RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna University Chennai)
DEPARTMENT OF ROBOTICS AND AUTOMATION
CURRICULUM AND SYLLABUS REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM
B.E. ROBOTICS AND AUTOMATION (w.e.f.2021)

VISION:

To be a department of excellence in academics, research and technological advancement in Robotics and Automation with a concern for society

MISSION:

- To impart high technical knowledge, strong fundamentals, practical skills and creative knowledge for making successful professionals in Robotics and Automation.
- To foster students by infusing leadership qualities to become successful Engineer.
- To inculcate the entrepreneurial qualities for creating, developing and managing global engineering ventures.

Programme Educational Objectives (PEOs):

PEO I

To impart students with strong and comprehensive knowledge in the analytical, scientific and engineering fundamentals for solving engineering problems

PEO II

To disseminate students with necessary skills, knowledge and leadership qualities for successful careers in industry

PEO III

To instil students with Technical expertise, Ethical practices and Team spirit and a concern towards greener society

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate

consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Design and develop efficient Automation system to enhance the quality of life by applying fundamentals of Basic Science, Mechanical and Mechatronics Engineering

PSO 2: Analyse and improve the performance of Manufacturing and Production system by implementing the Soft and hard Computing methods

PSO 3: Manage and lead a professional or an entrepreneur career in industries by applying modern Engineering, Management principles and best practices

CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1	HS19151	Technical English	HS	3	2	1	0	3
2	MA19151	Algebra and Calculus	BS	4	3	1	0	4
3	GE19101	Engineering Graphics	ES	4	2	2	0	4
LAB ORIENTED THEORY COURSES								
4	PH19141	Physics of Materials	BS	5	3	0	2	4
LABORATORY COURSES								
5	GE19121	Engineering Practices - Civil and Mechanical	ES	2	0	0	2	1
NON-CREDIT - MANDATORY COURSE								
6	MC19101	Environmental Science and Engineering	MC	3	3	0	0	0
			TOTAL	**21**	**13**	**4**	**4**	**16**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1.	MA19251	Differential Equations and Vector Calculus	BS	4	3	1	0	4
2.	GE19201	Engineering Mechanics	ES	3	2	1	0	3
LAB ORIENTED THEORY COURSES								
3.	CY19241	Engineering Chemistry	BS	5	3	0	2	4
4.	GE19141	Programming using C	ES	6	2	0	4	4
5.	EE19241	Basic Electrical Engineering	ES	5	3	0	2	4
LABORATORY COURSES								
6.	MT19221	Computer Aided Drawing Laboratory	ES	2	0	0	2	1
7.	GE19122	Engineering Practices-Electrical and Electronics	ES	2	0	0	2	1
NON-CREDIT - MANDATORY COURSE								
8.	MC19102	Indian Constitution and Freedom Movement	MC	3	3	0	0	0
			TOTAL	**30**	**16**	**2**	**12**	**21**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1	MA19355	Transforms and Applications	BS	4	3	1	0	4
2	MT19301	Analog Devices and Circuits	PC	3	3	0	0	3
3	MT19302	Digital System Design	PC	3	3	0	0	3
4	ME19303	Kinematics of Machinery	PC	3	2	1	0	3
5	RO19301	Mechanics of Materials	ES	4	3	1	0	4
LABORATORY COURSES								
6	GE19211	Problem solving and programming in Python	ES	5	1	0	4	3
7	MT19311	Digital System Design laboratory	PC	3	0	0	3	1.5
8	RO19311	Mechanics of Materials laboratory	ES	3	0	0	3	1.5
NON-CREDIT - MANDATORY COURSE								
9	MC19301	Essence of Indian Traditional Knowledge	MC	2	2	0	0	0
			TOTAL	**30**	**17**	**3**	**10**	**23**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1.	MA19455	Statistics and Numerical Methods	BS	4	3	1	0	4
2.	MT19402	Microcontrollers and Embedded Systems	PC	3	3	0	0	3
3.	RO19401	Basics of Robotics	PC	3	3	0	0	3
4.	RO19402	Manufacturing Science	PC	3	3	0	0	3
LABORATORY COURSES								
5.	CS19411	Python Programming for Machine Learning	ES	5	1	0	4	3
6.	ME19312	Manufacturing Technology laboratory	PC	3	0	0	3	1.5
7.	MT19411	Microprocessors and Microcontrollers for Automation Laboratory	PC	3	0	0	3	1.5
8.	GE19421	Soft skills – I	EEC	2	0	0	2	1
9.	RO19421	Internship – I	EEC	2	0	0	2	1
			TOTAL	**28**	**13**	**1**	**14**	**21**

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1	RO19501	Fluid Power Systems	PC	3	3	0	0	3
2	RO19502	Dynamics and Design of Machinery	PC	4	3	1	0	4
3	RO19503	Mechatronics and Manufacturing Automation	PC	3	3	0	0	3
4	MT19503	System Dynamics and Control	PC	3	3	0	0	3
5		Open Elective – I	OE	3	3	0	0	3
6		Professional Elective -I	PE	3	3	0	0	3
LABORATORY COURSES								
7	RO19511	Robotics laboratory	PC	3	0	0	3	1.5
8	RO19512	Fluid Power Systems laboratory	PC	3	0	0	3	1.5
9	GE19521	Soft Skills – II	EEC	2	0	0	2	1
10	RO19521	Internship – II	EEC	2	0	0	2	1
			TOTAL	**29**	**18**	**1**	**10**	**24**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1	RO19601	Mobile Robots	PC	3	3	0	0	3
2	RO19602	Resource Management Techniques	HS	3	3	0	0	3
3		Professional Elective - II	PE	3	3	0	0	3
4		Professional Elective - III	PE	3	3	0	0	3
LAB ORIENTED THEORY COURSES								
5	RO19643	Computer Aided Engineering	PC	7	3	0	4	5
6	RO19644	Robotic Vision and Intelligence	PC	7	3	0	4	5
LABORATORY COURSES								
7	RO19621	Internship – III	EEC	2	0	0	2	1
8	GE19621	Problem solving Techniques	EEC	2	0	0	2	1
			TOTAL	**30**	**18**	**0**	**12**	**24**

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1	GE19304	Fundamentals of Management for Engineers	HS	3	3	0	0	3
2	RO19702	Computer Integrated Manufacturing	PC	3	3	0	0	3
3	RO19703	Material Handling system	PC	3	3	0	0	3
4		Professional Elective - IV	PE	3	3	0	0	3
5		Open Elective – II	OE	3	3	0	0	3
LABORATORY COURSES								
6	RO19711	Innovation and Design thinking for Robotics and Automation	EEC	3	0	1	2	2
7	RO19721	Project Work - Phase 1	EEC	2	0	0	2	1
8	RO19712	Robotics and Automation Problem Solving using AI,ML and DL	PC	6	0	0	6	3
			TOTAL	**26**	**15**	**1**	**10**	**21**

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSES								
1		Professional Elective - V	PE	3	3	0	0	3
2		Professional Elective – VI	PE	3	3	0	0	3
PRACTICALS								
3	RO19811	Project Work- Phase II	EEC	14	0	0	14	7
			TOTAL	**20**	**6**	**0**	**14**	**13**

TOTAL NO. OF CREDITS: 163

Department of Robotics & Automation						
Professional Electives						
Electives Offered in Semester	**Common verticals**		**Department. Verticals**			
	VERTICAL 1	**VERTICAL 2**	**VERTICAL 3**	**VERTICAL 4**	**VERTICAL 5**	**VERTICAL 6**
	COMPUTATIONAL ENGINEERING	**LOGISTICS AND SUPPLY CHAIN MANAGEMENT**	**APPLIED ROBOTICS**	**DESIGN AND MANUFACTURING**	**INTELLIGENT SYSTEMS**	**DIVERSIFIED**
V	ME19A11-Machine Learning for Intelligent Systems	ME19B11-Reliability and Maintenance Engineering	RO19C11-Humanoid Robotics	**ME 19E15- Additive Manufacturing**	RO19E11-Fuzzy Logic and Artificial Neural Networks	**ME19603-Total Quality management**
VI	ME19A12-**CAD and CAE**	ME19B12-Warehousing Automation	RO19C12-Aerial Robotics	**ME 19D11-Design for X**	**MT19F17-Computer Vision and Deep Learning**	RO19F11-Object Oriented Programming in C++
	ME19A13-**Numerical heat transfer**	ME19B13-Operations Management	RO19C13-Agricultural Robotics and Automation	RO19D11-CNC Machine Tools and Programming	RO19E12-Industrial Network Protocols	**ME19701-Automobile Engineering**
VII	ME19A14-Theory on Computation and Visualization	ME19B14-Material Handling Equipment, Repair and Maintenance	RO19C14- Collaborative Robotics	ME19601-Finite Element Analysis	RO19E13-Condition Monitoring and Fault Diagnostics	MT19G15-Single Board Computers
	ME19A15-Computational Bio- Mechanics	ME19B15-Container Logistics	RO19C15-Robot Operating Systems	RO19D12-Advanced Manufacturing Systems	RO19E14-Applied Signal Processing	RO19F12-Virtual Instrumentation
	ME19A16-Advanced Statistics and Data Analytics	ME19B16-Production Planning and Control	RO19C16-AI in Robotics	**ME 19E17-Electronics Manufacturing Technology**	RO19E15-Applied Image Processing	**ME19G12-Industrial Safety**
VIII	ME19A17-**Noise acoustics & vibration**	ME19B17-Operations Research	RO19C17- MicroRobotics	RO19D13-Computer Aided Inspection and Testing	**MT19F13-Immersive Technologies and Haptic**	**ME 19D16-Process Planning and Cost Estimation**
	ME19A18-Computational Solid Mechanics	ME19B18-Supply chain and Logistics Management	RO19C18-Medical Robotics	RO19D14-Integrated Product Development	RO19E16-Total Integrated Automation	RO19F13-Project Management
	ME19A19-Computational Fluid Dynamics	ME19B19-Data Science	RO19C19-Parallel Manipulators	**ME 19E18-Digital Twin & Industry 4.0**	RO19E17-Advanced Optimization Techniques	**MT19C13-Medical Mechatronics**

SUMMARY

DEPARTMENT OF ROBOTICS AND AUTOMATION										
	Subject Area	**Credits Per Semester**								Credits Total	Percentage %
	Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
1.	Humanities and Social Studies (HS)	3					3	3		9	5.52
2.	Basic Sciences (BS)	8	8	4	4					24	14.723
3.	Engineering Sciences (ES)	5	13	8.5	3					29.5	18.098
4.	Professional Core (PC)			10.5	12	16	13	9		60.5	37.12
5.	Professional Electives (PE)					3	6	3	6	18	11.043
6.	Open Electives (OE)					3		3		6	3.681
7.	Project Work/ Employability Enhancement Course (PR/EEC)				2	2	2	3	7	16	9.815
	TOTAL	16	21	23	21	24	24	21	13	163	
8.	Non-Credit*/ (Mandatory)	√	√	√	-	-	-	-	-		

SEMESTER I

HS19151	TECHNICAL ENGLISH	HS	L	T	P	C
	Common to all branches of B.E./ B.Tech programmes – I semester		2	1	0	3

Objectives:	
•	To enable learners to acquire basic proficiency in English reading and listening.
•	To write in English precisely and effectively.
•	To speak flawlessly in all kinds of communicative contexts.

UNIT-I	VOCABULARY BUILDING	9

The concept of word formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives - Synonyms, antonyms, and standard abbreviations. Compound words – abbreviation – single word substitution – **Listening:** Listening comprehension, listening to motivational speeches, podcasts and poetry. **Speaking:** Short talks on incidents - place of visit – admiring personalities, etc.

UNIT-II	BASIC WRITING SKILLS	9

Sentence structures - Use of phrases and clauses in sentences - punctuation - coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely. Reading & Writing – Free writing – paragraphs - article reading and writing criticism - change of tense forms in short text or story – inferential reading – rewrite or interpret text - prepare questions based on the text.
Speaking: Everyday situations – conversations and dialogues, speaking for and against.

UNIT-III	GRAMMAR AND LANGUAGE DEVELOPMENT	9

Subject-verb agreement- Noun-pronoun agreement - Articles – Prepositions – Redundancies. **Reading & Writing:** Read from innovation and ideas that changed the world, newspaper column writing – **Speaking:** Demonstrative speakingpractice using visual aids (charts, graphs, maps, pictures, etc,.).

UNIT-IV	WRITING FOR FORMAL PRESENTATION	9

Nature and Style of sensible Writing - Describing – Defining – Classifying - Providing examples or evidence - Writing introduction and conclusion. Reading & Writing – Read from Literary pieces – identify different parts text – difference between print and digital writing. Writing: Recommendations - Foreword - Review of book. Speaking- Formal Presentations – Debate on social issues/taboos and solutions.

UNIT-V	EXTENDED WRITING AND SPEAKING	9

Writing: Précis writing – Essay writing – workplace communication: Resume – Business letters and emails – Proposals. **Speaking:** Panel discussion – reporting an event – mock interview – Master Ceremony.

	Total Contact Hours	:	45

Course Outcomes:	
On completion of the course students will be able to	
•	Discuss and respond to the listening content.
•	Read and comprehend different texts and appreciate them
•	Use different types of techniques in precise writing
•	Analyse different genres of communication and get familiarized with new words, phrases, and sentence structures.
•	Write and speak appropriately in varied formal and informal contexts.

Text Books:	
1	English for Technologists & Engineers, Orient Black Swan Publications, Chennai 2012.

Reference Books / Web links:	
1	Technical Communication, Meenakshi Raman & Sangeeta Sharma, Oxford University Press
2	Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi
3	Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press
4	Practical English Usage. Michael Swan. OUP. 1995.
5	Remedial English Grammar. F.T. Wood. Macmillan.2007
6	On Writing Well. William Zinsser. Harper Resource Book. 2001
7	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
8	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

MA19151	ALGEBRA AND CALCULUS	BS	L	T	P	C
	Common to I sem. B.E. – Aeronautical Engineering ,Automobile Engineering, Civil Engineering, Mechanical Engineering , Mechatronics& Robotics andAutomation		**3**	**1**	**0**	**4**

Objectives:	
•	To gain knowledge in using matrix algebra techniques and the limitations of using infinite series approximationsfor those problems arising in mathematical modelling.
•	To understand the techniques of calculus which are applied in the Engineering problems.

UNIT-I	**MATRICES**	**12**
Symmetric and skew – symmetric matrices , orthogonal matrices – Eigen values and Eigen vectors - Cayley – Hamilton theorem (without proof) and applications - orthogonal transformation and quadratic forms to canonical forms - Natureof quadratic forms.		
UNIT-II	**SEQUENCES AND SERIES**	**12**
Convergence of sequence and series – Test for convergence: Comparison Test, D'Alembert Ratio Test, Leibnitz Test, Integral test – Binomial series, Exponential series and logarithmic series: Summations and approximations.		
UNIT-III	**APPLICATIONS OF DIFFERENTIAL CALCULUS**	**12**
Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes -Evolute as envelope of normals.		
UNIT-IV	**FUNCTIONS OF SEVERAL VARIABLES**	**12**
Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.		
UNIT-V	**APPLICATION OF INTEGRATION**	**12**
Centre of Gravity – Moment of inertia - Double integrals in Cartesian and polar coordinates – Change of order of integration - Area of a curved surface - Triple integrals – Volume of Solids.		
	Total Contact Hours : 60	

Course Outcomes: **On completion of the course students will be able to**	
•	Apply the concept of Eigenvalues and eigenvectors, diagonalization of a matrix for solving problems.
•	Develop skills in solving problems involving sequences and series.
•	Analyze, sketch and study the properties of different curves and to handle functions of several variables andproblems of maxima and minima.
•	Obtain the center of gravity, moment of inertia for rigid bodies and also surface area and volume using multipleintegrals.
•	Process the data collected and analyzes the data for central tendencies.

Text Books:	
1	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	T Veerarajan, Engineering Mathematics –I , McGraw Hill Education, 2014

Reference Books / Web links:	
1	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	Erwin Kreyszig, " Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., NewDelhi, 2006.

PH19141	PHYSICS OF MATERIALS	BS	L	T	P	C
	Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanical Engineering , Mechatronics& Robotics and Automation		3	0	2	4

Objectives:
• To enhance the fundamental knowledge in Physics and its applications relevant to mechanical engineering streams.
• To familiarize students in various experimental setups and instruments that are used to study / determine thevarious properties of materials.

UNIT-I	MECHANICS & PROPERTIES OF MATTER	9
Basic definitions - Newton's laws – forces -solving Newton's equations - constraints and friction - cylindrical and spherical coordinates - potential energy function - conservative and non-conservative forces - central forces - conservation of angular momentum - non-inertial frames of reference - rotating coordinate system - centripetal and coriolis accelerations – Elasticity - stress-strain diagram - bending of beams - cantilever depression - Young's modulus determination - I-shape girders.		
UNIT-II	**CRYSTAL PHYSICS**	**9**
Basis – lattices - symmetry operations and crystal systems -Bravaislattics - atomic radius and packing fraction - SC, BCC, FCC, HCP lattices - Miller indices - diffraction by crystals - reciprocal lattice - interpreting diffraction patterns -crystal growth techniques-Czochralski and Bridgmann, crystal defects.		
UNIT-III	**PHYSICS OF MATERIALS**	**9**
Solid solutions - Hume-Rothery's rules –Gibb's phase rule - binary phase diagrams -isomporhpus systems - tie-line and lever rule - eutectic, eutectoid, peritectic, peritectoid, monotectic and syntectic systems - formation of microstructures - homogeneous and non-homogenous cooling – nucleation - iron-carbon phase diagram - eutectoid steel - hypo andhypereutectoid steel – diffusion - Fick's laws – T-T-T diagrams.		
UNIT-IV	**ENGINEERING MATERIALS & TESTING**	**9**
Metallic glasses – preparation and properties - Ceramics – types, manufacturing methods and properties - Composites – types and properties - Shape memory alloys – properties and applications - Nano-materials – top down and bottom upapproaches – properties - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.		
UNIT-V	**QUANTUM PHYSICS**	**9**
Blackbody problem -Planck's radiation law - duality of light -De Broglie hypothesis - properties of matter waves - wave packets –Schrodinger's equations (time dependent and time independent) - Born interpretation (physical significance ofwave function) - probability current - operator formalism (qualitative) - expectation values - uncertainty principle - particle in a box -eigen function and eigen values -Dirac notation (qualitative).		
	Contact Hours : 45	

List of Experiments				
1	Determination of Laser characteristics (wavelength and angular spread).			
2	Determination of Young's modulus by non-uniform bending method			
3	Determination of thermal conductivity of a bad conductor – Lee's Disc method.			
4	Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer			
5	Coupled oscillators - Two compound pendulums;			
6	Experiment on moment of inertia measurement- Torsional pendulum by resonance,			
7	LC circuit, LCR circuit and Resonance phenomena in LCR circuits;			
8	Experiments on electromagnetic induction – BH-Curve experiment			
9	Determination of thickness of a thin wire – Air wedge method			
10	Determination of solar cell characteristics.			
11	Measurement of hysteresis loss:B -H curve.			
12	Determination of creep characteristics of a metallic wire			
		Contact Hours	**:**	**30**
		Total Contact Hours	**:**	**75**

Course Outcomes: **On completion of the course students will be able to**	
●	Determine the elastic moduli of materials.
●	Apply the basic knowledge of crystallography in materials preparation and treatments.
●	Create binary phase diagrams and TTT charts and use them to analyse and measure the properties of alloys.
●	Test or measure various engineering material properties and use them in suitable applications.
●	Determine the characteristics of a given laser source by understand the concepts of quantum theory and the natureof light.

Text Books:	
1	Bhattacharya, D.K. &Poonam, T. *"Engineering Physics".* Oxford University Press, 2018.
2	Raghavan, V. *"Physical Metallurgy: Principles and Practice"*. PHI Learning, 2019.

Reference Books / Web links:	
1	Balasubramaniam, R. "Callister's Materials Science and Engineering". Wiley India Pvt. Ltd., 2017.
2	Raghavan, V. "Materials Science and Engineering: A First course". PHI Learning, 2019.
3	Resnick, R., Halliday, D., & Walker, J. "Principles of Physics", Wiley India Pvt., 2018.
4	Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2018.

GE19101	Engineering Graphics	ES	L	T	P	C
	Common to I sem. B.E. – Aeronautical Engineering ,Automobile Engineering, Civil Engineering, Mechanical Engineering , Mechatronics& Robotics andAutomation		2	2	0	4

Objectives:	
●	To understand the importance of the drawing in engineering applications
●	To develop graphic skills for communication of concepts, ideas and design of engineering products
●	To expose them to existing national standards related to technical drawings.
●	To improve their visualization skills so that they can apply these skill in developing new products.
●	To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination) **1**

Importanceofgraphicsinengineeringapplications–Useofdraftinginstruments– BIS conventions and specifications– Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions

UNIT-I	PLANECURVES AND FREE HAND SKETCH	11

Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method– Construction of cycloids, Construction of involutes of square and circle drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT-II	PROJECTION OF POINTS, LINES AND PLANE SURFACE	12

Orthographic projection- principles-Principal planes- projection of points. First angle projection - Projection of straightlines inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method- Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT-III	PROJECTION OF SOLIDS	12

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principalplanes by rotating object method.

UNIT-IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENTOF SURFACES	12

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

UNIT-V	ISOMETRIC AND PERSPECTIVEPROJECTIONS	12

Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

	Total Contact Hours	:	60

Text Book (s):	
1	Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2	Natrajan K.V., "A text book of Engineering Graphics", DhanalakshmiPublishers, Chennai, 2017.

Reference Books(s) / Web links:	
1	Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt. Ltd., 2013.
2	Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.
3	Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
4	Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, NewDelhi, 2018.

Course Outcomes: On completion of the course students will be able to	
●	Construct different plane curves and free hand sketching of multiple views from pictorial objects.
●	Comprehend the theory of projection and to draw the basic views related to projection of points, lines and planes
●	Draw the projection of solids in different views
●	Draw the projection of Sectioned solids and development of surfaces of solids
●	Visualize and prepare Isometric and Perspective view of simple solids

MC19101	ENVIROMENTAL SCIENCE AND ENGINEERING	MC	L	T	P	C
	Common to All Branches		**3**	**0**	**0**	**0**

Objectives:
• To understand the importance of natural resources, pollution control and waste management.
• To provide the students about the current social issues and environmental legislations.

UNIT-I	**NATURAL RESOURCES**	**9**

Environment -definition - scope and importance - forest resources -use and overexploitation -water resources - use and over utilization - dams - benefits and problems - water conservation -energy resources - growing energy needs - renewable and non renewable energy sources - use of alternate energy sources -land resources -land degradation – role of an individual in conservation of natural resources.

UNIT-II	**ENVIRONMENTAL POLLUTION**	**9**

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - controlof particulate and gaseous emission(Control of SO_2, NO_X, CO and HC). Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution- control of water pollution by physical, chemical and biological processes–waste water treatment-primary, secondary andtertiary treatment. Soil pollution: definition-causes-effects and control of soil pollution.

UNIT-III	**SOLID WASTE MANAGEMENT**	**9**

Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes Hazardous waste -definition - sources of hazardous waste-classification (biomedical waste, radioactive waste, chemical waste, household hazardous waste)-characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity - effects of hazardous waste -case study- bhopal gas tragedy - disposal of hazardous waste-recycling, neutralization, incineration, pyrolysis, secured landfill - E-waste management -definition-sources-effects – electronic waste recycling technology.

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

Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health - disaster management– floods, earthquake, cyclone and landslide.

UNIT-V	**TOOLS FOR ENVIRONMENTAL MANAGEMENT**	**9**

Environmental impact assessment (EIA) structure -strategies for risk assessment–EIS-environmental audit-ISO 14000- precautionary principle and polluter pays principle- constitutional provisions- - pollution control boards and pollution control acts- environmental protection act1986- role of non-government organisations-international conventions and protocols.

	Contact Hours	**:**	**45**

Course Outcomes:	
On completion of the course students will be able to	
●	Be conversant to utilize resources in a sustainable manner.
●	Find ways to protect the environment and play proactive roles.
●	Apply the strategies to handle different wastes
●	Develop and improve the standard of better living.
●	Be conversant with tools of EIA and environmental legislation.

Text Books:	
1	Benny Joseph, "Environmental Science and Engineering", 2nd edition, Tata McGraw-Hill, New Delhi, 2008.
2	Gilbert M. Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.

Reference Books / Web links:	
1	Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt., Ltd, New Delhi, 2007.
2	Erach Bharucha, "Textbook of Environmental Studies", 3rd edition, Universities Press(I) Pvt., Ltd, Hydrabad, 2015.
3	G. Tyler Miller and Scott E. Spoolman, "Environmental Science", 15th edition, Cengage Learning India PVT, LTD, Delhi, 2014.
4	Rajagopalan, R, "Environmental Studies-From Crisis to Cure", 3rd Edition, Oxford University Press, 2015.
5	De. A.K., "Environmental Chemistry", New Age International, New Delhi, 1996.
6	K. D. Wager, "Environmental Management", W. B. Saunders Co., Philadelphia, USA, 1998.

GE19121	ENGINEERING PRACTICES LABORATORY – Civil and Mechanical	ES	L	T	P	C
			0	0	2	1

Objectives:	
•	To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Experiments				
CIVIL ENGINEERING PRACTICE				
1.	Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows inhousehold fittings.			
2.	Preparation of basic plumbing line sketches for wash basins, water heaters, etc.			
3.	Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.			
Carpentry Works:				
4.	Study of joints in roofs, doors, windows and furniture.			
5.	Hands-on-exercise: Woodwork, joints by sawing, planning and chiselling.			
MECHANICAL ENGINEERING PRACTICE				
6.	Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.			
7	Gas welding practice.			
Basic Machining:				
8	Simple Turning and Taper turning			
9	Drilling Practice			
Sheet Metal Work:				
10	Forming & Bending:			
11	Model making – Trays and funnels			
12	Different type of joints.			
Machine Assembly Practice:				
13	Study of centrifugal pump			
14	Study of air conditioner			
		Total Contact Hours	**:**	**30**

Course Outcomes:	
On completion of the course students will be able to	
•	Perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.
•	Perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding ofthe joints in roofs, doors, windows and furniture.
•	Produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depthknowledge in the principle of operation of welding and other accessories
•	Perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
•	Perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

SEMESTER II

MA19251	DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS	BS	L	T	P	C
	Common to II sem.B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanical Engineering, Mechatronics& Robotics and Automation and B. Tech. - Biotechnology, Food Technology & Chemical Engineering		**3**	**1**	**0**	**4**

Objectives:	
●	To handle practical problems arise in the field of engineering and technology using differential equations.
●	To solve problems using the concept of Vectors calculus, Complex analysis, Laplace transforms.

UNIT-I	**SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS**	**12**
Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Cauchy's and Legendre's linear equations - Simultaneous first order linear equations with constant coefficients.		
UNIT-II	**PARTIAL DIFFERENTIAL EQUATIONS**	**12**
Formation of partial differential equations - Solutions of standard types of first order partial differential equations - Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficientsof both homogeneous and non-homogeneous types.		
UNIT-III	**VECTOR CALCULUS**	**12**
Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration –Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applicationsinvolving cubes and rectangular parallelopipeds.		
UNIT-IV	**ANALYTIC FUNCTIONS**	**12**
Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates – Properties Harmonic conjugates – Construction of analytic function - Conformal mapping and Bilinear transformation-Cauchy's integral theorem and Cauchy's integral formula (proof excluded) – Taylor's series and Laurent's series – Singularities Residues – Residue theorem (without proof), simple problems.		
UNIT-V	**LAPLACE TRANSFORM**	**12**
Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.		
	Total Contact Hours : 60	

Course Outcomes:	
On completion of the course students will be able to	
●	Apply various techniques in solving ordinary differential equations.
●	Develop skills to solve different types of partial differential equations
●	Use the concept of Gradient, divergence and curl to evaluate line, surface and volume integrals.
●	Use the concept of Analytic functions, conformal mapping and complex integration for solving Engineeringproblems.
●	Use Laplace transform and inverse transform techniques in solving differential equations.

Text Books:	
1	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	T Veerarajan, Engineering Mathematics –II , McGraw Hill Education, 2018

Reference Books / Web links:	
1	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., NewDelhi, 2006.
4	T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.

CY19241	ENGINEERING CHEMISTRY	BS	L	T	P	C
	Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Mechanical Engineering , Mechatronics& Robotics and Automation		**3**	**0**	**2**	**4**

Objectives:	
•	To understand the theoretical and practical principles of corrosion and its control
•	To familiarise the fundamentals of chemical energy conversions in batteries and fuels
•	To acquaint knowledge on alloys and analytical techniques

UNIT-I	**CORROSION AND PROTECTIVE COATINGS**	**9**
Cause and effects of corrosion - theories of chemical and electrochemical corrosion – emf series- types of corrosion: Galvanic, water-line, intergranular and pitting corrosion – passivity - factors affecting rate of corrosion - corrosion control methods- cathodic protection -sacrificial anode and impressed current cathodic methods - corrosion inhibitors - metal cladding - anodizing - electroplating - electroless plating - factors influencing electroplating - polarisation - decomposition potential - over voltage - current density - electrolyte concentration- additives - organic coatings – paints - constituents - functions - special paints - fire retardant - water repellent - temperature indicating and luminous paints.		
UNIT-II	**ENERGY STORAGE DEVICES**	**9**
Batteries - primary battery - alkaline battery - secondary battery (Lead acid storage battery, Nickel - Cadmium battery and Lithium – ion battery) - flow battery -components, working principle and applications of hydrogen-oxygen, solid oxide, direct methanol and proton exchange membrane fuel cells.		
UNIT-III	**PHASE RULE AND ALLOYS**	**9**
Phase rule - definition of terms - one component system -water system - reduced phase rule - thermal analysis - two component system- eutectic system - lead silver system - safety fuses and solders. Alloys - purpose of alloying - function and effects of alloying elements - properties of alloys - classification of alloys - Ferrous alloys - nichrome and stainless steel - Non-ferrous alloys - brass and bronze - heat treatment of alloys (annealing, hardening, tempering, normalising, carburizing and nitriding)		
UNIT-IV	**FUNDAMENTAL SPECTROSCOPIC TECHNIQUES AND THERMAL ANALYSIS**	**9**
Principles of spectroscopy - UV, visible and IR spectroscopy principle - instrumentation (block diagram) - applications. Principles, block diagram, instrumentation and applications of TGA, DTA, DSC and Flame photometry		
UNIT-V	**FUELS AND COMBUSTION**	**9**
Fuels- classification -coal-ranking of coal- proximate and ultimate analysis metallurgical coke - manufacture by Otto- Hoffmann method - Petroleum processing and fractions -knocking - octane number and cetane number - synthetic petrol - Fischer Tropsch and Bergius processes -power alcohol, biodiesel- Gaseous fuels CNG and LPG. Combustion-calorific value - Dulongs formula-problems- flue gas analysis – Orsat apparatus–theoretical air forcombustion – problems		
	Contact Hours : 45	

List of Experiments	
1	Determination of corrosion rate on mild steel by weight loss method
2	Estimation of DO by winkler's method
3	Determination of total, temporary and permanent hardness by EDTA method.
4	Estimation of alkalinity by indicator method.
5	Estimation of chloride by argentometric method
6	Estimation of extent of corrosion of Iron pieces by potentiometry
7	Estimation of mixture of acids by conductometry.
8	Estimation of acid by pH metry
9	Estimation of copper / ferrous ions by spectrophotometry.
10	Estimation of sodium and potassium in water by flame photometry.
11	Determination of flash and fire point of lubricating oil

12	Determination of cloud and pour point of lubricating oil			
13	Determination of phase change temperature of a solid.			
		Contact Hours	**:**	**30**
		Total Contact Hours	**:**	**75**

Course Outcomes:	
On completion of the course students will be able to	
●	Analyse type of corrosion and identify suitable corrosion control method
●	Construct electrochemical cells and measure its potential
●	Modify metal properties by alloying
●	Characterize various material systems
●	Know the importance of fuels in day to day applications

Text Books:	
1	P. C. Jain and Monika Jain, "Engineering Chemistry", DhanpatRai Publishing Company (P) Ltd., New Delhi, 2015.
2	O.G. Palanna, "Engineering Chemistry", McGraw Hill Education (India) PVT, Ltd., New Delhi, 2017.

Reference Books / Web links:	
1	C. N. Banwell and E.M. McCash, "Fundamentals of Molecular Spectroscopy", 4th Edn, Tata McGraw-Hill Edition, 1995
2	ShashiChawla, "A Text Book of Engineering Chemistry", DhanpatRai& Co, New Delhi, 2017.
3	Sharma Y.R., "Elementary Organic Spectroscopy", Sultan Chand & Sons, New Delhi, 2014.
4	Sharma B. K., "Analytical Chemistry", Krishna Prakashan Media (P) Ltd., Meerut, 2005.

GE19141	PROGRAMMING USING C	ES	L	T	P	C
			2	0	4	4

Objectives:	
●	To develop simple algorithms for arithmetic and logical problems.
●	To develop C Programs using basic programming constructs
●	To develop C programs using arrays and strings
●	To develop applications in C using functions, pointers and structures
●	To do input/output and file handling in C

UNIT-I	GENERAL PROBLEM SOLVING CONCEPTS	6
Computer – components of a computer system-Algorithm and Flowchart for problem solving with Sequential LogicStructure, Decisions and Loops.		
UNIT-II	**C LANGUAGE - TYPES OF OPERATOR AND EXPRESSIONS**	6
Introduction- C Structure- syntax and constructs of ANSI C - Variable Names, Data Type and Sizes, Constants,Declarations - Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment and Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation,proper variable naming and Hungarian Notation.		
UNIT-III	**I/O AND CONTROL FLOW**	6
Standard I/O, Formatted Output – Printf, Variable-length argument lists- Formatted Input – Scanf, Statements andBlocks, If-Else-If, Switch, Loops – while, do, for, break and continue, GoTo Labels.		
UNIT-IV	**FUNCTIONS AND PROGRAM STRUCTURE**	6
Basics of functions, parameter passing and returning type, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, C Pre-processor, Standard Library Functions and return types.		
UNIT-V	**POINTERS , ARRAYS AND STRUCTURES**	6
Pointers and addresses, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional arrays, Strings, Initialisation of Pointer Arrays, Command line arguments, Pointers to functions, complicated declarations. Basic Structures, Structures and Functions, Array of structures, Pointer of Structures, Self-referential Structures, Table look up, Typedef, Unions, Bit-fields, File Access -Error Handling, Line I/O, Miscellaneous Functions.		
	Contact Hours : 30	

List of Experiments			
1	Algorithm and flowcharts of small problems like GCD. Structured code writing with:		
2	Small but tricky codes		
3	Proper parameter passing		
4	Command line Arguments		
5	Variable parameter		
6	Pointer to functions		
7	User defined header		
8	Make file utility		
9	Multi file program and user defined libraries		
10	Interesting substring matching / searching programs		
11	Parsing related assignments		
	Contact Hours	**:**	**60**
	Total Contact Hours	**:**	**90**

Course Outcomes: On completion of the course students will be able to	
●	Formulate simple algorithms for arithmetic and logical problems.
●	Implement conditional branching, iteration and recursion.
●	Decompose a problem into functions and synthesize a complete program using divide and conquer approach.
●	Use arrays, pointers and structures to formulate algorithms and programs.
●	Apply programming to solve matrix addition and multiplication problems and searching and sorting problems.

Text Books:	
1	Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Pearson Education India; 2nd Edition, 2015.
2	Byron Gottfried, "Programming with C", Second Edition, Schaum Outline Series, 1996.

Reference Books:	
1	Herbert Schildt, "C: The Complete Reference", Fourth Edition, McGraw Hill, 2017.
2	YashavantKanetkar, "Let Us C", BPB Publications, 15th Edition, 2016.

Web links for virtual lab:	
1	https://www.tutorialspoint.com/compile_c_online.php
2	https://www.codechef.com/ide
3	https://www.jdoodle.com/c-online-compiler
4	https://rextester.com/l/c_online_compiler_gcc

EE19241	BASIC ELECTRICAL ENGINEERING	ES	L	T	P	C
	Common To Auto, ECE, Mech, , Mechatronics& Robotics and Automation		3	0	2	4

Objectives:	
•	To introduce electric circuits and provide knowledge on the analysis of circuits using network theorems.
•	To impart knowledge on the phenomenon of resonance in series and parallel circuits and also to obtain the transient response of RC, RL and RLC circuits.
•	To provide knowledge on the principles of electrical machines.
•	To learn the concepts of different types of power converter and batteries.
•	To teach methods of experimentally analyzing electrical circuits and machines

UNIT-I	**DC CIRCUITS**	**9**
Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's current and voltage laws, analysis ofsimple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.		
UNIT-II	**AC CIRCUITS**	**9**
Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections		
UNIT-III	**DC MOTORS AND TRANSFORMERS**	**9**
Construction, working, torque-speed characteristic and speed control of DC motors Construction and principle ofoperation- EMF Equation- regulation , losses and efficiency of Single Phase Transformers - Auto-transformer.		
UNIT-IV	**AC ROTATING MACHINES**	**9**
Construction and working of Synchronous Generators-EMF Equation - Construction and working- torque-slip characteristic- starting methods of three phase induction motors-Single-phase induction motors-Construction andWorking of Permanent Magnet Brushless DC Motors and Stepper Motors.		
UNIT-V	**BATTERIES AND POWER CONVERTERS**	**9**
Types of Batteries, Important Characteristics for Batteries -DC-DC buck and boost converters- duty ratio control -Single-phase and three-phase voltage source inverters – Sinusoidal modulation		
	Total Contact Hours : 45	

List of Experiments			
1	Experimental verification of Kirchhoff's voltage and current laws.		
2	Experimental verification of network theorems (Thevenin and, Norton Theorems).		
3	Load test on DC shunt motor.		
4	Speed control of DC shunt motor.		
5	Load test on single-phase transformer.		
6	Open circuit and short circuit tests on single phase transformer.		
7	Speed control of chopper fed DC motor.		
8	Speed control of 3Φ Induction motor.		
	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes:	
On completion of the course students will be able to	
•	Analyses DC and AC circuits and apply circuit theorems.
•	Realize series and parallel resonant circuits.
•	Understand the principles of electrical machines.
•	Understand the principles of different types of power converter and batteries.
•	Experimentally analyze the electric circuits and machines.

Text Book(s):	
1	D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2	M.H.Rashid, “Power Electronics: Circuits, Devices and Applications”, Pearson Education, PHI Third Edition,New Delhi, 2014.
3	David Linden and Thomas B. Reddy, “ Handbook of Batteries” McGraw-Hill Professional, 2001

Reference Books(s) / Web links:	
1	D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.
2	E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
3	D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.
4	L.S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
5	P.S.Bimbra “Power Electronics”, Khanna Publishers, 4th Edition, 2007.

GE19201	Engineering Mechanics	ES	L	T	P	C
	(Common to Mech, Aero, Auto Civil, MCT& Robotics andAutomation)		2	1	0	3

Objectives:	
•	To understand the basics of mechanics and apply the concept of equilibrium to solve problems of concurrentforces.
•	To understand the concept of equilibrium and to solve problems of rigid bodies.
•	To learn about the center of gravity and moment of inertia of surfaces and solids.
•	To learn the basic concepts of friction.
•	To learn the concepts in kinematics and kinetics of rigid bodies in plane motion.

UNIT-I	STATICS OF PARTICLES	9
Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of aparticle in space – Equivalent systems of forces – Principle of transmissibility.		
UNIT-II	**EQUILIBRIUM OF RIGID BODIES**	**9**
Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – 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 – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – (Descriptive treatment only)		
UNIT-III	**PROPERTIES OF SURFACES AND SOLIDS**	**9**
Centroids and centre of mass – Centroids of lines and 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 theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.		
UNIT-IV	**DYNAMICS OF PARTICLES**	**9**
Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton'slaws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.		
UNIT-V	**FRICTION AND RIGID BODY DYNAMICS**	**9**
Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction, Ladder friction, Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – GeneralPlane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to	
•	Comprehend and analysis the forces in the system.
•	Solve problems in engineering systems using the concept of static equilibrium.
•	Determine the centroid of objects such as areas and volumes, center of mass of body and moment of inertia ofcomposite areas.
•	Solve problems involving kinematics and kinetics of rigid bodies in plane motion.
•	Solve problems involving frictional phenomena in machines.

Text Book (s):	
1	Beer, F.P and Johnston Jr. E.R, Cornwell and Sanghi., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 11thEdition, McGraw-Hill Publishing company, New Delhi (2017).
2	Rajasekaran S and Sankara subramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

Reference Books(s) / Web links:	
1	Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, Wiley India,2017.
2	Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, PearsonEducation 2010.
3	Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics" 4thEdition,Pearson Education 2006.
4	S SBhavikatti, Engineering Mechanics, New Age International Publishers, 2019
5	Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

MC19102	INDIAN CONSTITUTION AND FREEDOM MOVEMENT	MC	L	T	P	C
	(Common to Mech, Aero, Auto Civil , Mechatronics& Robotics and Automation)		3	0	0	0

Objectives:	
•	To inculcate the values enshrined in the Indian constitution
•	To create a sense of responsible and active citizenship
•	To Know about Constitutional and Non-Constitutional bodies
•	To understand sacrifices made by the freedom fighters

UNIT-I	INTRODUCTION	9
Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens. Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of StatePolicy		
UNIT-II	**STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT**	**9**
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.		
UNIT-III	**STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY**	**9**
State Government _ Structure and Functions _ Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, ,Village level: Role of Elected and Appointed officials.		
UNIT-IV	**CONSTITUTIONAL FUNCTIONS AND BODIES**	**9**
Indian Federal System – Center – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies		
UNIT-V	**INDIAN FREEDOM MOVEMENT**	**9**
British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-Indian Freedom Struggle under Mahatma Gandhi-Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence ofIndia Act 1947-Freedom and Partition		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	Understand the functions of the Indian government
•	Understand and abide the rules of the Indian constitution.
•	Gain knowledge on functions of state Government and Local bodies
•	Gain Knowledge on constitution functions and role of constitutional bodies and non constitutional bodies
•	Understand the sacrifices made by freedom fighters during freedom movement

Text Book (s):	
•	Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi., 21st ed 2013
•	Bipan Chandra, History of Modern India, Orient Black Swan, 2009
•	Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016
•	Maciver and Page, "Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi. 2nd ed, 2014
•	P K Agarwal and K N Chaturvedi , PrabhatPrakashan, New Delhi, 1st ed , 2017

Reference Books(s) / Web links:	
•	U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.
•	Sharma, Brij Kishore, "Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.

MT19221	COMPUTER AIDED DRAWING LABORATORY	ES	L	T	P	C
			0	0	2	1

Objectives:	
•	To introduce the students the Indian standard code of practice for engineering drawing and general symbols and abbreviation used on the drawing.
•	To provide hands on experience to develop 2D and 3D models of engineering components.
•	To provide knowledge to use Drawing/Modeling software.

List of Experiments			
1	CODES AND STANDARDS Indian standard code of practice for engineering drawing – general principles of Presentation. Conventional representations of threaded parts, springs, gear and Common features. Abbreviations and symbols for use on technical drawings. Conventions for sectioning and dimensioning.		
2	GEOMETRIC DIMENSIONING & TOLERANCING (GD&T) PRINCIPLES Tolerances – types – representation of tolerances on drawing, fits – types – selection of Fits – allowance. Geometric tolerances – form and positional tolerances – datum, datum Features. Maximum material principle –symbols and methods of indicating it on drawing Surface finish symbols–welding symbols and methods of indicating it on drawing.		
3	INTRODUCTION TO DRAFTING SOFTWARE Introduction to the use of any drafting software – creation of simple geometric bodies using primitives (line, arc, circle etc.,) and editing for the drawing, Dimensioning and text writing, concept of layer creation and setting, linetypes.		
4	MANUAL AND CAD DRAWING OF MACHINE ELEMENTS Preparation of 2-D drawings using CAD software for components and assemblies of Plummer block, screw jack,machine vice, lathe tailstock, tool head of the shaper. Introduction to 3-D modeling solid and frame modeling.		
	Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course students will be able to	
•	Develop engineering drawing and dimensioning for the industrial component using Indian Standard code ofpractice.
•	Implement Geometric Dimensioning & Tolerancing principles in production drawing.
•	Use CAD software for drafting machine components.
•	Learn the working principles of different machine elements.
•	Develop 2D and 3D models of the component using manual/software.

GE19122	ENGINEERING PRACTICES- ELECTRICAL ANDELECTRONICS	ES	L	T	P	C
			0	0	2	1

Objectives:	
●	To provide hands on experience on various basic engineering practices in Electrical Engineering.
●	To impart hands on experience on various basic engineering practices in Electronics Engineering.

List of Experiments				
A. ELECTRICAL ENGINEERING PRACTICE				
1	Residential house wiring using switches, fuse, indicator, lamp and energy meter.			
2	Fluorescent lamp wiring.			
3	Stair case wiring.			
4	Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.			
5	Measurement of resistance to earth of an electrical equipment.			
B. ELECTRONICS ENGINEERING PRACTICE				
1	Study of Electronic components and equipment's – Resistor, colour coding, measurement of AC signal parameter(peak-peak, rms period, frequency) using CRO.			
2	Study of logic gates AND, OR, EOR and NOT.			
3	Generation of Clock Signal.			
4	Soldering practice – Components Devices and Circuits – Using general purpose PCB.			
5	Measurement of ripple factor of HWR and FWR.			
		Total Contact Hours	**:**	**30**

Course Outcomes:	
On completion of the course students will be able to	
●	Fabricate electrical and electronic circuits
●	Formulate the house wiring
●	Design the AC-DC converter using diode and passive components
●	Perform soldering activity
●	Measure ripple factor of HWR and FWR

REFERENCE	
1	Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.
2	Jeyachandran K., Natarajan S. & Balasubramanian S., "A Primer on Engineering Practices Laboratory", AnuradhaPublications, 2007.
3	Jeyapoovan T., Saravanapandian M. & Pranitha S., "Engineering Practices Lab Manual", Vikas Publishing House Pvt., Ltd, 2006.
4	Rajendra Prasad A. & Sarma P.M.M.S., "Workshop Practice", SreeSai Publication, 2002.

SEMESTER – III

MA 19355	TRANSFORMS AND APPLICATIONS	BS	L	T	P	C
	Common to III sem. B.E. Mechanical Engineering, Mechatronics, Civil Engineering & Robotics and Automation		3	1	0	4

Objectives:	
•	To introduce Fourier series and to solve boundary value problems that arise in the field of Engineering.
•	To acquaint the student with different transform techniques used in wide variety of situations.

UNIT-I	**FOURIER SERIES**	**12**
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series –Half range cosineseries – Parseval's identity – Harmonic analysis.		
UNIT-II	**BOUNDARY VALUE PROBLEMS – ONE DIMENSIONAL EQUATIONS**	**12**
Classification of second order quasi linear partial differential equations – Fourier series solutions of one dimensional wave equation – One dimensional heat equation: Problems with temperature and temperature gradients.		
UNIT-III	**BOUNDARY VALUE PROBLEMS – TWO DIMENSIONAL EQUATIONS**	**12**
Steady state solution of two-dimensional heat equation in Cartesian coordinates: Infinite and finite plates – Steady state solution of two-dimensional heat equation in Polar coordinates: Circular and Semicircular disks.		
UNIT-IV	**FOURIER TRANSFORMS**	**12**
Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity - Application to boundary value problems.		
UNIT-V	**Z - TRANSFORMS AND DIFFERENCE EQUATIONS**	**12**
Z- Transforms - Elementary properties – Inverse Z - Transform (using partial fraction and residues) – Convolution theorem - Formation of difference equations – Solution of difference equations using Z-transform.		
	Total Contact Hours : 60	

Course Outcomes:	
On completion of the course students will be able to	
•	Develop skills to construct Fourier series for different periodic functions and to evaluate infinite series.
•	Classify different types of PDE and solve one dimensional boundary value problems.
•	Solve two-dimensional heat equations.
•	Solve Engineering problems using Fourier transform techniques.
•	Solve difference equations using Z – transforms that arise in discrete time systems.

Text Books:	
1	Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
2	Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., NewDelhi, Second reprint, 2012.

Reference Books / Web links:	
1	Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2	Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi,2008.
3	Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
4	Ray Wylie C and Barrett. L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt., Ltd, SixthEdition, New Delhi, 2012.

MT 19301	ANALOG DEVICES AND CIRCUITS	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To study the IC fabrication procedure and basic characteristics of transistors.
•	To study characteristics; realize circuits; design for signal analysis using Op-amp ICs.
•	To study the applications of Op-amp.
•	To study internal functional blocks and the applications of special ICs like Timers, PLL circuits, regulator Circuits, ADCs.

UNIT-I	INTRODUCTION AND FABRICATION OF ANALOG DEVICES	9
Introduction to Integrated Circuit- IC Classification and Fabrication- Special Diodes, Transistor Characteristics,Configurations; BJT and FET- Working and Characteristics		
UNIT-II	**OPERATIONAL AMPLIFIER**	**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-V/I & I/V converters, summer,differentiator and integrator.		
UNIT-III	**APPLICATIONS OF OPAMP**	**9**
Instrumentation amplifier, Log and Antilog Amplifiers, first and second order active filters, comparators, multivibrators,waveform generators, clippers, clampers, peak detector, S/H circuit, Oscillators		
UNIT-IV	**APPLICATIONS OF ANALOG ICs**	**9**
Functional block, characteristics & application circuits with 555 Timer IC-566 voltage-controlled oscillator IC; 565-phase lock loop IC, Analog multiplier ICs.		
UNIT-V	**VOLTAGE REGULATOR ICs**	**9**
IC voltage regulators –LM78XX,79XX Fixed voltage regulators - LM317, 723 Variable voltage regulators, switchingregulator- SMPS- LM 380 power amplifier- ICL 8038 function generator IC.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	Analyze, linear and digital electronic circuits.
•	Learn different IC fabrication procedure.
•	Design Op-amp ICs for signal analysis.
•	Learn various applications of Op-amp.
•	Analyze various internal functional blocks and special ICs

Text Book (s):	
1.	Salivahanan S, Suresh kumar N “Electronic Devices and Circuits”, Third Edition, Tata McGraw Hill, 2012
2.	Roy D Choudhary, Sheil B. Jain, “Linear Integrated Circuits”, 5th edition, New Age, 2018.
3.	Ramakant A.Gayakward, “Op-amps and Linear Integrated Circuits”, IV edition, Pearson Education, 2015.

Reference Books(s) / Web links:	
1.	Fiore, “Opamps & Linear Integrated Circuits Concepts & Applications”, Cengage, 2010.
2.	Floyd, Buchla, “Fundamentals of Analog Circuits, Pearson, 2013.
3.	Jacob Millman, Christos C. Halkias, “Integrated Electronics - Analog and Digital circuits system”, Tata McGrawHill, 2003.
4.	Robert F. Coughlin, Fredrick F. Driscoll, “Op-amp and Linear ICs”, PHI Learning, 6th edition, 2012

MT 19302	DIGITAL SYSTEM DESIGN	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce basic postulates of Boolean algebra and shows the correlation between Boolean expressions
•	To outline the formal procedures for the analysis and design of combinational circuits
•	To outline the formal procedures for the analysis and design of sequential circuits
•	To illustrate the concept of synchronous and asynchronous sequential circuits
•	To introduce the concept of memories and programmable logic devices.

UNIT-I	**LOGIC GATES AND MINIMIZATION TECHNIQUES**	**9**
Gates, Logic circuits using gates – Multi level gate implementations – Boolean Postulates and Laws – Boolean Expressions – Minimization of Boolean expressions – SOP, POS – Karnaugh map Minimization – Don't CareConditions – Quine - McCluskey Method of Minimization.		
UNIT-II	**COMBINATIONAL CIRCUITS**	**9**
Adder, Subtractor, Carry Look Ahead Adder, BCD Adder – Code Converters – Encoder, Decoder – Multiplexer, Demultiplexer – Parity checker, Parity Generator – Code Converter.		
UNIT-III	**SEQUENTIAL CIRCUITS**	**9**
Latches, Edge Triggering – Level Triggering - Flip-Flops, SR, JK, D, T, Master Slave JK – Realization of one Flip-Flop using other Flip-Flop – Registers – Shift Registers, SISO, SIPO, PISO, PIPO, Bidirectional Shift Register, Universal Shift Register.		
UNIT-IV	**SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS**	**9**
Counters, Synchronous / Asynchronous Counters, Mod N Counters, Ring Counter, Johnson Counter – State Machines: State transition diagram, Moore and MEALY Machines – Design equation and circuit diagram.		
UNIT-V	**MEMORIES AND PROMMABLE LOGIC DEVICES**	**9**
Memory Basics, ROMs, PROMS, and EPROMs, RAMS – Sequential Programmable Logic Devices – PAL, PLA. Introduction and basic concepts of FPGA, VHDL and Verilog – Implementation of AND, OR, Adders using VHDL and Verilog.		
	Total Contact Hours :	**45**

Course Outcomes:	
On completion of the course students will be able to	
•	Design and Analyse any digital logic gate circuits.
•	Construct Combinational Logic Circuit for the given requirement.
•	Design and Analyse any Flip-Flop based systems.
•	Gain the capability of implementing various Counters.
•	Acquire basic knowledge on memories, FPGA, VHDL and Verilog.

Text Book (s):	
1.	Morris Mano M., "Digital Design: With an Introduction to the Verilog HDL, VHDL and System Verilog", 6th Edition, Pearson Education Pvt., Ltd., New Delhi, 2018.
2.	Charles H. Roth, " Fundamentals of Logic Design", 7th Edition, Thomson Learning, 2015.
3.	Ronald J. Tocci Neal S. Widmer and Gregory L. Moss, Digital Systems: Principles and Applications, Prentice Hallof India, New Delhi, 2010.

Reference Books(s) / Web links:	
1	Thomas L. Floyd, "Digital Fundamentals", 11th Edition, Pearson Education Inc., 2014
2	John F. Wakerly, "Digital Design", 5th Edition, Pearson/PHI, 2017
3	Donald P. Leach and Albert Paul Malvino, "Digital Principles and Applications", 8th Edition, TMH, 2014.
4	John. M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.
5	Donald D. Givone, "Digital Principles and Design", McGraw Hill Education, 2017.

ME 19303	KINEMATICS OF MACHINERY	PC	L	T	P	C
			2	1	0	3

Objectives:	
•	To understand the basic concepts of mechanisms
•	To develop the velocity, and acceleration diagram of mechanisms
•	To understand the cam mechanisms
•	To understand the basic concepts of cam mechanism, gears and gear trains
•	To have the basic knowledge on friction in machine elements

UNIT-I	BASICS OF MECHANISMS	9
Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Universal Joint – rocker mechanisms.		
UNIT-II	**KINEMATICS OF LINKAGE MECHANISMS**	**9**
Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points– Coriolis component of Acceleration – Introduction to linkage synthesis problem. Introduction to simulation software		
UNIT-III	**KINEMATICS OF CAM MECHANISMS**	**9**
Classification of cams and followers – Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles –Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.		
UNIT-IV	**GEARS AND GEAR TRAINS**	**9**
Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions –Gear tooth action – contact ratio – Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains.		
UNIT-V	**FRICTION IN MACHINE ELEMENTS**	**9**
Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes- Band and Block brakes		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	Analyze the mechanisms
•	Construct the velocity and acceleration diagrams for a given mechanism
•	Design and analyse the cam mechanisms.
•	Analyze the given gear trains
•	Analyze and predict the influence of friction in machine elements

Text Books:	
1	Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition, Reprint: 2017
2	Rattan, S.S, "Theory of Machines", McGraw-Hill Education Pvt. Ltd., 5th edition, 2019.

Reference Books(s) / Web links:	
1	Amitabha Ghosh and Asok Kumar Mallik, “Theory of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., 3rd edition, 1988.
2	Rao. J.S. and Dukkipati. R.V. “Mechanism and Machine Theory”, New Age International Pvt. Ltd., 2nd Edition,2014
3	Singh. V.P, “Theory of Machine”, Dhanpat Rai & Co., 6th Edition, 2017
4	Robert L. Norton, Kinematics and Dynamics of Machinery, McGraw-Hill Education, Special Indian Edition, Reprint-2017
5.	https://nptel.ac.in/courses/112/104/112104121/
6.	https://nptel.ac.in/courses/112105268/
7.	https://nptel.ac.in/courses/112101096/

RO 19301	MECHANICS OF MATERIALS	PC	L	T	P	C
			3	1	0	4

Objectives:	
•	To understand the fundamental concepts of stress, strain and elastic constants of solids under external loading
•	To learn about torsion of linearly elastic materials
•	To learn about the shear force, bending moment and deflection of beams
•	To study the Stresses in Beams and to analysis plane stress and strain
•	To learn about the stability of columns and shell structures like thin cylinders, spheres and thick cylinders

UNIT-I	TENSION, COMPRESSION, AND SHEAR	9

Introduction - Normal Stress and Strain, Mechanical Properties of Materials, Elasticity, Plasticity, and Creep, Linear Elasticity, Hooke's Law, and Poisson's Ratio, Shear Stress and Strain, Allowable Stresses and Allowable Loads, DesignFor Axial Loads and Direct Shear, Changes in Lengths of Axially Loaded Members, Changes in Lengths under Non uniform Conditions, Statically Indeterminate Structures, Thermal Effects, Misfits, and Prestrains, Stresses on Inclined Sections, Strain Energy, Impact Loading, Repeated Loading and Fatigue.

UNIT-II	TORSION	9

Torsional Deformations of a Circular Bar, Circular Bars of Linearly Elastic Materials, Non uniform Torsion, Stresses and Strains in Pure Shear, Relationship Between Moduli of Elasticity, Transmission of Power by Circular Shafts, Statically Indeterminate Torsional Members, Strain Energy in Torsion and Pure Shear, Torsion of Noncircular Prismatic Shafts, Thin-Walled Tubes, Stress Concentrations in Torsion .

UNIT-III	SHEAR FORCES , BENDING MOMENTS AND DEFLECTIONS OF BEAMS	9

Introduction, Types of Beams, Loads, and Reactions, Shear Forces and Bending Moments, Relationships among Loads, Shear Forces, and Bending Moments , Shear-Force and Bending-Moment Diagrams. Differential Equations of theDeflection Curve, Deflections by Integration of the Bending-Moment Equation.

UNIT-IV	STRESSES IN BEAMS AND ANALYSIS OF PLANE STRESS	9

Pure Bending and Nonuniform Bending , Curvature of a Beam, Longitudinal Strains in Beams, Normal Stresses in Beams (Linearly Elastic Materials), Design of Beams for Bending Stresses, Composite Beams, Principal Stresses and Maximum Shear Stresses, Mohr's Circle for Plane Stress, Hooke's Law for Plane Stress, Triaxial Stress, Plane Strain

UNIT-V	COLUMNS AND CYLINDERS	9

Buckling and Stability, Columns with Pinned Ends, Columns with Other Support Conditions, Columns with Eccentric Axial Loads, Secant Formula for Columns, stresses in thin cylinder and spheres, stresses in thick cylinder and compound cylinders.

	Total Contact Hours	:	45

Course Outcomes:	
On completion of the course students will be able to	
•	Apply the principle concepts behind stress, strain and deformation of solids for various engineering applications..
•	Draw the shear force diagram and bending moment diagram for beams subjected to different loading conditions.
•	Calculate the deformation of shafts subjected to torsional loads.
•	Calculate the deflection of beams through Macaulay's method, Moment area method and strain energy methods.
•	Analyze the Columns, thin and thick shells for various engineering applications..

Text Books:	
1	Barry J. Goodno and James M. Gere "Mechanics of Materials", Cl-Engineering; 9th edition., Canada, 2016.
2	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2015.

Reference Books(s) / Web links:	
1	Egor. P.Popov “Engineering Mechanics of Solids” Prentice Hall of India, New Delhi, 2001.
2	Ramamurtham S., "Strength of Materials", Dhanpat rai publishing company, 2011.
3	Hibbeler, R.C., "Mechanics of Materials", Pearson Education, 2018.
4	Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing „co. Ltd., New Delhi, 2016.
5.	https://nptel.ac.in/courses/112107146/

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
GE19211	**PROBLEM SOLVING AND PROGRAMMING IN PYTHON** (with effect from 2021 batch onwards) Common to all branches of B.E / B.Tech programmes (except – CSE, CSBS, CSD, IT, AI/ML)	ES	1	0	4	3

Course Objectives:	
•	To understand computers, programming languages and their generations and essential skills for a logical thinking forproblem solving.
•	To write, test, and debug simple Python programs with conditionals, and loops and functions
•	To develop Python programs with defining functions and calling them
•	To understand and write python programs with compound data- lists, tuples, dictionaries
•	To search, sort, read and write data from/to files in Python.

List of Experiments			
1.	Study of algorithms, flowcharts and pseudocodes.		
2.	Introduction to Python Programming and Demo on Python IDLE / Anaconda distribution.		
3.	Experiments based on Variables, Datatypes and Operators in Python.		
4.	Coding Standards and Formatting Output.		
5.	Algorithmic Approach: Selection control structures.		
6.	Algorithmic Approach: Iteration control structures.		
7.	Experiments based on Strings and its operations.		
8.	Experiments based on Lists and its operations.		
9.	Experiments based on Tuples and its operations.		
10.	Experiments based on Sets and its operations.		
11.	Experiments based on Dictionary and its operations.		
12.	Functions: Built-in functions.		
13.	Functions: User-defined functions.		
14.	Functions: Recursive functions.		
15.	Searching techniques: Linear and Binary.		
16.	Sorting techniques: Bubble and Merge Sort.		
17.	Experiments based on files and its operations.		
	Contact Hours	**:**	**75**

Course Outcomes: On completion of the course students will be able to	
•	Understand the working principle of a computer and identify the purpose of a computer programming language andability to identify an appropriate approach to solve the problem.
•	Write, test, and debug simple Python programs with conditionals and loops.
•	Develop python programs step-wise functions and calling them.
•	Use Python lists, tuples, dictionaries for representing compound data.
•	Apply searching, sorting on data and efficiently handle data using flat files.

Text Books:	
1.	Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3,Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2.	Guido Van Rossum and Fred L. Drake Jr, An Introduction to Python - Revised and updated for Python 3.2, NetworkTheory Ltd., 2011.

Reference Books:	
1.	John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MITPress , 2013.
2.	Robert Sedge wick, Kevin Wayne, Robert Dondero, Introduction to Programming inPython: An Inter-disciplinaryApproach, Pearson India Education Services Pvt. Ltd., 2016.
3.	Timothy A. Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.
4.	Kenneth A. Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2012.
5.	Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus, WileyIndia Edition, 2013.
6.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Scienceusing Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

MT 19311	DIGITAL SYSTEM DESIGN LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives:	
This laboratory course enables students to	
●	To understand the functionality of Logic Gates and Boolean Expressions.
●	To understand the functionality of Adder, Subtractor and Comparator.
●	To understand the functionality of Flip-Flops.
●	To understand the functionality of combinational and sequential circuits
●	To simulate basic combinational and sequential circuits using Hardware Description Language HDL

List of Experiments				
1	Verification of logic gates and realization of Boolean expressions using gates.			
2	Design and Implement Adders and Subtractors using logic gates.			
3	Design and Implement 4-bit Parallel Adder / Subtractor using IC 7483.			
4	Design and Implement 4-bit Magnitude Comparator using IC 7485.			
5	Realize 3-variable function 8:1 Mux using IC 74151.			
6	Realize 1:8 Demux and 3:8 Decoder using IC 74138.			
7	Verification of state tables of SR, JK, T and D Flip-Flops using NAND & NOR gates.			
8	Simulate Mod-8 Synchronous UP/DOWN Counter using Simulation tool.			
9	Simulate Mod-8 Asynchronous UP/DOWN Counter using Simulation tool.			
10	Realization of Digital circuits using HDL – Combinational circuits			
11	Realization of Digital circuits using HDL – Sequential circuits			
12	Mini project on design of a digital circuit for solving practical problems			
		Total Contact Hours	**:**	**45**

Course Outcomes:	
On completion of the course students will be able to	
●	Simplify complex Boolean functions.
●	Implement digital circuits using combinational logic ICs.
●	Learn the characteristics of various Flip-Flops.
●	Design digital circuits with combinational and sequential components.
●	Use HDL to build digital systems.

Web links for virtual lab (if any)	
1	http://vlabs.iitkgp.ernet.in/dec/index.html
2	http://he-coep.vlabs.ac.in/
3	https://www.iitg.ac.in/cseweb/vlab/vlsi/
4	https://www.ee.iitb.ac.in/fpgasimulation/docs/exp/sequence_detector/index.html
5	http://cse14-iiith.vlabs.ac.in/

RO19311	MECHANICS OF MATERIALS LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives:	
The main learning objective of this course is to prepare the students for	
•	To study the mechanical properties of materials when subjected to different types of loadings.
•	To study the impact strength of given specimen.
•	To study the hardness properties of given specimen.
•	To understand the deflection of different beams.
•	To verify the spring material properties by experimentally.
•	To calculate the mechanical properties of materials using strain gauge.

List 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 (Charpy and Izod test)			
5	Hardness test on metals – (Brinell and Rockwell Hardness Number)			
6	Deflection test on beams (Simply supported beam)			
7	Compression test on helical springs (Closed coil)			
8	Beam Deflections using Maxwell Reciprocal Theorem			
9	Strain Measurement			
10	Deflection Of Continuous Beam.			
		Total Contact Hours	**:**	**45**

Course Outcomes:	
On completion of the course students will be able to	
•	Perform Tension, shear test, Torsion, impact test and Hardness test on given material.
•	Determine the stiffness and modulus of rigidity of the spring wire.
•	Measure the deflection of a Continuous beam
•	Measure the stress & strain on cantilever beam using strain gauges
•	Determine the young's modulus of the material of the given beam using Maxwell's law of reciprocal deflections

MC 19301	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	MC	L	T	P	C
			2	0	0	0

Objectives:

- This course aims at imparting basic principles of thought process, reasoning and inference. Sustainability is the core of Indian traditional knowledge system connecting society and nature. Holistic life style of yogic science and wisdom are important in modern society with rapid technological advancements and societal disruptions. The course mainly focuses on introduction to Indian knowledge system, Indian perspective of modern science, basic principles of Yoga and holistic healthcare system, Indian philosophical, linguistic and artistic traditions.

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

UNIT-I	Introduction To Indian Knowledge System: Basic structure of the Indian Knowledge System – Veda – Upaveda - Ayurveda, Dhanurveda-Gandharvaveda, Sthapathyaveda and Arthasasthra. Vedanga (Six forms of Veda) – Shiksha, Kalpa, Nirukta, Vyakarana, Jyothisha and Chandas-Four Shasthras - Dharmashastra, Mimamsa, Purana and Tharkashastra.	**6**
UNIT-II	Modern Science And Yoga: Modern Science and the Indian Knowledge System – a comparison - Merits and demerits of Modern Science and the Indian Knowledge System - the science of Yoga - different styles of Yoga – types of Yogaasana, Pranayam, Mudras, Meditation techniques and their health benefits – Yoga and holistic healthcare – Case studies.	**6**
UNIT-III	Indian Philosophical Tradition: Sarvadharshan/Sadhdharshan – Six systems (dharshans) of Indian philosophy - Nyaya, Vaisheshika, Sankhya, Yoga, Mimamsa, Vedanta-Other systems-Chavarka,Jain (Jainism), Boudh (Buddhism) – Case Studies.	**6**
UNIT-IV	Indian Linguistic Tradition: Introduction to Linguistics in ancient India – history – Phonetics and Phonology – Morphology –Syntax and Semantics-Case Studies.	**6**
UNIT-V	Indian Artistic Tradition: Introduction to traditional Indian art forms – Chitrakala (Painting), Murthikala / Shilpakala (Sculptures), Vaasthukala, Sthaapathya kala (Architecture), Sangeeth (Music), Nruthya (Dance) and Sahithya (Literature) – Case Studies.	**6**
	Total Contact Hours : 30	

Course Outcomes:

- At the end of the course, students will be able to appreciate the importance of traditional Indian knowledge system, Yoga and other Indian traditions that are important in a modern society with technological advancements and lifestyle changes.

Text Book (s):

1	V. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014.
2	Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan.
3	Swami Jitatmanand, Holistic Science and Vedant, Bharatiya Vidya Bhavan.
4	Fritz of Capra, Tao of Physics.
5	Fritz of Capra, The Wave of life.

Reference Books(s) / Web links:

1	VN Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay Foundation, Velliarnad, Arnakulam.
2	Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata.
3	GN Jha (Eng. Trans.), Ed. RN Jha, Yoga-darshanam with Vyasa Bhashya,Vidyanidhi Prakashan, Delhi 2016.
4	RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakashan, Delhi 2016.

SEMESTER – IV

MA19455	STATISTICS AND NUMERICAL METHODS	BS	L	T	P	C
	Common to IV sem. B.E. Mechanical Engineering and Mechatronics		3	1	0	4

Objectives:	
•	To provide the necessary basic concepts of a few statistical methods in designing and solving problems.
•	To provide various numerical methods in solving problems that occur in the field of Engineering and Technology.

UNIT-I	TESTING OF HYPOTHESIS	12
Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means -Tests based on t, F and Chi-square test for single sample standard deviation. Chi-square tests for independence of attributes and goodness of fit.		
UNIT-II	**DESIGN OF EXPERIMENTS**	**12**
One way and two way classifications - Completely randomized design – Randomized block design –Latin squaredesign.		
UNIT-III	**SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**	**12**
Newton Raphson method – secant method – Gauss Jordan method – Iterative method of Gauss Seidel –Eigen value ofa matrix by power method and by Jacobi method for symmetric matrix.		
UNIT-IV	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**	**12**
Curve fitting ($y= a+ bx$, $y = a+bx+cx^2$)-Lagrange's interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical integration using Trapezoidaland Simpson's 1/3 rules.		
UNIT-V	**NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS**	**12**
Taylor's series method – Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations – Finite difference methods for solving second order equations- Finite difference solution of one dimensional heat equation by explicit and implicit methods - Two dimensional Laplace equation.		
	Total Contact Hours : 60	

Course Outcomes:	
On completion of course students will be able to	
•	Obtain statistical data from experiments and able to analyze the same using statistical test.
•	Design experiments using suitable ANOVA techniques and draw conclusions.
•	Solve algebraic equations and eigen value problems that arise during the study of engineering problems.
•	Use interpolation methods to solve problems involving numerical differentiation and integration
•	solve differential equations numerically that arise in course of solving engineering problems.

Text Books:	
1	Veerarajan T., Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks' , Mc Graw Hill, 2016.
2	Kandasamy P., Thilagavathi and K. Gunavathi., "Statistics and Numerical Methods", S. Chand & Company Ltd.(2010).

Reference Books / Web links:	
1	Johnson R.A., and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers",11th Edition, Pearson Education, Asia, 2011.
2	Walpole R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.
3	Spiegel M.R., Schiller. J., and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 2004.
4	Grewal B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2007.
5	Gerald C.F., and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 2006.

MT19402	MICROCONTROLLERS AND EMBEDDED SYSTEMS	PC	L	T	P	C
			3	0	0	3

Objectives:
• To learn about the architecture, functions, programming and usage of 8085 microprocessor.
• To understand architecture of microcontroller and usage of built-in special function blocks.
• To design and verify the various interfacing techniques with microcontrollers.
• To impart knowledge on basics of embedded system architecture.
• To provide essential knowledge on real time embedded operating system.

UNIT-I	BASICS OF MICROPROCESSOR	9
8085 Architecture – Address space – Instruction set – Addressing modes , Interrupts – Instruction cycle and Timingdiagram – Assembly Language Programming.		
UNIT-II	**MICROCONTROLLER**	**9**
Architecture of 8051 – Memory organization - I/O Ports - Instruction set - Addressing modes - Assembly language programming, PIC Architecture – Programming Techniques – PIC Development Systems – Application Design – Program Debugging - Introduction to Arduino microcontroller, Raspberry Pi.		
UNIT-III	**PROGRAMMING AND INTERFACING WITH PIC MICROCONTROLLER USING EMBEDDED C**	**9**
I/O Port Programming – Arithmetic, Logical Instructions and Programs – PIC18 Timer – Serial Port Programming, Interrupt Programming – LCD and Keyboard Interfacing – Stepper Motor Interfacing – DC Motor Control.		
UNIT-IV	**INTRODUCTION TO EMBEDDED SYSTEMS**	**9**
Embedded system Architecture - Design Process in Embedded system- Classification of Embedded system, Timer and Counting devices - Watchdog Timer - Real Time Clock - In circuit emulator - Target Hardware Debugging.		
UNIT-V	**REAL TIME OPERATING SYSTEM**	**9**
Introduction to basic concepts of RTOS – Tasks and Data – Threads – Multiprocessing and Multitasking – Semaphores – Priority Inversion - Priority Inheritance – Queues – Pipes, Washing machines - Cruise control - antilock braking systems - Automatic chocolate vending machine - Pick and Place Robot – Automatic lubrication of supplier Conveyor belt.		
	Total Contact Hours : 45	

Course Outcomes:
On completion of the course students will be able to
• Design 8085 microprocessor based system.
• Design and implement the programs of 8051.
• Design circuits for various applications using microcontrollers.
• Construct the basic architecture and components of embedded system.
• Develop embedded system in real time for simple applications.

Text Book (s):	
1	Raj Kamal, "Embedded Systems: Architecture, Programming and Design" Tata Mc Graw-Hill , 2015
2	Muhammad Ali Mazidi, Rolin D. McKinlay and Danny Causey, "PIC Microcontroller And Embedded Systems:Using Assembly And C For Pic 18", Pearson Education, 2016
3	Muhammad Ali Mazidi, Rolin D. McKinlay and Janice Gillispie Mazidi, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2016

Reference Books(s) / Web links:	
1	Santanu Chattopadhyay, "Embedded system Design" 2nd Edition, PHI Learning Private Limited, 2013.
2	K C Wang, "Embedded and Real time Operating systems" Springer, 2017
3	Martin Bates, "PIC Microcontrollers An Introduction to Microelectronics", Third Edition, 2011
4	John B Peatman, "Design with PIC microcontrollers", Eighth Edition, Pearson Education, 2009
5	Subrata Ghoshal, "8051 Microcontroller: Internals, Instructions, Programming and Interfacing" Pearson Education, 2010

RO19401	BASICS OF ROBOTICS	PC	L	T	P	C
			3	0	0	3

Objectives:

- To understand the Robot types and its end effectors.
- To introduce the concept of robot kinematics.
- To understand the methods in trajectory and motion planning.
- To impart knowledge on dynamics of robots.
- To learn the sensors and actuators used in robots.

UNIT-I	INTRODUCTION TO ROBOTICS	9

Introduction to robotics- History, growth; Robot applications- Manufacturing industry, defense, rehabilitation, medical etc., Laws of Robotics, degrees of freedom of planar and spatial manipulator, Robot classifications, work envelope, Internal Grippers and External Grippers; Selection and Design Considerations, resolution, accuracy and repeatability of robot, applications, robot teaching, specification.

UNIT-II	ROBOT KINEMATICS	9

Representation of objects in 3-D space-position and orientation, Frame transformations-translation-rotation-translation and rotation combined- translation operator-rotation operator, composite rotation matrix, representation of position in cylindrical, spherical coordinate system, representation of orientation using roll, pitch and yaw angles, representation of orientation using Euler angles. Denavit-Hartenberg notations- link and joint parameters-rules for coordinate assignments, forward and inverse kinematics, velocity analysis.

UNIT-III	TRAJECTORY AND MOTION PLANNING	9

Introduction, Linear trajectory function, polynomial trajectory function, Gross and fine motion planning, motion planning schemes-visibility graph, vornoi diagram ,tangent graph, accessibility graph, path velocity decomposition, incremental planning, relative velocity approach, reactive control strategy and potential field approach.

UNIT-IV	ROBOT DYNAMICS	9

Introduction to inverse and forward dynamics, determination of inertia tensor, Lagrange-Euler formation for jointtorque, control of robotic joints,

UNIT-V	ACTUATORS AND SENSORS	9

Actuators and types, DC motors, BLDC servo motors. Introduction to sensors, characteristics, sensor types-Touch,Potentiometer, Encoder, Force, Range and proximity. Economic Analysis of Robots.

	Total Contact Hours	:	45

Course Outcomes:

On completion of the course students will be able to

- Select the robot and its grippers based on application.
- Calculate robot position and orientation.
- Develop optimal trajectory and path planning of robots.
- Determine joint torques and forces in a robot.
- Select sensors and actuators for any robotic system.

Text Books:

1. Fu. K.S, Gonzalez. R.C, Lee. C.S.G "Robotics –Control, Sensing, Vision, and Intelligence", McGraw Hill, 2015
2. Pratihar. D.K, "Fundamentals of Robotics", Narosa Publishing House,India,2019.

Reference Books / Web links:

1. Groover Mikell .P, "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2014
2. Deb S.R., "Robotics Technology and Flexible Automation" Tata McGraw Hill Book Co., 2013.
3. Koren Y., "Robotics for Engineers", McGraw Hill Book Co., 1992
4. Maja J Mataric, "The Robotics Primer "Universities Press. 2013.
5. John J. Craig , "Introduction to Robotics Mechanics and Control", Pearson Education India,2008

RO19402	MANUFACTURING SCIENCE	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the basic concepts of sand casting technique and special casting technique.
•	To understand the principles, equipment's of different welding and joining techniques.
•	To understand the working principle and applications of Turning machines.
•	To understand the working principles of shaper, milling and gear cutting machines.
•	To know about Unconventional machining processes.

UNIT-I	METAL CASTING	9
Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting – Continuous casting, Vacuum casting- CO_2 process – Stir casting; Defects in Sand casting.		
UNIT-II	**METAL JOINING AND FORMING PROCESSES**	**9**
Operating principle of Fusion welding processes, Gas welding, metal arc welding, Gas Tungsten arc welding Gas metal arc welding, Plasma arc welding, Electron beam welding –Laser welding, Brazing and soldering; Weld defects: types, causes and cure. Adhesive bonding. Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling, Extrusion, Principle of rod and wiredrawing		
UNIT-III	**TURNING MACHINES**	**9**
Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi- automatic – single spindle: Swiss type, automatic screw type – multi spindle, Introduction to CNC machines.		
UNIT-IV	**SHAPER, MILLING AND GEAR CUTTING MACHINES**	**9**
Shaper - Types of operations. Drilling, reaming, boring, Tapping. Milling operations-types of milling cutter. Gear cutting – forming and generation principle and construction of gear milling, hobbing and gear shaping processes –finishing ofgears.		
UNIT-V	**INTRODUCTION TO UNCONVENTIONAL MACHINING PROCESS**	**9**
Unconventional machining Process–Need–classification–merits, demerits and applications. Abrasive Jet Machining– Water Jet Machining–Abrasive Water Jet Machining-Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles–equipment used–Process parameters–MRR-Applications.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course students will be able to	
•	Prepare patterns and perform casting processes for different applications.
•	Select the suitable joining and forming processes for an application.
•	Describe the constructional and operational features of centre lathe and other special purpose lathes.
•	Describe the constructional and operational features of shaper, , milling, and gear cutting machines
•	Explain non-traditional manufacturing techniques.

Text Books:	
1	HajraChoudhary. S.K and Hajra Choudhary. A.K., "Elements of Workshop Technology", volume I and II, MediaPromoters and Publishers Private Limited, Mumbai, 2014.
2	Kalpakjian. S, "Manufacturing Engineering and Technology", 7th Edition, Pearson Education India Edition, 2018

Reference Books(s) / Web links:	
1.	Roy A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2016
2.	Black J.T and Ronald A. Kosher, "Degarmos Materials and Processes, in Manufacturing" 12th Edition, WileyPublishers, 2017.
3.	Sharma, P.C., "A Text book of production Technology", S. Chand and Co. Ltd., 2006.
4.	Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", Vol 1, 4th Edition, Mcgraw Hill-2017.
5.	https://nptel.ac.in/courses/112107144/

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
CS19411	**PYTHON PROGRAMMING FOR MACHINE LEARNING** (with effect from 2021 batch onwards) Common to all branches of B.E / B.Tech programmes(except – CSE, CSBS, CSD, IT, AI/ML)	**ES**	**1**	**0**	**4**	**3**

Course Outcomes: On completion of the course students will be able to	
•	Understand the relationship of the data collected for decision making.
•	Know the concept of principle components, factor analysis and cluster analysis for profiling and interpreting the data collected.
•	Lay the foundation of machine learning and its practical applications.
•	Develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
•	Prepare for real-time problem-solving in data science and machine learning. .

List of Experiments			
1.	NumPy Basics: Arrays and Vectorized Computation		
2.	Getting Started with pandas		
3.	Data Loading, Storage, and File Formats		
4.	Data Cleaning and Preparation		
5.	Data Wrangling: Join, Combine, and Reshape		
6.	Plotting and Visualization		
7.	Data Aggregation and Group Operations		
8.	Time Series		
9.	Supervised Learning		
10.	Unsupervised Learning		
11.	Representing Data and Engineering Features		
12.	Model Evaluation and Improvement		
	Contact Hours	**:**	**75**

Course Outcomes: On completion of the course students will be able to	
•	Develop a sound understanding of current, modern computational statistical approaches and their application to avariety of datasets.
•	Use appropriate packages for analysing and representing data.
•	Analyze and perform an evaluation of learning algorithms and model selection.
•	Compare the strengths and weaknesses of many popular machine learning approaches.
•	Apply various machine learning algorithms in a range of real-world applications.

Text Books:	
1.	Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'Reilly Media Inc, 2017.
2.	Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python - A Guide for Data Scientists,First Edition, O'Reilly Media Inc, 2016.
Reference Books:	
1.	AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly MediaInc, 2019.

ME19312	MANUFACTURING TECHNOLOGY LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives:	
Enable the students	
•	To practice the moulding process using green sand.
•	To practice different types of sheet metal operations.
•	To perform various machining operations like facing, turning, knurling, thread cutting, shaping, grinding andmilling.
•	To obtain the knowledge of different gear manufacturing processes.
•	To acquire knowledge on selection of appropriate processes, machines to complete a given job.

LIST OF EXPERIMENTS			
1	Preparation of sand mould using single piece pattern		
2	Preparation of sand mould using split piece pattern		
3	Fabrication of tray in sheet metal		
4	Fabrication of funnel in sheet metal		
5	Taper turning using lathe		
6	Knurling and external thread cutting using lathe		
7	Step turning and drilling using Capstan / Turret lathe		
8	Drilling and Tapping		
9	Cube formation using shaper		
10	Study of Indexing mechanism in milling machine		
11	Hexagonal milling using vertical milling machine		
12	Spur gear cutting using milling machine		
13	Gear generation in gear hobbing machine		
14	Surface grinding		
15	Cylindrical grinding		
	Total Contact Hours	**:**	**45**

Course Outcomes:	
On completion of the course students will be able to	
•	Make a mould in green sand using different types of patterns.
•	Create different objects using sheet metal.
•	Perform different possible machining processes in lathe, shaper, grinders and milling machines.
•	Select and perform different gear generating process based on requirements.
•	Select suitable manufacturing method, machines, equipment and tools to make a job based on given requirements.

MT 19411	MICROPROCESSORS AND MICROCONTROLLERS FORAUTOMATION LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives:	
•	To focus on the implementation of arithmetic operations using microprocessors and microcontroller.
•	To simulate assembly language programs.
•	To implement various on-chip and off-chip interfacing and algorithms.
•	To develop practical knowledge in peripheral interfacing with 8085 microprocessor.
•	To develop practical knowledge in peripheral interfacing with 8051microcontroller.

List of Experiments:				
1	Arithmetic operations (addition, subtraction, multiplication, ascending, descending) using 8085 and 8051.			
2	Generation of specified time delay and display in CRO/ DSO.			
3	Analog to digital conversion in 8085.			
4	Digital to analog conversion in 8085.			
5	Interface MATRIX keyboard with 8085.			
6	Stepper motor control using Microcontroller.			
7	DC motor controller interface using Microcontroller.			
8	Interface an ADC and a temperature sensor to measure temperature using Microcontroller.			
9	Flash a LED connected at a specified output port terminal using 8085.			
10	Interface LCD with Microcontroller.			
11	Interface an ADC and a strain gauge to measure the given load using Microcontroller.			
12	Generation of waveform using embedded C software at a specified port terminal.			
13	Interfacing of traffic light control systems.			
14	Keyboard/Display Interface.			
15	Rolling display and Flashing display.			
16	Controlling AC &DC motors using Arduino and Raspberry Pi controllers			
		Total Contact Hours	**:**	**45**

Course Outcomes:	
On completion of the course students will be able to	
•	Develop simple programs using 8085 and 8051
•	Perform ADC and DAC Conversions
•	Develop interfacing circuits for real time applications
•	Develop simple programs using Embedded C software
•	Develop simple programs for Arduino and Raspberry Pi controllers

GE 19421	SOFT SKILLS-I	EEC	L	T	P	C
			0	0	2	1

Objectives:	
•	To help students break out of shyness.
•	To build confidence
•	To enhance English communication skills.
•	To encourage students' creative thinking to help them frame their own opinions,

Course Description:

The course, **"Soft Skills-I"** intends to enhance the students' confidence to communicate in front of an audience effectively. The emphasis is on improving the spoken skills of the students so that they can communicate both, inthe college and in the corporate setting to deliver their message successfully. In today's technology driven world,communicating with confidence is imperative. Hence, this course aims at providing students with the necessary practice in the form of debates, discussions and role plays.

Program Learning Goals:

This program will help our students to build confidence and improve their English communication in order to facethe corporate world as well as providing them with opportunities to grow within an organisation.

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Sl No	Activity Name	Description	Objective
1	Introduction	The trainer and the college facilitator talk to the students about the course and in turn the students introduce themselves.	To set expectations about the course and the students are made aware of the rules and regulations involved in this program
2	If I ruled theworld	This is a quick and useful game by getting students toform a circle and provide their point of view. Each student then repeats what the other has said and comes up with their own opinion.	The aim of this activity is to for students to get to know each other and also develop their listening skills as well as learning how to agree and disagree politely.
3	Picture Narrating	This activity is based on several sequential pictures. Students are asked to tell the story taking place in thesequential pictures by paying attention to the criteriaprovided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to usewhile narrating.	The aim of this activity is to make thestudents develop creative way of thinking.

4	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming is effective and learners generate ideas quickly and freely. The goodcharacteristics of brainstorming are that the students are not criticized for their ideas so students will be open to sharing new ideas.	The activity aims at making the students speak freely without the fearof being criticized. It also encouragesstudents to come up with their own opinions.
5	Debate	Is competition necessary in regards to the learning process?	The aim of this activity is to develop the students ability to debate and think out of the box
6	Short Talks	Here the students are given topics for which they takeone minute to prepare and two minutes to speak. They can write down points but can't read them out they can only use it as a reference.	The activity aims at breaking the students' shyness and encouraging them to standup in front of the class and speak. It also aims at creating awareness that they are restricted for time so they only speak points that are relevant and important.
7	Debate	Will posting students' grades on bulletin boards publicly motivate them to perform better or is it humiliating?	This activity aims at enhancing the students unbiased thought process when it comes to exams and grades as well as develop their skills to debate
8	The Art of diplomacy	The facilitator proceeds to share multiple concepts ofconversation and helps the participants to identify thevarious methods of being diplomatic and how do dealwith misinformation.	The aim of the lesson is to provide anopportunity for the participants to learn about body language and choosing the appropriate words for conversation.
9	Debate	Are humans too dependent on computers?	The aim of this activity is to test the students debating skills and thought process with a topic that affects everybody in daily life.
10	Story Completion	The teacher starts to tell a story but after 2 sentenceshe/she asks students to work in groups to create the rest of the story which includes the plot and the ending.	This activity aims at building their narrating skills as well as their creativity and ability to work in a team.
11	Role play debate	Students scrutinize different points of view or perspectives related to an issue. For example, a debate about the question "Should students be required to wear uniforms at school?" might yield a range of opinions. Those might include views expressed by a student (or perhaps two students – onerepresenting each side of the issue), a parent, a schoolprincipal, a police officer, a teacher, the owner of a clothing store, and others.	The aim of this activity is to get students to speak based on other people's perspective instead of their own. The students take the role of various characters and debate accordingly.
12	I Couldn't Disagree More	This is a game where students practice rebuttal techniques where one student provides a thought or an idea and the other students starts with the phrase Icouldn't disagree more and continues with his opinion	The aim of this activity is to improve general communication skills and confidence.
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits	The aim is to do both give feedback to students as well as obtain feedbackon the course from them.

Total Contact hours: 30

Course Outcomes:	
On completion of the course students will be able to	
●	Be more confident
●	Speak in front of a large audience
●	Be better creative thinkers
●	Be spontaneous
●	Know the importance of communicating in English.

Learning Resources:

1. Kings Learning work sheets.

RO19421	**INTERNSHIP-I***	**EEC**	**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**

Objectives:	
•	To enhance the knowledge of the students in professional engineering practice sought through industrial training ondifferent current technologies.
•	To expose students to real work life situations and to equip them with abreast of new technology that intensify theirjob acumen.
•	To employ the students in industrial projects and strengthen the practical skills of the students.
•	To develop significant commitment in the students profession and specialization.

STRATEGY:

The students individually undertake training in reputed Mechanical, Mechatronics and Automation engineering companies for the specified duration. At the end of the training, a report on the work done will be prepared and presented. The students will be evaluated through a viva-voce examination by a team of internal staff.

Course Outcomes	
•	On completion the course, the students will be able to
•	Apply prior acquired knowledge in a real-life environment.
•	Integrate classroom theory with workplace practice.
•	Acquire knowledge from the experts.
•	Work on a research project or undertake work experience under the guidance of industry and academic supervision.
•	Extend the knowledge through research and development in the chosen fields of specialization.

(* Two weeks at the end of Third Semester)

SEMESTER –V

RO19501	FLUID POWER SYSTEMS	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the basics of fluid properties and flow characteristics.
●	To learn about losses in fluid flow through pipes.
●	To develop hydraulic circuits and systems.
●	To know the working principles of pneumatic power system and its components.
●	To learn the trouble shooting methods in fluid power systems.

UNIT-I	FLUID PROPERTIES AND FLOW CHARACTERISTICS	9
Properties of fluids-Pressure Measurements-Buoyancy and floatation-Flow characteristics-Eulerian and Lagrangian Principle of fluid flow–concept of control volume and system –Reynold's transportation theorem-continuity equation, energy equation and momentum equation-Applications.		
UNIT-II	**FLOW THROUGH PIPES**	**9**
Reynold's Experiment-Laminar flow through circular conduits-Darcy Weisbach equation –friction factor-Moody diagram-minor losses-Hydraulic and energy gradient –Pipes in series and parallel. Introduction to Positive displacement and non-positive displacement pumps.		
UNIT-III	**HYDRAULIC ACTUATORS AND CIRCUIT DESIGN**	**9**
Hydraulic Actuators: Cylinders –Types and construction, Application, Hydraulic cushioning ,Hydraulic motors, Direction Control, Flow control and pressure control valves –Types, Construction and Operation –Accessories ,Fluid Power ANSI Symbols –Problems, Accumulators, Intensifiers, Industrial hydraulic Circuit Design and Analysis, Hydrostatic transmission, Sensors used in Electro hydraulic systems, Electro hydraulic circuits,–Servo and Proportional valves –Applications-Mechanical , hydraulic servo systems.		
UNIT-IV	**PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS**	**9**
Properties of air –Air preparation and distribution –Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit –classification-single cylinder and multi cylinder circuits-Cascade method –Integration of fringe circuits ,PLC-Architecture and types, Electro Pneumatic System – Elements –Ladder diagram –timer circuits-Problems, Introduction to fluidics and pneumatic logic circuits		
UNIT-V	**TROUBLE SHOOTING AND APPLICATIONS**	**9**
Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. –Low cost Automation –Hydraulic and Pneumatic power packs		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
•	Understand the behavior of fluids.
•	Calculate losses in fluid flow and Design the effective fluid flow system.
•	Design hydraulic circuits and systems for various applications.
•	Design and develop pneumatic and electro pneumatic systems.
•	Select, Install and Maintain fluid power systems.

Text Books:	
1	Anthony Esposito, “Fluid Power with Applications”, Pearson New International Edition, England, 2014.
2	Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 2017.

Reference Books / Web links:	
1	Jagadeesha. T., “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.
2	Joshi. P., Pneumatic Control”, Wiley India, 2008.
3	Majumdar, S.R., “Oil Hydraulics Systems –Principles and Maintenance”, TataMcGraw Hill, 2001
4	Shanmugasundaram. K., “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.
5	Srinivasan. R., “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.

RO19502	DYNAMICS AND DESIGN OFMACHINERY	PC	L	T	P	C
			3	1	0	4

Objectives:	
•	To derive the force-motion relationship in components subjected to external forces and analysis of standardmechanisms.
•	To interpret the effect of unbalancing of masses and vibrations.
•	To understand the concepts in design of machine elements.
•	To learn about shaft and fasteners design.
•	To learn the design principles involved in designing springs and bearings.

UNIT-I	FORCE ANALYSIS	9
Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams – Fly Wheels – Flywheels of punching presses- Dynamics of Cam-follower mechanism.		
UNIT-II	**BALANCING OF ROTATING MASSES AND VIBRATION**	**9**
Static and dynamic balancing – Balancing of rotating masses in different planes. Basic concepts of S.H.M, Causes andeffects of vibration - Degrees of freedom – Single degree of freedom – Free vibration – Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsionalvibration – Two rotor torsional systems. Introduction to Forced vibration.		
UNIT-III	**FUNDAMENTAL CONCEPTS IN DESIGN**	**9**
Introduction to the design process, factors influencing machine design, standards and codes used in material selection, selection of materials based on mechanical properties, Preferred numbers, design against static loads-Modes of failure -Factor of safety –stresses due to bending and torsion moment-eccentric loading-Eccentric loading, Design against fluctuating loads –curved beams –crane hook and "C" frame-theories of failure.		
UNIT-IV	**SHAFTS AND FASTERNERS DESIGN**	**9**
Shafts and Axles -Design of solid and hollow shafts based on strength, rigidity and critical speed –Keys and splines – Rigid and flexible couplings. Threaded fasteners -Bolted joints –Simple and eccentrically loaded bolted joints-Weldedjoints –welded joints subjected to bending, torsional and eccentric loads.		
UNIT-V	**SPRINGS AND BEARINGS**	**9**
Types of springs, design of helical and concentric springs–surge in springs ,Sliding contact and rolling contactbearings -Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs, -- Selection of Rolling Contact bearings -Seals and Gaskets.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
•	Analyze and predict the effects of force in mechanical system
•	Calculate the effect of unbalanced system and determine vibrational effects in a mechanical systems
•	Design machine members subjected to static and variable loads
•	Analyze bolted and welded joints for various kinds of loads.
•	Design and select springs and bearings.

Text Books:	
1.	Shigley. J., Mischke. C., Budynas, R., and Nisbett. K., "Mechanical Engineering Design", 10thEdition, TataMcGraw-Hill, 2014.
2.	Bhandari V, "Design of Machine Elements", 15th Reprint, Tata McGraw-Hill Book Co, 2014

Reference Books / Web links:	
1	Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”,2nd Edition, Tata McGraw Hill, 2006
2	Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition, Affiliated East-West Pvt. Ltd., New Delhi, 2006.
3	Design Data Hand Book, PSG College of Technology, 2013-Coimbatore
4	Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”,5th Edition, Wiley,2011.
5	Md. Jalaludeen , Machine Design, Volume II, Design of Transmission Systems, 4th edition, Anuradha Publications, 2014

RO19503	MECHATRONICS AND MANUFACTURING AUTOMATION	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand about Mechatronics systems
•	To introduce the concept of PLC programming to establish an automation.
•	To learn about drives and mechanisms
•	To know about the stages in mechatronics design
•	To study about manufacturing systems

UNIT-I	INTRODUCTION AND SENSORS	9
Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT –Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor – Temperature Sensors – Light Sensors		
UNIT-II	**PROGRAMMABLE LOGIC CONTROLLER**	**9**
Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays –Data Handling – Selection of PLC.		
UNIT-III	**DRIVES AND MECHANISMS**	**9**
Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts,electronic cams, indexing mechanisms, tool magazines, and transfer systems.		
UNIT-IV	**MECHATRONICS SYSTEM DESIGN**	**9**
Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car ParkBarrier.		
UNIT-V	**MANUFACTURING SYSTEMS**	**9**
Components of a Manufacturing system, Classification of Manufacturing Systems, overview of Classification Scheme,Single Station Manned Workstations and Single Station Automated Cells. Assembly process and systems assembly line,line balancing methods.		
	Total Contact Hours :	**45**

Course Outcomes:	
On completion of course students will be able to	
•	Select suitable sensors for all applications.
•	Integrate PLC for an automation system.
•	Design suitable drives and mechanisms for mechatronic applications.
•	Identify appropriate mechatronic system for an application.
•	Classify manufacturing systems and implement assembly line balancing methods.

Text Books:	
1.	Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2.	Frank Lamb, Industrial Automation: Hands On, McGraw-Hill Professional, 2013

Reference Books / Web links:	
1.	Groover and Zimmers, CAD/CAM; “Computer Aided Design and Manufacturing, Pearson Education”, NewDelhi, 2006.
2.	Davis G.Alciatore and Michael B.Histand, “Introduction to Mechatronics and Measurement systems”, McGrawHill Education, 2011.
3.	Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education,2015.
4.	Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
5.	Yoram Koren,“Computer Control of Manufacturing Systems”, McGraw Hill Education; 1st edition, 2017.

MT19503	SYSTEM DYNAMICS AND CONTROL	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce the elements of control system and their modeling using various Techniques.
•	To perform time domain analysis of control systems required for stability analysis.
•	To perform frequency domain analysis of control systems required for stability analysis.
•	To design the compensation technique that can be used to stabilize control systems.
•	To introduce the state variable analysis method.

UNIT-I	**CONTROL SYSTEM MODELING**	**9**
Basic Elements of Control System – Open loop and Closed loop systems - Differential equation - Transfer function,Modeling of Electric systems, Translational and rotational mechanical systems – Modeling of Semi active suspension system, Reduction Techniques - Block diagram – Industrial Automatic Flow Process, Signal flow graph – Automatictelescope Control.		
UNIT-II	**TIME RESPONSE ANALYSIS**	**9**
Time response analysis - First Order Systems - Impulse and Step Response - Analysis of second order systems - Steadystate errors – P, PI, PD and PID Compensation, Analysis of Compensation in Mechatronics systems.		
UNIT-III	**FREQUENCY RESPONSE ANALYSIS**	**9**
Frequency Response - Bode Plot, Polar Plot, Nyquist Plot - Frequency Domain specifications from the plots. Compensators - Lead, Lag, and Lead-Lag Compensators. Case Study: Frequency response Analysis in Robot Manipulator.		
UNIT-IV	**STABILITY ANALYSIS**	**9**
Stability, Routh-Hurwitz Criterion, Root Locus Technique, Construction of Root Locus, Stability, Dominant Poles, Application of Root Locus Diagram - Nyquist Stability Criterion - Relative Stability. Case study: Stability Analysis ofa Robot.		
UNIT-V	**STATE VARIABLE ANALYSIS**	**9**
State space representation of Continuous Time systems – State equations – Transfer function from State Variable Representation – Solutions of the state equations - Concepts of Controllability and Observability – State spacerepresentation for Discrete time systems. Case Study: Controllability and Observability of an N – Link Robot.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
•	Write mathematical equations for model mechanical, electrical systems and can able to compute transfer functionusing block diagram and signal flow graph methods.
•	Analyze the 1st and 2nd order systems in time domain for Mechatronic Systems.
•	Perform time domain and frequency domain analysis of control systems required for stability analysis in RobotControl.
•	Design the compensation technique that can be used to stabilize Robot control systems.
•	Design controllability and observability for higher order systems.

Text Books:	
1	Nagrath J and M.Gopal, “Control System Engineering”, New Age International Publishers, 6th Edition, 2017.
2	Levent Güvenç, Bilin Aksun Güvenç, Burak Demirel, Mümin Tolga Emirler, “Control of Mechatronic Systems”,Institution of Engineering and Technology, 2017.

Reference Books / Web links:	
1	Benjamin.C.Kuo, “Automatic control systems”, Prentice Hall of India, 9th Edition,2014.
2	Gopal M, “Control System – Principles and Design”, Tata McGraw Hill, 4nd Edition, 2012.
3	Schaum’s Outline Series, “Feedback and Control Systems” Tata McGraw-Hill, 2007.
4	Georg Pelz, “Mechatronic Systems Modeling and Simulation with HDLs”, wiley Publication, 2003.
5	Richard C. Dorf and Robert H. Bishop, “Modern Control Systems”, 13th Edition, Pearson Education Ltd, 2017.

RO19511	ROBOTICS LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives:	
The main learning objective of this course is to prepare the students	
•	To study the position of links.
•	To study the transformation matrix usage.
•	To study the robot application for pick and place.
•	To understand Trajectory Control.
•	To calculate the joint torque of a robot.

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 assembly process			
8	Trajectory Control Modeling with Inverse Kinematics			
9	Check for Environmental Collisions with Manipulators			
10	Robot programming for joint torque calculation.			
		Total Contact Hours	**:**	**45**

Course Outcomes:	
On completion of the course, the student is expected to be able to	
•	Perform modeling of robot based on the link positions.
•	Determine the orientation and position of robot.
•	Develop pick and place application system.
•	Integrate PLC and Robot.
•	Determine the joint torques of a robot.

RO19512	FLUID POWER SYSTEMS LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives:	
The main learning objective of this course is to prepare the students	
•	To study the pneumatic simulation software.
•	To study the hydraulic simulation software.
•	To learn PLC programming for fluid power circuits.
•	To understand Pneumatic components and its functions in different pneumatic circuits.
•	To know the functions of electrohydraulic systems.

List of Experiments				
1	Simulating Cylinder Sequencing hydraulic circuit			
2	Simulating Cylinder Reciprocating System using DCV's			
3	Simulating Cylinder synchronizing circuit.			
4	Simulating Speed control of Hydraulic Cylinder.			
5	Ladder PLC program using counters for alternate switching of two solenoid DCV			
6	Ladder PLC program using counters for controlling various LED s at different time sequences.			
7	Design and test two cylinders cascading in basic pneumatic trainer kit.			
8	Design and test two cylinders cascading in electro pneumatic trainer kit.			
9	Design and test two cylinders cascading in electro pneumatic trainer kit with PLC			
10	Design and test two cylinders cascading in basic hydraulic trainer kit.			
		Total Contact Hours	**:**	**45**

Course Outcomes:	
On completion of the course, the student is expected to be able to	
•	Perform simulation for various conditions.
•	Determine the force calculation of hydraulic actuators.
•	Design and Develop various fluid power circuits.
•	Integrate PLC with hydraulic and pneumatic components.
•	Design and test hydraulic trainer kit.

GE 19521	SOFT SKILLS - II	EEC	L	T	P	C
			0	0	2	1

Objectives:	
This laboratory course enables students to	
●	Help students break out of shyness.
●	Build confidence
●	Enhance English communication skills
●	Encourage students' creative thinking to help them frame their own opinions,

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use oftechnology and brief trainer input.

Week	Activity Name	Description	Objective
1	The News hour	Students are made to read news articles from the English newspapers. The students also have to find words and their meaning from the article they have not come across before and share it with the group. They then use these words in sentences of their own	The aim of this activity is notonly to get the students to read the newspaper but alsoaims at enhancing the students' vocabulary.
2	Court Case	The facilitator provides the participants the premise of a story and proceeds to convert the story into a court case. The students are required, department-wise to debate and provide their points to win the case for their clients.	The aim of the lesson is to encourage creative and out-of-the -box thinking to ensure a good debate and defense skills.
3	The ultimate weekend	The students design activities they are going to do over the weekend and they have to invite their classmates to join in the activity. The students move around the class and talk to other students and invite them.	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the grammatical structures of "going to" "have to" and asking questions.
4	The Four Corners	This is a debate game that uses four corners of the classroom to get students moving. The following is written on the 4 corners of the room "Strongly Agree, Somewhat Agree, Somewhat Disagree and Strongly Disagree". The topics are then given to the class and students move to thecorner that they feel best explains their opinions	This activity aims at getting students to come up with their own opinions and stand by it instead of being overshadowed by others and forcing themselves to change based on others opinions.
5	Debate	Boarding school or day school? Which is more beneficial for a student?	The aim of this activity is to encourage students to draw up feasible points on the advantages and benefits of both. And enhance their debating ability

6	Grand Master	The facilitator starts the session by keeping an individual in mind, upon which the students guess it only through "Yes or No" questions. Postfew trials the students are given same opportunity to do the same with the crowd.	The aim of the lesson is designed to teach the art of questioning. It also helps to enhance the students' speaking and listening skills.
7	Debate	Does violence on the TV and Video games influence children negatively?	This activity aims at encouraging the students to debate on real life scenarios that most students spend a lot of time on.
8	Turn Tables	This is a speaking activity where the students need to speak for and against the given topics when the facilitator shouts out 'Turn Table'.	The aim of this activity is to make the participants become spontaneous and have good presence of mind.
9	Debate	Do marks define the capabilities of a student?	This debate activity aims at allowing the students to argue on this worrisome adage of marks.
10	Fiction AD	The Participants are asked to create an Ad for a challenging topic only using fictional characters.	The activity aims at developing their creativity and presentation skills.
11	Debate	Are social networking sites effective, or are they just a sophisticated means for stalking people?	This activity aims at refining the students debating skills on a very real life situation
12	Talent Hunt	Talent Hunt is a fun activity where the students are selected at random and supported to present any of their own skills.	The aim of this activity is designed to evoke their inner talents and break the shyness and the fear of participating in front of a crowd
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits.	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Outcomes:

On completion of course students will be able to

- Be more confident
- Speak in front of a large audience without hesitation
- Think creatively
- Speak impromptu
- Communicate in English

RO19521	INTERNSHIP-II*	EEC	L	T	P	C
			0	0	2	1

Objectives:	
•	To enhance the knowledge of the students in professional engineering practice sought through industrial training ondifferent current technologies.
•	To expose students to real work life situations and to equip them with abreast of new technology that intensify theirjob acumen.
•	To employ the students in industrial projects and strengthen the practical skills of the students.
•	To develop significant commitment in the students' profession and specialization.

STRATEGY:
The students individually undertake training in reputed Mechanical, Mechatronics and Automation engineering companies for the specified duration. At the end of the training, a report on the work done will be prepared and presented. The students will be evaluated through a viva-voce examination by a team of internal staff.

Course Outcomes: On completion of the course students will be able to	
•	Apply prior acquired knowledge in a real-life environment.
•	Integrate classroom theory with workplace practice.
•	Acquire knowledge from the industrial experts.
•	Work on a research project or undertake work experience under the guidance of industry and academic supervision.
•	Extend the knowledge through research and development in the chosen fields of specialization.

(* Two weeks at the end of Fourth Semester)

SEMESTER VI

RO19643	Subject Name (Theory course with Laboratory)	Category	L	T	P	C
	COMPUTER AIDED ENGINEERING	PC	3	0	4	5

Objectives:	
•	To introduce the student to the basic tools of Computer-Aided Design (CAD), Computer- Aided Manufacturing(CAM) and Finite Element Methods (FEM).
•	To expose the student about geometric transformation methods and Modeling.
•	To expose the methods of FEM and its use in Engineering problems.
•	To expose the adequate knowledge in CNC System.
•	To familiarize the student on CNC machine structures.

UNIT-I	INTRODUCTION TO CAD/CAM	9
Fundamentals of CAD / CAM, product cycle and CAD/CAM, Basic components of CIM, Distributed communication system, Computer networks for manufacturing, Role of computer in CAD/CAM. Benefits of CAD/CAM. Concurrent Engineering, Design for Manufacturability, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations.		
UNIT-II	**GEOMETRIC TRANSFORMATION AND MODELING**	**9**
Coordinate Systems. Transformation: Representation of points; Homogeneous coordinates; General transformation –rotation, translation, scaling and shearing; Parallel projections –orthographic, axonometric and oblique; Perspective projections –single-point, two- point, three-point and vanishing points; Geometric modeling - wire frame, Surface and Solid models - CSG and B-Rep techniques – Wire frame versus Solid modeling.		
UNIT-III	**INTRODUCTION TO FINITE ELEMENT METHODS**	**9**
Direct approach. Mathematical modeling, Review of various approximate methods – Galerkin weighted residual approach and Variational Approach, Element properties, Application to Structural Mechanics Problems. Governing equation and convergence criteria of finite element method; Bar and Beam Elements; Shape Functions.		
UNIT-IV	**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		
UNIT-V	**STRUCTURE OF CNC MACHINE TOOL**	**9**
CNC Machine building, structural details, configuration and design - Guide ways Friction – Anti friction and other types of guide ways - Elements used to convert the rotary motion to a linear motion Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion -spindle assembly - torque transmission elements gears, timing belts, flexible couplings - Bearings.		
	Total Contact Hours : 45	

List of Experiments	
1	Fundamentals of CAD part modeling; conventions and techniques.
2	Creation of engineering drawings from CAD models.
3	Creating assembly models from parts models in CAD.
4	Creating detailed drawings and bills of materials of the parts and assemblies
5	Surface modeling techniques for designing free form shapes.
6	Sheet metal design
7	Structural analysis using FEA software
8	Beam deflection analysis using FEA software
9	Stress analysis of rectangular plate and rectangular plate with hole simulation software.
10	Thermal analysis using FEA software.
11	Modelling and tool path simulation – turning using any CAM package
12	Modelling and tool path simulation – milling using any CAM package

13	NC code generation for milling using any CAM package		
14	NC code generation for turning using any CAM package		
	Contact Hours	:	**60**
	Total Contact Hours	:	**105**

Course Outcomes:

On completion of course students will be able to

- Explain the role of cad/cam and perform Solid modeling.
- Explain the fundamentals of parametric curves, surfaces, Solid and their transformations.
- Perform finite element analysis on components modeled in CAD packages.
- Write part programs for machining in NC & CNC Machines.
- Select required components and assemble the CNC machines.

Text Books:

1	Groover.M.P, "Automation Production systems and Computer Integrated Manufacturing, Pearson Education" -New Delhi, 2016.
2	Ibrahim Zeid, R Sivasubramanian CAD/CAM, "Theory and Practice", Tata McGraw Hill Ed, 2009
3	Robert D Cook, David S Malkus, Michael E Plesha, 'Concepts and Applications of Finite Element Analysis', 4th edition, John Wiley and Sons, Inc., 2003.

Reference Books / Web links:

1	David F. Rogers and Alan Adams. J, "Mathematical Elements for Computer Graphics", McGraw - Hill Education,New York, 2017.
2	Rao, PN "CAD/CAM: Principles and Applications" McGraw Hill Education; 3rd edition 2017
3	Paul G. Ranky, "Computer Integrated Manufacture, Prentice" – Hall International, UK, 1986.
4	Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2003 (Indian Reprint 2013).
5	Radha Krishnan. P and Kothandaraman.C.P, "Computer Graphics and Design", Dhanpat Rai and sons, New Delhi, 1991.
6	William M. Newman, Robert F. Sproull, "Principles of Interactive Computer Graphics", McGraw-Hill International Book Company, second edition (reprint), 2010.

RO19644	Subject Name (Theory course with Laboratory)	Category	L	T	P	C
	ROBOTIC VISION AND INTELLIGENCE	PC	3	0	4	5

Objectives:	
•	To study the basics of the vision systems.
•	To expose the student on the algorithms used in vision systems.
•	To study the recognition technique for objects.
•	To understand the applications and software for vision systems.
•	To introduce the concept on the usage od Fuzzy Logic and Neural network.

UNIT-I	VISION SYSTEMS	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 depth values.		
UNIT-IV	**VISION TRACKING**	**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	**INTRODUCTION TO FUZZY LOGIC AND NEURAL NETWORK**	**9**
Fuzzy sets, Difference between fuzzy and crisp set, standard operations in fuzzy sets and relations, properties of fuzzy sets, Fuzzy logic controller (Mamdani and Sugeno approach),Biological Neuron, Artificial Neuron, A layer of neurons,multiple layer of neurons, Supervised and unsupervised neural network (NN),Training, Multi-Layer feed forward neuralnetwork: forward calculation, Training using Back-propagation algorithm.		
	Total Contact Hours : 45	

List of Experiments				
1	Histogram Equalization			
2	Image Stitching using SIFT			
3	Counting similar shaped objects from image.			
4	Classifying similar objects from image.			
5	Calculate included angles between Lines in Images Using Hough transform.			
6	Detecting cells using Image Segmentation.			
7	Texture Segmentation of an image using Filters.			
8	Color-Based Segmentation Using K-Means Clustering.			
9	Camera Calibration			
10	Motion Tracking			
11	Line follower robot control.			
12	Study of Navigation control of mobile robot using Neural Network algorithm.			
13	Study of mobile robot control using Fuzzy logic algorithm.			
14	Implementing SLAM in Raspberry Pi mobile robot.			
	Contact Hours	**:**	**60**	
	Total Contact Hours	**:**	**105**	

Course Outcomes:	
On completion of course students will be able to	
•	Select the vision systems components.
•	Apply suitable algorithm to recognize objects.
•	Perform object recognition techniques for detecting the objects.
•	Design vision system for robot applications.
•	Implement soft computing techniques in vision systems.

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 Books(s) / Web links:	
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 PiRobot Production, 2012.
4.	Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill Inc, 2010
5.	Dilip K Pratihar, "Soft Computing fundamentals and applications", Narosa publishing house,India,2015.

RO19601	MOBILE ROBOTS	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce the concept of mobile robots locomotion.
•	To understand the mobile robot kinematics and dynamics.
•	To expose the localization and mapping techniques.
•	To know about motion control.
•	To learn advanced mobile robots.

UNIT-I	INTRODUCTION TO MOBILE ROBOTS	9
Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion. Types of mobile robots: ground robots (wheeled and legged robots), aerial robots, underwater robots and water surface robots.		
UNIT-II	**KINEMATICS AND DYNAMICS**	**9**
Kinematics of wheeled mobile robot, degree of freedom and maneuverability, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots. Dynamics of mobile robot: Lagrange-Euler and Newton-Euler methods. Computer based dynamic (numerical) simulation of different wheeled mobile robots.		
UNIT-III	**LOCALIZATION AND MAPPING**	**9**
Magnetic and optical position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual and motion sensing systems. Localization, Map based localization, Markov localization, Kalman filter localization Error propagation model, Probabilistic map based localization, Autonomous map building, Simultaneous localization and mapping (SLAM),		
UNIT-IV	**MOTION CONTROL**	**9**
Collisions free path planning and sensor-based obstacle avoidance. Motion controlling methods, kinematic control,dynamic control and cascaded control.		
UNIT-V	**MODERN MOBILE ROBOTS**	**9**
Introduction, Swarm robots, cooperative and collaborative robots, mobile manipulators, autonomous mobile robots.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
•	Differentiate different types of robots.
•	Analyze the mobile robot kinematics and dynamics.
•	Summarize the different types of localization approach.
•	Design collisions free path planning.
•	Summarize the different types of Swarm robots, Cooperative and Collaborative robots.

Text Books:	
1	Kelly, A "Mobile Robotics: Mathematics, Models, and Methods", Cambridge University Press, USA, 2013.
2	Dudek, M Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, USA, 2010.

Reference Books / Web links:	
1	Siegwart,R Nourbakhsh, and Scaramuzza, "Introduction to Autonomous Mobile Robots", MIT Press, USA, 2011.
2	Tzafestas, "Introduction to Mobile Robot Control, Elsevier", USA, 2014.
3	Choset, Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, "Principles of Robot Motion:Theory, Algorithms, and Implementations", MIT Press, 2005.
4	Thrun, W Burgard, D Fox, Probabilistic Robotics, MIT Press, USA, 2005.

RO19602	RESOURCE MANAGEMENT TECHNIQUES	HS	L	T	P	C
			3	0	0	3

Objectives:	
•	To expose the students to the concept of linear programming.
•	To learn various network optimization models.
•	To understand the various nonlinear optimization approaches.
•	To model the project management as network model and analyze the critical path.
•	To understand the nontraditional optimization techniques.

UNIT-I	LINEAR PROGRAMMING	9
Introduction to linear and non-linear programming formulation of different models. Geometry of linear programming, Graphical method,Linear programming (LP)in standard form, Solution of LP by simplex and revised simplex methods, Exceptional cases in LP, Duality theory, Dual Simple method, Sensitivity analysis.		
UNIT-II	**NETWORK ANALYSIS**	**9**
Transportation problem (with transshipment), Assignment problem, Traveling-Salesman Problem (TSP), Shortest routeproblem, Minimal Spanning Tree (MST), Maximum flow problem.		
UNIT-III	**NON-LINEAR PROGRAMMING**	**9**
Characteristics, Concepts of convexity, maxima and minima of functions of n-variables using Lagrange multipliers and Kuhn-Tuker conditions, One dimensional search methods, Fibonacci, golden section method and gradient methods forunconstrained problems		
UNIT-IV	**PROJECT MANAGEMENT**	**9**
Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction byCrashing of activity.		
UNIT-V	**NON TRADITIONAL OPTIMIZATION TECHNIQUES**	**9**
Concept of Genetic algorithm (GA), Encoding, Fitness function, GA Operators-Crossover, Mutation, SimulatedAnnealing, Ant colony optimization. Application on optimal AGV shuttle movement.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of course students will be able to	
•	Formulate and solve the linear model optimization problems.
•	Calculate optimal solutions to networks and find best route for TSP and MST.
•	Implement suitable non-linear programming techniques.
•	Control the projects and manage the resources.
•	Apply Genetic algorithm, Simulated Annealing, Ant colony optimization for computationally expensive problems.

Text Books:	
1	Hillier and Libeberman, “Operations Research”, McGraw-Hill Higher Education, New York, 2010.
2	Kalyanmoy Deb, “Optimization for Engineering Design Algorithms and Examples”, PHI Learning PrivateLimited, New Delhi,2012.

Reference Books(s) / Web links:	
1	Bazara M.J., Jarvis and Sherali H., “Linear Programming and Network Flows”, John Wiley, 2009
2	Budnick F.S., “Principles of Operations Research for Management”, McGraw-Hill Inc.,US, 1998
3	Philip D.T. and Ravindran A., “Operations Research”, John Wiley, 2007
4	Shennoy G.V. and Srivastava U.K.,“Operation Research for Management”, New Age International Publishers;India, 2018
5.	Singiresu S.Rao, “Engineering Optimization: Theory and Practice”, New Age International Publishers, India,2013

RO19621	INTERNSHIP-III*	EEC	L	T	P	C
			0	0	2	1

Objectives:	
•	To enhance the knowledge of the students in professional engineering practice sought through industrial training ondifferent current technologies.
•	To expose students to real work life situations and to equip them with abreast of new technology that intensify theirjob acumen.
•	To employ the students in industrial projects and strengthen the practical skills of the students.
•	To develop significant commitment in the students'' profession and specialization.

STRATEGY:
The students individually undertake training in reputed Mechanical, Mechatronics and Automation engineering companies for the specified duration. At the end of the training, a report on the work done will be prepared and presented. The students will be evaluated through a viva-voce examination by a team of internal staff.

Course Outcomes: On completion of the course students will be able to	
•	Apply prior acquired knowledge in a real-life environment.
•	Integrate classroom theory with workplace practice.
•	Acquire knowledge from the industrial experts.
•	Work on a research project or undertake work experience under the guidance of industry and academic supervision.
•	Extend the knowledge through research and development in the chosen fields of specialization.

(* Two weeks at the end of Fifth Semester)

GE19621	PROBLEM SOLVING TECHNIQUES	EEC	L	T	P	C
			0	0	2	1

Objectives: This laboratory course enables students	
•	To improve the numerical ability
•	To improve problem-solving skills.
•	To utilize different tools and techniques
•	To introduce different methodologies for problem solving process
•	To know the significance of research methodologies for problem solving process

Topics covered			
1	Number system		
2	Reading comprehension		
3	Data arrangements and Blood relations		
4	Time and Work		
5	Sentence correction		
6	Coding & Decoding, Series, Analogy, Odd man out and Visual reasoning		
7	Percentages, Simple interest and Compound interest		
8	Sentence completion and Para-jumbles		
9	Profit and Loss, Partnerships and Averages		
10	Permutation, Combination and Probability		
11	Data interpretation and Data sufficiency		
12	Logarithms, Progressions, Geometry and Quadratic equations.		
13	Time, Speed and Distance		
	Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course, the student will be able to:	
•	Recognize what problem solving actually is and why it's important to be good at it.
•	Describe methods for researching and gathering data needed for problem solving.
•	Utilize the process, tools and techniques available to determine the best solution to a problem.
•	Know methodologies you may use when making tough decisions in the problem-solving process, and
•	Identify your strengths and available resources for determining the most appropriate problem-solving process.

Reference Books / Web links:	
1	S.G. Krantz, “Techniques of Problem Solving”, Universities Press, 1997.
2	Arthur Engel, “Problem-Solving Strategies”, Springer New York, 2008.
3	Arthur B. Vangundy, “Techniques of structured problem solving”, Springer Netherlands, 1988.
4	James M. Higgins, “101 Creative Problem-Solving Techniques - The Handbook of New Ideas for Business”,New Management Publishing Company, 2006.
5	L. Fernandez, H. Gooransarab, “Solutions Manual for Techniques of Problem Solving”, Universities Press, 1997.

SEMESTER VII

RO19702	COMPUTER INTEGRATED MANUFACTURING	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To study the different types of production system.
•	To learn the computer aided process planning.
•	To introduce the concepts Group Technology and Cellular Manufacturing.
•	To understand flexible manufacturing system.
•	To know the database and CIM communication.

UNIT-I	INTRODUCTION	9
Concepts of CAD/CAM –CIM concepts and elements –Types of production –Manufacturing Metrics and Economics –Production Performance Metrics –Manufacturing Cost -Simple problems –Basic Elements of an Automated system –Advanced Automation Functions -Levels of Automation –Lean Production and Just-In-Time Production,Introduction to reverse engineering.		
UNIT-II	**PRODUCTION AND COMPUTER AIDED PROCESS PLANNING**	**9**
Production planning and Control System -Aggregate Production Planning and Master Production Schedule – Material Requirement Planning (MRP I) –Simple Problems –Capacity Planning –Shop Floor Control –Inventory Control –EOQ, WIP costs & Inventory Holding Costs -Simple Problems – Introduction to Manufacturing Resource Planning (MRP II) & Enterprise Resource Planning (ERP) - Process planning –Manual Process Planning and case studies Computer Aided Process Planning (CAPP)		
UNIT-III	**GROUP TECNOLOGY AND CELLULAR MANUFACTURING**	**9**
Group Technology(GT) -Part Families –Parts Classification and coding –Simple Problems in OPITZ Part Coding system –Production flow Analysis –Cellular Manufacturing –Composite part concept –Machine cell design and layout –Quantitative analysis in Cellular Manufacturing –Rank Order Clustering Method - Arranging Machines in a GT cell–Hollier Method –Simple Problems Performance Metrics in Cell Operation –Simple Problems.		
UNIT-IV	**FLEXIBLE MANUFACTURING SYSTEM**	**9**
Types of FMS & Flexibility –FMS Components –FMS Application & Benefits –FMS Planning and Implementation Issues –Quantitative analysis of Bottleneck Model on simple problems in FMS - Alternative Approach in Flexible Manufacturing-Automated Guided Vehicle System (AGVS) –Types of AGVS -Applications –Vehicle Guidancetechnologies –Vehicle Management & Safety		
UNIT-V	**COMMUNICATIONS AND DATABASE MANAGEMENT**	**9**
Information, Communications matrix, Computer communications, Network architecture, Tools and techniques, Manufacturing data, database technology, Database management, Management of CIM –role, cost justification,expert systems		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
•	Identify the production systems.
•	Select optimal inventory ordering system.
•	Group part and machine families for Cellular Manufacturing System.
•	Implement flexible manufacturing system.
•	Design proper database and CIM communication system.

Text Books:	
1	Mickel P Groover, "Automation production systems and computer integrated manufacturing", PHI, secondedition, 2018.
2	Kant Vajpayee S, "Principles of Computer-Integrated Manufacturing", PHI, 2015.

Reference Books / Web links:	
1	Groover and Zimmers, CAD/CAM; "Computer Aided Design and Manufacturing, Pearson Education", NewDelhi, 2006.
2	Paul G. Ranky, "Computer Integrated Manufacture, Prentice" – Hall International, UK,1986.
3	Rao,PN "CAD/CAM: Principles and Applications" McGraw Hill Education; 3rd edition 2017.
4	Ibrahim Zeid, R Sivasubramanian CAD/CAM, "Theory and Practice", Tata McGraw Hill Ed, 2009.
5	Yoram Koren,"Computer Control of Manufacturing Systems", McGraw Hill Education; 1st edition, 2017.

RO19703	MATERIAL HANDLING SYSTEM	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce the concept of material handling.
•	To understand the design principles of belt and chain drives.
•	To expose the strength and wear considerations in gears.
•	To know the significance of friction in clutch and brakes.
•	To familiarize with lifting equipment.

UNIT-I	INTRODUCTION TO MATERIAL HANDLING	9
Overview of Material Handling: Principles of Material, unit load concept, Handling, classification of materialshandling equipment- Basic Equipment Type and Classification of Handling Equipment		
UNIT-II	**DESIGN OF FLEXIBLE ELEMENTS**	**9**
Motor power capacity for various applications -Design of Flat belts and pulleys -Selection of V belts and sheaves, Design of Transmission Chains and Sprocket.		
UNIT-III	**SPUR AND HELICAL GEARS**	**9**
Gear materials -Design of straight tooth spur & helical gears based on speed ratios, number of teeth, Fatigue strength, Factor of safety, strength and wear considerations. Force analysis –Tooth stresses - Dynamic effects -Helical gears –Module -normal and transverse, Equivalent number of teeth –forces, Design of Gear box.		
UNIT-IV	**CLUTCHES AND BRAKES**	**9**
Design of single and multi-plate clutches, cone clutches, internal expanding rim clutches and Electromagnetic clutches. Design of brakes: External shoe brakes -Single and Double Shoe, Internal expanding shoe brakes and Bandbrakes.		
UNIT-V	**LIFTING EQUIPMENTS**	**9**
Hoist Components of Hoist –Load Handling attachments hooks, grabs and clamps, Principle operation of EOT,Gantry and jib cranes Hoisting Mechanisms, Travelling mechanisms, lifting mechanisms –Slewing Mechanisms –Elevators and lifts, . Overload protection and drives in cranes, elevators and hoists. Case study in lifting equipment.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
•	Differentiate different types of material handling system.
•	Design transmission systems using belt and chain drives.
•	Design gear drive systems.
•	Design and select clutches and brakes for the applications.
•	Summarize the different types of lifting equipment.

Text Books:	
1	Bhandari V, “Design of Machine Elements”, 15th Reprint, Tata McGraw-Hill Book Co, 2014
2	Siddhartha Ray , “Introduction To Materials Handling”, New Age International (P) Ltd., India,2017.

Reference Books / Web links:	
1	Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”,2nd Edition, TataMcGraw Hill, 2006
2	C.S.Sharma, KamleshPurohit, “Design of Machine Elements”, Prentice Hall of India,Pvt. Ltd., 2003
3	Design Data Hand Book, PSG College of Technology, 2013-Coimbatore
4	Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”,5th Edition, Wiley, 2011.
5	Md. Jalaludeen , “Machine Design, Volume II, (Design of Transmission Systems)”, 4th edition, Anuradha Publications,2014

GE19304	FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS	HS	L	T	P	C
			3	0	0	3

Objectives:	
•	To expose the students to the basic concepts of management in order to aid in understanding how an organization functions, and in understanding the complexity and wide variety of issues managers face in today's business firms.

UNIT-I	**Introduction To Management:** Definition, Nature and Scope, Functions, Managerial Roles,Levels of Management, Managerial Skills, Challenges of Management; Evolution of management thought. Organization: Types and environmental factors.	**9**
UNIT-II	**Planning And Decision Making:** General Framework for Planning – Planning Process, Types of Plans, Management by Objectives; Decision making and Problem Solving - Steps inProblem Solving and Decision Making.	**9**
UNIT-III	**Organization And HRM:** Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization. Human Resource Management & Business Strategy: Talent Management and Strategic Human Resource Planning; Recruitment and Selection; Training and Development; PerformanceAppraisal.	**9**
UNIT-IV	**Leading And Motivation:** Leadership, Power and Authority, Leadership Styles, Leadership Skills,Leader as Mentor and Coach, Team Leadership. Motivation – Types of Motivation; Relationshipbetween Motivation, Performance and Engagement, Content Motivational Theories – Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y.	**9**
UNIT-V	**Controlling:** Control, Types and Strategies for Control, Steps in Control Process, Budgetary andNon- Budgetary Controls. Characteristics of Effective Controls, Establishing control systems. Managing productivity- Cost control- Purchase control- Maintenance control- Quality control-Planning operations. Managing globally- Strategies for International business.	**9**
	Total Contact Hours : 45	

Course Outcomes: After completing the course, the Learners should be able to:	
•	Understand and apply the basic principles of management.
•	Understand and apply the planning, organizing and control processes.
•	Understand and design organization as well as manage and develop human resource.
•	Understand various theories related to the development of leadership skills, motivation techniques and team work.
•	Understand and apply controlling practices in all applications.

Text Book (s):	
1	Principles of Management, Prakash Chandra Tripathi, Tata McGraw-Hill Education, 2008.
2	Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009.
Reference Books(s) / Web links:	
1	Essentials of Management, Koontz Kleihrich, Tata Mc – Graw Hill.
2	Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.

RO19711	INNOVATION AND DESIGN THINKING FOR ROBOTICSAND AUTOMATION	EEC	L	T	P	C
			0	1	2	2

Objectives:	
This course enables students to	
•	Has a special focus on skill development through active engagement in real world problems.

	Design Thinking			
	Introduction to Design Thinking - What Is Design Thinking? - The Good Kitchen Story - Business ModelInnovation - Challenges Best-Suited for Design Thinking - Visualization Tool			
	Preparing Your Mind for Innovation			
	The Physics of Innovation - The Story of George & Geoff - How Prepared Is Your Mind? - Storytelling Tool			
	Idea Generation			
	The Idea Generation Process - The Me You Health Story Part I: What Is? - The Me You Health Story Part II:What If? - Mind Mapping Tool			
	Experimentation			
	The IBM Story - Learning Launch Tool - Strategic Opportunities – case studies relevant to Robotics and Automation			
		Total Contact Hours	**:**	**45**

Course Outcomes:	
On completion of the course, the student will be able to	
•	Appreciate various design process procedure.
•	Generate and develop design ideas through different technique.
•	Identify the significance of reverse engineering to understand products.
•	Conceive, organize and lead successful projects in any robotics and automation discipline.
•	Implement, and evaluate successful projects in any robotics and automation discipline.

RO 19721	PROJECT WORK PHASE -1	EEC	L	T	P	C
			0	0	2	1

Objectives:
This laboratory course enables students to

- To develop the ability to solve a specific problem right from its identification and literature review till thesuccessful solution of the same
- To train the students in preparing project reports and to face reviews and viva voce examination

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of afaculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

Each batch is required to select any new component or an integrated robotics /automation/mechatronics system thatinvolves various sub components which are to be designed in Project Work Phase - I

The project report shall carry a maximum of 20 marks. The project report shall be submitted as per the approved guidelines as given by Dean-Academics. Same mark shall be awarded to every student within the project group for the project report. The viva-voce examination shall carry 40 marks. Marks are awarded to each student of the project group based on the individual performance in the viva-voce examination.

Continuous Assessment 40 Marks			End semester Examination 60 Marks			
Review I	Review II	Review III	Project Report Evaluation 20 marks		Viva-Voce 40 marks	
			Internal	External	Internal	External
10	15	15	10	10	20	20

Total Contact Hours : 30

Course Outcomes:
On completion of the course, the student will be able to:

- Fabricate any components using appropriate manufacturing techniques.
- Use of design principles and develop conceptual and engineering design in robotics and automation field.
- Demonstrating the function of the fabricated model.
- Prepare the project as a technical report and deliver it in oral presentation.
- Show their team work and technical skills.

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
RO19712	Robotics and Automation Problem Solving using AI,ML and DL	PC	0	0	6	3

Objectives:	
•	To understand the basics of Artificial intelligence, Machine and Deep learning.
•	To know about Multilayer Perceptron.
•	To learn Convolutional Neural Networks models.
•	To create awareness about RNN model.
•	To learn programming in Notebook.

Course Outcomes: On completion of course students will be able to	
•	Differentiate between of machine and deep learning.
•	Apply the Multilayer Perceptron.
•	Program in notebook for object recognition and detection.
•	Implement Convolutional Neural Networks models.
•	Work on deep architectures used for solving various Vision and NLP tasks.

List of Experiments			
1.	Study of Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet		
2.	Real-Time application of Google Net model for classification		
3.	Real-Time image classification using raspberry pi		
4.	Real-Time pose estimation using raspberry pi		
5.	Real-Time object detection using raspberry pi		
6.	AI algorithm based blocks world problem solving.		
7.	Robot task control using nlp.		
8.	Soldering defect identification in printed circuit board using Deep learning.		
9.	Identify Punch and Flex Hand Gestures Using Machine Learning Algorithm on Arduino Hardware		
10.	Identify Shapes Using Machine Learning on Arduino Hardware		
	Contact Hours	**:**	**75**

Course Outcomes: On completion of the course students will be able to	
●	Differentiate between of machine and deep learning.
●	Apply the Multilayer Perceptron.
●	Program in notebook for object recognition and detection.
●	Implement Convolutional Neural Networks models.
●	Work on deep architectures used for solving various Vision and NLP tasks.

Text Books:	
1.	Ian J. Goodfellow,Yoshua Bengio and Aaron Courville. "Deep learning." An MIT Press book in preparation,2015.
2.	Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1,2009.

Reference Books:	
1.	Tom Mitchell, “Machine Learning”, McGraw Hill, USA,1997.
2.	Josh Patterson, “Deep Learning: A Practitioner's Approach” , Shroff/O'Reilly; First edition, 2017.
3.	Ethem Alpaydin, “Introduction to Machine Learning”, The MIT Press,USA,2014.
4.	Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus, WileyIndia Edition, 2013.
5.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Scienceusing Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

SEMESTER VIII

RO19811	PROJECT WORK PHASE -II	EEC	L	T	P	C
			0	0	14	7

Objectives:
This laboratory course enables students to

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same
- To train the students in preparing project reports and to face reviews and viva voce examination

GUIDELINE FOR REVIEW AND EVALUATION

The student in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

The system designed in Phase-I need to be fabricated/ implemented in Phase II of the project.

The project report shall carry a maximum of 20 marks. The project report shall be submitted as per the approved guidelines as given by Dean-Academics. Same mark shall be awarded to every student within the project group for the project report. The viva-voce examination shall carry 40 marks. Marks are awarded to each student of the project group based on the individual performance in the viva-voce examination.

Continuous Assessment 40 Marks			End semester Examination 60 Marks			
			Project Report Evaluation 20 marks		Viva-Voce 40 marks	
Review I	Review II	Review III	Internal	External	Internal	External
10	15	15	10	10	20	20

Total Contact Hours	**:**	**210**

Course Outcomes:
On completion of the course, the student will be able to:

- Fabricate any components using appropriate manufacturing techniques.
- Use of design principles and develop conceptual and engineering design in robotics and automation field.
- Demonstrating the function of the fabricated model.
- Prepare the project as a technical report and deliver it in oral presentation.
- Show their team work and technical skills.

PROFESSIONAL ELECTIVES

RO19C11	HUMANOID ROBOTICS		L	T	P	C
			3	0	0	3

Course Objectives:	
•	To know the basic knowledge about Humanoid robots.
•	To impart knowledge in kinematics of humanoids
•	To learn about the dynamics in humanoid robots.
•	To understand the basic in biped walking.
•	To know about the different walking patterns.

UNIT-I	INTRODUCTION	9
Historical development of Humanoids, Human Likeness of a Humanoid Robot, Trade-Offs in Humanoid Robot Design, Human-Friendly Humanoid Robot Design, characteristics of humanoidrobots		
UNIT-II	**KINEMATICS**	**9**
Kinematic structure, forward and inverse kinematic problems, differential kinematics, Twist, Spatial Velocity, and Spatial Transform, Inverse Differential Kinematic Relations. Differential kinematics at singular configurations- Gait Analysis		
UNIT-III	**ZMP AND DYNAMICS**	**9**
ZMP Overview,2D Analysis,3D Analysis, Measurement of ZMP, General Discussion- ZMP of Each Foot, ZMP for Both Feet Contact, Dynamics of Humanoid Robots, Humanoid Robot Motionand Ground Reaction Force , Momentum, Angular Momentum, Angular Momentum and Inertia Tensor of Rigid Body, Calculation of Robot's Center of Mass, Link Speed and Angular Velocity, Calculation of Robot's Momentum and Angular Momentum		
UNIT-IV	**BIPED WALKING**	**9**
Two Dimensional Walking Pattern Generation, Two Dimensional Inverted Pendulum, Behavior of Linear Inverted Pendulum, Orbital Energy, Support Leg Exchange, Planning a Simple Biped Gait, Extension to a Walk on Uneven Terrain		
UNIT-V	**WALKING PATTERN GENERATION**	**9**
ZMP Based Walking Pattern Generation, Cart-Table Model, Off-Line Walking Pattern Generation, Stabilizer, Principles of Stabilizing Control, Stabilizing Control of Honda Humanoid Robot, Advanced Stabilizers.		
	Contact Hours : 45	

Course Outcomes: On completion of the course, the student will be able to:	
•	Describe about the evolution of Humanoid robots
•	Expose the basic knowledge in kinematics of humanoids
•	Calculate the Humanoid Robot Motion and Ground Reaction Force.
•	Identify Two-Dimensional Walking pattern on different terrain.
•	Create the Walking Pattern models.

Text Books:	
1	Dragomir N. Nenchev, Atsushi Konno, “Humanoid Robots Modeling and Control”, Butterworth Heinemann, 2019
2	Shuuji K, Hirohisa H, Kensuke H, Kazuhito, Springer-Verlag GmbH ”Introduction to Humanoid Robotics”, Springer, London, 2014.
3	Goswami Ambarish, Vadakkepat Prahlad, "Humanoid Robotics: A Reference", Springer,2019.
4	J. Craig, "Introduction to Robotics: Mechanics and Control", Fourth Edition, Pearson, 2022

Reference Books / Web links:	
1	A. Goswami, P. Vadakkepat (Eds.), “Humanoid Robotics: A Reference”, Springer, Netherlands, Dordrecht, 2018
2	J K. Harada, E. Yoshida, K. Yokoi (Eds.), “Motion Planning for Humanoid Robots”,Springer, London, 2010.
3	Lorenzo Sciavicco and Bruno Siciliano, "Modelling and Control of RobotManipulators", second edition, Springer, 2000.
4	Jean-Claude Latombe, "Robot Motion Planning", Kluwer Academy Publishers, 2004.

Subject Code	Subject Name (Lab oriented Theory Courses)	Category	L	T	P	C
RO19C12	AERIAL ROBOTICS		2	0	2	3

Objectives:	
•	To provide students with an introduction to the aerial Robotics and its application.
•	To study about the mechanics involved in aerial robotics.
•	To enable the students to study the Flight control and the sensors operations in UAV.
•	To explain the concept of Flight control and the weather factors.
•	To describe the importance of Safety systems in aerial robotics.

UNIT-I	Introduction to aerial Robotics	6
Introduction - UAV categories - Components of UAV – Battery of UAV - UAV Materials, Launching system, attachment of UAV and Applications.		
UNIT-II	**Aerial Mechanics**	6
Introduction – Modeling representation – Aerodynamic forces, Viscosity, Stall speed, Compressibility, Earth's atmosphere, Navier-Stockes equations – Frames - geodetic coordinate system, ECEF, NED, body coordinate system kinematic – Dynamic modeling – longitudinal – Lateral mode-Quad rotor dynamics.		
UNIT-III	**Flight Control**	6
Introduction – Architecture –Auto pilot – Sensor – Sense and avoid technique – Camera and Control – Radio Communication – Ground control system – First person view – Data Fusion.		
UNIT-IV	**Flight Operation**	6
Introduction – Linear control methods – TRM trajectory generation – Situational awareness – Flight operation – Decision making – airport operations – preliminaries – analysis of weather factor – weather information.		
UNIT-V	**Safety Systems**	6
Introduction, hazardous operations, Safety promotion, Maintenance, Human Factor, Risk analysis and prevention.		
	Total Contact Hours : 30	

List of Experiments			
1	Design a Drone propeller using modeling software.		
2	Design a Drone frame using modeling software.		
3	Exercise on PID tuning in Aerial robotics.		
4	Exercise on Drone simulation and control		
5	Design and Fabricate drone propeller in 3D printer		
6	Exercise on assembling a quad-copter		
7	Calibration of Drone using mission planner software		
8	Integration and testing Remote Controlled Vertical Take-off and Landing UAV		
	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**60**

Course Outcomes:	
On completion of the course, the students will be able to	
●	Know the Problem solving sessions Activity Based Learning importance of aerial robotics and the components used in uav
●	Design an aerial robotics considering the mechanics involved in system.
●	Model a control framework which includes sensor, vision with an Data fusion
●	Plan the aerial operation thinking about the strategies and weather analysis
●	Know the significance of the safety , maintenance and risk analysis of aerial robotics

Text Books:	
1	Yasmina Bestaoui Sebbane ,“A First Course in Aerial Robots and Drones”,CRC Press, 2022
2	“Autonomous Flying Robots” by Kenzo Nonami, Farid Kendoul, Satoshi Suzuki, Wei Wang, Daisuke Nakazawa
3	“Planning and Decision Making for Aerial Robots” by Yasmina Bestaoui Sebbane

Reference Books / Web links:	
1	Vachtsevanos,G.J. and Valavanis,K.P.(2015), Handbook of Unmanned Aerial Vehicles, 3rd Edition, Springer
2	Fahlstrom,P.G., and Gleason, T.J.,(2012), Introduction to UAV Systems, 4th Edition, Wiley
3	Vijay Kumar, Aerial robotics, University of Pennsylvania, Link: https://www.coursera.org/learn/roboticsflight#syllabus.

RO19C13	AGRICULTURAL ROBOTICS AND AUTOMATION	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To learn about Farming related Machines.
•	To understand the global position and information system in machines.
•	To know about traction and testing.
•	To familiarize the concept on weed management.
•	To learn about machinery selection.

UNIT-I	INTRODUCTION	9
History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, andHarvesting, Agricultural Automation - Agricultural Vehicle Robot.		
UNIT-II	**PRECISION AGRICULTURE**	**9**
Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable RateApplications and Controller Area Networks.		
UNIT-III	**TRACTION, AND TESTING**	**9**
Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction-Traction models, Traction predictor spreadsheet, Soil Compaction, Traction Aids, Tractor Testing.		
UNIT-IV	**SOIL TILLAGE AND WEED MANAGEMENT**	**9**
Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation. Automatic Spraying Robots For Agricultural Use – Background of Automatic Agricultural Spraying – Design Consideration of The System – Software Details.		
UNIT-V	**MACHINERY SELECTION**	**9**
Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs. Economics and Applications of Agricultural Robots – Economics – Crop Establishment – Croup Scouting –Selective Harvesting – Economic Scenarios – Field Scouting For Weed Detection..		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, the students will be able to	
•	Design robot for agriculture purposes.
•	Integrate sensor and system for required agricultural applications.
•	Develop suitable testing and tracking devices.
•	Implement suitable Weed Management system.
•	Develop and select suitable machinery for specific tasks.

Text Books:	
1	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster , "Engineering Principles ofAgricultural Machines", ASAE Publication, 2006.
2	Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2013

Reference Books(s) / Web links:	
1	Qin Zhang, Francis J. Pierce , "Agricultural Automation Fundamentals and Practices", CRC Press, 2013.
2	StephenL.Young, Francis J.Pierce , "Automation: The Future of Weed Control in Cropping Systems", Springer,Dordrecht Heidelberg New York London, 2014.
3	R.A.Kepner, Roy Bainer, E.L.Barger , "Principles of Farm Machinery", 3rd Edition, CBS Publishers, New Delhi,2017.
4	Guangnan Chen , "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2018.
5.	Hazem Shawky Fouda, ―Automation and Robotics in Agriculture, E-Book Edition 2021, Delve Publishing

RO19C14	COLLABORATIVE ROBOTICS		L	T	P	C
			3	0	0	3

Objectives:	
•	To know the fundamentals of Collaborative Robotics
•	To introduce Swarm robot and trajectory planning for Swarm
•	To introduce Modular Robotics and its Mechanics
•	To learn about various Natural models of robot collaboration
•	To introduce the concept of Reconfigurable robot

UNIT-I	INTRODUCTION TO COBOTICS	9

Collaborative Robotics- Properties - Introduction to Modern Mobile Robots: Swarm Robots, Cooperative and Collaborative Robots, Mobile Robot Manipulators-Current Challenges.

UNIT-II	SWARM ROBOTICS	9

Introduction, mapping, kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios-aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security.

UNIT-III	MODULAR ROBOTICS	9

Module Designs - Modular Robot Representation -Modular Serial Robot Kinematics - Kinematic Calibration for Modular Serial Robots- Modular Serial Robot Dynamics - Modular Parallel Robot Kinematics.

UNIT-IV	NATURALLY INSPIRED COLLABORATION	9

Collective Decision-Making. Group Decision Making in Animals, Collective Motion as Decision Process, Models for Collective Decision-Making Processes, Urn Models, Voter Model ,Majority Rule , Hegselmann and Krause , Kuramoto Model , Axelrod Model, Ising Model, Fiber Bundle Model, Sznajd Model, Bass Diffusion Model, Sociophysics and Contrarians**.**

UNIT-V	RECONFIGURABLE ROBOTS	9

V-Shaped Formation Control for Robotic Swarms Constrained by Field of View — formation of reconfigurable virtual linkage - Reconfigurable Formation Control of Multi-Agents - Self-Assembly Modular Robot Platform Based on Sambot - Swarm Dynamics Emerging from Asymmetry.

	Contact Hours	:	45

Course Outcomes:	
On completion of the course, the students will be able to	
•	Recognize the fundamentals of Collaborative Robotics
•	Apply Swarm robots technology in real time applications
•	Analyze and select the suitable concept of Modular Robotics and its Mechanics formodelling a collaborative robot
•	Create various Natural models for robot collaboration
•	Develop collaborative robots for various requirement in industrial tasks.

Text Books:	
1	Guilin Yang, I-Ming Chen, “Modular Robots: Theory and Practice”, Springer, 2022.
2	Giandomenico Spezzano, “Swarm Robotics”, Applied Sciences, MDPI, 2019.

Reference Books / Web links:	
1	Heiko Hamann, “Collective Decision-Making in Swarm Robotics: A Formal Approach”,Springer, 2019.

R019C15	ROBOT OPERATING SYSTEMS		L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce ROS and programming
•	To develop the Robot environment
•	To obtain the simulation robots in ROS with GAZEBO
•	To simulate robots with V-Rep
•	To understand mapping, navigation and motion planning ROS with Move-it

UNIT-I	ROS ESSENTIALS	9

Introduction to ROS- Advantages and Disadvantages of ROS - ROS Framework- ROS package C++, Python — ROS computation Graph — nodes, Messages, topics, services, bags, ROS Master- ROS Community- Basic programming and Syntax overview in C++ and Python — start with ROS programming - Creating Environment - Services-Actions and Nodes- Simple Interaction with the Simulation environment

UNIT-II	BUILD YOUR OWN ROBOT ENVIRONMENT	9

CAD Tools for Robot Modelling – ROS Packages for robot modelling – Unified Robot Description Format and Tags- Kinematics and Dynamics Library — Create URDF Model - Robot Modelling using Unified Robot Description Format (URDF),-ROS parameter server and adding real-world object representations to the simulation environment _ Create Robot description using 7 DOF: joint number, name, type and angle limits — Xacro — Rviz — viewing of 7 DOF arm — creation of wheeled robot

UNIT-III	SIMULATION ROBOTS IN ROS WITH GAZEBO	9

Robot simulation - Gazebo –create simulation model at Gazebo- Adding colors, textures, transmission tags, 3D vision sensor to Gazebo- Moving robot joints using ROS controllers- ROS controller interacts with Gazebo, interfacing state controller, simulation of moving the robot joints — simulation of differential wheeled robot in Gazebo.

UNIT-IV	ROS WITH VREP	9

V-REP is a multi-platform robotic simulator - Simulating the robotic arm using V-REP - Adding the ROS interface to V-REP joint - Simulating a differential wheeled robot, Adding a laser sensor , 3D vision sensor

UNIT-V	MAPPING, NAVIGATION AND MOTION PLANNING	9

Move it Instattion - Generating the Self-Collision matrix .virtual joints, planning groups, robot poses, robot end effector - MoveIt Architecture Diagram - Trajectory from RViz GUI executing in Gazebo - Planning scene overview diagram- Collision Checking - Motion Planning, Pick and Place Behaviors using Industrial Robots with ROS Moveit — ROS with MATLAB - ROS with Industrial

	Total Contact Hours	:	45

Course Outcomes:	
Upon successful completion of the course, students should be able to:	
•	Recognize the concept of ROS and programming
•	Evaluate various robot algorithms in ROS programming
•	Deploy mapping, navigation and motion planning ROS with Move-it.
•	Simulate robots in ROS with GAZEBO and V-REP
•	Program a Robot using ROS and its tool boxes

Text Books:	
1	Lentin Joseph, Jonathan Cacace, “Mastering ROS for Robotics Programming”, Second Edition, Packt Publishing, 2018.

Reference Books(s) / Web links:	
1	Lentin Joseph, Aleena Johny, “Robot Operating System (ROS) for Absolute Beginners Robotics Programming Made Easy”, Second Edition, Apress, 2022.
2	Lentin Joseph, “ROS Robotics Projects”, Packt publishing, 2017

RO19C16	AI IN ROBOTICS	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To study the concepts of Artificial Intelligence.
•	To learn the methods of solving problems using Artificial Intelligence.
•	To introduce the concepts of Probabilistic reasoning and Speech recognition.
•	To understand about learning methods.
•	To understand the role of Artificial intelligence in Robotics

UNIT-I	INTRODUCTION	9
History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents. PROBLEM SOLVING: Solving problems by searching –Informed search and exploration– Constraint satisfaction problems–Adversarial search, knowledge and reasoning– knowledge representation – first order logic.		
UNIT-II	**PLANNING**	**9**
Planning with forward and backward State space search – Partial order planning – Planning graphs– Planning withpropositional logic – Planning and acting in real world.		
UNIT-III	**REASONING**	**9**
Uncertainity – Probabilistic reasoning–Filtering and prediction–Hidden Markov models–Kalman filters– DynamicBayesian Networks, Speech recognition, making decisions.		
UNIT-IV	**LEARNING**	**9**
Forms of learning – Knowledge in learning – Statistical learning methods –reinforcement learning, communication, perceiving and acting, Probabilistic language processing, perception. Usage of learning algorithms in autonomousdriving tasks.		
UNIT-V	**AI IN ROBOTICS**	**9**
Introduction to Genetic algorithm (GA) and Artificial Neural Network (ANN). Robotic assembly sequence planning and generation using AND/OR Graph and GA. Robotic perception, localization, mapping-configuring space, planninguncertain movements, Application of ANN in industrial and mobile robots.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of course students will be able to	
•	Identify problems that are amenable to solution by AI methods.
•	Identify appropriate AI planning methods to solve a given problem.
•	Implement basic AI algorithms for Speech recognition and making decisions.
•	Develop learning algorithms for autonomous driving tasks.
•	Apply appropriate AI methods to solve assembly problem.

Text Books:	
1	Stuart Russell, Peter Norvig, ―Artificial Intelligence: A modern approch, Pearson Education, India,2009.
2	Negnevitsky, M, ―Artificial Intelligence: A guide to Intelligent Systems, Harlow: Addison-Wesley, 2002.

Reference Books / Web links:	
1	David L. Poole and Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents,Cambridge University Press, 2010
2	Raju Bahubalendruni and Bibhuthi Bhushan Biswal, Computer aided Optimal Robotic Assembly SequenceGeneration, Lap Lambert Academic Publishing; 1st edition, 2017.
3	Tim Jones M, ―Artificial Intelligence: A Systems Approach, Jones & Bartlett Learning; 1st edition, 2008
4	Ian GoodFellow, Yoshua Bengio & Aaron Courville, Deep Learning, MIT Press, USA,2016.
5	Deepak Khemani, ―A first course in Artificial Intelligence,McGraw Hill,India,2018.

RO19C17	MICROROBOTICS		L	T	P	C
			3	0	0	3

Course objectives	
•	To expose students to the fundamental aspects of the emerging field of micro robotics.
•	To expose students to micro scale, technologies for fabricating small devices, bio-inspireddesign, and applications of the field.
•	To expose students to various Mathematical formalism for flexures, Electrostatic actuators,Piezo-electric actuators, Magneto-strictive actuator and other sensors.
•	To apply micro robotics to various applications
•	To engage students in implementation of microrobotics

UNIT-I	INTRODUCTION TO MICROROBOTICS	9
Introduction to Micro robotics -MST (Micro System Technology) - Micromachining - Working principles of Microsystems Applications of Microsystems - Micro-fabrication principles-Design selection criteria for micromachining - Packaging and Integration aspects - Micro-assembly platforms and manipulators		
UNIT-II	**SCALING LAWS AND MATERIALS FOR MEMS**	**9**
Introduction - Scaling laws - Scaling effect on physical properties scaling effects on Electrical properties - scaling effect on physical forces - Physics of Adhesion - Silicon - compatible materialsystem - Shape memory alloys - Material properties - Piezoresistivity, Piezoelectricity and Thermoelectricity		
UNIT-III	**FLEXURES, ACTUATORS AND SENSORS**	**9**
Elemental flexures - Flexure systems - Mathematical formalism for flexures - Electrostatic actuators - Piezo-electric actuators - Magneto-strictive actuators - Electromagnetic sensors - Optical-based displacement sensors - Motion tracking with microscopes		
UNIT-IV	**MICROROBOTICS**	**9**
Introduction - Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro- robots - Mobility and Functional-based definition of micro-robots - Applicationsfor MEMS based micro-robots.		
UNIT-V	**IMPLEMENTATION OF MICROROBOTS**	**9**
Arrayed actuator principles for micro-robotic applications - Micro-robotic actuators - Design of locomotive micro-robot devices based on arrayed actuators - Micro-robotics devices - Micro- grippers and other micro-tools - Micro-conveyors - Walking MEMS Micro-robots - Multi-robot system: Micro-robot powering, Micro-robot communication.		
	Contact Hours :	**45**

Course Outcomes: On completion of course students will be able to	
•	Explain and apply the concepts of mass, energy, and momentum balance in microrobotics.
•	Apply adapt, and synthesize learned engineering skills to create microrobot.
•	Modelmicrorobots for different robotics applications
•	Formulate the specifications and design of mechatronic systems.
•	Program the Microrobot for different robotics applications

Text Books:	
1	Mohamed Gad-el-Hak , "The MEMS Handbook", 2nd Edition, CRC Press, New York, 2019.
2	Yves Bellouard, "Microrobotics Methods and Applications", CRC Press, Massachusetts, 2019.

Reference Books / Web links:	
1	NadimMaluf and KirtWilliams, "An Introduction to Microelectromechanical systemsEngineering", 2nd edition, Artech House, 2004
2	Julian W Gardner, "Microsensors: Principles and Applications", 2nd edition, Wiley,2007.
3	MetinSitti, "Mobile Microrobotics", MIT Press, 2017.
4	Nicolas Chaillet, Stephane Rangier "Microrobotics for Micromanipulation", JohnWiley & Sons, 2013.

RO19C18	MEDICAL ROBOTICS		L	T	P	C
			3	0	0	3

Objects:	
•	Identify and describe different types of medical robots and their potential applications.
•	Know basic concepts in kinematics, Dynamics, and control relevant to Medical Robotics.
•	Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image guided interventions.
•	Be familiar with the state of the art in applied medical robotics and medical robotics research.
•	Understand the various roles that robotics can play in healthcare.

UNIT-I	INTRODUCTION	9
Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – Stateof art of robotics in the field of healthcare-DICOM		
UNIT-II	**LOCALIZATION AND TRACKING**	**9**
Position sensors requirements - Tracking - Mechanical linkages - Optical — Sound based - Electromagnetic - Impedance-based - In-bore MRI tracking-Video matching - Fiber optic tracking systems - Hybrid systems.		
UNIT-III	**DESIGN OF MEDICAL ROBOTS**	**9**
Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security.		
UNIT-IV	**SURGICAL ROBOTICS**	**9**
Minimally invasive surgery and robotic integration - surgical robotic sub systems - synergistic control - Control Modes - Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging -Cardiac Surgery – Neurosurgery - case studies		
UNIT-V	**ROBOTS I REHABILITATION AND MEDICAL CARE**	**9**
Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - Assistive robots - Robotsin Physiotherapy - case studies.		
	Total Contact Hours : 45	

Course Outcomes:	
Upon successful completion of the course, students should be able to:	
•	Identify various medical robots and their potential applications.
•	Recognize the position tracking and hybrid systems.
•	Apply Robotics and its concepts in Medical field
•	Simulate a MIS procedure and be aware of the state of art in surgical and oncology robotics
•	Design a medical robotic system given the specific requirements for Rehabilitation and Medical care.

Text Books:	
1	Achim Ernst Floris Schweikard, "Medical Robotics", Springer, 2016.
2	Paula Gomes, "Medical robotics Minimally invasive surgery", Woodhead, 2013.

Reference Books / Web links:	
1	Jaydev P Desai, Rajni V Patel, Antoine Ferreira; Sunil Kumar Agrawal, "The Encyclopedia of Medical Robotics", World Scientific Publishing Co. Pvt. Ltd, 2019.
2	Jocelyne Troccaz , "Medical Robotics", John Wiley & Sons Incorporated, 2013.
3	Vanja Bonzovic , "Medical Robotics", I-tech Education publishing, Austria, 2008.
4	Farid Gharagozloo "Robotic Surgery", Springer, 2022.

RO19D11	CNC MACHINE TOOLS AND PROGRAMMING		L	T	P	C
			3	0	0	3

Objectives:	
•	Explain the mechanics of metal cutting and the factors affecting machinability
•	Explain the working of basic and advanced turning machines
•	Teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
•	Explain the constructional features of CNC machine tools.
•	Explain the basics of CNC programming and the machine tools through planning, writing codesand ,setting up CNC machine tools

UNIT-I	MECHANICS OF METAL CUTTING	9
Mechanics of chip formation, forces in machining, types of chip, cutting tools — Single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability		
UNIT-II	**TURNING MACHINES**	**9**
Centre lathe, constructional features, specification, operations — taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes - tool layout — automatic lathes: semi- automatic – single spindle: Swiss type, automatic screw type – multi spindle		
UNIT-III	**RECIPROCATING MACHINE TOOLS**	**9**
Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods		
UNIT-IV	**CNC MACHINES**	**9**
Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems — Open/closed, point-to-point/continuous - Turning and machining centers - Work holding methods in Turning and machining centers, Coolant systems, Safety features.		
UNIT-V	**PROGRAMMING OF CNC MACHINE TOOLS**	**9**
Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.		
	Total Contact Hours : 45	

Course Outcomes:	
Upon successful completion of the course, students should be able to:	
•	Analyse the mechanics of metal cutting process and to identify the factors involved in improving machinability.
•	Understand the constructional features and working principles of basic and advanced turning machines.
•	Evaluate and select suitable machining operation to manufacture a given component.
•	Understand the constructional features and working principles of CNC machine tools.
•	Program CNC machine tools through planning, writing codes and setting up CNC machine tools to manufacture a given component.

Text Book (s):	
1	Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education 8th Edition,2022.
2	Michael Fitzpatrick, "Machining and CNC Technology", McGraw-Hill Education;4th edition, 2019.

Reference Books(s) / Web links:	
1	Roy. A. Lindberg, "Processes and materials of manufacture", Pearson India Education ServicesPvt. Ltd, 4th edition, 2015.
2	Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1985.
3	Rao. P.N, "Manufacturing Technology Volume 2, Metal Cutting and Machine Tools", McGraw-Hill, New Delhi, 3rd edition, 2013.
4	Peter Smid, "CNC Programming Handbook", Industrial Press Inc., 3rd edition, 2007.
5	A. B. Chattopadhyay, "Machining and Machine Tools", Wiley, 2nd edition, 2017.

RO19D12	ADVANCED MANUFACTURING SYSTEMS		L	T	P	C
			3	0	0	3

Course Objectives:	
•	The objective of this course is to teach the lean tools to attain optimum level in quality.
•	To enhance the ability to make decisions for new product development.
•	Aims to develop the students to conserve energy and natural resources, and to ensure that theyhave minimal impact on the environment and society.
•	To give students an introduction to an advanced information process technique.
•	To learn about the various smart manufacturing techniques and applications.

UNIT-I	INTRODUCTION TO LEAN MANUFACTURING	9
Objectives of lean manufacturing-key principles and implications of lean manufacturing -traditional Vs lean manufacturing- flow-continuous improvement/Kaizen –worker involvement- 5S principles elements of JIT - uniform production rate - Kanban system - Lean implementation, Reconciling leanwith other systems - lean six sigma- lean and ERP - lean with ISO 9001:2000		
UNIT-II	**AGILE MANUFACTURING**	**9**
Agile Manufacturing Vs Mass Manufacturing - Agile practice for product development - Manufacturing agile practices - Implementing new technology - A checklist, technology applicationsthat enhance agility - agile technology make or buy decisions. - Costing for Agile Manufacturing practices.		
UNIT-III	**SUSTAINABLE MANUFACTURING**	**9**
Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.		
UNIT-IV	**INTELLIGENT MANUFACTURING**	**9**
Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.		
UNIT-V	**SMART MANUFACTURING**	**9**
Introduction to various Smart Manufacturing Techniques-Supply chain management-Block chain ofinventory management-Plant digitization-Predictive maintenance-Supply chain visibility- Warehouse-Cost reduction-Waste management-Automated systems-Applications		
	Total Contact Hours :	**45**

Course Outcomes:	
Upon successful completion of the course, students should be able to:	
•	Demonstrate on basic lean manufacturing.
•	Integrate the knowledge on agile manufacturing.
•	Formulate strategy in sustainable manufacturing.
•	Apply artificial intelligence (AI) and fuzzy techniques to improve the efficiency ofmanufacturing systems.
•	Exposure to smart manufacturing and its various techniques.

Text Book (s):	
•	Lonnie Wilson, “How to Implement Lean manufacturing”, McGraw-Hill Professional; 2nd edition, 2015.
•	Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
•	Kusiak, Andrew, “Intelligent Manufacturing Systems”, Prentice Hall, 1st edition, 1990.

REFERENCE	
1	Black .J.T. and Kohser R.A, “DeGarmo’s Materials and Processes in Manufacturing”,Published by Wiley, 11th edition, 2011.
2	Christian N. Madu, “Handbook of environmentally conscious manufacturing”, SpringerUS Publishers, 1st edition, 2001.
3	John Schey, “Introduction to Manufacturing Processes”, Tata McGraw-Hill Education ,3rdedition,1999
4	Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer,United States, 2012, ISBN 978-3-642-27289-9.
5	Rao R. V, “Advanced Modeling and Optimization of Manufacturing Processes”, 2ndedition, 2006.
6	Ronald G. Askin and Jeffrey B. Goldberg, “Design and Analysis of Lean ProductionSystems”, John Wiley and Sons, 2003.
7	Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., UnitedStates, 2007, ISBN: 978-0-471-72636-4.

RO19D13	COMPUTER AIDED INSPECTION AND TESTING		L	T	P	C
			3	0	0	3

Course Objectives:	
•	To familiar the measurement standards and to know the instruments used and various errors in measurements
•	To recognize the use of basic and advanced instruments for measurements.
•	To learn the applications of opto-electronics device for measurements.
•	To describe the various measurement techniques using laser metrology.
•	To gain knowledge on computer aided inspection and advances in metrology.

UNIT-I	FUNDAMENTALS AND CONCEPTS IN METROLOGY	9
Standards of Measurement – Analog and Digital Measuring Instruments - Comparators – Limits, Fits and Tolerances – Gauge Design –Surface Roughness – Form Errors and Measurements.		
UNIT-II	**INSPECTION AND GENERAL 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 SineBar – Angle Alignment Telescope – Autocollimator – Applications - Inspection of Gears And Threads Tool Makers' Microscope – Universal Measuring Machine.		
UNIT-III	**OPTO ELECTRONICS IN ENGINEERING INSPECTION**	9
Use of Optoelectronics in Tool Wear Measurements – Microhole Measurement and Surface Roughness – Applications in In-Process Measurement and On-Line Inspection.		
UNIT-IV	**LASER METROLOGY**	9
Precision instrument based on Laser - Use of Lasers - Principle –Interferometers, Interference microscope - Optical flats - Laser Interferometer - Application in Linear and Angular measurements - Testing of machine tools using Laser Interferometer. Use of Laser Interferometer in Machine ToolInspection – Uses of Laser in On-Line Inspection – Laser Micrometer – Laser Alignment Telescope.		
UNIT-V	**COMPUTER AIDED INSPECTION AND ADVANCES IN METROLOGY**	9
Co-ordinate Measuring Machines - Constructional features - Types - Applications of CMM - CNC CMM applications - Measurement arms, Laser tracker - Fundamentals of Computer Aided Inspection - Introduction to Nano metrology.		
	Total Contact Hours : 45	

Course Outcomes: Upon successful completion of the course, students should be able to:	
•	Practice the standards in measurements and to avoid the various forms of errors inmeasurements.
•	Use of basic and advanced metrology instruments for measurements.
•	Acquire the knowledge on non-contact opto-electronics device for measurements.
•	Describe various measurement techniques using laser metrology.
•	Recognize the computer aided inspection and advances in metrology.

Text Books:	
1	Anil. K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India Pvt. Ltd., 2006.
2	Alan S. Morris, “The Essence of Measurement”, Prentice Hall of India, 2002.
3	Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2014.

Reference Books(s) / Web links:	
1	Charles Reginald Shotbolt, “Metrology for Engineers”, Cengage Learning EMEA,5thedition, 1996.
2	Jain R.K., “Engineering Metrology”, Khanna Publishers, 2012.
3	Robert G. Seippel, “Opto-Electronics for Technology and Engineering”, Prentice Hall,1989.
4	Robert J. Hocken, Paulo H. “Coordinate Measuring Machines and Systems”, CRC Press, 2nd edition, 2016.

RO19D14	INTEGRATED PRODUCT DEVELOPMENT		L	T	P	C
			3	0	0	3

Course Objectives:	
•	To understand the global trends and development methodologies of various types of products and services
•	To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
•	To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
•	To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
•	To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT-I	FUNDAMENTALS OF PRODUCT DEVELOPMENT	9
Global Trends Analysis and Product decision - Social Trends - Technical Trends-Economic Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and services - Types of Product Development - Overview of Product Development methodologies- Product Life Cycle — Product Development Planning and Management.		
UNIT-II	**REQUIREMENTS AND SYSTEM DESIGN**	**9**
Requirement Engineering - Types of Requirements - Requirement Engineering -traceability Matrix and Analysis - Requirement Management - System Design & Modeling -Introduction to System Modeling - System Optimization - System Specification - Sub-System design - InterfaceDesign.		
UNIT-III	**DESIGN AND TESTING**	**9**
Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques — Challenges in Integration of Engineering Disciplines — Concept Screening & Evaluation - Detailed Design - Component Design and Verification –Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation		
UNIT-IV	**SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT**	**9**
Introduction to Product verification processes and stages - Introduction to Product Validationprocesses and stages - Product Testing Standards and Certification - Product Documentation - Sustenance - Maintenance and Repair – Enhancements - Product EOL – ObsolescenceManagement – Configuration Management - EOL Disposal		
UNIT-V	**BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY**	**9**
The industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems — Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.		
	Total Contact Hours :	**45**

Course Outcomes: Upon successful completion of the course, students should be able to:	
•	Define, formulate and analyze a problem.
•	Solve specific problems independently or as part of a team
•	Gain knowledge of the Innovation & Product Development process in the Businesscontext
•	Work independently as well as in teams
•	Manage a project from start to finish

Text Books:	
1	Book specially prepared by NASSCOM as per the MoU. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2020.
2	John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition.

Reference Books(s) / Web links:	
1	Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2	Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3	Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4	Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 20131. Hiriyappa B, “Corporate Strategy — Managing the Business”, Author House, 2015.
5	Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2016.
6	Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
7	Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013.

RO19E11	FUZZY LOGIC AND ARTIFICIAL NEURAL NETWORKS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the fuzzy operations and fuzzy clustering
●	To Familiarize and create awareness on fuzzy logic controller
●	To learn the neural network models
●	To impart knowledge on modeling of different ANN techniques
●	To know the hybrid systems of ANN

UNIT-I	INTRODUCTION TO FUZZY SETS	9
Crisp Sets, Notations Used in Set Theory, Crisp Set Operations, Properties of Crisp Sets, Fuzzy Sets, Representationof a Fuzzy Set, Difference Between Crisp Set and Fuzzy Set, Standard Operations in Fuzzy Sets and Relations, Properties of Fuzzy Sets, Measures of Fuzziness and Inaccuracy of Fuzzy Sets, Fuzzy Clustering, Fuzzy C-MeansClustering, Entropy-based Fuzzy Clustering.		
UNIT-II	**FUZZY REASONING**	**9**
Introduction, Fuzzy Logic Controller, Two Major Forms of Fuzzy Logic Controller, Hierarchical Fuzzy LogicController, Sensitivity Analysis, Advantages and Disadvantages of Fuzzy Logic Controller.		
UNIT-III	**FUNDAMENTALS OF NEURAL NETWORKS**	**9**
Introduction, Biological Neuron, Artificial Neuron, Layer of Neurons, Multiple Layers of Neurons, Static vs. Dynamic Neural Networks, Training of Neural Networks, Supervised Learning, Un-supervised Learning, Incremental Training, Batch Mode of Training. Multi-Layer Feed-Forward Neural Network (MLFFNN), Forward Calculation, Training of Network Using Back-Propagation Algorithm.		
UNIT-IV	**ANN MODELS**	**9**
Radial Basis Function Network (RBFN), Forward Calculations, Tuning of RBFN Using Back-Propagation Algorithm, Self-Organizing Map (SOM), Competition, Cooperation, Updating, Final Mapping, Counter-Propagation Neural Network (CPNN), Full CPNN, Forward-Only CPNN, Recurrent Neural Networks (RNNs), Elman Network, Jordan Network, Combined Elman and Jordan Network.		
UNIT-V	**COMBINED GENETIC ALGORITHMS: FUZZY LOGIC**	**9**
Introduction to Genetic Algorithm, Fuzzy-Genetic Algorithm, Genetic-Fuzzy System, Working Principle of Genetic-Fuzzy Systems.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of the course, the students will be able to	
●	Apply fuzzy composition rules for different problems.
●	Implement different fuzzy models for prediction of operating parameters.
●	Implement supervised neural networks.
●	Design and control systems using different ANN models.
●	Develop an optimal hybrid control model.

Text Books:	
1	Dilip K. Pratihar, "Soft Computing Fundaments and Applications", Narosa Publishing House,2015
2	Laurence Fausett, Fundamentals of Neural Networks, Prentice Hall, Englewood Cliffs, N.J., 2012

Reference Books(s) / Web links:	
1	Zhang Huaguang and Liu Derong, ―Fuzzy Modeling and Fuzzy Control Series: Control Engineering, 2000
2	Millon W.T., Sutton R.S. and Webrose P.J., ―Neural Networks for Controll, MIT press, 1992
3	Kevin M. Passino and Stephen Yurkovich, Fuzzy Control, Addison Wesley Longman, Menlo Park, 1998.
4	Timothy J. Ross, ―Fuzzy Logic with Engineering Applications, McGraw Hill Inc, 2010
5.	Erdal Kayacan, Mojtaba Ahmadieh Khaneswar, ― Fuzzy neural networks for Real time control applications, Elsevier, 2015

RO19E12	INDUSTRIAL NETWORK PROTOCOLS		L	T	P	C
			3	0	0	3

Objectives:	
•	To study the various types wired protocols for electronic system.
•	To know the various types wireless protocols for electronic system.
•	To aware the various industrial wired protocols in automation.
•	To study the various types wireless protocols for industrial automation.
•	To develop the wired and wireless functions of various protocols.

UNIT-I	WIRED BUSES AND PROTOCOLS	9

Wireless - Wired Networks Comparison - Serial Communication Protocols - RS232-UART- SPI - I2C – UNI/O Bus -1 Wire -Camera Link - Parallel Communication -PPI - Wishbone Bus —AMBA – JTAG - Fireware IEEE 1394 Bus - Ethernet Overview - RS485

UNIT-II	WIRELESS PROTOCOLS	9

Antenna Technology- Network Topologies - Wireless Local Area Networks (WLAN) - Wireless Personal Area Networks (WPAN) - Wimedia – Wimax - RF – Bluetooth- Wi-Fi – Zigbee – Wireless Industrial Automation Protocols.

UNIT-III	INDUSTRIAL AND AUTONOMOUS SYSTEMS WIRED NETWORKS	9

Overview of Industrial Wired Networks – Terminal Bus- Modbus - HART Network Mechatrolink- II – EtherCAT- Sercos II/III – CAN- Canopen - Modbus IDA-PROFINET-PROFIBUS-Ethernet/IP- Ethernet Powerlink- AG Automation and Drives (AS-I) - Device Net

UNIT-IV	INDUSTRIAL WIRELESS NETWORKS	9

Overview of Industrial Wireless Networks - IWLAN - ISA100 Standards — Remote Networks-Controller-Based Networks - Wireless HART Technology - 3G/4G for Automation – RFID Data Tags.

UNIT-V	APPLICATION OF COMMUNICATION PROTOCOLS	9

Wired Machine Networking of Sub-elements and Machines - Wireless Machine Networking of Sub-elements and Machines – Networking of Industry - Communication Network Layout Design - Networking for TIA-Cloud Computing – IOT - Case Studies in Automation Applications.

	Total Contact Hours	:	45

Course Outcomes: At the end of the course students able to	
•	Design wired protocols for electronic system.
•	Use wireless protocols for electronic system.
•	Practice industrial wired protocols in automation.
•	Select wireless protocols for industrial automation.
•	Demonstrate the wired and wireless functions of various protocols in applicationdevelopment.

Text Books:	
1	Borko Furht, “Encyclopaedia of Wireless and Mobile Communications - Three VolumeSet”, CRC Press, 2012.
2	Dick Caro, “Wireless Networks for Industrial Automation”, 2014.

Reference Books(s) / Web links:	
1	MMC-SD SERCOS Drive, “G&L Motion Control”, Hardware Manual, 2005.
2	Olaf Pfeiffer, Andrew Ayre and Christian Keydel, “Embedded Networking with CAN andCANopen”, Copperhill Technologies Corporation, 2016.
3	Richard Zurawski, “Industrial Communication Technology”, CRC Press, 2017.
4	Siemens IK, “Industrial Ethernet: IEEE 802.3”, 2005.
5	Wolfram Behardt and Jorg Wollert, “The wireless B: Evolution and Communication”, Stetue Germany, 2016.

RO19E13	CONDITION MONITORING AND FAULT DIAGNOSTICS	EEC	L	T	P	C
			0	0	2	1

Course Objectives:	
•	To Understand the basics of various condition monitoring methods.
•	To Identify the selection of condition monitoring sensors for various applications.
•	To study various signal processing for condition monitoring applications.
•	To Know about various failure analysis, maintenance and machine learning.
•	To provide a basic understanding with case studies on different fault diagnosis method.

UNIT-I	CONDITION MONITORING TECHNIQUES AND MACHINE CONDITION MONITORING	9
Condition Monitoring in manufacturing industries; Noise monitoring, Wear and debris Analysis, Thermography, Cracks monitoring, Ultrasonic techniques - Case studies. Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system, Case studies.		
UNIT-II	**SENSORS FOR FAULT DIAGNOSTICS**	9
Introduction - Contaminant monitoring sensors- Corrosion monitoring sensors - Force monitoringsensors - Gas leakage monitoring - sensors Air pollution monitoring sensors - Liquid contamination monitoring sensors - Non-destructive testing techniques - Optical examination - Temperature sensing.		
UNIT-III	**SIGNAL PROCESSING AND ANALYSIS**	9
Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions. Time domain and Frequency domain and Time-frequency domain analysis.		
UNIT-IV	**FAILURE ANALYSIS, MAINTENANCE AND MACHINE LEARNING**	9
Maintenance Principles, Failure mode analysis - Equipment down time analysis – Breakdown analysis - condition based maintenance, Vibration, Acoustic emission and vibrio-acoustics signal analysis; intelligent fault detection system, Case studies.		
UNIT-V	**MONITORING SYSTEMS CASE STUDEIS**	9
Introduction - Marine monitoring systems - Marine turbine monitoring systems - Shipboard vibration monitoring - Monitoring integrity verification - Aircraft condition monitoring - Condition monitoring - generating plant - Automotive diagnostic equipment - Systematic fault monitor selection.		
	Total Contact Hours : 45	

Course Outcomes: Upon successful completion of the course, students should be able to:	
•	Understand the basics of various condition monitoring methods.
•	Select suitable condition monitoring sensors for various applications.
•	Recall various signals processing for condition monitoring applications.
•	Know about various failure analysis, maintenance and machine learning.
•	Apply different fault diagnosis method for various applications.

Text Books:	
1	R. A. Collacott ,"Mechanical Fault Diagnosis and condition monitoring" , Chapman and HallLondon A Halstead Press Book John Wiley & Sons, New York

Reference Books(s) / Web links:	
1	W.H. Tang, Q.H. Wu, "Condition Monitoring and Assessment of Power Transformers Using ComputationalIntelligence", Springer-Verlag London

RO19E14	APPLIED SIGNAL PROCESSING	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the characteristics of various types of signals.
●	To carry out the preprocessing of continuous time signals and systems.
●	To learn DTFT, FFT and Z-Transform methods in signals processing
●	To design digital IIR, FIR filters for signal processing
●	To learn about various signal processors and its applications of signals

UNIT-I	INTRODUCTION TO SIGNALS AND SYSTEMS	9
Elementary signals in continuous and discrete time - graphical and mathematical representation - Elementary operations and classification of continuous and discrete time signals — CT systems and DT systems - Properties of CT systems and DT systems Classification of systems		
UNIT-II	**ANALYSIS OF CONTINUOUS TIME SIGNALS AND SYSTEMS**	9
The continuous time Fourier series - Fourier Transform properties - Laplace transform and properties - Impulse response - convolution integrals - Fourier and Laplace transforms in Analysis of CT systems - Frequency response of systems characterized by differential Equations.		
UNIT-III	**ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS**	9
Fourier Transform of discrete time signals (DTFT) Properties of DTFT - Discrete Fourier Transform Fast Fourier Transform (FFT) - Z Transform and Properties – Impulse response - Convolution sum System analysis from difference equation model - Stability of systems		
UNIT-IV	**DESIGN OF DIGITAL FILTERS**	9
Review of design techniques for analog low pass filters - Frequency transformation — IIR filters - Properties - Design of IIR digital filters using bilinear transformation - FIR filters - Characteristics of FIR filters with linear phase - Design of FIR filters using Window functions		
UNIT-V	**DIGITAL SIGNAL PROCESSORS AND APPLCATIONS**	9
Architecture of TMS320C54xx DSP - Addressing Modes - Instructions and Programming - Applications: Signal Compression - Sine wave generators - Noise generators — DTMF Tone Detection - Echo cancellation - Speech enhancement and recognition.		
	Total Contact Hours : 45	

Course Outcomes: Upon successful completion of the course, students should be able to:	
●	Understand the characteristics of various types of signals.
●	Analyze continuous time signals and systems
●	Understand DTFT, FFT and Z-Transform methods in signals processing.
●	Design digital IIR, FIR filters for signal processing
●	Analyze and Apply various signal processors and its applications of signals.

Text Books:	
1	Alan V Oppenheim, Alan S Willsky, Hamid Nawab S , "Signals and Systems", 2nd edition,Phi Learning, New Delhi, 2015.
2	John G. Proakis, Dimitris K Manolakis , "Digital Signal Processing, 5th edition, Hoboken,NJ :Pearson Education, New Delhi, 2021

Reference Books(s) / Web links:	
1	Lonnie C Ludeman, "Fundamentals of Digital Signal Processing", Wiley & Sons, NewDelhi, 2014.
2	Emmanuel C Ifeachor, Barrie W Jervis, "Digital Signal Processing", PearsonEducation, New Delhi, 2013.
3	Haykin S, Barry Van Veen, "Signals and Systems", John Wiley and sons, New Delhi,2016.
4	Vinay K Ingle, John G Proakis , "Digital Signal Processing using MATLAB", CengageLearning, New Delhi, 2012.

RO19E15	APPLIED IMAGE PROCESSING	PC	L	T	P	C
			3	0	0	3

Course Objectives:	
•	To introduce various image processing and preprocessing techniques.
•	To learn about feature detection and matching using Image processing.
•	To learn about segmentation using Image processing techniques.
•	To learn about computational photography.
•	To learn about image recognition using Image processing techniques.

UNIT-I	IMAGE FORMATION AND PROCESSING	9
Introduction - Geometric primitives and Transformations - Photometric Image formation - The digitalcamera. Introduction to image processing - point - spatial - Fourier Transform - Pyramids and wavelets - Geometric transformations - global optimization		
UNIT-II	**FEATURE DETECTION AND MATCHING**	**9**
Introduction - Points and patches - Feature detectors - Feature Descriptors - SIFT - PCA SIFT - Gradient location orientation histogram		
UNIT-III	**SEGMENTATION**	**9**
Introduction - Active contours - Snakes - Scissors - Level sets - Split and merge - Watershed —Region splitting - region merging - and graph based segmentation - mean shift and mode finding - Normalized cuts – graph cuts and energy based methods – application		
UNIT-IV	**COMPUTATIONAL PHOTOGRAPHY**	**9**
Photometric calibration - Radiometric response function - Noise level estimation - Vignetting - Optical blur - High dynamic range imaging - Super resolution and blur removal - Color image demos icing —application.		
UNIT-V	**IMAGE RECOGNITION**	**9**
Object detection - Face recognition - Instance recognition - category recognition - Bag of words - Part based models - context and scene understanding- Application: Image search.		
	Total Contact Hours :	**45**

Course Outcomes: Upon successful completion of the course, students should be able to:	
•	Understand various image processing and preprocessing techniques.
•	Design a feature detection algorithm for given application
•	Design a segmentation algorithm for given application.
•	Understand and recognize various computational photography techniques.
•	Design an image recognition for given application.

Text Books:	
1	Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2010.
2	Hartley R, Zisserman A, "Multiple View Geometry in Computer Vision", CambridgeUniversity Press, 2004.

Reference Books(s) / Web links:	
1	Forsyth D A, Ponce J, “Computer Vision: A Modern Approach”, 2nd Edition Bostan Pearson,2015
2	Duda R O, Hart P E, Stork D G, "Pattern Classification", Wiley, 2001.
3	Richard Sc "Computer Vision: Algorithms and Applications", Springer, 2010.
4	Simon J.D.Prince "Computer Vision: Models,Learning and Inference", Cambridge UniversityPress, New York, 2014.

RO19E16	TOTALLY INTEGRATED AUTOMATION	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To gain knowledge on 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

UNIT-I	TOTALLY INTEGRATED AUTOMATION	9
Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integrationstructure.		
UNIT-II	**HMI SYSTEMS**	**9**
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 502and remove		
UNIT-III	**SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)**	**9**
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**	**9**
Proprietary and open Protocols – OLE/OPC – DDE – Server/Client Configuration – Messaging – Recipe – Useradministration – Interfacing of SCADA with PLC, drive, and other field device		
UNIT-V	**DISTRIBUTED CONTROL SYSTEMS (DCS)**	**9**
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.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, the students will be able to	
•	Implement PLC & PAC in an automation system.
•	Develop HMI systems and integrate it with other systems.
•	Develop SCADA system and generate reports.
•	Acquire information‘s on communication protocols in automation systems.
•	Design and develop automatic control system using distributed control systems.

Text Books:	
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 Company1995 .

Reference Books(s) / Web links:	
1	Win C C Software Manual, Siemens, 2003
2	RS VIEW 32 Software Manual, Allen Bradly, 2005
3	CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004

RO19E17	ADVANCED OPTIMIZATION TECHNIQUES	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the basics of Optimization
•	To know about constraints in optimization problems
•	To introduce the concept of Nonlinear programming
•	To learn about different nonlinear models.
•	To create awareness about advanced methods

UNIT-I	INTRODUCTION	9
Introduction, Historical Development, Engineering Applications of Optimization, Statement of an Optimization Problem, Design Vector, Design Constraints, Constraint Surface, Objective Function, Objective Function Surface, Classification of Optimization Problems, Classification Based- Existence of Constraints- Design Variables – Physical Structure of the Problem- Equations Involved- Permissible Values of the Design Variables- the Deterministic Nature of the Variables-the Separability of the Functions - Number of Objective Functions.		
UNIT-II	**CLASSICAL OPTIMIZATION TECHNIQUES**	**9**
Introduction, Single-Variable Optimization, Multivariable Optimization with Constraints, Saddle Point, Multivariable Optimization with Equality Constraints, Solution by Direct Substitution, Solution by the Method of ConstrainedVariation, Solution by the Method of Lagrange Multipliers.		
UNIT-III	**NONLINEAR PROGRAMMING I**	**9**
Unrestricted Search, Search with Fixed Step Size, Search with Accelerated Step Size, Exhaustive Search, DichotomousSearch, Interval Halving Method, Fibonacci Method, Golden Section Method, Comparison of Elimination Methods. Direct Root Methods- Newton Method- Quasi-Newton Method - Secant Method.		
UNIT-IV	**NONLINEAR PROGRAMMING II**	**9**
Random Search Methods, Random Jumping Method, Random Walk Method, Random Walk Method with Direction Exploitation, Advantages of Random Search Methods, Grid Search Method, Univariate Method, Pattern Directions,Powell's Method.		
UNIT-V	**ADVANCED METHODS**	**9**
Zoutendijk's Method of Feasible Directions , Determination of Step Length, Rosen's Gradient Projection Method,Firefly Algorithm, Artificial Bee Colony (ABC) algorithm.		
	Total Contact Hours :	**45**

Course Outcomes:	
On completion of the course, the students will be able to	
•	Differentiate between various Optimization models.
•	Apply suitable techniques for constrained and unconstrained models.
•	Formulate and solve One-Dimensional Minimization Methods.
•	Understand the problem and Solve using Unconstrained Optimization Techniques.
•	Provide solution to complex models.

Text Books:	
1	Singiresu S.Rao, ―Engineering Optimization: Theory and Practice, New Age International Publishers,India, 2013
2	Kalyanmoy Deb, ―Optimization for Engineering DesignAlgorithms and Examples, PHI Learning Private Limited, New Delhi,2012.

Reference Books(s) / Web links:	
1	Bazara M.J., Jarvis and Sherali H., Linear Programming and Network Flows, John Wiley, 2009
2	Budnick F.S., Principles of Operations Research for Management, McGraw-Hill Inc.,US, 1998
3	Philip D.T. and Ravindran A., Operations Research, John Wiley, 2007
4	Shennoy G.V. and Srivastava U.K.,Operation Research for Management, New Age International Publishers; India, 2018
5.	Hillier and Libeberman, Operations Research, McGraw-Hill Higher Education, New York, 2010.

RO19F11	OBJECT ORIENTED PROGRAMMING IN C++		L	T	P	C
			3	0	0	3

Course Objectives:	
•	To understand the basics in OOPS and control structures
•	To Know about the various functions in C++
•	To obtain the knowledge in Constructors and Deconstructors
•	To understand the concepts in pointers, virtual functions and polymorphism
•	To aware of the modelling and abstraction models

UNIT-I	PRINCIPLES OF OOPS AND CONTROL STRUCTURES	9

Object Oriented Programming Paradigm, Basic Concepts of Object Oriented Programming, Benefits of Object Oriented Programming, Object Oriented Languages, Applications of Object Oriented Programming, Beginning with C++,Tokens, Keywords, Identifiers and Constants, Data Types, Type Compatibility, Variables, Operators in C++,Implicit Conversions, Operator Overloading, Operator Precedence, Control Structures.

UNIT-II	FUNCTIONS IN C++, CLASSES AND OBJECTS	9

The Main Function, Function Prototyping, Call by Reference, Return by Reference, InlineFunctions, Function Overloading, Friend and Virtual Functions. Specifying a class, Member Functions, Arrays within a class, Static Member Functions, Arrays of Objects, Friendly Functions.

UNIT-III	CONSTRUCTORS AND DESTRUCTORS, OPERATORSBOVERLOADING	9

Constructors, Parameterized Constructors, Copy Constructors, Dynamic Constuctors, Destructors, Defining Operator Overloading, Overloading Operators, Rules for Overloading Operators, Type Conversions

UNIT-IV	POINTERS, VIRTUAL FUNCTIONS AND POLYMORPHISM	9

Pointers, Pointers to Objects, this pointer, Pointer to Derived Classes, Virtual Functions, Classesfor File Stream Operations, Opening and Closing a File, File Modes, File Pointers, Input Output Operations, Updating a File.

UNIT-V		9

Object Orientation O Development O Themes, Modelling, Abstraction Models

	Total Contact Hours	:	45

Course Outcomes:	
At the end of the course students able to	
•	Master the fundamental principles of OO programming, Master key principles in OOanalysis, design, and development.
•	Be familiar with the application of the Unified Modeling Language (UML) towardsanalysis and design.
•	Master common patterns in OO design and implement them
•	Be familiar with alternative development processes and be familiar with group/teamprojects and presentations.
•	Be exposed to technical writing and oral presentations.

Reference Books(s) / Web links:	
1	James Rumbaugh ,"Object Oriented Modelling and Design" , Pearson publication,1991
2	Robert Lafore ,"Object-oriented programming in Turbo C++", Galgotia Publication,2004.
3	by E.Balagurusamy , "Object-oriented programming with C++", 8th Edition, TMH.,2021.

RO19F12	VIRTUAL INSTRUMENTATION		L	T	P	C
			3	0	0	3

Course Objectives:	
•	To Introduce virtual instrumentation concepts and applications.
•	To train to program virtual instrumentation software for biomedical applications
•	To understand the data acquisition and control in VI
•	To obtain the knowledge in instrument interfaces
•	To analyze the applications of VI in Bio Medical Engineering

UNIT-I	INTRODUCTION	9
History of Virtual Instrumentation (VI), advantages, block diagram and architecture of a virtual instrument, Programming paradigms – Virtual Instrumentation – Lab VIEW software – Lab VIEW basics — Lab VIEW environment.		
UNIT-II	**VI USING LABVIEW**	**9**
Creating, Editing and debugging a VI in Lab VIEW – Creating a sub VI – Loops and charts – Case and sequence structures – File I/O – VI customization.		
UNIT-III	**DATA ACQUISITION AND CONTROL IN VI**	**9**
Plug-in DAQ boards – Organization of the DAQ VI System – Performing analog input and analog output – Scanning multiple analog channels – Driving the digital I/Os – Buffered data acquisition – Simple problems.		
UNIT-IV	**INSTRUMENT INTERFACES**	**9**
Current loop, RS 232C/RS 485, GPIB, System basics, Interface basics: USB, PCMCIA, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control. ADC, DAC, DIO, DMM, waveform generator.		
UNIT-V	**APPLICATION OF VI IN BIOMEDICAL ENGINEERING**	**9**
Design of virtual applications for Electrocardiography (ECG), Electromyography (EMG), Air Flow and Lung Volume, Heart Rate variability analysis, Noninvasive Blood Pressure Measurement, Biofeedback, Virtual Reality & 3D graphical modeling, Virtual Prototyping.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course students able to	
•	To comprehend and appreciate the significance and role of this course in the presentcontemporary world.
•	Identify salient traits of a virtual instrument.
•	Understand the use of VI for data acquisition.
•	Experiment, analyze and document different types of interfaces.
•	Apply the virtual instrumentation technologies for medical applications

Text Books:	
1	Gary Johnson, “LABVIEW Graphical Programming”, McGraw Hill, 4th edition,2006.
2	Lisa K. Wells and Jeffrey Travis, “LABVIEW for Everyone”, PHI, 1997.
3	Skolkoff, “Basic concepts of LABVIEW 4”, PHI, 1998.
4	Jerome, Jovitha, “Virtual Instrumentation and LABVIEW”, PHI Learning, New Delhi, 1st Edition,2010.
5	Sanjay Gupta and Joseph John, “Virtual Instrumentation using Lab VIEW”, Tata Mc Graw —Hill Publishing Company Limited, New Delhi, 1st Edition, 2010.

Reference Books(s) / Web links:	
1	Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement,Instrumentation and Control”, Newnes, 2003.
2	S. Gupta, J.P. Gupta, “PC Interfacing for Data Acquisition and Process Control”, ISA, 2ndEdition, 1994.
3	Technical Manuals for DAS Modules of Advantech and National Instruments.
4	Jon B. Olansen, Eric Rosow, “Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in Lab VIEW” Pearson Education, 2001.

RO19F13	PROJECT MANAGEMENT	PE	L	T	P	C
			3	0	0	3

Course Objectives:	
•	To familiarize the tasks of planning and implementation of the projects.
•	To teach the concepts of project monitoring and control.
•	To impart knowledge on evaluation and selection of the most desirable projects.
•	To provide knowledge on accounting the rate of return in the projects.
•	To learn the source of finance and capital structure.

UNIT-I	INTRODUCTION	9
Objectives of project management: Types of Projects: Project Management Life Cycle: Project Selection: Feasibility study: Estimation of Project Cost, Cost of Capital, Network analysis Techniques : PERT,CPM, Government regulations and statutory for various projects:		
UNIT-II	**PROJECT MONITORING AND CONTROL**	**9**
Project representation: Role of project Managers, relevance with objective of organization, preliminary Manipulations, Basic Scheduling concepts: Resource Leveling, Resource Allocation, Setting a base line, Project management information system: Importance of contracts in projects: Team work in Project Management: Formation of Effective terms.		
UNIT-III	**PROJECT EVALUATION**	**9**
Project Evaluation: Project auditing: Phase of project audit Project closure reports, computers, e-markets in ProjectManagement:		
UNIT-IV	**WORKING CAPITAL MANAGEMENT AND CAPITAL BUDGETING**	**9**
Current assets management: Estimation of working capital requirements: Capital budgeting: Capital budgeting methods: Present value method: Accounting rate of return methods.		
UNIT-V	**FINANCE AND ACCOUNTING**	**9**
Source of finance: Term Loans: Capital Structure: Financial Institution Accounting Principles: Preparation and Interpretation of balance sheets, profit and loss statements , Fixed Assets, Current assets, Depreciation methods : Break even analysis:		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, the students will be able to	
•	Analyze the current market trends and choose projects.
•	Control resource and allocate resources effectively.
•	Undertake project auditing and prepare reports.
•	Maintain assets and calculate the asset‘s revenue.
•	Arrange various sources of finance and Prepare balance sheets.

Text Books:	
1	Arun Kanda, ―Project Management A Life Cycle Approach, Prentice Hall of India, 2011.
2	Palanivelu VR, ―Accounting for Management, Laxmi Publication (P) Ltd., 2007.

Reference Books(s) / Web links:	
1	Panneerselvam R and Senthilkumar P, ―Project Management, Prentice Hall of India,2009.
2	Khanna R B, ―Project Management, Prentice Hall of India, 2011.
3	Bhattacharya. S.K. and John Deardon, ―Accounting for Management –Text and cases, Vikas publishing House, New Delhi, 1996.
4	James, Van Horne, ―Fundamental of Financial Management Pearson Education, 12th Edition, 2012
5	Prasanna Chandra, ―Financial Management, Tata McGraw-Hill,2008

ME19A11	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce basic machine learning techniques such as regression, classification
•	To learn about introduction of clustering, types and segmentation methods
•	To learn about fuzzy logic, fuzzification and defuzzification
•	To learn about basics of neural networks and neuro fuzzy networks.
•	To learn about Recurrent neural networks and Reinforcement learning.

UNIT-I	INTRODUCTION TO MACHINE LEARNING	9
Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics.		
UNIT-II	**CLUSTERING AND SEGMENTATION METHODS**	**9**
Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K-nearest neighbor algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.		
UNIT-III	**FUZZY LOGIC**	**9**
Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application		
UNIT-IV	**NEURAL NETWORKS**	**9**
Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics		
UNIT-V	**RNN AND REINFORCEMENT LEARNING**	**9**
Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics.		
	Total Contact Hours :	**45**

Course Outcomes:	
On completion of the course, the students will be able to	
•	Develop simple programs using 8085 and 8051
•	Perform ADC and DAC Conversions
•	Develop interfacing circuits for real time applications
•	Develop simple programs using Embedded C software
•	Develop simple programs for Arduino and Raspberry Pi controllers

Text Books:	
1	MichealNegnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011

Reference Books(s) / Web links:	
1	Bruno Siciliano, Oussama Khatib, “Handbook of Robotics”, 2016 2nd Edition, Springer
2	Simon Haykin, “Neural Networks and Learning Machines: A Comprehensive Foundation”, Third Edition, Pearson, delhi 2016.
3	Timothy J Ross, “Fuzzy Logic with Engineering Applications”, 4th Edition, Chichester, 2011, Sussex Wiley.

ME19B11	RELIABILITY AND MAINTENANCE ENGINEERING		L	T	P	C
			3	0	0	3

Objectives:	
•	To impart knowledge about basic concepts of reliability
•	To learn about various models of reliability
•	To know about maintenance functions and objectives, maintenance planning and scheduling,maintenance organization.
•	To impart knowledge about Principles of CBM, pillars of condition monitoring, CBMimplementation and benefits
•	To learn about reliability centered maintenance, TPM and FMECA

UNIT-I	BASIC CONCEPTS OF RELIABILITY	9
Probability distributions used in maintenance engineering- Binomial, Poisson, Exponential, Normal, Log-normal, Gamma and Weibull distribution; failure rate, hazard rate, failure modes, MTTR, MTBF,MTTF		
UNIT-II	**SYSTEM RELIABILITY MODELS**	**9**
System reliability–n-component series systems, m-component parallel systems and combined system; standby systems; K-out-of-m systems; redundancy techniquesin system design; event space, decomposition (Key Stone), cut and tie sets, Markov analysis, reliability and quality, unreliability, maintainability, availability		
UNIT-III	**MAINTENANCE CONCEPTS AND STRATEGIES**	**9**
Introduction, maintenance functions and objectives, maintenance planning and scheduling, maintenance organization. General Introduction to Maintenance Types: Breakdown, emergency, corrective, predictive, and preventive; maintenance prevention; design-out maintenance, productive maintenance, shutdown maintenance and scheduled maintenance.		
UNIT-IV	**CONDITION BASED MAINTENANCE**	**9**
Principles of CBM, pillars of condition monitoring, CBM implementation and benefits; condition monitoring techniques- visual monitoring, vibration monitoring, wear debris monitoring, corrosion monitoring, performance monitoring		
UNIT-V	**RELIABILITY CENTERED MAINTENANCE (RCM)**	**9**
Concept, methodology, benefits; Total Productive Maintenance: Evolution of TPM, TPM objectives, concept, pillars of TPM. Failure Modes and Effects Analysis (FMEA)/ Failure Modes, Effects and Criticality Analysis (FMECA): Overview, elements of FMECA, applications and benefits, risk evaluation, risk priority numbers, criticality analysis, process FMEA, qualitative and quantitative approach to FMECA; design FMEA and steps for carrying out design FMEA		
	Total Contact Hours :	**45**

Course Outcomes:	
On completion of the course, the students will be able to	
•	Recognize about basic concepts of reliability
•	Know about the various models of reliability
•	Apply the various maintenance functions and objectives, maintenance planning and scheduling, maintenance organization.
•	Demonstrate Principles of CBM, pillars of condition monitoring, CBM implementation
•	Apply the reliability centered maintenance, TPM and FMECA

Text Books:	
1	Ebeling CE; An Introduction To Reliability & Maintainability Engg McGraw Hill Education; 12th edition , 2017
2	Srinath L.S; Reliability Engineering; East West Press, 2005

Reference Books(s) / Web links:	
1	Naikan, V.N.A., Reliability engineering and life testing; PHI,2008
2	Kapur KC and Lamberson LR; Reliability in Engineering Design; Wiley India 1997
3	Telang AD and Telang A; Comprehensive Maintenance Management; PHI
4	Mishra R.C; Reliability and Maintenance Engineering; New age International publisher2006.
5	Balaguruswamy,E., Reliability Engg; TMH,2017
6	Dhillon; Engg Maintainability- How to design for Reliability and easy maintenance; PHI, 1999.
7	Davidson John; The Reliability of mechanical system; Institution of Mech. Engineers, London 1994
8	Patrick D.T and O.'Connor; Practical Reliability Engineering; John Wiley and Sons,1991
9	Terje Aven; Reliability and Risk Analysis, Springer Netherlands, 2000

SubjectCode	Subject Name (Theory course)	Category	L	T	P	C
ME19E15	ADDITIVE MANUFACTURING	PE	3	0	0	3

Objectives:	
●	To familiarize the development of Additive Manufacturing, various business opportunities and applications.
●	To understand various software tools, techniques and file formats to create 3D models that helps in productdevelopment / prototyping requirements using AM.
●	To be familiar with Liquid and Solid based AM processes.
●	To be familiar with Powder and Wax based processes.
●	To understand the use of Bio Additive manufacturing and 4D printing.

UNIT-I	INTRODUCTION	9
Need, Fundamentals of Additive and digital Manufacturing, Advantages and Applications, Comparison of Additive Manufacturing with traditional Manufacturing, Additive Manufacturing (AM) process chain: 3D model, converting into STL file, transfer to system, checking, machine setup and building, Post process. Classification of AM process. Materials used in Additive Manufacturing Processes, Need for AM in product development and rapid tooling.		
UNIT-II	**REVERSE ENGINEERING AND DESIGN FOR ADDITIVE MANUFACTURING(DFAM)**	9
Introduction to Reverse Engineering: Applications, Steps in reverse Engineering. Design for additive manufacturing:CAD model preparation, Part orientation and support generation and removal, Model slicing and software's – Tool path generation. File formats in AM. Data Processing and Controllers.		
UNIT-III	**LIQUID AND SOLID BASED ADDITIVE MANUFACTRING PROCESSES**	9
Guidelines for process selection, Liquid based AM process - Stereo lithography apparatus, Polyjet printing, Digital Light Processing - Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies. Solid Based AM process - Fused Deposition Modeling (FDM), Solid Ground Curing (SGC), Laminated Object Manufacturing (LOM) - Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies.		
UNIT-IV	**POWDER BASED AND OTHER ADDITIVE MANUFACTRING PROCESSES**	9
Selective Laser Sintering (SLS), Selective Laser Melting (SLM) and Electron Beam Melting (EBM), Laser Engineered Net Shaping (LENS): Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies. Wax printing– Principle, Process, materials used and applications.		
UNIT-V	**BIO ADDITIVE MANUFACTURING AND 4D PRINTING**	9
Bio-Additive Manufacturing, Computer Aided Tissue Engineering (CATE) – Processing Steps and Case Studies. Customized Implants and Prosthesis, Materials used in bio printing and limitations. Design and Production of Medical devices. Sustainability in AM processes – Introduction to 4D printing and Smart materials used.		
	Total Contact Hours : 45	

Course Outcomes:	
At the end of this course, students can have the	
●	Ability to explain the development of AM technology and how AM technology propagated into variousbusinesses and developing opportunities.
●	Ability to explain the process of transforming a concept / existing product into 3D model used in AM technology.
●	Ability to explain Liquid and Solid based AM processes.
●	Ability to explain Powder and Wax based processes.
●	Ability to evaluate the advantages, limitations, applications and use of Bio Additive manufacturing and 4Dprinting.

Text Books:	
1	Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015.
2	Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping toDirect Digital Manufacturing”, 2nd edition, Springer., United States, 2015.

Reference Books(s) / Web links:	
1	Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015.
2	Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011
3	Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States, 2006.
4	Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototypedevelopment”, CRC Press., United States, 2011.
5.	Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, WoodheadPublishing., United Kingdom, 2016.

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19603	Total Quality Management	PC	3	0	0	3

Objectives:	
●	To facilitate the understanding of basic quality management in engineering.
●	To facilitate the understanding of various principles of TQM.
●	To be acquainted with management tools, six sigma and benchmarking.
●	To be acquainted with quality functions, TPM concepts &continuous improvement tools.
●	To learn various quality systems and TQM implementation in manufacturing and service sectors.

UNIT-I	INTRODUCTION	9
Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.		
UNIT-II	**TQM PRINCIPLES**	9
Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen, 8D methodology - Supplier partnership - Partnering, Supplier selection, Supplier Rating.		
UNIT-III	**TQM TOOLS AND TECHNIQUES I**	9
The seven traditional tools of quality - New management tools - Six sigma, Lean Six Sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.		
UNIT-IV	**TQM TOOLS AND TECHNIQUES II**	9
Quality Circles – Cost of Quality – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM –Concepts, improvement needs – Performance measures, POKA-YOKE, JIT Concepts.		
UNIT-V	**QUALITY MANAGEMENT SYSTEM**	9
Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000– ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.		
	Total Contact Hours : 45	

Course Outcomes:	
At the end of this course, students can have the	
●	Ability to explain the importance of quality in engineering.
●	Ability to explain various principles in TQM.
●	Explore the knowledge of implementing various TQM tools.
●	Ability to create rapport among workers to form a quality team.
●	Ability to explain the benefits of implementing ISO-9000 & ISO-14000 in manufacturing and service sectors.

Text Book:	
1	Dale H.Besterfield, Carol Besterfield - Michna, Glen H. Besterfield, Mary Besterfield - Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised ThirdEdition, Indian Reprint, Sixth Impression, 2013.

Reference Books(s) / Web links:	
1	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First IndianEdition, Cengage Learning, 2012.
2	Suganthi. L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3	Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd.,2006.
4.	ItayAbuhav , “ISO9001-2015 standards-A Complete Guide to Quality Management Systems”, CRC Press, 2017
5.	Poka - Yoke, "Improving Product Quality by Preventing Defects", Productivity Press, 2004.

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19601	FINITE ELEMENT ANALYSIS	PC	3	0	0	3

Objectives: To introduce the students about the	
●	Mathematical formulation and solution for engineering problem.
●	Fundamentals of 1D Finite elements for structural analysis
●	Application of 1D finite element to Heat transfer and Vibration domain
●	Fundamentals of 2D Finite elements for structural analysis.
●	Need for Isoparametric formulation and numerical integration.

UNIT-I	INTRODUCTION	9
Historical Background – Mathematical Modeling of field problems in Engineering –Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.		
UNIT-II	**ONE DIMENSIONAL ANALYSIS**	**9**
One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of problems from solid mechanics. Fourth Order Beam Equation- Problems on it.		
UNIT-III	**APPLICATION OF ONE-DIMENSIONAL ELEMENT TO HEAT TRANSFER AND VIBRATION**	**9**
Derivation of matrices and vector for heat transfer. Problems on Heat transfer. Natural frequencies of longitudinal vibration and mode shapes. Transverse Natural frequencies of beams.		
UNIT-III	**TWO-DIMENSIONAL ANALYSIS**	**9**
Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems. Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations.		
UNIT-IV	**ISOPARAMETRIC FORMULATION AND NUMERICAL INTEGRATION**	**9**
Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and twodimensions – Serendipity elements – Numerical integration - Introduction to non-linearity.		
	Total Contact Hours :	**45**

Course Outcomes: On successful completion of the course, the student will be able to	
●	Develop mathematical models for Boundary Value Problems and their numerical solution
●	Apply the concepts of Finite Element Analysis to solve one dimensional problem in structural analysis
●	Apply the concepts of Finite Element Analysis to solve one dimensional problem in Heat transfer and Dynamics
●	Apply the concepts of Finite Element Analysis to solve two dimensional problems in structural analysis
●	Apply the Isoparametric transformation and the use of numerical integration for various analysis

Text Books:	
1	Rao, S.S., "The Finite Element Method in Engineering", 6th Edition, ButterworthHeinemann,2018.
2	Tirupathi R. Chandrupatla and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.

Reference Books(s) / Web links:	
1	David Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill, 2017
2	Reddy,J.N. "Introduction to the Finite Element Method", 4th Edition, Tata McGrawHill,2018.

3	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2007.
4	Seshu. P, “Text Book of Finite Element Analysis”, PHI Learning Pvt. Ltd., New Delhi, 2013.
5	https://nptel.ac.in/content/storage2/courses/112104116/ui/Course_mod_1.htm