opposite directions – important formulae.

UNIT 5	STATEMENT - CONCLUSION , ARGUMENTS, CAUSE & EFFECT, ASSERTION & REASON	6

STATEMENT AND CONCLUSION: Statement to be true - Two conclusions together - Logically follows.
STATEMENT AND ARGUMENTS: Arguments strong with respect to the statement.
CAUSE AND EFFECT: Cause and effect relationship between the two statements.
ASSERTION AND REASON: Assertion(A) and Reason(R) – Both (A) and (R) are individually true and (R) - (A) is true but (R) is false – (A) is false but (R) is true.

REFERENCES:

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing

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Company Ltd, 2012.
3. R.V.Praveen,"Quantitative Aptitude and Reasoning"Third Edition, PHI Learning ,2016.
4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017.
5. Arun Sharma "How to Prepare for Quantitative Aptitude"Eight Edition, McGraw Hill Education,2018.
6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication,2020.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA604	AUTOMATION SYSTEM DESIGN LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- To illustrate the design and simulation of multiple actuator systems using pneumatic, electro- pneumatic and PLCs and enable the students to integrate various fringe conditions in multiple actuator systems.
- To design a system using PNEUMOSIM software
- To design a Microcontroller kit with stepper motor and drive circuit using LABVIEW software
- To expose the students in sensors/actuators interfaced with computers.
- To design a circuit using stepper motor.

Course Outcomes: At the end of this course, learners will be able to:

- Able to design and layout multiple actuator systems with start shop and emergency modules
- Able to develop Ladder logic for electro-pneumatic actuator systems.
- Acquiring skill of interfacing different sensors like LVDT, ultrasonic and touch sensors.
- Ability to develop control system for stepper motors.
- Ability to design Microcontroller kit with stepper motor and drive circuit using LABVIEW software

LIST OF EXPERIMENTS

1. Co-ordinated motion of multiple pneumatic actuators in a desired sequence using Cascade method
2. Integration of fringe condition modules in multiple actuator pneumatic systems
3. Co-ordinated motion of multiple actuator, electro – pneumatic systems in a desired sequence using hard – wire programmed control systems
4. Co-ordinated motion of multiple actuators, electro – pneumatic systems in a desired sequence using PLC.
5. Interfacing of an LVDT with a PC for monitoring the displacement of machine slide and raising an alarm if the displacement exceeds specified limit.
6. Inspection using Machine vision System
7. Control of speed, direction and number of revolutions of a stepper motor using PC.
8. Development of an obstacle avoidance robot using servo motors, ultrasonic and touch sensors.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	Basic Pneumatic Trainer Kit with manual and electrical controls	1 each
2.	PNEUMOSIM software / Automation studio	10 sets
3.	8051 – Microcontroller kit with stepper motor and drive circuit LABVIEW software	2 sets
4.	machine vision system with software	1 no
5.	stepper motors with PC interface cards	2 nos
6.	servo motor with PC interface card	1 no
7.	ultrasonic, touch and non contact sensors	2 each

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RA605	INDUSTRIAL AUTOMATION LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Programming of PLC and DCS.
- Sensor data acquisition, data processing and visualization
- Interfacing the various field devices with PLC
- Learn about designing and implementing control schemes in PLC & DCS
- Know about the Fieldbus /IOT/Wireless HART Enabled Transmitter

Course Outcomes: At the end of this course, learners will be able to:

- Ability to understand and Programming of PLC, SCADA and DCS
- Ability to working with industrial automation system
- Be able to design and implement control schemes in PLC & DCS
- Ability to interface field devices with PLC & DCS
- Understand the Fieldbus /IOT/Wireless HART Enabled Transmitter

LIST OF EXPERIMENTS

1. Study of PLC field device interface modules (AI,AO,DI,DO modules)
2. Programming Logic Gates Function in PLC
3. Implementing Mathematical Operations in PLC
4. Programming Jump-to-subroutine & return operations in PLC
5. PLC Exercises:- 1. Traffic Light Control and Filling/Draining Control Operation
6. PLC Exercise: 1. Reversal of DC Motor Direction 2. ON/OFF Controller for Thermal Process
7. PC based control of Level Process
8. On-line Monitoring and Control of a Pilot plant using DCS
9. PLC based Control of Flow Process
10. Study of Foundation Fieldbus /IOT/Wireless HART Enabled Transmitter

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Sl.No.	Description of Equipment	
1.	Programmable Logic controller	5 Nos.
2.	Programmable Logic controller Software	10 User License
3.	DAQ card	2 Nos.
4.	Filling /Draining System	1 No.
5.	Traffic Light Controller	2 Nos
6.	DC Motor	5 Nos
7.	Personal computer-	10 Nos
8.	DCS along with Interface modules	1 set
9.	Thermal Process, Level Process & Flow Process stations	1 set each
10.	Smart Transmitter	1 No.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS602	PROFESSIONAL SKILLS FOR AUTOMATION ENGINEERS	0	0	2	0	30	100	

Course Objective (s):

- To develop students' communicative competence in English with Listening skills.
- To improve their ability to communicate effectively in interviews.
- To enable the learners to fine-tune their comprehending level of different texts.
- To prepare the error-free documents.
- To strengthen their thinking level and update their knowledge for career growth.

Course Outcomes: At the end of this course, learners will be able to

- Develop listening skills to comprehend general / technical talks.
- Make effective presentations in group/pair and attend job interviews
- Understand various concepts by reading different texts.
- Enhance the writing skills to express the ideas of the learners.
- Strengthen their soft skills.

Unit I	LISTENING	6

Conversational skills (formal and informal) - Watching Group discussion & effective presentations, Listening/watching interviews conversations, documentaries - Listening to lectures, discussions from TV/ Radio/ Podcast

Unit II	SPEAKING	6

Introduction to Group Discussion - Participating in group discussions - Understanding group dynamics - Different types of Interview format - answering questions - offering information - Mock interviews - Body language (paralinguistic features) - Articulation of sounds - Intonation - Making effective presentations

Unit III	READING	6

Reading different genres ranging from newspapers, technical articles and short stories - Predicting the content - Gap filling exercises - Sequencing the sentences

Unit IV	WRITING	6

Writing Job applications - Resume preparation - E-mail writing - Letters(formal & informal) - Memos - Reports - Interpreting the visual texts – Common Errors in English - Preparation of Essays

Unit V	CAREER SKILLS	6

Introduction to Employability and Career Skills - developing a long term career plan - making career changes - Time Management - General awareness of Current Affairs - Managing changes - Stress management - Leadership traits - Team work - Intercultural communication - Creative and Critical thinking

TEXT BOOK(S):

1.E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015

REFERENCE(S):

1.Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015.

2.Interact English Lab Manual for Undergraduate Students, OrientBalckSwan: Hyderabad, 2016.

3.Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014

4.S. Hariharan etal. Soft Skills. MJP Publishers: Chennai, 2010

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LANGUAGE
ELECTIVE

Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HSX201	ENGLISH FOR ENGINEERS	3	0	0	3	45	100	

Course Objective (s):

- To acquire usage of grammar in Englishlanguage.
- To develop listening skills which will enable to listen lectures and comprehend different types oftexts.
- To enhance the reading skill to comprehend technicalwritings.
- To improve writing skills to express thoughtsfreely.
- To help learners develop their speaking skills and speak fluently in realcontexts.

Course Outcomes: At the end of this course, learners will be able to:

1. Improve their language usage in LSRWskills.
2. Develop listening skills to understand sentence stress andintonations.
3. Acquire the ability to understand different writtentexts.
4. Enhance the writing skills to express the ideas of thelearners.
5. Communicate fluently in pair /team.

Unit I	LANGUAGE FOCUS	9

Prepositions - Articles - Conjunctions - Voice(Active & Passive) - Reported speech - Conditionals - Collocations - Discourse markers - One word substitution - Phrasal verbs

Unit II	LISTENING	9

Listening to identify topic, content, function - Sentence stress - Rhythm – Intonation

Unit III	READING	9

Reading graphs and charts - Skimming and scanning texts - Read business articles for specific information - Understanding the structure of a text - Error identification

Unit IV	WRITING	9

Application for a job - Recommendations - Report writing (accident and survey) - Writing review (book and movie) - Transcoding

Unit V	SPEAKING	9

Collaborative task - Turn taking (initiating and responding appropriately) - Negotiating - Exchanging - Language Functions: suggesting - comparing and contrasting – expressing - Finding out facts, attitudes and opinions - Commonly mispronounced words

TEXT BOOK(S):

1.Communicative English by KN Shoba ,Lourdes Joavani Rayen Publised by Cambridge university 2017

REFERENCE(S):

1.Jeremy Comfort, Pamela Rogerson, Trish Stott, and Derek Utley, Speaking Effectively and Developing Speaking Skills for Business English, Cambridge: Cambridge University Press, 2002.

2.Eric H. Glendinning and Beverly Holmstrom, Study Reading: A Course In Reading for Academic Purposes.United Kingdom: Cambridge University Press, 2004.

3.Murphy, Raymond. English Grammar in Use – A Self-Study Reference and Practice Book For Intermediate learners Of English .Ived. United Kingdom: Cambridge University Press. 2012.

4.Seely, John. Oxford Guide to Effective Writing and Speaking. Indian ed. New Delhi: Oxford University Press. 2005.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HSX203	JAPANESE	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- help students acquire the basics of Japaneselanguage
- teach them how to converse in Japanese in variousoccasions
- teach the students the Japanese cultural facets and socialetiquette

Course Outcomes: At the end of this course, learners will be able to communicate effectively with:

- Improved fluency inJapanese
- Clarity on the basic sounds of the Japaneselanguage
- Propervocabulary

Unit I	Introduction	9

Introduction to Japanese - Japanese script - Pronunciation of Japanese(Hiragana) - Long vowels -Pronunciation of in,tsu,ga - Letters combined with ya,yu,yo - Daily Greetings and Expressions Numerals. N1 wa N2 des - N1 wa N2 ja arimasen - S ka - N1mo - N1 no N2 - .san - Kanji - Technical Japanese Vocabulary (25 Numbers) - Phonetic and semantic resemblances between Tamil and Japanese

Unit II	Vocabulary & Grammar 語彙と文法	9

Introduction - Kore - Sore - are - Kono N1 - Sono N1 - ano N1 - so des - so ja arimasen - S1 ka - S2 ka - N1 no N1 - so des ka ' koko - soko - asoko - kochira - sochira - achira - N1 wa N2 (Place) des - dhoko-N1 no N2 - Kanji-10 - ima-.ji-fun des - Introduction of verb - V mas - V masen - V mashitha-V masen deshitha - N1(Time) ne V - N1 kara N2 des - N1 tho N2 / S ne Kanji-10 - Technical Japanese Vocabulary (25 Numbers) - Dictionary Usage.

Unit III	Noun&Types 名詞とタイプ	9

N1(Place) ye ikimas - ki mas - kayerimasu - Dhoko ye mo ikimasen - ikimasendheshitha - N1(vehicle) de ikimasu - kimasu - kayerimasu - N1(Personal or Animal) tho V ithsu - S yo. - N1 wo V (Transitive) - N1 wo shimus - Nani wo shimasu ka - Nan & Nani - N1(Place) de V - V masen ka - V masho - Oo. Kanji-10 , N1(tool - means) de V - Word / Sentence wa go nan des ka - N1(Person) ne agemus - N1(Person) ne moraimus - mo V shimashitha - , Kanji-10 - Japanese Typewriting using JWPCE Software, Technical Japanese Vocabulary (25Numbers)

Unit IV	Vocabulary & Grammar 語彙と文法	9

Introduction to Adjectives - N1wanaadj des. N1 wa ii adj des - naadjna N1 - ii adj ii N1 - Thothemo - amari - N1 wadho des ka - N1 wadhonna N2 des ka - S1 ka S2 - dhore - N1 gaarimasu - wakarimasu - N1 ga suki masu - N1 gakiraimasu - jozu des - hetha des - dhonna N1 - Usages of yoku - dhaithai - thakusan - sukoshi - amari - zenzen - S1karaS2-dhoshithe,N1gaarimasu-imasuN1(Place)neN2gaarimasu-iimasu-N1waN2(Place)nearimasu-iimasu - N1(Person,Place,or Thing) no N2 (Position) - N1 ya N2, Kanji-10 - Japanese Dictionary usage using JWPCE Software, Technical Japanese Vocabulary (25 Numbers)

Unit V	Root Word & Vocabulary 語彙と語彙	9

Saying Numbers , Counter Suffixes , Usages of Quantifiers -Interrogatives - Dhonokurai - gurai - Quantifier-(Period) ne -.kai V - Quantifier dhake / N1 dhake Kanji - Past tense of Noun sentences and na Adjective sentences - Past tense of ii-adj sentences - N1 wa N2 yoriadj des - N1 tho N2 tho Dhochiragaadj des ka and its answering method - N1 [no naka] de {nani/dhoko/dhare/ithsu} ga ichiban adj des ka - answering -N1 gahoshides
- V1 mas form dhake mas - N1 (Place) ye V masu form ne ikimasu/kimasu/kayerimasu - N1 ne V/N1 wo V - Dhokoka - Nanika - gojumo - Technical Japanese Vocabulary (25 Numbers)

TEXT BOOK(S):

1. Modern Japanese Vocabulary: A Guide for 21st Century Students | Edward P. Trimnell Publisher: Beechmont Crest Publishing (April28
2. Japanese Verbs & Essentials of Grammar" | Rita Lampkin Passport Books ,2013

REFERENCE(S):

1. JapaneseforEveryone:Elementary MainTextbook1-1,GoyalPublishersandDistributorsPvt.Ltd.,Delhi, 2007.
2. JapaneseforEveryone:Elementary MainTextbook 1-2,Goyal PublishersandDistributorsPvt.Ltd.,Delhi, 2007

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HSX202	HINDI	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- To help students to acquire the basics ofHindi
- To teach them how to converse in Hindi on variousoccasions
- To help learners acquire the ability to understand a simple technical text inHindi

Course Outcomes: At the end of this course, learners will be able to:

- An ability to communicate effectively with: (a) Improved fluency in Hindi (b) Clarity on the basic sounds of the Hindi language (c) Propervocabulary

Unit I	HINDI ALPHABET	9

Genders (Masculine & Feminine Nouns ending in a ,e,i,o, u,)- Masculine & Feminine - Reading Exercises. Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu&Visarg -Table of Alphabet -Vocabulary.

Unit II	NOUNS IN HINDI	9

Genders (Masculine & Feminine Nouns ending in a ,e,i,o, u,)- Masculine & Feminine - Reading Exercises.

Unit III	PRONOUNS AND TENSES	9

Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

Unit IV	CLASSIFIED VOCABULARY	9

Parts of body - Relatives - Spices- Eatables- Fruit & Vegetables - Clothes - Directions-Seasons - Professions.

Unit V	SPEAKING	9

Model Sentences - Speaking practice for various occasions.

TEXT BOOK(S):

1. Elementary Hindi: Learn to Communicate in Everyday Situations by Richard Delacy Tuttle Publication 2013
2. Colloquial Hindi: The Complete Course for Beginners by Tej K.Bhatia

REFERENCE(S):

1. B. R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi,2009.
2. Syed, PrayojanMulak Hindi, RahamathullahVaniPrakasan, New Delhi,2002.
3. Ramdev, VyakaranPradeep, SaraswathiPrakasan, Varanasi,2004.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HSX204	FRENCH	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- help students acquire the basics of Frenchlanguage
- teach them how to converse in French in variousoccasions

Course Outcomes: At the end of this course, learners will be able to:

- The students will become familiar with the basics of French language and start conversing inFrench.

Unit I	Alphabet Français	6

Alphabet Français (alphabets) - Les Accents Français (the accents in French) - aigu - grave - circonflexe - tréma cédille - écrire son nom dans le français (spellingone -sname in French) - Les noms de jours de la semaine (Days of theweek)

Unit II	Grammaire	6

Les noms de mois de l'année (Months) - Numéro 1 à 100 (Numbers 1 to 100) GRAMMAIRE :Conjugaison

Unit III	Moyens de transport	10

Moyens de transport (Transport) - Noms de Professions (Professions) - Noms d'endroits communs (Places) - Nationalités (Nationalities) ECOUTER : (Listening) Écouter l - alphabet associéà des prénoms français - Écouter etrépondre PARLER (Speaking)Présntation - même /Présentez - Vous (Introducingoneself)LIRE :Lireles phrases simples

Unit IV	Pronoms	12

Pronoms (Pronouns) - Noms communs masculins et de femme (Common masculine and Femininenouns) - Verbes communs (Common verbs)COUTER :couter et crier les prnoms - Observer les dessins et couter les dialogues LIRE : Lire les profils d'utilisateurs d'interlingua (alter ego)PARLER :Parler de sa ville - Parler de saprofession

Unit V	Europe PARLER	11

Narration de son nom et l'endroit où on vit - Son âge et date de naissance - Numéro de téléphone et'dresse -Narration du temps - La France en Europe PARLER :Conversation entre deux amis - Jouer la scène ÉCOUTER :Ecouter les conversations (CD alter ego)ÉCRIRE :Écrireune carte postale

TEXT BOOK(S):

1. Le Bon Usage by M. Grevisse Publisher- Duculot 14 edition (25 January2001)
2. Advanced French by Monique L'Huillier, Cambridge UniversityPress,2013

REFERENCE(S):

1. Alter ego+ Niveaua1
2. Grammaire Progressive duFrançais
3. Collins Easy Learning French Verbs&Practice
4. FrançaisLinguaphone
5. FrançaisI.Harrisonburg: The Rosetta Stone: Fairfield LanguageTechnologies

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PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVE – I

Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RAX01	SYSTEM SOFTWARE	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is:

- Understand the phases in a software project.
- Understand fundamental concepts of requirements engineering and Analysis Modeling.
- Understand the major considerations for enterprise integration and deployment.
- Learn various testing and maintenance measures.
- Learn about various parsing techniques.

Course Outcomes: At the end of this course, learners will be able to:

- Identify the key activities in managing a software project.
- Compare different process models.
- Concepts of requirements engineering and Analysis Modeling.
- Apply systematic procedure for software design and deployment.
- Compare and contrast the various testing and maintenance.

Unit I	ASSEMBLERS	16

General Design procedures – Design of an Assembler – data structures – format of databases – algorithm – flow chart – PASS structures – modular functions. MACRO LANGUAGE AND MACRO PROCESSORS: Macro instructions, features of a macro facility –implementation.

Unit II	LOADERS	08

Loader schemes – compile and go loaders , general load scheme – absolute loaders – direct linking loaders and their design. Other loading schemes : linking loaders, overlays, dynamic binders.

Unit III	COMPILERS	10

Introduction – Structure of a compiler – phases of a compiler - compiler writing tools. LEXICAL ANALYSIS: Role of a lexical analyzer – finite automata –regular expressions to finite automata – minimizing the number of states of a deterministic finite automata – implementation of a lexical analyzer.

Unit IV	PARSING TECHNIQUES	06

Context free grammars – derivations and parse trees – ambiguity – capabilities of context free grammars. Top down and bottom up parsing – handles – shift reduce parsing – operator precedence parsing – recursive descent parsing – predictive parsing.

Unit V	INTERMEDIATE CODE GENERATION	05

Postfix notation, Quadruples, triples , indirect triples – Representing information in a symbol table – introduction to code optimization – basic blocks – DAG representation – error detection and recovery - code generation.

REFERENCE(S):

1. Leland Beck - "System Software – An Introduction to Systems Programming", Third Edition, Pearson Education, Inc., 2008

2. Srimanta Pal, " Systems Programming " , Oxford University Press, 2011.

3. John J Donovan, " Systems Programming", McGraw Hill , 1999.

4. Aho A V, Sethi R and Ullman J D, "Compilers: Principles, Techniques and Tools", Addison Wesley, Longman, 1999.

5. Dhamdhere D M, "Compiler Construction Principles and Practice", Macmillan Company, 1997.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RAX02	AUTOMOBILE ENGINEERING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is:

- To understand the construction and working principle of various parts of an automobile.
- To have the practice for assembling and dismantling of engine parts and transmission system.
- To learn the function of various components in transmission and drive lines of a vehicle.
- To study the concept and working of steering, brakes and suspension systems in automobile.
- Learn about various alternate sources of energy.

Course Outcomes: At the end of this course, learners will be able to:

- Recognize the various parts of the automobile and their functions and materials.
- Compare the engine auxiliary systems and engine emission control.
- Distinguish the working of different types of transmission systems.
- Can explain the Steering, Brakes and Suspension Systems.
- Predict possible alternate sources of energy for IC Engines.

Unit I	VEHICLE STRUCTURE AND ENGINES	09

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines –components-functions and materials, variable valve timing (VVT).

Unit II	ENGINE AUXILIARY SYSTEMS	09

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

Unit III	TRANSMISSION SYSTEMS	09

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

Unit IV	STEERING, BRAKES AND SUSPENSION SYSTEMS	09

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

Unit V	ALTERNATIVE ENERGY SOURCES	09

Use of Natural Gas, Liquefied Petroleum Gas, Bio – Diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles – Engine Modification required – Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

REFERENCE(S):

1. Jain K.K. and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.
2. Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.
3. Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2012
4. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998
5. Martin W, Stockel and Martin T Stockle , "Automotive Mechanics Fundamentals," The Good heart - Will Cox Company Inc, USA ,1978.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RAX03	VIRTUAL INSTRUMENTATION SYSTEMS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- To review background information required for studying virtual instrumentation.
- To study the basic building blocks of virtual instrumentation.
- To study the various techniques of interfacing of external instruments of PC.
- To study the various graphical programming environment in virtual instrumentation.
- To study a few applications in virtual.

Course Outcomes: At the end of this course, learners will be able to communicate effectively with:

- Ability to understand the virtual instrumentation.
- To study the basic building blocks of virtual instrumentation.
- To study the various techniques of interfacing of external instruments of PC.
- To study the various graphical programming environment in virtual instrumentation.

To study a few applications in virtual.

Unit I	REVIEW OF DIGITAL INSTRUMENTATION	6

Representation of analog signals in the digital domain – Review of quantization in amplitude and time axes, sample and hold, sampling theorem, ADC and DAC.

Unit II	FUNDAMENTALS OF VIRTUAL INSTRUMENTATION	10

Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer-counter and analog outputs on the universal DAQ card.

Unit III	CLUSTER OF INSTRUMENTS IN VI SYSTEM	10

Interfacing of external instruments to a PC – RS232, RS 422, RS 485 and USB standards - IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus.

Unit IV	GRAPHICAL PROGRAMMING ENVIRONMENT IN VI	10

Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI - Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures - Types of data – Arrays – Formulae nodes –Local and global variables – String and file I/O.

Unit V	ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI	9

Fourier transform - Power spectrum - Correlation – Windowing and filtering tools – Simple temperature indicator – ON/OFF controller – P-I-D controller - CRO emulation - Simulation of a simple second order system – Generation of HTML page.

TEXT BOOK(S):

1. S. Gupta and J.P Gupta, 'PC Interfacing for Data Acquisition and Process Control', Instrument society of America, 1994.
2. Peter W. Gofton, 'Understanding Serial Communications', Sybex International.
3. Robert H. Bishop, 'Learning with Lab-view', Prentice Hall, 2003.

REFERENCE(S):

1. Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control', Newness, 2000.
2. Gary W. Johnson, Richard Jennings, 'Lab-view Graphical Programming', McGraw Hill Professional Publishing, 2001.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RAX04	PROFESSIONAL ETHICS IN ENGINEERING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is:

- Give an overview of the Human values.
- Provide a fundamental understanding of engineering ethics.
- Learn about the responsibilities of a Engineer.
- Know about safety, responsibilities and rights.
- Provide ethics towards society.

Course Outcomes: At the end of this course, learners will be able to:

- To understand the basic human values.
- Ability to know about the model of professional roles.
- To know about the code of ethics
- To expose students to the respect of Authority.
- To understand role of Engineer in society.

Unit I	HUMAN VALUES	10

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

Unit II	ENGINEERING ETHICS	09

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

Unit III	ENGINEERING AS SOCIAL EXPERIMENTATION	09

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

Unit IV	SAFETY, RESPONSIBILITIES AND RIGHTS	09

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Unit V	GLOBAL ISSUES	08

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

REFERENCE(S):

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi,2003.
3. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
4. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
5. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
6. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
7. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.
8. World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011.

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OPEN ELECTIVES

Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RAY01	PRINCIPLES OF ROBOTICS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is:

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

Course Outcomes: At the end of this course, learners will be able to:

- Ability to understand basic concept of robotics.
- To analyze Instrumentation systems and their applications to various
- To know about the differential motion add statics in robotics
- To know about the various path planning techniques.
- To know about the dynamics and control in robotics industries.

Unit I	BASIC CONCEPTS	09
Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and control issues-Various manipulators – Sensors - work cell - Programming languages.		
Unit II	**DIRECT AND INVERSE KINEMATICS**	**09**
Mathematical representation of Robots - Position and orientation – Homogeneous transformation- Various joints-Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics-SCARA robots- Solvability – Solution methods-Closed form solution.		
Unit III	**MANIPULATOR DIFFERENTIAL MOTION AND STATICS**	**09**
Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.		
Unit IV	**PATH PLANNING**	**09**
Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.		
Unit V	**DYNAMICS AND CONTROL**	**09**
Lagrangian mechanics- 2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.		

REFERENCE(S):

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
2. John J.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 3. 2009.
3. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
4. K. K.Appu Kuttan, Robotics, I K International, 2007.
5. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
6. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
7. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration Allied Publishers,Chennai, 1998.
8. S.Ghoshal, "Embedded Systems & Robotics" – Projects using the 8051 Microcontroller", Cengage Learning, 2009.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
19RAY02	TOTALLY INTEGRATED AUTOMATION	L	T	P	C	45	100	
		3	0	0	3			

Course Objective (s): The purpose of learning this course is:

- To gain knowledge in automation in industries.
- To gain knowledge in various electrical and electronic programmable automations and their applications.
- To know about the basic in SCADA and DCS systems.
- To gain knowledge in communication protocols in an integrated system
- To know about the advanced in automation industries

Course Outcomes: At the end of this course, learners will be able to:

- Knowledge of PLC & PAC automation
- Knowledge in HMI systems and to integrate it with other systems.
- Ability to apply SCADA and usage of C programming for report generation
- Acquiring information's on communication protocols in automation systems
- Ability to design and develop automatic control system using distributed control systems.

Unit I	TOTALLY INTEGRATED AUTOMATION	09

Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integration structure.

Unit II	HMI SYSTEMS	09

Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI- Text display - operator panels - Touch panels - Panel PCs - Integrated displays (PLC & HMI). Check with PLC 502 and remove.

Unit III	SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)	09

Overview – Developer and runtime packages – architecture – Tools – Tag – Internal &External graphics, Alarm logging – Tag logging – structured tags– Trends – history– Report generation, VB & C Scripts for SCADA application.

Unit IV	COMMUNICATION PROTOCOLS of SCADA	09

Proprietary and open Protocols – OLE/OPC – DDE – Server/Client Configuration – Messaging – Recipe – User administration – Interfacing of SCADA with PLC, drive, and other field device

Unit V	DISTRIBUTED CONTROL SYSTEMS (DCS)	09

DCS – architecture – local control unit- programming language – communication facilities – operator interface – engineering interfaces. APPLICATIONS OF PLC & DCS: Case studies of Machine automation, Process automation, Introduction to SCADA Comparison between SCADA and DCS.

REFERENCE(S):

1. John.W.Webb & Ronald A. Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2003.
2. Michael P. Lukas, "Distributed Control systems", "Van Nostrand Reinfold Company"1995 .
3. Win C C Software Manual, Siemens, 2003
4. RS VIEW 32 Software Manual, Allen Bradly, 2005
5. CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RAY03	AIR POLLUTION AND CONTROL ENGINEERING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- To review background information regarding air pollution.
- To study the meteorology on air pollution.
- To study the various techniques on particulate contaminants.
- To study the various gaseous contaminants and their process control.
- To study a few applications in air pollutant and its emerging trends.

Course Outcomes: At the end of this course, learners will be able to communicate effectively with:

- An understanding of the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management
- Ability to identify, formulate and solve air and noise pollution problems
- Ability to design stacks and particulate air pollution control devices to meet applicable standards.
- Ability to select control equipments.
- Ability to ensure quality, control and preventive measures.

Unit I	INTRODUCTION	07

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards.

Unit II	METEOROLOGY	06

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

Unit III	CONTROL OF PARTICULATE CONTAMINANTS	11

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle - Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators.

Unit IV	CONTROL OF GASEOUS CONTAMINANTS	11

Factors affecting Selection of Control Equipment – Working principle - absorption, Adsorption, condensation, Incineration, Bio filters – Process control and Monitoring.

Unit V	INDOOR AIR QUALITY MANAGEMENT	10

Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness- Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

TEXT BOOK(S):

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, springer science + science media LLC,2004.
2. Noel de Nevers, "Air Pollution Control Engineering", Waveland press,Inc 2017.
3. Anjaneyulu. Y, "Air Pollution and Control Technologies", Allied Publishers (P) Ltd., India 2002.

REFERENCE(S):

1. David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000.
2. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
3. Wayne T.Davis, "Air Pollution Engineering Manual", John Wiley & Sons, Inc, 2000.
4. M.N Rao and HVN Rao, "Air Pollution",Tata Mcgraw Hill Publishing Company limited,2007.
5. C.S.Rao, "Environmental Pollution Control Engineering",New Age International(P) Limited Publishers,2006.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RAY05	INTELLECTUAL PROPERTY RIGHTS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is:

- To give an idea about IPR, registration and its enforcement.
- To learn the registration process in IPR.
- To study the concept of agreements and legislation.
- Learn about digital products and laws.
- To learn about enforcement of IPR.

Course Outcomes: At the end of this course, learners will be able to:

- Ability to manage Intellectual Property portfolio to enhance the value of the firm.

Unit I	INTRODUCTION	09

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

Unit II	REGISTRATION OF IPRs	10

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad.

Unit III	AGREEMENTS AND LEGISLATIONS	10

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

Unit IV	DIGITAL PRODUCTS AND LAW	09

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

Unit V	ENFORCEMENT OF IPRs	07

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

REFERENCE(S):

1.V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012.
2.S.V. Satarkar, Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.
3.Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.
4.Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.
5.Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.

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Department	ROBOTICS AND AUTOMATION					R 2019	Semester VI	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19RAY04	INDUSTRIAL SAFETY ENGINEERING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- To provide in depth knowledge in Principles of Environmental safety and its applications in various fields.
- To provide the knowledge of air and water pollution and their control.
- To expose the students to the basics in hazardous waste management

Course Outcomes: At the end of this course, learners will be able to communicate effectively with:

- Illustrate and familiarize the basic concepts and scope of engineering safety.
- Understand the standards of professional conduct that are published by professional safety organizations and certification bodies.
- Illustrate the importance of safety of employees while working with machineries.

Unit I	SAFETY IN METAL WORKING AND WOOD WORKING MACHINES	09

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards. Inspection of material handling equipments.

Unit II	SAFETY IN WELDING AND GAS CUTTING	09

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.

Unit III	SAFETY IN COLD FORMING AND HOT WORKING OF METALS	09

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes - Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures - Safety in Gas Furnace Operation, Cupola, Crucibles, Ovens, Foundry Health Hazards, Work Environment, Material Handling in Foundries, Foundry Production Cleaning And Finishing Foundry Processes

Unit IV	SAFETY IN FINISHING, INSPECTION AND TESTING	09

Heat treatment operations, Electro Plating, Paint Shops, Sand And Shot Blasting, Safety In Inspection And Testing, Dynamic Balancing, Hydro Testing, Valves, Boiler Drums And Headers, Pressure Vessels, Air Leak Test, Steam Testing, Safety In Radiography, Personal Monitoring Devices, Radiation Hazards, Engineering And Administrative Controls, Indian Boilers Regulation.

Unit V	INDUSTRIAL SAFETY	09

Advances in Industrial Ergonomics and safety, Work and protective clothing, Theory and practice of Industrial safety, Industrial Noise and Vibration, Machine Guarding and Industrial machine safety, Manual material handling, Modeling for safety and health.

REFERENCE(S):

1. Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly, Accident Prevention Manual – NSC, Chicago, 2009.
2. Charles D. Reese, Occupational Health and Safety Management, CRC Press, 2003.
3. John V. Grimaldi and Rollin H. Simonds Safety Management by All India Travelers Book seller, New Delhi, 1989.
5. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
6. Anil Mital Advances in Industrial Ergonomics and Safety Taylor and Francis Ltd, London, 1989

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