RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna University Chennai)

DEPARTMENT OF MECHATRONICS ENGINEERING
CURRICULUM AND SYLLABUS
REGULATIONS – 2019 Choice Based Credit System
(w.e.f. 2022 Batch onwards)
B.E. MECHATRONICS ENGINEERING

VISION:

To attain excellence in academics, research and technological advancement in Mechatronics Engineering with a concern for society.

MISSION:

- To impart high quality professional education and produce Mechatronics Engineers with all round knowledge of multi-disciplinary branches of engineering and technology.
- To foster skill sets required to be a global professional in the areas of automation, intelligent systems, robotics, research for technology management and to fulfill the expectations of industry and needs of the society.
- To inculcate entrepreneurial qualities for creating, developing and managing global engineering ventures.

Programme Educational Objectives (PEOs):

PEO I

Graduates will have comprehensive knowledge in the analytical, scientific and engineering fundamentals necessary to model, analyse and solve engineering problems and to prepare them for graduate studies and for successful careers in industry.

PEO II

Graduates will effectively design and develop products in the areas such as automation, manufacturing, Internet of Things, machine vision, system simulation, intelligent systems and robotics.

PEO III

Graduates will acquire Technical expertise, Leadership skills, Ethical practices and Team spirit with 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)

Engineering Graduates will be able:

PSO 1: To innovate a Mechatronics system to meet the requirements and specifications.

PSO 2: To analyse and improve the performance of a Mechatronics system and enhance the intellectual capabilities of the system

PSO 3: To lead professional career in industries or an entrepreneur by applying Engineering and Management principles and practices**.**

PEO / PO Mapping

Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	**PSO1**	**PSO2**	**PSO3**
PEO I	3	3	2	2	2	1	1	-	2	1	1	1	3	2	2
PEO II	3	3	3	1	3	1	1	-	-	-	-	1	2	3	2
PEO III	-	-	-	-	-	3	3	3	3	2	2	2	2	2	3

CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	HS19151	Technical English	HS	3	2	1	0	3
2	MA19151	Algebra and Calculus	BS	4	3	1	0	4
3	PH19141	Physics of Materials	BS	5	3	0	2	4
4	GE19101	Engineering Graphics	ES	4	2	2	0	4
PRACTICALS								
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								
1.	MA19251	Differential Equations and Vector Calculus	BS	4	3	1	0	4
2.	CY19241	Engineering Chemistry	BS	5	3	0	2	4
3.	EE19241	Basic Electrical Engineering	ES	5	3	0	2	4
4.	GE19201	Engineering Mechanics	ES	3	2	1	0	3
5.	GE19207	தமிழர் மரபு	HSM	1	1	0	0	1
PRACTICALS								
6.	GE19141	Programming using C	ES	6	2	0	4	4
7.	MT19221	Computer Aided Drawing Laboratory	ES	2	0	0	2	1
8.	GE19122	Engineering Practices- Electrical and Electronics	ES	2	0	0	2	1
NON-CREDIT - MANDATORY COURSE								
9.	MC19102	Indian Constitution and Freedom Movement	MC	3	3	0	0	0
			TOTAL	**31**	**17**	**2**	**12**	**22**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA19355	Transforms and Applications	BS	4	3	1	0	4
2	MT19301	Analog Devices and Circuits	ES	3	3	0	0	3
3	MT19302	Digital System Design	PC	3	3	0	0	3
4	MT19303	Fluid mechanics and thermal sciences	PC	4	3	1	0	4
5	MT19304	Mechanics of Solids	PC	3	3	0	0	3
6	GE19307	தமிழரும் தொழில்நுட்பமும்	HSM	1	1	0	0	1
PRACTICALS								
7	GE19211	Problem Solving and Programming in Python	ES	5	1	0	4	3
8	MT19311	Digital System Design Laboratory	PC	3	0	0	3	1.5
9	MT19312	Strength of Materials and Fluid Mechanics Laboratory	PC	3	0	0	3	1.5
NON-CREDIT - MANDATORY COURSE								
10	MC19301	Essence of Indian Traditional Knowledge	**MC**	3	3	0	0	0
			TOTAL	32	20	2	10	24

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA19455	Statistics and Numerical Methods	BS	4	3	1	0	4
2.	MT19401	Manufacturing Technology	PC	3	3	0	0	3
3.	MT19402	Microcontrollers and Embedded Systems	PC	3	3	0	0	3
4.	MT19403	Sensors and Instrumentation	PC	3	3	0	0	3
5.	MT19503	System Dynamics and Control	PC	3	3	0	0	3
6.		Open Elective - I	OE	3	3	0	0	3
PRACTICALS								
7.	MT19421	Manufacturing Technology laboratory	PC	2	0	0	2	1
8.	MT19411	Microprocessors and Microcontrollers for Automation Laboratory	PC	3	0	0	3	1.5
9.	MT19412	Sensors and Instrumentation Laboratory	PC	3	0	0	3	1.5
10.	GE19421	Soft Skills - I	EEC	2	0	0	2	1
			TOTAL	29	18	1	10	24

SEMESTER V

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MT19501	Industrial Electronics	PC	3	3	0	0	3
2	MT19502	Theory of Machines and Mechanisms	PC	4	3	1	0	4
3	MT19601	Design of Mechatronics System	PC	3	3	0	0	3
4		Open Elective - II	OE	3	3	0	0	3
5		Professional Elective -I	PE	3	3	0	0	3
PRACTICALS								
6	CS19411	Python Programming for Machine Learning	ES	5	1	0	4	3
7	MT19511	Theory of Machines laboratory	PC	3	0	0	3	1.5
8	MT19512	Industrial Electronics laboratory	PC	3	0	0	3	1.5
9	GE19521	Soft Skills - II	EEC	2	0	0	2	1
			TOTAL	**29**	**16**	**1**	**12**	**23**

SEMESTER VI

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	GE19304	Fundamentals of Management for Engineers	HS	3	3	0	0	3
2	MT19602	Fundamentals of Machine Design	PC	3	3	0	0	3
3	MT19641	Industrial Robotics	PC	6	3	0	3	4.5
4	MT19642	Applied Hydraulics and Pneumatics	PC	6	3	0	3	4.5
5		Professional Elective -II	PE	3	3	0	0	3
PRACTICALS								
6	MT19611	Innovation and Design Thinking for Mechatronics	EEC	4	0	0	4	2
7	MT19621	Mini project	EEC	2	0	0	2	1
8	GE19621	Problem Solving Techniques	EEC	2	0	0	2	1
			TOTAL	**29**	**15**	**0**	**14**	**22**

SEMESTER VII

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MT19701	Automotive Mechatronics	PC	3	3	0	0	3
2	MT19702	Computer Aided Design and Manufacturing	PC	3	3	0	0	3
3	MT19703	Industrial Automation	PC	3	3	0	0	3
4	MT19704	Machine Vision	PC	3	3	0	0	3
5		Professional Elective - III	PE	3	3	0	0	3
PRACTICALS								
6	MT19711	Computer Aided Engineering Laboratory	PC	3	0	0	3	1.5
7	MT19712	Industrial Automation Laboratory	PC	3	0	0	3	1.5
8	MT19713	Mechatronics Problem Solving using AI, ML and DL	EEC	4	0	0	4	2
9	MT19721	Project Work- Phase I	EEC	2	0	0	2	1
			TOTAL	**27**	**15**	**0**	**12**	**21**

SEMESTER VIII

SL NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1		Professional Elective - IV	PE	3	3	0	0	3
2		Professional Elective - V	PE	3	3	0	0	3
PRACTICALS								
3	MT19811	Project Work - Phase II	EEC	18	0	0	18	9
			TOTAL	**24**	**6**	**0**	**18**	**15**

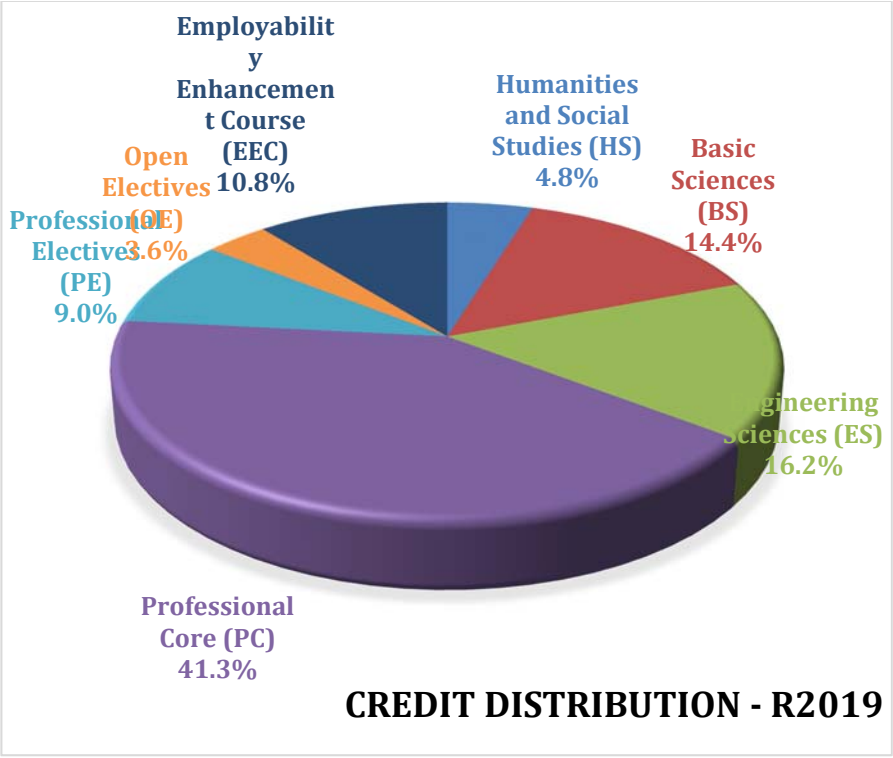
TOTAL NO. OF CREDITS: 167

PROFESSIONAL ELECTIVES (PE)*

DEPARTMENT OF MECHATRONICS ENGINEERING								
REGULATIONS 2019 (2021 batch onwards)								
Category		Common verticals		Dept. Verticals- MCT			Diversified	
	Professional Elective	VERTICAL 1	VERTICAL 2	VERTICAL 3	VERTICAL 4	VERTICAL 5	VERTICAL 6	VERTICAL 7
Offered in		COMPUTATIONAL ENGINEERING	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	ROBOTICS	SMART MANUFACTURING	AUTOMATION	Diversified	Diversified
V SEM	PE I	ME19A11-Machine Learning for Intelligent Systems	ME19B11-Reliability and Maintenance Engineering	MT19C11-Autonomous Mobile Robots	MT19D11-CNC Technology and Applications	MT19E11-VLSI and FPGA	MT19F11-Advanced Microprocessors and Microcontrollers	MT19P55-Automobile Engineering
V SEM	PE I	ME19A12-CAD and CAE	ME19B12-Warehousing Automation	MT19C12-Soft and Microrobotics	ME 19D11-Design For X	MT19E12-Total Integrated Automation	MT19F12-Internet Tools and Java Programming	MT19G11-Smart Sensors and Micro Electro Mechanical Systems
VI SEM	PE II	ME19A13-Numerical heat transfer	ME19B13-Operations Management	MT19C13-Medical Robotics	MT19D13-Product Design and Development	MT19E13-Virtual Instrumentation	MT19F13-Immersive Technologies and Haptics	ME 19F14-Hybrid and Electrical Vehicles
VI SEM	PE II	.	.	MT19C14-Humanoid Robotics	ME19E15-Additive Manufacturing	MT19E14-Motion Control System	MT19F14-Systems Modelling and Simulation Methods	MT19G12-Battery Management System
VII SEM		ME19A14-Theory on Computation and Visualization	ME19B14-Material Handling Equipment, Repair and Maintenance					
VII SEM	PE III	ME19A15-Computational Bio-Mechanics	ME19B15-Container Logistics	MT19C15-Programming for Robot Operating System	MT19D14-Advanced Manufacturing Technology	MT19E15-Internet of Things for Mechatronics	MT19F15-Applied Signal Processing	MT19G13-Advanced Driver Assistance Systems
VII SEM	PE III	ME19A16-Advanced Statistics and Data Analytics	ME19B16-Production Planning and Control	MT19C16-Agricultural Robotics and Automation	ME 19E17-Electronics Manufacturing technology	ME 19E18-Digital Twin & Industry 4.0	MT19F16-Neural Networks and Fuzzy Systems	MT19G14-Single Board Computers
VIII SEM	PE IV	ME19A17-Noise acoustics & vibration	ME19B17-Operations Research	MT19C17-Underwater robotics	ME 19E19-Non-Destructive Testing and Evaluation	MT19E16-Wireless Networks for Industrial Automation	MT19F17-Computer Vision and Deep Learning	ME19G15-Principles of Management
VIII SEM	PE V	ME19A18-Computational Solid Mechanics	ME19B18-Supply chain and Logistics Management	MT19C18-Robots and Systems in Smart Manufacturing	ME 19D16-Process planning and cost estimation	MT19E17-Intelligent Control Systems	MT19F18-Project Management	ME19G16-Entrepreneurship Development
VIII SEM	PEV	ME19A19-Computational Fluid Dynamics	ME19B19-Data Science	ME 19C11-Drone Technologies	MT19D15-Industrial Design and Applied Ergonomics	ME 19C17-Smart Mobility and Intelligent Vehicles	ME 19F17-Advanced energy storage technologies	ME19G18-Research Methodology and Intellectual Property Rights

SUMMARY

DEPARTMENT OF MECHATRONICS ENGINEERING											
	Subject Area	**Credits Per Semester**								Credits Total	Percentage %
	Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
1.	Humanities and Social Studies (HS)	3	1	1	0	0	3	0	0	8	4.79
2.	Basic Sciences (BS)	8	8	4	4	0	0	0	0	24	14.37
3.	Engineering Sciences (ES)	5	13	6	0	3	0	0	0	27	16.17
4.	Professional Core (PC)	0	0	13	16	13	12	15	0	69	41.32
5.	Professional Electives (PE)	0	0	0	0	3	3	3	6	15	8.98
6.	Open Electives (OE)	0	0	0	3	3	0	0	0	6	3.59
7.	Project Work/ Employability Enhancement Course (PR/EEC)	0	0	0	1	1	4	3	9	18	10.78
	TOTAL	**16**	**22**	**24**	**24**	**23**	**22**	**21**	**15**	**167**	
8.	Non-Credit*/ (Mandatory)	1	1	1							



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 speaking practice 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
●	Understand structures and techniques of 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 BlackSwan 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

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	-	-	-	-	-	1	-	2	3	1	3	-	-	-
CO 2	-	3	-	2	-	-	-	-	-	2	1	1	-	-	-
CO 3	-	-	-	1	-	-	-	-	-	3	-	-	-	1	2
CO 4	-	1	-	1	-	-	-	-	-	3	-	2	-	-	-
CO 5	1	1	1	1	1	1	1	1	2	3	1	1	-	-	-
Average	1	1.6	1	1.2	1	1	1	1	2	2.8	1	1.7	-	1	2

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

Objectives:	
●	To gain knowledge in using matrix algebra techniques and the limitations of using infinite series approximations for 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 - Nature of 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 and problems of maxima and minima.
●	Obtain the centre of gravity, moment of inertia for rigid bodies and also surface area and volume using multiple integrals.
●	Process the data collected and analyze 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 , Mc Graw 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., New Delhi, 2006.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA19151.1	3	3	3	3	3	1	-	-	-	-	2	2	2	3	-
MA19151.2	3	3	3	3	2	1	-	-	-	-	-	2	2	3	-
MA19151.3	3	3	3	3	3	1	1	-	-	-	2	3	2	2	-
MA19151.4	3	3	3	3	3	1	1	-	-	-	2	2	2	2	-
MA19151.5	3	3	3	3	3	1	-	-	-	-	1	2	2	2	-
Average	3	3	3	3	2.8	1	1	-	-	-	1.8	2.2	2	2.4	-

PH19141	PHYSICS OF MATERIALS	BS	L	T	P	C
	Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanical Engineering & Mechatronics		**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 the various 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 and hypereutectoid 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 up approaches – 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 of wave 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	
●	Understand foundational mechanics and elastic nature of materials and 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.
●	Understand various engineering materials, test or measure their properties and use them in suitable applications.
●	Understand the concepts of quantum theory and the nature of light and determine the characteristics of a given laser source.

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"*.DhanpatRai Publishers, 2018.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PH19141.1	3	3	3	2	1	1	1	1	2	1	1	2	2	1	1
PH19141.2	3	3	3	2	1	1	1	1	2	1	1	2	2	1	1
PH19141.3	3	3	3	2	1	1	1	1	2	1	1	2	2	1	1
PH19141.4	3	3	2	2	1	1	1	1	2	1	1	2	2	1	1
PH19141.5	3	3	2	2	1	1	1	-	2	1	1	2	2	1	1
AVERAGE	3	3	2.6	2	1	1	1	1	2	1	1	2	2	1	1

GE19101	Engineering Graphics	ES	L	T	P	C
			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 OFPOINTS, LINES AND PLANESURFACE**	**12**
Orthographic projection- principles-Principal planes- projection of points. First angle projection - Projection of straight lines 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	**PROJECTIONOFSOLIDS**	**12**
Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes 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 and perpendicular 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 PERSPECTIVE PROJECTIONS**	**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	

Course Outcomes: After learning the course, the students should be able	
●	To construct different plane curves and free hand sketching of multiple views from pictorial objects.
●	To comprehend the theory of projection and to draw the basic views related to projection of points, lines and planes
●	To draw the projection of solids in different views
●	To draw the projection of Sectioned solids and development of surfaces of solids
●	To visualize and prepare Isometric and Perspective view of simple solids

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", Dhanalakshmi Publishers, Chennai, 2017.

Reference Books(s) / Web links:	
1	Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt.Ltd., 2013.
2	Venugopal K. and PrabhuRaja 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, New Delhi, 2018.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
GE19101.1	1	1	-	1	2	1	-	-	2	3	1	2	3	-	-
GE19101.2	1	1	-	1	2	1	-	-	2	3	1	2	3	-	-
GE19101.3	1	1	-	1	2	1	-	-	2	3	1	2	3	-	-
GE19101.4	1	1	-	1	2	1	-	-	2	3	1	2	3	-	-
GE19101.5	1	1	-	1	2	1	-	-	2	3	1	2	3	-	-
AVERAGE	1	1	-	1	2	1	-	-	2	3	1	2	3	-	-

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 renewableenergy 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 - control of 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 and tertiary 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	ErachBharucha, "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, CengageLearning India PVT, LTD, Delhi, 2014.
4	Rajagopalan, R, "Environmental Studies-From Crisis to Cure", 3rdedition,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.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC19101.1	1	1	-	-	-	3	3	2	-	-	-	2	-	-	1
MC19101.2	1	1	-	-	-	3	3	2	-	-	-	2	-	-	1
MC19101.3	1	1	-	-	-	3	3	2	-	-	-	1	-	-	1
MC19101.4	1	1	-	-	-	2	3	2	-	-	-	2	-	-	1
MC19101.5	1	1	-	-	-	2	3	1	-	-	-	1	-	-	1
AVERAGE	1	1	-	-	-	2.6	3	1.8	-	-	-	1.6	-	-	1

GE19121	ENGINEERING PRACTICES – 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 in household 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	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:

- 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.
- Able to perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
- Able to produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
- Able to perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
- Able to perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

TOTAL: 30 PERIODS

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19121.1	2	1	1	-	2	2	2	-	1	-	2	2	2	1	-
GE19121.2	2	1	1	-	2	2	2	-	1	-	2	2	2	1	-
GE19121.3	2	1	1	-	2	2	2	-	1	-	2	2	2	1	-
GE19121.4	2	1	1	-	2	2	2	-	1	-	2	2	2	1	-
GE19121.5	2	1	1	-	2	2	2	-	1	-	2	2	2	1	-
AVERAGE	2	1	1	-	2	2	2	-	1	-	2	2	2	1	-

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, Mechatronics & Mechanical Engineering and B. Tech. - Biotechnology, Food Technology & Chemical Engineering		**3**	**1**	**0**	**4**

Objectives:	
●	To handle practical problems arising 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 coefficients of 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 applications involving 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 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 Engineering problems.
●	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 , Mc Graw 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., New Delhi, 2006.
4	T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA19251.1	3	3	3	3	3	2	-	-	-	-	2	2	3	3	-
MA19251.2	3	3	3	3	3	2	-	-	-	-	2	2	3	3	-
MA19251.3	3	3	3	3	2	1	-	-	-	-	2	2	3	2	-
MA19251.4	3	3	2	2	2	1	-	-	-	-	1	1	3	2	-
MA19251.5	3	3	2	2	2	1	-	-	-	-	1	1	3	2	-
AVERAGE	3	3	2.6	2.6	2.4	1.4	-	-	-	-	1.6	1.6	3	2.4	-

CY19241	ENGINEERING CHEMISTRY	BS	L	T	P	C
	Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Mechanical Engineering and Mechatronics		**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 for combustion – 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
●	Understand the role 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 Mc Graw-Hill Edition, 1995
2	Shashi Chawla, "A Text Book of Engineering Chemistry", Dhanpat Rai & Co, New Delhi, 2017.
3	Sharma Y.R., "Elementary Organic Spectroscopy", Sultan Chand & Sons, New Delhi, 2014.
4	Sharma B. K.,"AnalyticalChemistry",Krishna Prakashan Media (P) Ltd., Meerut, 2005.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO11	PO12	PSO 1	PSO 2	PSO 3
CY19241.1	3	2	2	2	1	1	2	1	1	1	1	2	1	-	1
CY19241.2	3	2	2	1	2	1	2	1	2	1	2	2	1	1	1
CY19241.3	3	2	2	2	2	1	1	-	1	1	1	1	1	1	1
CY19241.4	2	1	1	1	1	-	-	-	1	-	-	1	1	-	-
CY19241.5	3	2	2	2	2	1	2	1	1	1	2	2	1	-	-
AVERAGE	2.8	1.8	1.8	1.6	1.6	1	1.75	1	1.2	1	1.5	1.6	1	1	1

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	
Computer – components of a computer system-Algorithm and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.		
UNIT-II	**C LANGUAGE - TYPES OF OPERATOR AND EXPRESSIONS**	
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**	
Standard I/O, Formatted Output – Printf, Variable-length argument lists- Formatted Input – Scanf, Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, GoTo Labels.		
UNIT-IV	**FUNCTIONS AND PROGRAM STRUCTURE**	
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**	
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:	
●	Develop simple algorithms for arithmetic and logical problems.
●	Develop C programs using basic programming constructs.
●	Develop C programs using arrays and strings
●	Develop applications in C using functions, pointers and structures
●	Do input / output and file handling in C

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	Yashavant Kanetkar, "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

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
GE19141.1	2	3	3					1		2		1			
GE19141.2	2	2	2									2	1		
GE19141.3	1	2	1									2	1		
GE19141.4		2	1	3								2	3	2	2
GE19141.5		2	1	2								3	3	3	3
AVERAGE	1.7	2.2	1.6	2.5				1.0		2.0		2.0	2.0	2.5	2.5

EE19241	BASIC ELECTRICAL ENGINEERING	ES	L	T	P	C
	Common To Auto, ECE, Mech, and MCT		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 of simple 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 of operation- 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 and Working 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, the students will be able to	
●	analyse 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.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EE19241.1	3	3	2	3	3	1	1					2	1	2	1
EE19241.2	3	3	2	3	3	1	1						1	2	1
EE19241.3	3	3	2	3	3	2	2		1			2	2	2	1
EE19241.4	3	3	2	3	3	2	2				2	2	3	3	2
EE19241.5	3	3	2	3	3	1	2	1	1	1	2	2	3	3	2
AVERAGE	3	3	2	3	3	1.4	1.6	1	1	1	2	2	2	2.4	1.4

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

Objectives:	
•	To understand the basics of mechanics and apply the concept of equilibrium to solve problems of concurrent forces.
•	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 a particle 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's laws 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 – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.		
	Total Contact Hours : 45	

Course Outcomes: On the successful 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 of composite 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 Sankarasubramanian 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, Pearson Education 2010.
3	Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics" 4thEdition, Pearson Education 2006.
4	S S Bhavikatti, Engineering Mechanics, New Age International Publishers, 2016
5	Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19201.1	3	2	2	2	1	1						1	3	2	1
GE19201.2	3	2	2	2	1	1						1	3	2	1
GE19201.3	3	2	2	2	1	1						1	3	2	1
GE19201.4	3	2	2	2	1	1						1	3	2	1
GE19201.5	3	2	2	2	1	1						1	3	2	1
AVERAGE	3	2	2	2	1	1						1	3	2	1

GE19207 தமிழர் மரபு **L T P C**
1 0 0 1

அலகு **I** மொழி மற்றும் இலக்கியம்: **3**

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமய சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழிக் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு **II** மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு **III** நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு **IV** தமிழர்களின் திணைக் கோட்பாடுகள்: **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு **V** இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr. S. Singaravelu)(Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr. S. V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies).

9. Keeladi – ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

MC19102	INDIAN CONSTITUTION AND FREEDOM MOVEMENT	MC	L	T	P	C
	(Common to Mech, Aero, Auto Civil and MCT)		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 State Policy		
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 of India Act 1947-Freedom and Partition		
	Total Contact Hours : 45	

Course Outcomes: On the successful 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 , Prabhat Prakashan, New Delhi, 1st ed , 2017

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

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC19102.1							2	2				1			2
MC19102.2							2	2				1			2
MC19102.3							2	2				1			2
MC19102.4							2	2				1			2
MC19102.5							2	2				1			2
AVERAGE							2	2				1			2

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, line types.			
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, the students will be able to	
●	Ability to develop engineering drawing and dimensioning for the industrial component using Indian Standard code of practice.
●	Able to implement Geometric Dimensioning & Tolerancing principles in production drawing.
●	Use CAD software for drafting machine components.
●	Recognize various working principles of different machine elements.
●	Ability to develop 2D and 3D models of the component using manual/software.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19221.1	1	1	-	-	3	-	-	-	-	2	-	2	2	1	-
MT19221.2	1	1	-	-	3	-	-	-	-	2	-	2	2	1	-
MT19221.3	1	1	-	-	3	-	-	-	-	2	-	2	2	1	-
MT19221.4	1	1	-	-	3	-	-	-	-	2	-	2	2	1	-
MT19221.5	1	1	-	-	3	-	-	-	-	2	-	2	2	1	-
AVERAGE	1	1			3					2		2	2	1	

GE19122	ENGINEERING PRACTICES - ELECTRICAL AND ELECTRONICS	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, the students will be able to	
●	fabricate electrical and electronic circuits
●	formulate the house wiring
●	design the AC-DC converter using diode and passive components

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", Anuradha Publications, 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.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19122.1	2	1	1	-	2	2	2	-	1	-	2	2	2	1	1
GE19122.2	2	1	1	-	2	2	2	-	1	-	2	2	2	1	1
GE19122.3	3	3	3	3	3	1	1		2	1	3	3	2	2	1
GE19122.4	3	3	3	3	2	2	2		2	1	3	3	1	2	1
GE19122.5	3	3	3	3	3	1	1		2	1	3	3	2	2	1
AVERAGE	2.6	2.2	2.2	3	2.4	1.6	1.6		1.6	1	2.6	2.6	1.8	1.6	1

SEMESTER - III

MA19355	TRANSFORMS AND APPLICATIONS	BS	L	T	P	C
	Common to III sem. B.E. Mechanical Engineering, Mechatronics and Civil Engineering		**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 cosine series – 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 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.,New Delhi, 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, Sixth Edition, New Delhi, 2012.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA 19355.1	3	3	3	2	1	-	-	-	-	-	-	2	2	-	1
MA 19355.2	3	3	3	3	2	-	-	-	-	-	-	2	2	-	1
MA 19355.3	3	3	3	3	2	-	-	-	-	-	-	2	2	-	1
MA 19355.4	3	3	3	2	1	-	-	-	-	-	-	2	2	-	1
MA 19355.5	3	3	3	2	1	-	-	-	-	-	-	2	2	-	1
Avg	3	3	3	2.4	1.4	-	-	-	-	-	-	2	2	-	1

MT19301	Analog Devices and Circuits	ES	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, switching regulator- SMPS- LM 380 power amplifier- ICL 8038 function generator IC.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
●	Ability to understand and analyse, 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 McGraw Hill, 2003.
4.	Robert F.Coughlin, Fredrick F. Driscoll, “Op-amp and Linear ICs”, PHI Learning, 6th edition,2012

CO \ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
MT 19301.1	3	3	3	2	1	-	-	-	-	-	-	-	2	2	1
MT 19301.2	3	3	3	2	1	-	-	-	-	-	-	-	3	3	3
MT 19301.3	3	3	3	3	2	2	-	-	-	-	-	1	3	2	3
MT 19301.4	3	3	3	1	-	1	-	-	-	-	-	1	1	1	2
MT 19301.5	3	2	2	1	-	1	-	-	-	-	-	2	3	1	3
Avg	3	2.8	2.8	1.8	1.3	1.3	-	-	-	-	-	1.3	2.4	1.8	2.4

MT19302	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 Care Conditions – 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: After the successful completion of the course, the student 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, " Fu ndamentals 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 Hall of 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.

CO PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT 19302.1	3	3	3	2	1	-	-	-	-	-	-	-	2	2	1
MT 19302.2	3	3	3	2	1	-	-	-	-	-	-	-	3	3	3
MT 19302.3	3	3	3	3	2	2	-	-	-	-	-	1	3	2	3
MT 19302.4	3	3	3	1	-	1	-	-	-	-	-	1	1	1	2
MT 19302.5	3	2	2	1	-	1	-	-	-	-	-	2	3	1	3
Avg	3	2.8	2.8	1.8	1.3	1.3	-	-	-	-	-	1.3	2.4	1.8	2.4

MT19303	FLUID MECHANICS AND THERMAL SCIENCES	PC	L	T	P	C
			3	1	0	4

Objectives:	
●	To introduce the basic concepts of fluid mechanics.
●	To make students understand the working principle of different types of pumps and Hydraulic turbines.
●	To make students understand the basic laws of thermodynamics.
●	To introduce various mechanisms of heat transfer

UNIT-I	PROPERTIES OF FLUIDS AND FLUID STATICS	12
Fluid - definition, distinction between solid and fluid - Units and dimensions – Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapor pressure, capillary and surface tension. Fluid statics: Pascal law - Hydrostatic law - Pressure measurements using Manometers and pressure gauges.		
UNIT-II	**FLIUD KINEMATICS AND FLUID DYNAMICS**	**12**
Fluid Kinematics – Types of flow - velocity and acceleration - continuity equation. Fluid dynamics - equations of motion - Euler's equation along streamline - Bernoulli's equation – Applications - Venturi meter, Orifice meter, Pitot tube. Hagen Poiseuille Equation - Darcy Weisbach equation - Friction factor – Major and minor energy losses - Flow through pipes in series and in parallel. Basics of dimensional analysis.		
UNIT-III	**HYDRAULIC MACHINES**	**12**
Introduction and classification of hydraulic machines. Reciprocating pump: constructional details, working principle, co-efficient of discharge, slip, power required. Centrifugal pump: classification and working principle, specific speed. Turbines: classification, working principle of a Pelton wheel turbine.		
UNIT-IV	**LAWS OF THERMODYNAMICS**	**12**
Thermodynamic system and surroundings – properties of system – STATE AND EQUILIBRIUM – Forms of energy – Quasi static process – Zeroth law of thermodynamics – Work and heat transfer – Path and point functions – First law of thermodynamics applied to open systems – SFEE equation and its applications. Second law of thermodynamics applied to Heat engines, Refrigerators& Heat pumps. Carnot's theorem and Clausius inequality – Concept of entropy applied to reversible and irreversible processes – Third law of thermodynamics.		
UNIT-V	**HEAT TRANSFER MECHANISMS**	**12**
Heat transfer mechanisms: Conduction – Fourier's Law, thermal resistance. Convection – Newton's law of cooling. Radiation – Wien's law, Kirchhoff's law, Stefan-Boltzmann law. Heat exchangers – LMTD – NTU – Fins.		
	Total Contact Hours : 60	

Course Outcomes: After the successful completion of the course, the student will be able to:	
●	Describe the properties of fluids and its importance in selection of fluid for suitable application
●	Identify the major and minor losses involved in the fluid flow through pipes
●	Differentiate the types of hydraulic machines and describe the working principle.
●	Apply the basic laws of thermodynamics for different applications.
●	Distinguish various modes of heat transfer and determine the heat transfer rate.

Text Book (s):	
1	White FM., "Fluid Mechanics", 7th Edition, Tata McGraw-Hill, New Delhi, 2011
2	Rajput R.K., "Heat and Mass transfer", S.Chand and Co Publishing, 2008
3	Modi PN., Seth SM., "Hydraulics and fluid mechanics including hydraulic machines", 20thedition, Standard publishers, 2015

Reference Books(s) / Web links:	
1	Cengel YA., Cimbala J M., "Fluid Mechanics – Fundamentals and applications", 2nd Edition, McGraw Hill higher education, 2010
2	Bansal RK., "Fluid Mechanics and Hydraulics Machines", 9th edition, Laxmi publications (P) Ltd., New Delhi, 2011.
3	Holman, J.P, " Heat Transfer", 3rd Edition, McGraw-Hill, 2007.
4	Ramamirtham S., "Fluid Mechanics and Hydraulics and Fluid Machines", Dhanpat Rai and Sons, Delhi, 2006
5	Nag P.K., "Engineering thermodynamics", Tata McGraw hill, 2005.

CO PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT 19303.1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1
MT 19303.2	2	1	2	2	2	2	2	2	2	2	1	1	1	1	2
MT 19303.3	2	1	2	2	2	2	2	2	2	2	1	1	1	2	2
MT 19303.4	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1
MT 19303.5	3	2	1	1	1	1	3	2	1	1	3	2	1	1	1
Avg	2	1.4	1.6	1.6	1.6	1.	2	1.8	1.6	1.6	1.6	1.2	1.2	1.4	1.4

MT19304	MECHANICS OF SOLIDS	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the fundamental concepts of stress, strain and elastic constants of solids under external loading
●	To learn about the transverse loading and bending loads acting on structural components
●	To learn about the deformation of shafts and springs subjected to torsion
●	To know about the various methods for calculating deflection of beams
●	To learn about the various stresses acting in shell structures like thin cylinders and spheres

UNIT-I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9
Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.		
UNIT-II	**TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM**	**9**
Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stresses in beams – Shear flow.		
UNIT-III	**TORSION ON SHAFTS AND SPRINGS**	**9**
Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Maximum shear stress in spring section including Wahl Factor - Deflection of helical springs, carriage springs.		
UNIT-IV	**DEFLECTION OF BEAMS AND COLUMNS**	**9**
Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams – Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns.		
UNIT-V	**THIN CYLINDERS, SPHERES AND THICK CYLINDERS**	**9**
Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lame's theorem.		
	Total Contact Hours :	45

Course Outcomes: At the end of this course, students able to	
●	Understand the concepts of principal planes and stresses and draw Mohr's circle for the given stress conditions.
●	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.
●	Understand the effect of stresses acting on thin cylinders and spheres and calculate the deformation.

Text Books:	
1	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2015.
2	Jindal U.C., "Strength of Materials", Pearson Pvt. Ltd., New Delhi, 2012.

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/

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT 19304.1	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
MT 19304.2	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
MT 19304.3	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
MT 19304.4	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
MT 19304.5	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
Avg	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2

GE19307 தமிழரும் தொழில்நுட்பமும் **L T P C**
1 0 0 1

அலகு **I** நெசவு மற்றும் பானைத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பண்டங்களில் கீறல் குறியீடுகள்.

அலகு **II** வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப்பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாடு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ - சாரோசெனிக் கட்டிடக் கலை.

அலகு **III** உற்பத்தித் தொழில் நுட்பம்: **3**

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு **IV** வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: **3**

அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கல்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.

அலகு **V** அறிவியல் தமிழ் மற்றும் கணித்தமிழ் : **3**

அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

13. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
14. கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
15. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
16. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
17. Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
18. Social Life of the Tamils – The Classical Period (Dr. S. Singaravelu)(Published by: International Institute of Tamil Studies.
19. Historical Heritage of the Tamils (Dr. S. V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
20. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies).
21. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
22. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)

23. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
24. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE19211	PROBLEM SOLVING AND PROGRAMMING IN PYTHON	ES	L	T	P	C
	(with effect from 2021 batch onwards)		1	0	4	3

Course Objectives:

This course is aimed at enabling the students to:

- Understand computers, programming languages and their generations and essential skills for a logical thinking for problem solving.
- write, test, and debug simple Python programs with conditionals, and loops and functions
- Develop Python programs with defining functions and calling them
- Understand and write python programs with compound data- lists, tuples, dictionaries
- Read and write data from/to files in Python.

Concepts (Theory) and List of Experiments for Practice

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, Selection and Insertion.
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 and ability 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 by defining functions and calling them
- Use Python lists, tuples, dictionaries for representing compound data.
- Efficiently handle data using flat files to process and store data for the given problem

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, Network Theory Ltd., 2011.

Reference Books:

1. John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press , 2013.
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, 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, Wiley India Edition, 2013.
6.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

MT19311	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, the student will be able to:	
●	Simplify complex Boolean functions.
●	Implement digital circuits using combinational logic ICs.
●	Understand 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/

CO \ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT 19311.1	3	1	1	-	-	-	-	-	-	-	-	-	-	-	-
MT 19311.2	3	2	3	2	-	-	-	-	-	-	-	-	-	-	-
MT 19311.3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
MT 19311.4	3	3	3	3	2	-	-	-	2	-	-	2	2	3	3
MT 19311.5	3	3	3	1	3	-	-	-	3	-	-	3	2	3	3
Avg	3	2.25	2.5	2	2.5	-	-	-	2.5	-	-	2.5	2	3	2.6

MT19312	STRENGTH OF MATERIALS AND FLUID MECHANICS 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 and hardness properties of given specimen
●	To understand the study of deflection and compression test on beam and spring for given material
●	To verify the principles studied in fluid mechanics by experimentally.
●	To verify the principles studied in hydraulic machines by experimentally of their performance and efficiencies.

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	Determination of the Coefficient of discharge of given Orifice meter.
9	Determination of the Coefficient of discharge of given Venturi meter.
10	Calculation of the rate of flow using Rota meter.
11	Determination of friction factor for a given set of pipes.
12	Conducting experiments and drawing the characteristic curves of centrifugal pump
13	Conducting experiments and drawing the characteristic curves of reciprocating pump.
14	Conducting experiments and drawing the characteristic curves of Pelton wheel.
15	Conducting experiments and drawing the characteristics curves of Kaplan turbine.
	Total Contact Hours : 45

Course Outcomes: On completion of the course, the student is expected to be able to	
●	Perform Tension, shear test, Torsion, impact test and Hardness test on given material.
●	Perform deflection and compression test on beam and springs.
●	Verify and apply Bernoulli equation for flow measurement like orifice/venturi meter
●	To measure the friction factor from given set of pipes
●	Determine the performance characteristics and efficiencies of pumps and Turbines.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19312.1	2	1	1	-	-	-	-	-	-	-	-	-	-	3	-
MT19312.2	2	2	1	-	-	-	-	-	-	-	-	-	-	3	-
MT19312.3	3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
MT19312.4	3	3	1	-	-	-	-	-	-	-	-	-	-	-	-
MT19312.5	3	3	2	2	-	-	1	-	1	-	-	1	-	3	1
Avg	2.6	2.4	1.4	2	-	-	1	-	1	-	-	1	-	3	1

MC19301	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	MC	L	T	P	C
			3	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.	9
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.	9
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.	9
UNIT-IV	Indian Linguistic Tradition: Introduction to Linguistics in ancient India – history – Phonetics and Phonology – Morphology –Syntax and Semantics-Case Studies.	9
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.	9
	Total Contact Hours : 45	

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	Fritzof Capra, Tao of Physics.
5	Fritzof 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 square design.		
UNIT-III	**SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**	**12**
Newton Raphson method – secant method – Gauss Jordan method – Iterative method of Gauss Seidel –Eigen value of a 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 Trapezoidal and 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",11thEdition, Pearson Education, , Asia, 2011.
2	Walpole R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineersand 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.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA 19455.1	3	3	3	3	2	-	-	-	-	-	2	2	3	-	2
MA 19455.2	3	3	3	3	2	-	-	-	-	-	2	2	3	-	2
MA 19455.3	3	3	3	2	1	-	-	-	-	-	1	2	2	-	1
MA 19455.4	3	3	3	2	1	-	-	-	-	-	1	2	2	-	1
MA 19455.5	3	3	3	2	1	-	-	-	-	-	1	2	2	-	1
Avg	3	3	3	2.4	1.4	-	-	-	-	-	1.4	2	2.4	-	1.2

MT19401	MANUFACTURING TECHNOLOGY	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 techniques.
●	To know the various conventional and unconventional machining operations and equipment.
●	To understand the working principle and applications of different types of sheet metal processes.
●	To understand the working principles of different types of thermoplastic manufacturing methods.

UNIT-I	METAL CASTING	9
Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Cores –Types and applications Moulding machines– Types and applications; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting – Defects in Sand casting.		
UNIT-II	**METAL JOINING PROCESSES**	9
Operating principle, basic equipment, merits and applications of Fusion welding processes: Gas Tungsten arc welding Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding –Laser welding- Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects.		
UNIT-III	**MACHINING PROCESS**	9
General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine,Universal drilling machine, Cylindrical grinding machine, Capstan and Turret lathe. Basics of CNC machines. General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Electron beam machining and Laser beam machining.		
UNIT-IV	**FORMING AND SHAPING OF PLASTICS**	9
Types of plastics - Characteristics of the forming and shaping processes – Moulding of Thermoplastics – Working principles and typical applications of - Injection moulding – Blow moulding – Rotational moulding – Film blowing – Extrusion - Typical industrial applications Thermoforming – Processing of Thermosets – Working principles and typical applications - Compression moulding – Transfer moulding – Bonding of Thermoplastics – Fusion and solvent methods		
UNIT-V	**METAL FORMING AND POWDER METALLURGY**	9
Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning, Powder metallurgy – Principal steps involved advantages, disadvantages and limitations of powder Metallurgy.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this course, students will be able to	
●	Explain the requirements, process, application and defects of sand casting and special casting processes.
●	Explain the working principles and applications of different arc welding processes, special welding process and defects associated with it.
●	Explain single-point machining relationships taking tool material and machine constraints into consideration and principles of non-traditional machining processes.
●	Distinguish various manufacturing methods of plastic components.
●	Explain different metal forming methods and powder metallurgy process.

Text Books:	
1	HajraChoudhary. S.K and Hajra Choudhary. A.K., "Elements of Workshop Technology", volume I and II, Media Promoters 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, Wiley Publishers, 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/

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19401.1	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
MT19401.2	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
MT19401.3	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
MT19401.4	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
MT19401.5	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
Avg	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2

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 Timing diagram – 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: Upon completion of this course the students can 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

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19402.1	3	1	1	1	1	-	1	-	1	1	2	2	2	2	2
MT19402.2	3	2	2	1	2	-	2	-	1	1	1	1	3	2	3
MT19402.3	3	2	1	1	2	-	-	-	1	1	1	1	2	3	2
MT19402.4	3	2	1	1	1	1	-	-	3	1	2	2	3	2	3
MT19402.5	3	2	1	1	1	1	2	-	2	1	1	2	2	3	2
Avg	3	1.8	1.2	1	1.4	0.4	1	-	1.6	1	1.4	1.6	2.4	2.4	2.4

MT19403	SENSORS AND INSTRUMENTATION	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the concepts of measurement and various transducers.
●	To learn the various sensors used to measure various physical parameters.
●	To acquire knowledge on acceleration, flow and optical measurements.
●	To know about the different ranging sensors and advanced sensors.
●	To learn about the fundamentals of data acquisition system and signal conditioning.

UNIT-I	SCIENCE OF MEASUREMENT	9
Basics of measurement – Significance of measurement – Units and Standards – Calibration techniques – Errors in measurement – Generalized measurement system – Sensors and Transducers – Classification of transducer – Static and dynamic characteristics of transducer – Sensor calibration techniques.		
UNIT-II	**DISPLACEMENT, FORCE, PRESSURE AND TEMPERATURE SENSOR**	**9**
Potentiometric Sensor –Capacitive sensors – Inductive and Magnetic sensors – LVDT, RVDT, Eddy Current, Hall effect, Magneto resistive, Magneto strictive – Ultrasonic – Radar – Strain Gauge – Tactile Sensor – Piezo electric Bellows, Membranes, and Thin Plates – Piezoresistive Sensors – Vacuum sensor – Thermosensitive Sensors – RTD – Thermistors – Thermoelectric Contact Sensors – Optical Temperature sensor – Pyrometers.		
UNIT-III	**ACCELERATION, FLOW, ACOUSTIC AND OPTICAL SENSOR**	**9**
Capacitive Accelerometers – Piezo Accelerometers – Gyroscopes – Flow Measurement – Orifice, Venturi meter, Turbine flow meter – Acoustic – Fiber optic, Piezoelectric microphone – Light Detectors – Photo resistor, Photodetector, Phototransistor, Pyroelectric sensor, Camera		
UNIT-IV	**RANGE, HEADING AND ADVANCED SENSORS**	**9**
Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR) – Heading Sensors – GPS, Compass – Humidity sensor – Hygrometer – Radiation Sensors – Scintillation, Ionization detector – Smart Sensors – Gas Sensors – Bio sensor – Film sensor – MEMS & Nano Sensors – Kinect – LASER sensors and Applications.		
UNIT-V	**DATA ACQUISTION AND SIGNAL CONDITIONING**	**9**
Components of Analog & Digital DAQ system – Uses of Data Acquisition systems – DAQ Hardware & Software – Data Loggers – Amplification – Isolation – Filtering – Sample and Hold circuits – A/D and D/A Converters – Data Acquisition case studies – Strain Gauge Weighing System, PH Control System, Skip Control of a CD Player,		
	Total Contact Hours : 45	

Course Outcomes:	
●	Familiar with various measurements, calibration techniques and types of transducers.
●	Understand the basic principles of various displacement, pressure and temperature sensors.
●	Describe the working of accelerometer, flow and optical sensor.
●	Apply the various sensors in the Automotive and Mechatronics applications.
●	Ability to implement the DAQ systems with different sensors for real time applications.

Text Book (s):	
1	Sawhney A K and Puneet Sawhney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.
2	Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
3	Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques‖, Prentice Hall of India, 1stedition, 2016

Reference Books(s) / Web links:	
1	Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
2	Jacob Fraden, “Handbook of Modern Sensors, Physics, Design and Applications”, Third Edition, Springer, 2004.
3	Jovitha Jerome, “Virtual Instrumentation Using LabVIEW”, PHI, New Delhi, 2010.
4	Devdas Shetty, Richard A. Kolk, “Mechatronics system design”, 2nd Edition, Cengage Learning, 2011.
5	Steve Mackay, John Park, “Practical Data Acquisition for Instrumentation and Control Systems”, Elsevier, 2003.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19403.1	3	2	1	1	1	-	-	-	-	-	-	1	1	1	1
MT19403.2	2	1	2	1	1	-	-	-	-	-	-	1	1	1	1
MT19403.3	2	1	2	1	1	-	-	-	-	-	-	1	1	1	1
MT19403.4	2	1	2	1	1	-	-	-	-	-	-	1	1	1	1
MT19403.5	3	2	1	1	2	-	-	-	-	-	-	1	2	2	1
Avg	2.4	1.4	1.6	1	1.2	-	-	-	-	-	-	1	1.2	1.2	1

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 – Automatic telescope Control.		
UNIT-II	**TIME RESPONSE ANALYSIS**	**9**
Time response analysis - First Order Systems - Impulse and Step Response - Analysis of second order systems - Steady state 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 of a 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 space representation 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 function using block diagram and signal flow graph methods.
●	Analyse 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 Robot Control.
●	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, “Feed back 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.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19503.1	3	2	2	-	-	-	-	-	-	-	2	2	1	2	2
MT19503.2	2	3	2	-	-	-	-	-	-	-	-	3	2	3	3
MT19503.3	2	2	3	3	3	-	-	-	-	-	3	3	3	3	3
MT19503.4	3	2	2	-	3	-	-	-	-	-	-	-	1	2	3
MT19503.5	2	2	3	3	1	-	-	-	-	-	3	3	3	2	3
Average	2.4	2.2	2.4	3	2.3	-	-	-	-	-	2.6	2.7	2	2.4	2.8

MT19421	MANUFACTURING TECHNOLOGY LABORATORY	PC	L	T	P	C
			0	0	2	1

Objectives: Enable the students	
●	To practice the moulding process using green sand.
●	To practice different types of sheet metal operating
●	To perform various machining operations like facing, turning, knurling, thread cutting, shaping, grinding and milling.
●	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	**:**	**30**

Course Outcomes: At the end of this course students will have the	
●	Ability to make a mould in green sand using different types of patterns.
●	Ability to create different objects using sheet metal.
●	Ability to perform different possible machining processes in lathe, shaper, grinders and milling machines.
●	Ability to select and perform different gear generating process based on requirements.
●	Ability to select suitable manufacturing method, machines, equipment and tools to make a job based on given requirements.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19421.1	3	-	-	-	-	1	1	-	2	-	-	3	-	1	2
MT19421.2	3	-	-	-	-	1	1	-	2	-	-	3	-	1	2
MT19421.3	3	-	-	-	-	1	1	-	2	-	-	3	-	1	2
MT19421.4	3	-	-	-	-	1	1	-	2	-	-	3	-	1	2
MT19421.5	3	-	-	-	-	1	1	-	2	-	-	3	-	1	2
Avg	3	-	-	-	-	1	1	-	2	-	-	3	-	1	2

MT19411	MICROPROCESSORS AND MICROCONTROLLERS FOR AUTOMATION 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.		
	Total Contact Hours	**:**	**45**

Course Outcomes: Upon 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

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19411.1	3	3	3	2	2	-	-	-	1	-	-	-	3	2	2
MT19411.2	3	3	3	2	2	-	-	-	1	-	-	-	2	2	3
MT19411.3	3	3	3	2	2	-	-	-	1	-	-	-	3	2	2
MT19411.4	3	3	3	2	2	-	-	-	1	-	-	-	3	3	3
MT19411.5	3	3	3	2	2	-	-	-	1	-	-	-	3	3	3
Avg	3	3	3	2	2	-	-	-	1	-	-	-	3	3	3

MT 19412	SENSORS AND INSTRUMENTATION LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives:	
•	Study the interfacing of different sensors with LabVIEW.
•	To design a LabView program to obtain a required measurement data for temperature
•	To generate appropriate design procedure to obtain a required measurement data for force
•	To create appropriate design procedure to obtain a required measurement data for displacement.
•	To develop an appropriate design procedure, suitable for signal conversion to interface with computer.

List of Experiments			
1	Design and testing of Digital Comparator		
2	Design and testing of Voltage to frequency converter and frequency to voltage converter		
3	Design and testing of sample and hold circuit.		
4	Design and testing of Flash type Analog to Digital Converters.		
5	Design and testing of instrumentation amplifier using OP-AMP.		
6	Displacement measurement using potentiometer and LVDT and plotting the characteristic curves.		
7	Study of Characteristics and calibration of strain gauge and Load Cell		
8	Measurement of strain using resistive type strain gauges with temperature compensation and various bridge configurations.		
9	Temperature measurement using Thermocouple, Thermistor and RTD and comparing the characteristics.		
10	Comparison of capacitive and resistive type transducer for humidity measurement with their characteristics.		
11	Measurement of sound using microphones and sound level meter.		
12	Conversation of time domain audio signal into frequency domain signal (FFT).		
13	Measurements of 3 phase power and power factor.		
	Total Contact Hours	**:**	**45**

Course Outcomes: Upon completion of the course, students will be able to:	
●	Design a LabView program to obtain a required measurement data for temperature
●	Generate appropriate design procedure to obtain a required measurement data for force
●	Develop appropriate design procedure to obtain a required measurement data for displacement.
●	Develop an appropriate design procedure, suitable for signal conversion to interface with computer.
●	Develop the LabView program to control the speed and position of servomotor

CO \ PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT 19412.1	3	3	3	2	2	1	-	-	1	-	-	-	3	2	1
MT 19412.2	3	3	3	2	2	-	-	-	1	-	-	-	3	2	2
MT 19412.3	3	3	3	3	2	1	-	-	1	-	-	1	3	2	2
MT 19412.4	3	3	3	1	1	1	-	-	1	-	-	1	1	1	2
MT 19412.5	3	2	3	1	1	1	-	-	1	-	-	2	2	1	2
Avg	3	2.8	3	1.8	1.6	1.3	-	-	1.6	-	-	1.3	2.4	1.6	1.8

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, in the 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 face the 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 the world	This is a quick and useful game by getting students to form 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 the sequential pictures by paying attention to the criteria provided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to use while narrating.	The aim of this activity is to make the students develop creative way of thinking.
4	Brainstormi ng	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 good characteristics 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 fear of being criticized. It also encourages students 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 take one 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 of conversation and helps the participants to identify the various methods of being diplomatic and how do deal with misinformation.	The aim of the lesson is to provide an opportunity 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 sentences he/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 – one representing each side of the issue), a parent, a school principal, 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 I couldn'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 feedback on the course from them.

Total Contact hours : 30

Course Outcomes: Upon 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.

CO-PO mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	1	3	-	1	-	-	1
CO2	-	-	-	-	-	-	1	-	1	3	1	1	-	-	1
CO3	1	-	-	-	-	-	-	-	-	3	-	-	-	-	1
CO4	-	-	-	-	-	-	-	-	-	3	-	-	-	-	1
CO5	-	-	-	-	-	-	-	-	-	3	-	-	-	-	1
Average	1	0	0	0	0	0	1	0	1	3	1	1	0	0	1

SEMESTER V

MT19501	INDUSTRIAL ELECTRONICS	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To get an overview of different types of power semiconductor devices and their switching characteristics.
●	To understand the operation, characteristics and performance parameters of controlled rectifiers.
●	To study the operation, switching techniques and basics topologies of DC-DC switching regulators.
●	To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
●	To study the operation of AC voltage controller and various configurations.

UNIT-I	POWER SEMI-CONDUCTOR DEVICES	9
Study of switching devices, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT- Static characteristics: SCR, MOSFET and IGBT - Triggering and commutation circuit for SCR- Introduction to Driver and snubber circuits – di/dt and dv/dt protection.		
UNIT-II	**PHASE-CONTROLLED CONVERTERS**	**9**
Single phase half and full converters, 3 phase half converters and 3 phase full converter – inverter operation – input power factor – use of flywheel diode in controlled rectifier configurations– Thyristor triggering circuits.		
UNIT-III	**INVERTERS AND CHOPPERS**	**9**
Classification of inverters–Single phase and three phase voltage source inverters (both 120° mode and 180° mode)– buck-boost converter–Voltage and Current commutated choppers–PWM inverters–Principle of chopper–Chopper classification–Step up and Step down chopper.		
UNIT-IV	**AC TO AC CONVERTERS**	**9**
Introduction to AC converters–Types of regulators–Single phase AC voltage controller – multistage sequence control – step up and step down cycloconverters – single phase and three phase cycloconverters.		
UNIT-V	**INDUSTRIAL APPLICATIONS**	**9**
Solid-state switching circuits, Relays, Electronic Timer, Sawtooth generator, applications in Industrial process control, Motor drive applications, Electronic regulator, Induction heating, Dielectric Heating.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Relate the basic semiconductor physics to the properties of real power semiconductor devices and differentiate from low power devices.
●	Describe the operation, switching techniques and basics topologies of DC-DC switching regulators.
●	Compare different modulation techniques of pulse width modulated inverters and harmonic reduction methods.
●	Recognise the operation of AC voltage controllers and various configurations.
●	Use power electronic devices in industrial applications.

Text Books:	
1	Bimbhra P.S. “Power Electronics” Khanna Publishers, Fifth Edition, 2012.
2	Rashid M.H., ‘Power Electronics: Circuits, Devices and Applications’, Pearson Education, PHI Fourth Edition, New Delhi, 2013

Reference Books / Web links:	
1	Daniel.W.Hart, “Power Electronics”, Indian Edition, Mc Graw Hill, 3rd Print, 2013.
2	Dubey, G.K., Doradia, S.R., Joshi, A. and Singh, R.M., “Thyristorised Power Controllers”, Wiley Eastern Limited, 2 nd Edition, 2010.
3	Joseph Vithayathil, “Power Electronics, Principles and Applications”, McGraw Hill Series, 6th Reprint, 2013
4	Ned Mohan, Tore. M. Undel and, William. P. Robbins,‘ Power Electronics: Converters, Applications and Design’, John Wiley and sons, third edition,2003.
5	Philip T. Krein, “Elements of Power Electronics” Oxford University Press, 2012 Edition.
6	Singh M.D and K.B. Khanchandani, “Power Electronics,” Mc Graw Hill India, 2013.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19501.1	-	-	-	-	-	3	2	3	2	2	3	2	-	-	3
MT19501.2	-	-	-	-	-	3	2	3	2	2	3	2	-	-	3
MT19501.3	-	-	-	-	-	3	2	3	2	2	3	2	-	-	3
MT19501.4	-	-	-	-	-	3	2	3	2	2	3	2	-	-	3
MT19501.5	-	-	-	-	-	3	2	3	2	2	3	2	-	-	3
Average	-	-	-	-	-	3	2	3	2	2	3	2	-	-	3

MT19502	THEORY OF MACHINES AND MECHANISMS	PC	L	T	P	C
			3	1	0	4

Objectives:	
•	To understand the basic components and layout of linkages in the assembly of a system/ machine and to draw velocity acceleration diagrams for mechanisms.
•	To understand the basic concepts of toothed gearing and kinematics of gear trains and cam mechanisms for specified output motions.
•	To understand the basic concepts and the effects of friction in motion transmission and in machine components.
•	To study the inertia forces on machine elements.
•	To understand static and dynamic balancing techniques and vibration in machine elements.

UNIT-I	MECHANISMS	12
Machine Structure – Kinematic link, pair and chain – Mobility- Kutzbach criterion- Grashoff's law – 4bar, Slider crank mechanisms – Inversions – Applications Kinematic analysis of simple mechanisms – Displacement, velocity and acceleration- Graphical Method (Relative velocity method)		
UNIT-II	**GEARS AND CAMS**	**12**
Gear profile and geometry – Nomenclature of spur gears –contact ratio - Gear trains: Simple, compound gear trains and epicylic gear trains - Determination of speed Cams – Types of cams – Design of profiles – Knife edged and roller ended followers with and without offsets for various types of follower motions.		
UNIT-III	**FRICTION**	**12**
Friction in screw and nut – screw jack – Plate and disc clutches Belt (flat) drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive.		
UNIT-IV	**INERTIA FORCES AND BALANCING**	**12**
Inertia force and Inertia torque – D' Alemberts principle - Dynamic Analysis of slider crank mechanism. Turning moment diagrams and Fly wheels. Static and dynamic balancing – Balancing of Single and several rotating masses in same and different planes		
UNIT-V	**VIBRATION**	**12**
Free undamped and damped vibrations of single degree of freedom systems (longitudinal) - Free undamped vibrations of single degree of freedom systems (transverse) Forced vibrations – Force transmitted to supports – Vibration isolation – Vibration absorption – Whirling speed of shaft		
	Total Contact Hours : 60	

Course Outcomes: On completion of course students will be able to	
•	Develop the design concepts of different types of mechanism with lower pairs and higher pairs. Analyze the velocity and acceleration of links of different mechanisms
•	Design a gear transmission drive and draw gear profiles
•	Design clutches and belt drives
•	Perform static and dynamic balancing of unbalanced machine elements
•	Compute natural frequency in free vibration and vibration response in forced vibrations

Text Books:	
1	Rattan, S.S, "Theory of Machines", 5th Edition, Tata McGraw-Hill, 2019
2	Uicker, J.J., Pennock G.R and Shigley, J.E. "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, 2014

Reference Books / Web links:	
1	Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", 3rd Edition, Affiliated East-West Pvt.Ltd., New Delhi, 2006
2	Ramamurthi. V, "Mechanics of Machines", Narosa Publishing House, 2002
3	Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992

4	Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009
5	Thomas Bevan, "Theory of Machines", 3rd Edition, Pearson Education India, 2009

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19502.1	3	2	2	3	-	-	-	-	-	-	-	2	1	3	-
MT19502.2	2	3	2	3	-	-	-	-	-	-	-	2	2	3	-
MT19502.3	2	2	3	3	-	-	-	-	-	-	-	2	3	3	-
MT19502.4	3	2	2	3	-	-	-	-	-	-	-	2	1	3	-
MT19502.5	2	2	3	3	-	-	-	-	-	-	-	2	3	3	-
Average	2.4	2.2	2.4	3	-	-	-	-	-	-	-	2	2	3	-

MT19601	DESIGN OF MECHATRONICS SYSTEM	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To provide the mechatronic system design and their structure, ergonomic and safety.
●	To provide an exposure on modeling and design of mechatronic system.
●	The students will be exposed to design mechatronic system in Labview & Vim –Sim Simulation Software's.
●	To develop the knowledge about the MEMS.

UNIT-I	INTRODUCTION TO MECHATRONICS SYSTEM	9
Key elements – Mechatronics Design process –Design Parameters – Traditional and Mechatronics designs – Advanced approaches in Mechatronics - Industrial design and ergonomics, safety.		
UNIT-II	**SYSTEM MODELLING**	**9**
Introduction-model categories-fields of application-model development-model verification-model validation-model simulation-design of mixed systems-electro mechanics design-model transformation- domain-independent description forms-simulator coupling.		
UNIT-III	**REAL TIME INTERFACING**	**9**
Introduction-selection of interfacing standards Elements of Data Acquisition & control Systems- Over view of I/O process, General purpose I/O card and its installation, Data conversion process, Application Software- Lab view Environment and its applications, Vim-Sim Environment & its applications -Man machine interface.		
UNIT-IV	**MICRO MECHATRONIC SYSTEM**	**9**
Introduction- System principle - Component design – System design – Scaling laws – Micro actuation Micro robot – Micro pump – Applications of micro mechatronic components.		
UNIT-V	**CASE STUDIES ON MECHATRONIC SYSTEM**	**9**
Introduction – semi-active suspension system Fuzzy based Washing machine – pH control system – Autofocus Camera, exposure control– Motion control using D.C.Motor & Solenoids – Engine management systems.– Controlling temperature of a hot/cold reservoir using PID- Control of pick and place robot – Part identification and tracking using RFID – Online surface measurement using image processing.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Design systems in mechatronics approach using modern software packages.
●	Will be able to model real time physical systems.
●	Perform data acquisition and interfacing between the physical system and software.
●	Develop mechatronic systems for real time applications.
●	Design micro mechatronic system.

Text Books:	
1	Devdas shetty, Richard A. Kolk, "Mechatronics System Design", 2nd Edition, Cengage Learning 2011
2	Georg pelz, "Mechatronic Systems: Modeling and simulation" with HDL's, John wiley and sons Ltd, 2003.
3	Tai-Ran Hsu, "MEMS & Microsystems Design and Manufacture", Tata McGraw-Hill, 2007.

Reference Books / Web links:	
1	Bishop, Robert H, "Mechatronics Hand book", CRC Press, 2002.
2	Bradley, D.Dawson, N.C. Burd and A.J. Loader, "Mechatronics: Electronics in Products and Processes", CRC Press 1991 , First Indian print 2010.
3	De Silva, "Mechatronics: A Foundation Course", Taylor & Francis, Indian Reprint, 2013.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19601.1	1	1	2	-	-	-	-	-	-	-	-	-	3	-	1
MT19601.2	2	3	3	3	-	-	-	-	-	-	2	2	3	3	3
MT19601.3	2	3	3	3	3	-	-	-	-	-	2	2	3	3	3
MT19601.4	2	3	3	3	-	-	-	-	-	-	-	1	3	3	2
MT19601.5	2	3	3	3	-	-	-	-	-	-	-	1	3	3	1
Average	1.8	2.6	2.8	3	3	-	-	-	-	-	2	1.5	3	3	2

CS19411	Python Programming for Machine learning	Category	L	T	P	C
		ES	1	0	4	3

Course Objectives:

This course is aimed at enabling the students to:

- To understand the relationship of the data collected for decision making.
- To know the concept of principal components, factor analysis and cluster analysis for profiling and interpreting the data collected.
- Lay the foundation of machine learning and its practical applications and prepare students for real-time problem-solving in data science.
- Develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
- Distinguish overtraining and techniques to avoid it such as cross-validation.

Concepts (Theory) and List of Experiments for practice

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 and Pre-processing
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 a variety of datasets.
- Analyze and perform an evaluation of learning algorithms and model selection.
- Compare the strengths and weaknesses of many popular machine learning approaches.
- Appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
- Design and implement 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. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media Inc, 2019.

CO - PO – PSO matrices of course

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO3
CS19411.1	2	2	2	2	1	-	-	-	1	2	-	1	2	3	1
CS19411.2	2	2	1	1	2	-	-	-	-	-	-	1	2	3	1
CS19411.3	2	3	2	1	2	-	-	-	1	1	-	1	2	3	1
CS19411.4	1	1	1	-	1	-	-	-	-	1	1	-	3	2	1
CS19411.5	3	3	2	3	3	-	-	-	2	1	-	1	1	1	3
Average	**2**	**2.2**	**1.6**	**1.75**	**1.8**	**-**	**-**	**-**	**1.33**	**1.25**	**1**	**1**	**2**	**2.4**	**1.4**

MT19511	THEORY OF MACHINES LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives: This laboratory course enables students to	
●	To supplement the principles learnt in kinematics and Dynamics of Machinery
●	To understand how certain measuring devices are used for dynamic testing
●	To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms
●	To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism
●	To understand the principles in mechanisms used for speed control and stability control

List of Experiments				
1	Study of gear parameters. Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains			
2	Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms. Kinematics of single and double universal joints			
3	Determination of Mass moment of inertia of Fly wheel and Axle system			
4	Single degree of freedom Spring Mass System			
5	Determination of torsional natural frequency of single and Double Rotor systems			
6	Balancing of rotating masses and Balancing of reciprocating masses.			
7	Transverse vibration of Free-Free beam – with and without concentrated masses			
8	Motorized gyroscope – Study of gyroscopic effect and couple.			
9	Cams – Cam profile drawing, Motion curves and study of jump phenomenon			
10	Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.			
		Total Contact Hours	**:**	**45**

Course Outcomes: On completion of the course, the student will be able to:	
●	Demonstrate the principles of kinematics and dynamics of machinery
●	Use the measuring devices for dynamic testing
●	Derive force-motion relationship in components subjected to external forces and analysis of standard mechanisms
●	Distinguish all the control mechanisms of machines
●	Enumerate the undesirable effects of unbalances resulting from prescribed motions in mechanism

Web links for virtual lab (if any)	
1	http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/experimentlist.html
2	http://vlabs.iitkgp.ac.in/kdm/#
3	https://mm-nitk.vlabs.ac.in/#

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT 19511.1	3	2	2	-	-	-	-	-	-	-	2	2	1	3	-
MT 19511.2	2	3	2	-	-	-	-	-	-	-	-	2	2	3	-
MT 19511.3	2	2	3	3	2	-	-	-	-	-	3	2	3	3	-
MT 19511.4	3	2	2	-	2	-	-	-	-	-	-	2	1	3	-
MT 19511.5	2	2	3	3	2	-	-	-	-	-	3	2	3	3	-
Avg	2.4	2.2	2.4	3	2	-	-	-	-	-	2.6	2	2	3	-

MT19512	INDUSTRIAL ELECTRONICS LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives: This laboratory course enables students to	
●	To introduce the students different power electronic components and usage of them in electronic circuits
●	To study characteristic of different power electronics and its components
●	To study the practical applications of all the experiments
●	To perform characteristic study on the electronics components
●	To know how to use bread board, chips and other components that are present in electronic circuit

List of Experiments				
1	Study of SCR, MOSFET & IGBT characteristics			
2	UJT, R, RC firing circuits for SCR			
3	Voltage & current commutated chopper			
4	SCR phase control circuit			
5	TRIAC phase control circuit			
6	Study of half controlled & fully controller converters			
7	Study of three phase AC regulator			
8	Speed control of DC shunt motor using three phase fully controlled converter			
9	SCR single-phase cyclo converter			
10	SCR series and parallel inverters			
11	IGBT Chopper			
12	IGBT based PWM inverter (single phase)			
		Total Contact Hours	**:**	**45**

Course Outcomes: On completion of the course, the student will be able to:	
●	Use SCR, MOSFET, TRIAC in electronic circuit
●	Determine characteristic study on the electronics components
●	Recognise different power electronics components and use them in electronic circuits
●	Compare the characteristics of different electron devices
●	Develop simple circuits using electronic devices for real time applications

Web links for virtual lab (if any)	
1	http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/power_electronics/labs/index.php

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19512.1	3	3	3	1	2	2	-	-	1	-	-	-	3	2	2
MT19512.2	3	3	3	1	2	-	-	-	1	-	-	-	3	2	2
MT19512.3	3	3	3	1	2	1	-	-	1	-	-	-	2	2	2
MT19512.4	3	3	3	1	1	1	-	-	1	-	-	1	1	1	2
MT19512.5	3	3	3	1	1	1	-	-	1	-	-	2	2	1	2
Avg	3	3	3	1	1.6	1	-	-	1.6	-	-	0.6	2.2	1.6	2

GE19521	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 of technology 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 not only to get the students to read the newspaper but also aims 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 the corner 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. Post few 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	FictionAD	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 the course, the student will be able to:	
•	Be more confident
•	Speak in front of a large audience without hesitation
•	Think creatively
•	Speak impromptu
•	Communicate in English

CO \ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
GE 19521.1	-	-	-	-	-	-	-	-	2	3	1	1	-	-	3
GE 19521.2	-	-	-	-	-	-	-	-	2	3	2	-	-	-	2
GE 19521.3	-	1	-	-	-	-	-	-	2	3	1	1	-	2	3
GE 19521.4	-	-	-	-	-	-	-	-	2	3	-	-	-	-	1
GE 19521.5	-	1	-	-	-	-	-	-	2	3	1	1	-	1	3
Avg	0	1	0	0	0	0	0	0	2	3	1.25	1	0	1.5	2.4

SEMESTER VI

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 in Problem 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; Performance Appraisal.	**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; Relationship between 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 and Non- 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.
- Will be able to 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.
- Will be able to 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.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19304.1	3	3	3	3	2	-	-	-	-	-	2	2	3	-	2
GE19304.2	3	3	3	3	2	-	-	-	-	-	2	2	3	-	2
GE19304.3	3	3	3	2	1	-	-	-	-	-	1	2	2	-	1
GE19304.4	3	3	3	2	1	-	-	-	-	-	1	2	2	-	1
GE19304.5	3	3	3	2	1	-	-	-	-	-	1	2	2	-	1
Avg	3	3	3	2.4	1.4	-	-	-	-	-	1.4	2	2.4	-	1.2

MT19602	FUNDAMENTALS OF MACHINE DESIGN	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To familiarize with various steps involved in the Design Process.
●	To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
●	To learn to use standard practices and standard data
●	To learn to use catalogues and standard machine components (Use of P S G Design Data Book is permitted)

UNIT-I	STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS	9
Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations –calculation of principle stresses for various load combinations, eccentric loading Factor of safety Theories of failure - Design for variable loading		
UNIT-II	**CURVED BEAMS, SHAFTS AND COUPLINGS**	**9**
Curved beams – crane hook and 'C' frame Design of solid and hollow shafts based on strength, rigidity – Rigid and flexible couplings.		
UNIT-III	**JOINTS and SPRINGS**	**9**
Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints –theory of bonded joints. Various types of springs, design of helical springs - leaf springs.		
UNIT-IV	**GEARS**	**9**
Gear Speed ratios and number of teeth-Force analysis -Tooth stresses- Factor of safety - Gear materials – Design of straight tooth spur gears based on strength and wear considerations. Introduction to design of micro gears, timing belts.		
UNIT-V	**BEARINGS**	**9**
Sliding contact and rolling contact bearings - Hydrodynamic journal bearings. Selection of Rolling Contact bearings. Introduction to ball screw, and guide rail systems. Mechanisms for securing materials – Clamps, T-Slots, Vises		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Design machine components for various types of loading.
●	Carry out shaft design for different applications.
●	Design threaded fasteners and joints based on the requirements.
●	Design spur gears based on strength and wear considerations.
●	Select suitable bearing based on application.

Text Books:	
1	Bhandari V.B, "Design of Machine Elements", 5th Edition, Tata McGraw-Hill Book Co, 2020.
2	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 11th Edition, Tata McGraw-Hill, 2019.

Reference Books / Web links:	
1	Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw- Hill Book Co.(Schaum's Outline), 2010.
2	Ansel Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw- HillBook Co, 2003.
3	Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Prentice Hall, 2003.
4	Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
5	Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design",4thEdition,Wiley, 2005.
6	Sundararajamoorthy T. V. Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.
7	Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000,

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19602.1	3	3	3	3	-	-	-	-	-	-	-	1	2	2	1
MT19602.2	3	3	3	3	-	-	-	-	-	-	-	1	2	2	1
MT19602.3	3	3	3	3	-	-	-	-	-	-	-	1	2	2	1
MT19602.4	3	3	3	3	-	-	-	-	-	-	-	1	2	2	1
MT19602.5	3	3	3	3	-	-	-	-	-	-	-	1	2	2	1
Average	3	3	3	3	-	-	-	-	-	-	-	1	2	2	1

MT19641	INDUSTRIAL ROBOTICS	PC	L	T	P	C
			3	0	3	4.5

Objectives:	
•	To study the Basics of the Industrial Robotics and its components
•	To study the kinematics of Industrial Robots
•	To study the kinds of Robots Programming and Languages
•	To study the basics of Ros and applications of robots in industry

UNIT-I	FUNDAMENTALS OF ROBOTICS	9
Introduction to Robot, Classification of robots; Serial and parallel manipulators Robot Anatomy – Robot Configurations – Work Volume – Robot Safety; Structure, Performance, Selection of Industrial Robots; Mechanical grippers- Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers- Miscellaneous grippers Gripper force analysis-Gripper design		
UNIT-II	**KINEMATICS OF INDUSTRIAL ROBOTS**	9
Co-ordinate frames, Rotations, Homogeneous Coordinates, Link co-ordinates, D-H Representation, Arm equation – Multi axis robot Inverse Kinematic problem, General properties of solutions, Tool configuration, Inverse Kinematics of multi axis robots		
UNIT-III	**ROBOT LANGUAGES AND PROGRAMMING**	9
Robot Language Structure, Textual and Generations of Robot Programming Languages, Constants, Variables, Data Objects, Motion Commands; End Effector and Sensor Commands; Methods of Robot Programming, Motion Interpolation, Program Control and Subroutines.		
UNIT-IV	**INTRODUCTION TO Robot Operating Systems (ROS)**	9
ROS Concepts, Writing ROS Nodes, ROS Tools; Messages, Classes and Servers in ROS; Simulation and Visualization in ROS		
UNIT-V	**APPLICATIONS OF INDUSTRIAL ROBOTS**	9
Robot Applications – Welding, Palletizing, Deburring, Assembly- material handling and processing applications, recent trends in industrial robots- Building of grippers		
	Contact Hours : 45	

LIST OF EXPERIMENTS:
1. Study of different types of robots based on configuration, Links, Joints and application.
2. Study of components of robots with drive system and end effectors.
3. Determination of maximum and minimum position of links.
4. Modeling the Forward and inverse kinematics for 3 and 4 axis robotic arm.
5. Perform the machine tending operation of a six axis robot using Teach pendant.
6. Perform the palletizing operation of a six axis robot using Teach pendant.
7. Offline programming of a six axis robot using Robotics simulation Software.
8. Identify a simple part using machine vision technology
Total Contact Hours : 90

Course Outcomes: After the successful completion of the course, the student will be able to:	
●	Organize the components and terminology related to Industrial Robots
●	Determine the kinematics model of simple robots
●	Predict and Select the right programming Language for simple applications
●	Design simple robot applications
●	Interpret the applications of Industrial Robots

Text Book (s):	
1.	Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley Publications, 2020
2.	Industrial Robotics, Groover, Tata McGraw-Hill, 2012
3.	Robert J. Schilling, ―Fundamentals of Robotics Analysis and Control‖, PHI Learning, 2009.

Reference Books(s) / Web links:	
1.	Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
2.	Saha S K, ―Introduction to Robotics‖, Tata McGraw Hill Education Pvt. Ltd, 2010.
3.	Wyatt Newman A Systematic Approach to Learning Robot Programming with ROS, CRC Press, 2018
4.	John J Craig, ―Introduction to Robotics‖, Pearson, 2009.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19641.1	3	3	3	2	1	-	-	-	-	-	-	-	2	2	1
MT19641.2	3	3	3	2	1	-	-	-	-	-	-	-	3	3	3
MT19641.3	3	3	3	3	2	2	-	-	-	-	-	1	3	2	3
MT19641.4	3	3	3	1	-	1	-	-	-	-	-	1	1	1	2
MT19641.5	3	2	2	1	-	1	-	-	-	-	-	2	3	1	3
Average	3	2.8	2.8	1.8	1.3	1.3	-	-	-	-	-	1.3	2.4	1.8	2.4

MT19642	APPLIED HYDRAULICS AND PNEUMATICS	PC	L	T	P	C
			3	0	3	4.5

Objectives:	
●	Graduates will demonstrate and understand the principle and working of Fluid power system.
●	Graduates will have the basic knowledge about the various sources of fluid power system.
●	Graduates will be broadly educated and will have an understanding about the components of hydraulic and pneumatic system
●	Graduates will be able to design pneumatic and hydraulic circuits for various applications.
●	Graduates will be able to troubleshoot hydraulic and pneumatic systems in industrial applications.

UNIT-I	FLUID POWER BASICS	09
Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids- Properties of fluids – Basics of Hydraulics – Pascal's Law- Principles of flow – Laminar and Turbulent flow– Reynolds number – Darcy's equation – Losses in fluid power system - Problems. Properties of air– Perfect Gas Laws – Static head pressure Vacuum- Problems. Machine plumbing – Sizing pneumatic lines – types of layout – pipe materials and sizes - O rings - Sizing hydraulic lines- Suction line – Return lines – Working Pressure lines.		
UNIT-II	**SOURCE OF FLUID POWER**	09
Overview of basic hydraulic system - Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, and Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps - Problems. Overview of basic pneumatic system - Types of compressor - Construction and working of compressor - Performance of compressor. Need for compressed air conditioning – pneumatic dryer – Filter, regulator and lubricator – Muffler – purpose and types.		
UNIT-III	**COMPONENTS OF HYDRAULIC AND PNEUMATIC SYSTEMS**	09
Hydraulic and Pneumatic actuators – Types – linear and rotary, Construction and working of double acting cylinder, special actuators – rod less, tandem, telescopic cylinders - flexible actuators. Cushioning mechanism. Types of actuating mechanism. Sensors – limit switches, reed switches and pressure switches. Direction control, Flow control and Pressure control valves, Quick Exhaust valve, sequencing and relief valve - Types, Construction and Operation- Power pack. Fluid Power ANSI Symbols.		
UNIT-IV	**HYDRAULIC AND PNEUMATIC CIRCUITS**	09
Design of simple hydraulic and pneumatic circuits-Speed and force calculation of linear actuator - Accumulators, Intensifiers, Regenerative, Pump Unloading, Double- pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-safe, Speed control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical Hydraulic servo systems. Design of pneumatic circuit cascade method- Electro pneumatic circuits, Introduction to Fluidics, Pneumatic logic circuits.		
UNIT-V	**SERVO MECHANISM AND TROUBLESHOOTING**	09
Servo systems - Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Installation, Selection, Maintenance, Troubleshooting and Remedies in Hydraulic and Pneumatic systems. Low cost Automation - Applications of fluid power systems –case studies.		
	Contact Hours : 45	
List of Experiments		
Simulation of the performance of compressor and pump		
Design and execution of speed control of pneumatic and hydraulic actuators		
Simulation and modeling of flow and pressure of Pneumatic system		
Simulation and modeling of flow and pressure of Hydraulic system		
Design and execution of electro pneumatic circuit with programmed logic sequence using an PLC		
Design and execution of Logic circuits using pneumatic trainer kit.		
Modeling and simulation of hydraulic system model using MATLAB/LabVIEW software		
Design and simulation of pneumatic circuit for the sequential operation.		
Design and simulation of hydraulic circuit for the sequential operation.		
Design and simulation of electro pneumatic circuit for the sequential operation.		
Design and simulation of electro pneumatic circuit using electro pneumatic trainer kit.		
Design and simulation of Pneumatic Sequencing circuit by cascade method using pneumatic software.		
	Contact Hours : 45	
	Total Contact Hours : 90	

Course Outcomes: On completion of course students will be able to	
●	Design and analysis the performance of hydraulic and pneumatics actuators by recalling operating principles of fluid power systems
●	Exhibit the knowledge on selection of components of fluid power systems
●	Clarify the specific functional operations of hydraulic and pneumatic system
●	Identify the given problem and design the suitable circuit using pneumatic and hydraulic software
●	Troubleshoot and maintenance of the hydraulic and pneumatic systems

Text Books:	
1	Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2013.
2	Majumdar.S.R ” oil hydraulic system-Principle and Maintenance” Tata McGraw Hill, 2012.

Reference Books / Web links:	
1	Dudelyt, A Pease and John J Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.
2	Joji.P, “Pneumatic Controls”, Wiley India, 2008.
3	Majumdar, S.R., “Pneumatic Systems – Principles and Maintenance”, Tata McGraw Hill, 2007.
4	Shanmugasundaram.K, “Hydraulic and Pneumatic Controls”, Chand & Co, 2006.
5	Srinivasan.R, “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.

Web links for Theory & Lab:	
	https://www.hydraulicspneumatics.com/fluid-power-basics
	http://mech01-iitg.virtual-labs.ac.in/
	https://eerc03-iiith.vlabs.ac.in/

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19642.1	3	3	3	2	3	-	-	-	-	-	2	3	2	2	3
MT19642.2	3	2	2	-	1	-	-	-	-	-	1	2	3	3	2
MT19642.3	3	2	3	-	1	-	-	-	-	-	1	2	3	2	2
MT19642.4	3	3	3	2	3	-	-	-	-	-	1	2	1	2	2
MT19642.5	3	3	3	3	2	-	-	-	-	-	1	2	3	2	1
Average	3	2.6	2.8	1.4	2	-	-	-	-	-	1.2	2.2	2.4	2.2	2

MT19611	INNOVATION AND DESIGN THINKING FOR MECHATRONICS	EEC	L	T	P	C
			0	0	4	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 Model Innovation - 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 Mechatronics			
		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, lead, implement, and evaluate successful projects in any mechatronics discipline

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19611.1	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
MT19611.2	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
MT19611.3	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
MT19611.4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
Avg	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3

MT19621	MINI PROJECT	EEC	L	T	P	C
			0	0	2	1

Objectives: This laboratory course enables students to	
●	The main objective is to give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor. A project report has to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination 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 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 Internal Assessment					End semester Examinations	
Review I	Review II	Review III	Supervisor Assessment	Report evaluation by the supervisor	Report evaluation by the external examiner	Viva-Voce
5	10	15	10	10	10	40

		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 design principles and develop conceptual and engineering design of any mechatronics component
●	Demonstrate 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

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19621.1	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1
MT19621.2	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1
MT19621.3	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1
MT19621.4	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1
MT19621.5	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1
Avg	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1

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.

	Topics covered		
1	Numbers 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:	
●	Have mental alertness
●	Have numerical ability
●	Solve quantitative aptitude problems with more confident

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE 19621.1	1	1	1	-	-	-	-	-	-	-	-	3	1	-	-
GE 19621.2	1	1	1	-	-	-	-	-	-	-	-	3	1	-	-
GE 19621.3	1	1	1	-	-	-	-	-	-	-	-	3	1	-	-
GE 19621.4	1	1	1	-	-	-	-	-	-	-	-	3	1	-	-
GE 19621.5	1	1	1	-	-	-	-	-	-	-	-	3	1	-	-
Avg	1	1	1	-	-	-	-	-	-	-	-	3	1	-	-

SEMESTER VII

MT19701	AUTOMOTIVE MECHATRONICS	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To study about the basic Architecture and different systems in Automotive system
●	To observe the characteristics of the sensors used in Automotive Applications
●	To study about the working of different Control System in Automobiles
●	To find the fault occurrences and safety measures in Automobiles
●	To study about Hybrid Vehicles

UNIT-I	**INTRODUCTION**	**9**
Vehicle System Architecture - Electronic Control Unit: Operation, Design, Control Unit Software Motronic Engine Management System – Electronic Diesel Control.		
UNIT-II	**SENSORS AND ACTUATORS IN AUTOMOTIVE SYSTEMS**	**9**
Measuring Variables –Crank Shaft Sensor - Air Flow Rate Sensor – Throttle Angle Sensor – Coolant Sensor – Exhaust Gas Oxygen Sensor – Knock Sensor – Flex Fuel Sensor – Automotive Engine Control Actuators – Exhaust Gas Recirculation Actuator – Electric Motor Actuators.		
UNIT-III	**CONTROL AND COMMUNICATION SYSTEM**	**9**
Digital Engine Control and Features – Control Modes for Fuel Control – Discrete Time Idle Speed Control – EGR Control – Electronic Ignition Control – Digital Cruise Control – Antilock Braking System – Digital Braking System – Electronic Suspension Control System - Overview of automotive communication protocols, CAN, LIN, Flex Ray - TCP/IP for automotive - 802.11x communication protocols.		
UNIT-IV	**DIAGNOSTICS AND SAFETY IN AUTOMOTIVE SYSTEMS**	**9**
ISO 26262- Functional safety standard - Electronic Engine Control Diagnostics – Service Bay Diagnostic Tool – Onboard Diagnostics – Model Based Sensor Failure Detection – Misfire Detection – Expert systems in Automotive Diagnostics – Airbag Safety – Blind Spot Detection – Automatic Collision Avoidance System – Tire Pressure Monitoring System – Enhanced Vehicle Stability - AUTOSAR- standardized automotive software design.		
UNIT-V	**HYBRID DRIVES AND E-VEHICLES**	**9**
Drive Concepts: Introduction to Electric Motors, Power Electronics, Electric Drives, and Motor Control– Operating Strategies for Electric Hybrid Vehicle – Recuperative Brake System – Electrical Energy Accumulators – Tesla Roadster – Toyota Mirai - Volkswagen Golf GTE - Automotive energy storage systems: Batteries, ultracapacitors, flywheels and hydraulic accumulators - System design, integration and energy management.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Recognize the different system architecture of Automotive systems
●	Compare the sensor characteristics and Determine its suitability in Real time Environment
●	Determine the control system characteristics in Automotive Systems
●	Analyze the Fault Occurrences and Recognize the safety measures in Automobiles
●	Compare the system of the Hybrid Vehicles with other Vehicles

Text Books:	
1	Konrad Reif, “Automotive Mechatronics”, Springer, 2016
2	Robert Bosch GmbH, “Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, Springer, 2016.
3	Tom Denton , “Electric and Hybrid Vehicles”, IMI, 2016.

Reference Books / Web links:	
1	Mandy Concepcion, Automotive Electronic Diagnostics, Automotive Diagnostics and Publishing, 2009.
2	William Ribbens, “Understanding Automotive Electronics: An Engineering Perspective” Elsevier, 2017.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19701.1	3	2	2	-	2	-	-	-	-	-	-	2	3	-	3
MT19701.2	3	2	2	2	3	3	2	-	-	-	-	3	2	2	2
MT19701.3	3	1	1	2	-	1	-	-	-	-	-	1	-	3	2
MT19701.4	3	3	3	3	3	3	3	-	-	-	-	2	2	3	2
MT19701.5	3	-	2	-	-	-	-	-	-	-	-	2	2	2	1
Average	3	2	2	2.3	2.6	2.3	2.5	-	-	-	-	2	2.2	2.5	2

MT19702	COMPUTER AIDED DESIGN AND MANUFACTURING	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To introduce the student to the basic tools of computer-aided design (CAD) and computer- aided manufacturing (CAM).
●	To expose the student to contemporary computer design tools for aerospace and mechanical engineers
●	To expose the construction of solid models and usage of FEM
●	To expose the adequate knowledge in CNC System
●	To prepare the student to be an effective user of a CAD/CAM system

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.		
UNIT-II	**INTERACTIVE COMPUTER GRAPHICS**	**9**
Introduction of Hardware and Software - Input and Output devices - Creation of Graphics primitives - Graphical Input techniques -**Vector Tools for Graphics**- Display transformation in 2D and 3D - viewing transformation - clipping - hidden line elimination – Model storage and data structure - Data structure organization, Hierarchical data structure. Network data structure - Relational data structure. Data storage and search methods.		
UNIT-III	**SOLID MODELING AND GRAPHICS SYSTEM**	**9**
Geometric modeling - wire frame, Surface and Solid models - CSG and B-Rep techniques – Wire frame versus Solid modeling - **Assembly Modeling** Introduction the software Configuration of Graphics System, Functions of Graphics Packages, Graphic standards - Introduction to Finite Element Analysis.		
UNIT-IV	**CNC MACHINES**	**9**
Basic principles of numerical control; Methods of coding, Computer Numerical Control (CNC) System, Machine Structure, drive system, CNC programming, Machining center, CNC Tooling. Direct Numerical control (DNC), Adaptive control machining systems: Adaptive control optimization, Adaptive control constraints.		
UNIT-V	**COMPUTER AIDED PROCESS PLANNING SYSTEMS**	**9**
Principle of computer integrated manufacturing, Approaches to Computer aided Process Planning (CAPP) - Generative and Retrieval CAPP systems, benefits of CAPP, Material Requirement Planning (MRP), mechanism of MRP, Capacity Planning, Computer integrated production planning and control, Shop floor control.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics
●	Explain the fundamentals of parametric curves, surfaces and Solids
●	Summarize the different types of Standard systems used in CAD
●	Apply NC & CNC programming concepts to develop part programme for Lathe & Milling Machines
●	Summarize the different types of techniques used in Cellular Manufacturing and FMS

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

Reference Books / Web links:	
1	David F. Rogers and Alan Adams. J, “Mathematical Elements for Computer Graphics”, McGraw - Hill Education, New York, 2017.
2	Groover and Zimmers, CAD/CAM; “Computer Aided Design and Manufacturing, Pearson Education” , New Delhi, 2006.
3	Paul G. Ranky, “Computer Integrated Manufacture, Prentice” – Hall International, UK,1986.

4	Radha Krishnan.P and Kothandaraman.C.P, “Comuter Graphics and Design”, Dhanpat Rai and sons, New Delhi, 1991.
5	William M. Newman, Robert F.Sproull, “Principles of Interactive Computer Graphics”, McGraw-Hill International Book Company, second edition (reprint), 2010.
6	PN Rao, “CAD/CAM: Principles and Applications” McGraw Hill Education; 3rd edition 2017

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19702.1	-	-	-	3	3	-	-	-	-	2	-	2	1	1	-
MT19702.2	-	-	-	3	3	-	-	-	-	2	-	2	1	1	-
MT19702.3	-	-	-	3	3	-	-	-	-	2	-	2	1	1	-
MT19702.4	-	-	-	3	3	-	-	-	-	2	-	2	1	1	1
MT19702.5	-	-	-	3	3	-	-	-	-	2	-	2	1	1	1
Average	-	-	-	3	3	-	-	-	-	2	-	2	1	1	1

MT19703	INDUSTRIAL AUTOMATION	PC	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the various types of Automation processes
●	To study about the hardware and software involved in a PLC
●	To provide the control functions involved in DCS and SCADA
●	To give adequate information in the interfaces used in HMI

UNIT-I	INTRODUCTION TO INDUSTRIAL AUTOMATION	9
Introduction to Industrial Automation, Requirements of Industrial Automation, Types of Automation – Localized Process-Distributed process-supervisory and data acquisition, Components of Industrial Automation, Advantages of industrial automation.		
UNIT-II	**PROGRAMMABLE LOGIC CONTROLLER**	**9**
PLC architecture, Parts of PLC, CPU and Memory, Input/output modules, power supplies, relays, switches, Relay logic, PLC programming languages, Ladder logic, Timers and Counters, selection of PLC based on input and output.		
UNIT-III	**DISTRIBUTED CONTROL SYSTEM**	**9**
Introduction to DCS - Distributed Control System (DCS) architecture, Database organization in DCS, System elements of DCS - Field station - Intermediate station - Central computer station, Reliability parameters of DCS, Classifications of Alarms in DCS.		
UNIT-IV	**SCADA SYSTEM & ARCHITECTURE**	**9**
Introduction, Application areas of SCADA, Major elements of SCADA systems, Comparison of SCADA, DCS and PLC, Considerations and benefits of SCADA system. Introduction to field- programmable gate array (FPGA).		
UNIT-V	**HUMAN MACHINE INTERFACE**	**9**
HMI –Automation system structure, Instrumentation subsystem, control subsystem, Human interface subsystem-operator panel-construction of the panel-Interfacing with control sub system-Types of Mimic panels, Advance HMI system-Intelligent operator panel-operator station- Data logging station. Case studies: Loading and unloading, Material Transfer application.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Relate the significance of control in automation.
●	Choose appropriate PLC and explain the architecture, installation procedures and trouble shooting.
●	Connect the PLC peripherals with the ladder programming.
●	Summarize the working of various elements of DCS and SCADA.
●	Identify and interpret the processes in HMI.

Text Books:	
1	Dobrivoje Popovic and Vijay Bhatkar, “Distributed control for Industrial Automation”, Marcel Dekker Inc, 2012.
2	Frank D Petruzella, “Programmable Logic Controllers”, Tata McGraw Hill Publications, 2016.

Reference Books / Web links:	
1	Michael P.Lukas, “Distributed Control system”, Van Nostrand Reinhold co, Canada, 2012.
2	Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.
3	Stuart A Boyer, “SCADA-supervisory control and data acquisition”, International Society of automation, 3rd edition,2011.
4	William T. Shaw, Cybersecurity for SCADA systems, Penn Well Books, 2006.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19703.1	3	3	3	3	1	-	-	1	1	-	-	1	2	2	1
MT19703.2	3	3	3	3	1	-	-	-	1	-	-	1	2	2	1
MT19703.3	3	3	3	3	1	-	-	-	1	-	-	1	2	2	1
MT19703.4	3	3	3	3	1	-	-	-	1	-	-	1	2	2	1
MT19703.5	3	3	3	3	1	-	-	-	1	-	1	1	2	2	1
Average	3	3	3	3	1	-	-	1	1	-	1	1	2	2	1

MT19704	MACHINE VISION	PC	L	T	P	C
			3	0	0	3

Objectives:	
•	To study the Basics of the vision systems
•	To study the algorithms of vision systems
•	To study the recognition technique for objects
•	To study the applications and software for vision systems

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 dept values.		
UNIT-IV	**APPLICATIONS**	9
Transforming sensor reading, Mapping Sonar Data, aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.		
UNIT-V	**ROBOTS VISION**	9
Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV – The cv bridge Package.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
●	Predict the vision systems fundamentals
●	Determine which vison algorithm will be suited to predict objects
●	Design object recognition techniques for detecting the objects
●	Design simple vision robot applications
●	Interpret the applications of Vision Robots in different software

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 Pi Robot Production, 2012.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19704.1	3	3	3	2	1	-	-	-	-	-	-	-	2	2	1
MT19704.2	3	3	3	2	1	-	-	-	-	-	-	-	3	3	3
MT19704.3	3	3	3	3	2	2	-	-	-	-	-	1	3	2	3
MT19704.4	3	3	3	1	-	1	-	-	-	-	-	1	1	1	2
MT19704.5	3	2	2	1	-	1	-	-	-	-	-	2	3	1	3
Average	3	2.8	2.8	1.8	1.3	1.3	-	-	-	-	-	1.3	2.4	1.8	2.4

MT 19711	COMPUTER AIDED ENGINEERING LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives: This laboratory course enables students to	
●	To impart the fundamental knowledge on using various CAD tools for Engineering Simulation. To know various fields of engineering where these tools can be effectively used to improve the output of a product

List of Experiments			
1	Modelling of a part using any CAD package		
2	Modelling and assembling of the mechanical assembly using any CAD package		
3	Structural analysis using FEA software – any analysis package		
4	Beam deflection analysis using FEA software – any analysis package		
5	Modelling and tool path simulation – turning using any CAM package		
6	Modelling and tool path simulation – milling using any CAM package		
7	NC code generation for milling using any CAM package		
8	NC code generation for turning using any CAM package		
	Total Contact Hours	**:**	**45**

Course Outcomes: On completion of the course, the student will be able to:	
●	Develop a model using CAD Package for real time applications
●	Model and assemble a given three-dimensional engineering components
●	Perform various analyses on simple structures for the application of different loads
●	Generate CNC programs for a given components to work with CNC machines
●	Develop CNC programs for real time applications

CO \ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT19711.1	-	-	-	3	3	-	-	-	-	2	-	2	1	1	-
MT19711.2	-	-	-	3	3	-	-	-	-	2	-	2	1	1	-
MT19711.3	-	-	-	3	3	-	-	-	-	2	-	2	1	1	-
MT19711.4	-	-	-	3	3	-	-	-	-	2	-	2	1	1	1
MT19711.5	-	-	-	3	3	-	-	-	-	2	-	2	1	1	1
Avg	-	-	-	3	3	-	-	-	-	2	-	2	1	1	1

MT19712	INDUSTRIAL AUTOMATION LABORATORY	PC	L	T	P	C
			0	0	3	1.5

Objectives: This laboratory course enables students to	
●	To be able to do PLC programming for automation
●	To be Familiar with HMI
●	To be familiar with SCADA

List of Experiments			
1	To study the block diagram and input and output modules interfaces of Programmable Logic Controller		
2	Introduction to ladder programming and to implement basic logic gates		
3	Water level and flow control with PLC programming		
5	Temperature control with PLC programming		
7	Belt conveyor control with PLC programming and HMI		
8	Washing Machine Control		
9	Position control of servo motor		
10	IOT/wireless control of electrical appliance using PLC		
11	Automatic Bottle filling system using PLC		
12	Basic hardware wiring connection panel kit with PLC		
13	Create a New SCADA for Temperature control application		
14	Density based four way traffic light control with pedestrians control		
	Total Contact Hours	**:**	**45**

Course Outcomes: On completion of the course, the student will be able to:	
●	Analyze the working of PLC
●	Analyze the programming logics in PLC
●	Design control circuits using HMI
●	Develop interfacing circuits with PLC
●	Design and develop PLC programs for real time applications

Web links for virtual lab (if any)	
1	https://plc-coep.vlabs.ac.in/

CO \ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
MT 19712.1	3	2	1	-	1	-	1	-	-	-	1	1	3	1	2
MT 196712.2	3	2	1	-	1	-	1	-	-	-	1	1	3	1	1
MT 19712.3	3	2	1	-	1	-	2	-	-	-	-	1	3	2	2
MT 19712.4	3	2	1	-	1	-	2	-	-	-	-	2	3	2	2
MT 19712.5	3	2	2	-	1	-	3	-	-	-	3	2	3	2	3
Avg	3	2	1.2	-	1	-	1.8	-	-	-	1	1.4	3	1.6	2

MT19713	MECHATRONICS PROBLEM SOLVING USING AI, ML AND DL	EEC	L	T	P	C
			0	0	4	2

Objectives: This laboratory course enables students to	
●	Collect the data and prepare the data for analysis using various AI, ML techniques
●	Analyse the data and perform post processing to interpret the results obtained by AI Ml techniques

GUIDELINE FOR REVIEW AND EVALUATION			
	The students will be required to identify a number of problems (a minimum of 5 problems from various mechatronics sub-domains). The data collection and preprocessing of the data will be done either through experimental setup or real-time data will be collected from open source online resources. Various artificial intelligence techniques will be employed to analyze the data and interpret the outcome of the analysis. The students will be required to use any of software tools for coding to implement the same and provide the results. Assessment will be based on the continuous internal reviews for 50 marks and the final viva carrying 50 marks.		
	Total Contact Hours	**:**	**60**

Course Outcomes: On completion of the course, the student will be able to:	
●	Ability to identify and analyze an engineering problem
●	Use various software tools to prepare and organize the data for analysis
●	Solve a mechatronics problem using AI, ML and DL methods
●	Perform coding using any of the software
●	Prepare a report based on the problems solved and provide solutions for the problems based on the analysis.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE 19721.1	3	3	3										3	3	1
GE 19721.2	1	1	1		3								3	3	1
GE 19721.3	2	2	2	2	3				3	2	3	3	3	3	1
GE 19721.4					3							3	3	3	1
GE 19721.5									3	2	3	3	3	3	1
Avg	2	2	2	2	3				3	2	3	3	3	3	1

MT 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 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 students 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.

Each batch is required to select any new component or an integrated mechatronics system that involves 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 Internal Assessment					End semester Examinations	
Review I	Review II	Review III	Supervisor Assessment	Report evaluation by the supervisor	Report evaluation by the external examiner	Viva-Voce
5	10	15	10	10	10	40

Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course, the student will be able to:	
●	Ability to identify and analyze an engineering problem
●	Use of design principles and develop conceptual and engineering design of any mechatronics component
●	Demonstrating the ability to perform literature review and analyse an engineering problem
●	Ability to prepare the project as a technical report and deliver it in oral presentation
●	Ability to show their team work and technical Skills

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE 19721.1	3	3	3	3									3	3	
GE 19721.2	3	3	3	3	3	2	2	2					3	3	
GE 19721.3	3	3	3										3	3	
GE 19721.4									3	2	3	3			1
GE 19721.5									3	2	3	3			1
Avg	3	3	3	3	3	2	2	2	3	2	3	3	3	3	1

MT19722	COMPREHENSION IN MECHATRONICS ENGINEERING	EEC	L	T	P	C
			0	0	2	1

Objectives: This laboratory course enables students to	
●	To encourage the students to comprehend the knowledge acquired from the first Semester to Sixth Semester of B.E Degree Course through periodic exercise

GUIDELINE FOR REVIEW AND EVALUATION			
1	**Assessment Scheme** The Internal assessment marks will be evaluated based on five internal assessments (each with a weightage of 10 marks), consisting of Minimum 100 multiple choice questions from each of the domains such as Mechanical, Electronics, Electrical and control, Automation and robotics, and Programming. The end semester assessment will be conducted with 30 two marks questions and 80 MCQs for 100 marks.		
	Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course, the student will be able to:	
●	Understand and comprehend any given problem related to mechatronics engineering field
●	Recall basic concepts from various domains such as mechanical, electrical, electronics and programming
●	Understand the impact of the professional engineering solutions in societal and environmental contexts,
●	Communicate effectively on the engineering problems and solutions
●	Acquire the skills for lifelong learning

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE 19722.1	3	3	1	2	1								1	3	1
GE 19722.2	3	3	1	2	1								1	3	1
GE 19722.3						2	2	2					1	3	1
GE 19722.4									2	2			1	3	1
GE 19722.5											1	1	1	3	1
Avg	3	3	1	2	1	2	2	2	2	2	1	1	1	3	1

SEMESTER VIII

MT19811	PROJECT WORK PHASE -II	EEC	L	T	P	C
			0	0	16	8

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

The project report shall carry a maximum of 30 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 50 marks. Marks are awarded to each student of the project group based on the individual performance in the viva-voce examination

Continuous Internal Assessment					End semester Examinations	
Review I	Review II	Review III	Supervisor Assessment	Report evaluation by the supervisor	Report evaluation by the external examiner	Viva-Voce
5	10	15	10	10	10	40

Total Contact Hours	**:**	**240**

Course Outcomes: On completion of the course, the student will be able to:	
●	Ability to fabricate any components using appropriate manufacturing techniques
●	Use of design principles and develop conceptual and engineering design of any mechatronics component
●	Demonstrate the function of the fabricated model
●	Prepare the project as a technical report and deliver it in oral presentation
●	Exhibit their team work and technical Skills

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE 19811.1	3	3	3	3	3								3	3	1
GE 19811.2	3	3	3	3	3								3	3	1
GE 19811.3	3	3	3	3	3								3	3	1
GE 19811.4						1	1	1	3	2	3	3	3	3	1
GE 19811.5						1	1	1	3	2	3	3	3	3	1
Avg	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1

PROFESSIONAL ELECTIVES (PE)*

DEPARTMENT OF MECHATRONICS ENGINEERING
R2019- Professional Elective Syllabus
VERTICAL 1
COMPUTATIONAL ENGINEERING

ME19A11	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	PE	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 Perceptron's, 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: Upon completion of the course students should be able to:	
CO1	Understand basic machine learning techniques such as regression, classification
CO2	Understand about clustering and segmentation
CO3	Model a fuzzy logic system with Fuzzification and Defuzzification
CO4	Understand the concepts of neural networks and neuro fuzzy networks.
CO5	Gain knowledge on Reinforcement learning.

TEXT BOOKS:	
1	Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011
2.	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997

REFERENCES:	
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,
4.	https://nptel.ac.in/courses/106106202
5.	https://nptel.ac.in/courses/108104049

ME19A12	CAD and CAE	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
	Applying the fundamental concepts of computer graphics and its tools in a generic framework.
	Creating and manipulating geometric models using curves, surfaces, and solids.
	Applying concept of 3D modeling, visual realism,and CAD standard practices in engineering design
	Developing mathematical models for Boundary Value Problems and their numerical solution.
	Formulating solution techniques to solve non-linear problems

UNIT-I	FUNDAMENTALS OF COMPUTER GRAPHICS	9
Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations - Graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation. Standards for computer graphics		
UNIT-II	**GEOMETRIC MODELING**	**9**
Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling – Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (B-Rep), Sweeps Representation, Constructive Solid Geometry (CSG).		
UNIT-III	**VISUAL REALISM and CAD STANDARDS**	**9**
Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence algorithms, Warnock's Algorithm, Priority Algorithms– shading – coloring – computer animation. Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange imagesOpen Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc.		
UNIT-IV	**FINITE ELEMENT ANALYSIS**	**9**
Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational. Formulation of Boundary Value Problems – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems.		
UNIT-V	**NON-LINEAR ANALYSIS**	**9**
Introduction to Non-linear problems - some solution techniques- computational procedure- material non-linearity- Plasticity and visco-plasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing –Mesh quality- Error estimate- Introduction to Analysis Software.		
	Total Contact Hours	**: 45**

Course Outcomes: At the end of the course, the students would be able to	
CO1	Discuss the fundamental concepts of computer graphics and its tools in a generic framework.
CO2	Create and manipulate geometric models using curves, surfaces and solids.
CO3	Discuss concept of 3D modeling , visual realism and standard CAD practices in engineering design.
CO4	Develop the mathematical models for one dimensional finite element problems and their numerical solutions.
CO5	Formulate solution techniques to solve non-linear problems.

Text Books:	
1	Ibrahim Zeid ―Mastering CAD CAM‖ Tata McGraw-Hill Publishing Co.2007
2	Seshu.P, ―Textbook of Finite Element Analysis‖, PHI Learning Pvt. Ltd., NewDelhi, 2012.

Reference Books(s) / Web links:	
1	William M Neumann and Robert F.Sproul ―Principles of Computer Graphics‖, McGraw Hill Book Co. Singapore, 1989.
2	Donald Hearn and M. Pauline Baker ―Computer Graphics‖'. Prentice Hall, Inc, 1992.
3	Foley, Wan Dam, Feiner and Hughes – ―Computer graphics principles & practice‖, Pearson Education - 2003
4	Reddy,J.N. ―Introduction to the Finite Element Method‖, 4thEdition, Tata McGrawHill,2018.

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	1	1	1	2	1	3	2	2	1	2	2	1	1
CO2	2		1	1	1	2	1	3	2	2	1	2	2	1	1
CO3	1	1	1	1	2	1	3	2	3	1	1	2	2	1	1
CO4	3	3	2	2	2	1	3	2	3	1	1	1	2	1	1
CO5	3	3	2	2	2	1	3	2	3	1	1	1	2	1	1
	2	2	1.4	1.4	1.6	1.4	2.2	2.4	2.6	1.4	1	1.6	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

ME19A13	NUMERICAL HEAT TRANSFER	Category	L	T	P	C
		PE	3	0	0	3

Objectives:

	To analyse mathematical and computational methods for fluid flow and heat transfer simulations
	To use the Nature of Numerical Methods and Methods of Deriving the Discretization Equations
	To assess the Conduction flow analysis
	To assess the flow of Convection and Diffusion flow analysis
	To assess the flow parameters in internal and external flows

UNIT-I	Mathematical Description of Physical Phenomena	9

Governing Differential Equation – Meaning of Differential Equation, Conservation of Chemical Species, The Energy Equation, A Momentum Equation, The Time -Average Equation for Turbulent -Flow, The General Differential Equations. Nature of Coordinates – Independent variables, Proper choice of coordinates, one-way and two-way coordinates problem

UNIT-II	Discretization Methods	9

The Nature of Numerical Methods – The Task, The Discretization concept, The structure of Discretization Equation. Methods of Deriving the Discretization Equations- Taylor Series Formulation, Variation Formulation , Method of Weighted Residuals, Control volume Formulation and examples,

UNIT-III	Heat Conduction	9

Steady one-dimensional conductions, The Basic Equations, The Grid Spacing, The interface Conductivity, Nonlinearity, Source-term Linearization, Boundary Conditions. Unsteady one-Dimensional Conduction- The General Discretization‘s Equation, Explicit, Crank-Nicolson and Fully Implicit Schemes. Two and Three Dimensional Situations, Geometric considerations.

UNIT-IV	Convection and Diffusion	9

Steady One-dimensional convection and Diffusion – Upwind scheme, The exact solution, The Exponential Scheme, Hybrid scheme. Discretization Equation for Two Dimensions, Discretization Equation for Three Dimensions, One way space coordinate and False Diffusion.

UNIT-V	Calculation of the Flow Field	9

Need for a special procedure, Representation of the Pressure-Gradient Term and Continuity Equation. The Momentum Equation, The Pressure and Velocity Corrections, The SIMPLE Algorithm, The SIMPLER Algorithm and PISO Algorithms.

	Total Contact Hours	45

Course Outcomes: Upon completion of the course students should be able to:

CO1	Derive and apply the governing equations and boundary conditions for Fluid dynamics
CO2	Analyze Discretization concept and Discretization Equations
CO3	Analyze Finite difference and Finite volume method for Conduction problems
CO4	Analyze Finite difference and Finite volume method for Convection and Diffusion problems
CO5	Analyze Flow field problems

Text Books:

1	Patankar, S.V. ―Numerical Heat Transfer and Fluid Flow‖, Hemisphere Publishing Corporation, 2004
2	P. S. Ghoshdastidar, Computer Simulation of Flow and heat transfer, Tata McGraw Hill Publications, New Delhi.
3	Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Tata McGraw Hill Book Company.
4	Varsteeg, Malalasekera, An introduction to Computational Fluid Dynamics The finite volume method, Pearson Prentice

Reference Books(s) / Web links:

1	Chung, T.J. ―Computational Fluid Dynamics‖, Cambridge University, Press, 2002
2	Fletcher, C. A. J., ―Computational Techniques for Fluid Dynamics‖, Springer Verlag, 2011
3	Hyoung Woo Oh, ―Applied Computational Fluid Dynamics‖, InTech Publishers, 2012
4	John F Wendt ―Computational Fluid Dynamics‖ Springer, 2012

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	3	2	1	1	1	-	-	-	-	1	3	2	3
CO 2	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3
CO 3	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3
CO 4	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3
CO 5	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3
Avg	3	2	3	2	1.8	1	1					1	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A14	THEORY OF COMPUTATION AND VISUALIZATION	PE	3	0	0	3

Objectives:

- To develop a comprehensive understanding of finite automata.
- To Master the concept of regular expressions
- To Understand the Chomsky hierarchy, explore context-free grammars and languages
- To Acquire a foundational understanding of data visualization
- To develop proficiency in visualizing spatial, geospatial, and multivariate data using vario techniques.

UNIT-I	**Automata And Regular Expression**	**9**

Need for automata theory - Introduction to formal proof – Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Equivalence between NFA and DFA – Finite Automata with Epsilon transitions – Equivalence of NFA and DFA- Equivalence of NFAs with and without ε-moves- Conversion of NFA into DFA – Minimization of DFAs.

UNIT-II	**Regular Expressions And Languages**	**9**

Regular expression – Regular Languages- Equivalence of Finite Automata and regular expressions – Proving languages to be not regular (Pumping Lemma) – Closure properties of regular languages.

UNIT-III	**Context Free Grammar And Push Down Automata**	**9**

Types of Grammar - Chomsky_s hierarchy of languages -Context-Free Grammar (CFG) and Languages – Derivations and Parse trees – Ambiguity in grammars and languages – Push Down Automata (PDA): Definition – Moves - Instantaneous descriptions -Languages of pushdown automata – Equivalence of pushdown automata and CFG-CFG to PDA-PDA to CFG – Deterministic Pushdown Automata.

UNIT-IV	**Foundations For Visualization**	**9**

Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables –

Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson_s Affordance theory – A

UNIT-V	**Visualization Techniques**	**9**

Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three Dimensional Data - Dynamic Data - Combining Techniques. Geospatial Data : Visualizing Spatial Data - Visualization of Point Data -Visualization of Line Data - Visualization of Area Data – Other Issues in Geospatial Data Visualization Multivariate Data : Point-Based Techniques – LineBased Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.

Total Contact Hours: 45

Course Outcomes: At end of this course,

CO1: Analyze a given language and design an appropriate finite automaton

CO2: Formulate regular expressions for specific languages and prove the equivalence between finite automata and regular expressions.

CO3: classify grammars based on Chomsky's hierarchy, generate languages using context-free grammars

CO4: capable of designing effective visualizations and appreciating the historical development of visualization techniques.
CO5: Apply appropriate visualization techniques to represent different types of data effectively

Text Book(s):
1. Hopcroft J.E., Motwani R. & Ullman J.D., "Introduction to Automata Theory, Languages and Computations", 3rd Edition, Pearson Education, 2008.
2. John C Martin , "Introduction to Languages and the Theory of Computation", 4th Edition, Tata McGraw Hill, 2011.

Reference Books(s) / Web links:
1. Harry R Lewis and Christos H Papadimitriou, "Elements of the Theory of Computation", 2nd Edition, Prentice Hall of India, 2015
2. Peter Linz, "An Introduction to Formal Language and Automata", 6th Edition, Jones & Bartlett, 2016.
Colin Ware, ―Information Visualization Perception for Design‖, 4th edition, Morgan Kaufmann Publishers, 2021.

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
CO2	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
CO3	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
CO4	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
CO5	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A15	COMPUTATIONAL BIOMECHANICS	PE	3	0	0	3

Objectives:	
•	To Introduce principles and concepts of bio-mechanics
•	Focuses on the studies of tissues and structure of musculoskeletal system.
•	To study the mechanics of joints and human motion.
•	To explain the computational approaches in biomechanics
•	To learn the quantification of forces and motion.

UNIT-I	**Introduction To Biomechanics**	**9**
Perspective of biomechanics, Terminologies, Kinematic and kinetic concepts for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human Movement, Mechanical properties of soft tissues, bones, and muscles.		
UNIT-II	**Biomechanics Of Tissues And Structures Of The Musculoskeletal System**	**9**
Biomechanics of Bone, Biomechanics of Articular Cartilage, Tendons and Ligaments, Peripheral Nerves and Spinal Nerve Roots, Skeletal Muscle.		
UNIT-III	**Biomechanics Of Joints And Human Motion**	**9**
Knee, Hip, Foot and Ankle, Lumbar Spine, Cervical Spine, Shoulder, Elbow Wrist, and Hand, Linear kinematic and kinetic aspects of human movement, angular kinematic and kinetic aspects of human movement, equilibrium and human moment.		
UNIT-IV	**Computational Approaches In Biomechanics**	**9**
Finite Element Analysis in Biomechanics, Computational modelling of Vancouver Periprosthetic Fracture in Femur, Scaffolds, artificial hip and knee joints, Aortic Valve.		
UNIT-V	**Gait Analysis**	**9**
Exoskeleton design, Ergonomics, Sports mechanics, Performance Analysis, Biomechanical analysis, 3D printing.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course students should be able to:	
	Discuss the principles of mechanics.
	Elaborate the tissues and structures of the musculoskeletal system
	Discuss of joint mechanics and human motion.
	Create Examples of computational mathematical modelling applied in biomechanics.
	Describe the analysis of human motion.

Text Books:	
1	Susan J Hall, ―Basic Biomechanics, 6th Edition, The McGraw-Hill Companies Inc., 2011
2	Jay D Humphrey and Sherry L Delange, ―An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, 1st edition, Springer-Verlag, 2010
Reference Books(s) / Web links:	

1	Jay D. Humphrey, Sherry De Lange, ―An Introduction to Biomechanics: Solids and Fluids, Analysis and Design‖, Springer Science Business Media, 2004
2	Shrawan Kumar, ―Biomechanics in Ergonomics‖, Second Edition, CRC Press2007
3	Sheraz S. Malik et. al. ―Orthopaedic Biomechanics Made Easy‖, Cambridge University Press, 2015.

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	3	3	-	-	-	-	-	-	-	-	-	2	-
CO2	-	-	-	2	-	-	-	-	-	-	-	2	3		-
CO3	-	-	2	2	-	-	-	-	-	-	-		3		-
CO4	-	-	-	-	2	2	2	-	-	-	-	-	-	-	-
CO5	-	-	-	3	-	3		-	-	-	-	-	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A16	ADVANCED STATISTICS AND DATA ANALYTICS	PE	3	0	0	3

Objectives:	
•	To introduce the basic concepts of linear regression and multiple regression
•	To introduce exploratory data analysis
•	To study logistic regression models for classification
•	To develop the forecasting techniques for the predictions
•	To introduce the time series analysis for the prediction of future behavior

UNIT-I	Regression	9
Introduction – Linear regression - Correlation analysis -Limitations, errors, and caveats of using regression and correlation analyses - Multiple regression and correlation analysis - Inferences about population parameters – Modeling techniques. - Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Ridge regression.		
UNIT-II	**Exploratory Data Analysis**	**9**
Rise of statistics, Data Wrangling, Data Quality. Visual encoding – Mapping Data to Visual Variables, Encoding Effectiveness, Scales & Axes, Aspect Ratio, Regression Lines, Multidimensional Data, Parallel Coordinates, Dimensionality Reduction.		
UNIT-III	**Logistic And Multinomial Regression**	**9**
Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer Lemshow Test,		
UNIT-IV	**FORECASTING AND CAUSAL MODELS**	**9**
Forecasting – Basics, Methods of forecasting, Quantitative Methods, Delphi method, Qualitative methods , Moving average, Exponential Smoothing, Casual Models.		
UNIT-V	**TIME SERIES ANALYSIS**	**9**
Time series analysis- Types- Auto regression (AR), Moving Average(MA) Models, ARMA, ARIMA models , Multivariate Model,		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Apply regression analysis techniques to fit a mathematical model to given data,
•	Analyze and interpret data through the application of explanatory data analysis techniques
•	Integrate knowledge and skills to create a novel solution for data classification.
•	Analyzing forecasting techniques and causal inferences.
•	Assess and apply advanced time series analysis techniques to forecast future data behavior.

Text Books:	
1	Douglas C Montgomery and George C Runges, ―Applied Statistics and Probability for Engineer John Wiley &Sons, 2014
2	Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, ―Introduction to Time Series Analysis and Forecasting‖ ,Wiley,2015

Reference Books(s) / Web links:	
1	David Forsyth, _Probability and Statistics for Computer Science‘, Springer; 2018
2	Michael J. Evans, Jeffrey S. Rosenthal, _Probability and Statistics - The Science of Uncertainty‘. W H Freeman & Co, 2010
3	Max Kuhn, Kjell Johnson, —Applied Predictive Modeling‖, Springer, 2014.
4	Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers, —Probability and Statistics for Engineers and Scientists‖, Pearson Education, 2014.
5	Daniel T. Larose, Chantal D. Larose —Data Mining and Predictive Analytics‖, Wiley,2015
6	Thomas W.Miller, —Modeling Techniques in Predictive Analytics with Python and R: A guide to Data Science‖, Pearson Education, 2014.

PO-PSO CO	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1
CO2	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1
CO3	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1
CO4	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1
CO5	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A17	NOISE ACOUSTICS AND VIBRATION	PE	3	0	0	3

Course Objectives	
•	To introduce the concept of noise and its analysis methods
•	To impart knowledge about the source of noise and its control techniques
•	To introduce the concepts of Acoustics and measuring devices
•	To familiarize the students with knowledge about various types of vibrations
•	To enlighten the students with vibration measuring devices and control it.

UNIT-I	Basics Of Noise	9
Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.		
UNIT-II	**Source Of Noise And Its Control**	**9**
Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers		
UNIT-III	**Introduction To Acoustics And Its Measurements**	**9**
Theory of Sound—Predictions and Measurement, Sound Sources, Sound Propagation in the Atmosphere, Sound Radiation from Structures and Their Response to Sound. Signal Acquisition, and Processing, Acoustical Transducer Principles and Types of Microphones, Sound Level Meters, Noise Dosimeter, and Impedance tube		
UNIT-IV	**Fundamentals Of Vibration**	**9**
Basic definitions and concepts - Free vibration of single-degree-of-freedom systems Harmonic Motion and Harmonically Excited Vibration, Damping in Vibrating Systems, Introduction and response to forced vibration system.		
UNIT-V	**Vibration Measurement And Control**	**9**
Specification of Vibration Limits –Vibration severity standards- Vibration analysis in structural health monitoring – Vibration based fault detection in mechanical systems - Vibration Absorbers.		
	Total Contact Hours	**45**

Course Outcomes: At the end of the course the students would be able to:	
•	Comprehend the foundational principles of noise and differentiate between various methods for analyzing its diverse types
•	Apply methods for controlling noise and comprehend the principles of noise control techniques.
•	Utilize various measuring techniques to demonstrate a comprehensive understanding of the fundamental principles of sound.
•	Classify among various types of vibration, showcasing a comprehensive understanding of the fundamental principles of vibration.
•	Evaluate vibration severity using standards and perform **diagnosis** of structural health and fault detection in mechanical systems

Text Books:	
1	S.S Rao, ―Mechanical Vibration,‖ Sixth Edition, **Pearson Education**, 2018.
2	C. Sujatha, Vibrations and Acoustics, Measurement and Signal Analysis, McGraw-Hill Education (India) Pvt Limited, 2017.

Reference Books(s) / Web links:	
1	Debasish Chattopadhyay and Phatik Chandra Rakshit, Vibrations, Waves, and Acoustics, Books and Allied (P) Ltd, Kolkatta, 2010.
2	Malcolm J. Crocker (Author), Jorge P. Arenas (Author), Engineering Acoustics: Noise and Vibration Control (Wiley Series in Acoustics Noise and Vibration), Wiley Publication, 2021.
3	https://www.digimat.in/nptel/courses/video/112107087/
4	https://www.digimat.in/nptel/courses/video/112106225/

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	-	-	-	1	-	-	-	-	-	-	-	-	1
CO2	2	1	1	-	-	1	-	-	-	-	-	-	-	-	1
CO3	2	1	1	-	-	1	-	-	-	-	-	-	-	-	1
CO4	2	1	1	-	-	1	-	-	-	-	-	-	-	-	1
CO5	2	1	1	-	-	1	-	-	-	-	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A18	COMPUTATIONAL SOLID MECHANICS	PE	2	0	2	3

Objectives:
To study the definition and basics on theory of elasticity
To learn finite element method and procedure for static linear elasticity
To study the Non Linear and History depend problems
To study time dependent and dynamic problems of Small and large strain visco-plasticity
To study Structural Elements & Interfaces and contact using penalty method.

UNIT-I	**Basic On Theory Of Elasticity**	**9**
Definitions- notations and sign conventions for stress and strain, Equations of equilibrium. Strain – displacement relations, Stress – strain relations, Lame‘s constant –cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr‘s circle, Saint Venant‘s principle.		
UNIT-II	**Finite Element Method For Static Linear Elasticity**	**9**
Derivation and implementation of a basic 2D FE code with triangular constant strain elements. Generalization of finite element procedures for linear elasticity: interpolation and numerical integration in 1D, 2D and 3D. Deriving finite element equations - constructing variation forms; mixed methods. Accuracy and convergence; the Patch test.		
UNIT-III	**Non Linear And History Depend Problems**	**9**
Small strain hypo-elastic materials - Small strain visco-plasticity - Large strain elasticity -Large strain visco-plasticity.		
UNIT-IV	**Time Dependent And Dynamic Problems**	**9**
First-order systems - the diffusion equation - Explicit time integration – the Newmark method - Implicit time integration - Modal analysis and modal time integration.		
UNIT-V	**Structural Elements & Interfaces And Contact**	**9**
Continuum Beams – Shells – Cohesive Zones - Enforcing constraints using penalty methods and Lagrange Multipliers - Contact elements (in two dimensions)		
	Total Contact Hours	**: 45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Deliberate the definition and basics on theory of elasticity
•	Develop the finite element method for static linear elasticity, solve problems.
•	Examine non-linear and history-dependent problems, and apply problem-solving techniques to address them.
•	Examine time-dependent and dynamic problems, applying problem-solving skills to resolve the
•	Examine structural elements, interfaces, and contact in the context of problem-solving.

List of Exercises
1. Importing 3d model to FEA software and patch work
2. Mesh Convergence study
3. Nonlinear FEA- Geometry and material

4. Modal Analysis of rotor blade
5. Crushing analysis of can
6. Drop weight impact analysis
7. Composite stress analysis

Text Books:	
1	L.S.Srinath, Advanced Mechanics of Solids, 3rd Edition, Mcgraw Hill Publication, 2017.
2	R.D.Cook, Concepts and Applications of Finite Element Analysis, 4th Edition 2007

Reference Books(s) / Web links:	
1	S.Timoshenko, Theory of Elasticity, McGraw-Hill Education (India) Pvt Limited, 2010.
2	The Finite Element Analysis of Shells - Fundamentals (Computational Fluid and Solid Mechanics) by Dominique Chapelle and Klaus-Jurgen Bathe | 27 January 2013.
3	Inelastic Analysis of Solids and Structures (Computational Fluid and Solid Mechanics) by M. Kojic and Klaus-Jurgen Bathe | 22 October 2010.
4	https://archive.nptel.ac.in/courses/112/104/112104193/.
5	https://nptel.ac.in/courses/112106135

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	1	-	-	-	-	1	-	-	1	3	1	1
CO2	3	3	2	1	-	-	-	-	1	-	-	1	3	1	1
CO3	3	3	2	1	-	-	-	-	1	-	-	1	3	1	1
CO4	3	3	2	1	-	-	-	-	1	-	-	1	3	1	1
CO5	3	3	2	1	-	-	-	-	1	-	-	1	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A19	COMPUTATIONAL FLUID DYANAMICS	PE	3	0	0	3

Objectives:	
•	To analyze mathematical and computational methods for fluid flow and heat transfer simulations
•	To use the Finite difference and volume method for solving diffusion problems
•	Differentiate between datums, datum features, and the parts of datum systems
•	Understand various forms and orientation
•	Understand various tolerances and its application

UNIT-I	**Governing Equations And Boundary Conditions**	**9**
Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations		
UNIT-II	**Finite Difference And Finite Volume Methods For Diffusion**	**9**
Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three - dimensional diffusion problems – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.		
UNIT-III	**Finite Volume Method For Convection Diffusion**	**9**
Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportive, Hybrid, Power-law, QUICK Schemes		
UNIT-IV	**Flow Field Analysis**	**9**
Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms		
UNIT-V	**Turbulence Models And Mesh Generation**	**9**
Turbulence models, mixing length model, Two equation (k- Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Derive and apply the governing equations and boundary conditions for Fluid dynamics
•	Analyze Finite difference and Finite volume method for Diffusion problems
•	Examine and assess the Finite Volume Method applied to convective diffusion problems.
•	Apply Finite Volume Methods, executing pressure gradient representation, continuity, and advanced algorithms for fluid flow.
•	Interpret the Turbulence models and Mesh generation techniques

Text Books:	
1	Versteeg, H.K., and Malalasekera, W., ―An Introduction to Computational Fluid Dynamics: The finite volume Method‖, Pearson Education Ltd., 2007
2	Ghoshdastidar, P.S., ―Computer Simulation of flow and heat transfer‖, Tata McGraw Hill Publishing Company Ltd., 1998.

Reference Books(s) / Web links:	
1	Patankar, S.V. ―Numerical Heat Transfer and Fluid Flow‖,Hemisphere Publishing Corporation, 2004
2	Chung, T.J. ―Computational Fluid Dynamics‖, Cambridge University, Press, 2002
3	Fletcher, C. A. J., ―Computational Techniques for Fluid Dynamics‖, Springer Verlag, 2011
4	Hyoung Woo Oh, ―Applied Computational Fluid Dynamics‖, InTech Publishers, 2012
5	John F Wendt ―Computational Fluid Dynamics‖ Springer, 2012
6	Jiyuan TL, Guan Heng Yeoh, ―Computational Fluid Dynamics a Practical Approach‖ Butterworth-Heinemann, 1st Edition 2008.
7	Anderson, Jr., John D.., ―Computational fluid Mechanics the Basics with Applications‖ McGraw Hill Education, 2012.
8	https://nptel.ac.in/courses/112105045
9	https://archive.nptel.ac.in/courses/112/105/112105254/

PO-PSO / **CO**	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	3	2	1	1	1	-	-	-	-	1	3	2	3
CO2	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3
CO3	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3
CO4	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3
CO5	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

VERTICAL 2
LOGISTICS AND SUPPLY CHAIN MANAGEMENT

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

Objectives: The main learning objective of this course is

- To inculcate the fundamentals of the reliability concepts
- To inculcate the fundamentals of the reliability concepts
- To describe basic maintenance concepts
- To extract optimum maintenance decisions
- To Illustrate the root cause for maintenance problems

UNIT-I	RELIABILITY CONCEPTS	9

Reliability engineering - fundamentals – failure data analysis, Mean failure rate, Mortality curves concept of burn – in period, useful life and wear out phase of a system, mean time to failure, meantime between failure, hazard rate – failure density and conditional reliability-Maintainability and availability – simple problems

UNIT-II	RELIABLITY ESTIMATION	9

System reliability: Series, Parallel and Mixed configurations, Reliability improvement techniques, use of Pareto analysis – design for reliability – redundancy unit and standby redundancy- fault tree analysis – Optimization in reliability – Product design – Product analysis – Product development Product life cycles.

UNIT-III	MAINTENANCE CONCEPT	9

Proactive/reactive maintenance - Maintenance policies – Imperfect maintenance Preventive / breakdown maintenance – Optimal PM schedule and product characteristics – Inspection decisions - Maximizing profit - Minimizing downtime – Replacement decisions.

UNIT-IV	MAINTENANCE MODELS	9

Proactive/reactive maintenance - Maintenance policies – Imperfect maintenance Preventive / breakdown maintenance – Optimal PM schedule and product characteristics – Inspection decisions - Maximizing profit - Minimizing downtime – Replacement decisions.

UNIT-V	MAINTENANCE QUALITY	9

Five zero concept – FMEA- FMECA – Root cause analysis – Repair time distribution – Analysis of downtime – Maintainability prediction – Design for maintainability – Reliability Centered Maintenance.

	Total Contact Hours	: 45

Course Outcomes: Upon completion of the course students should be able to:

CO 1	Evaluate the different reliability measurements while applying the reliability concepts
CO 2	Select the suitable method of improving the reliability and integrate reliability concepts in new product design and development.
CO 3	Describe basic maintenance concepts
CO 4	Extract maintenance policies for maximizing the profit
CO 5	Make a diagnosis of maintenance problems

Text Books:

1	Srinath. L.S., ―Reliability Engineering‖, 4th edition Affiliated East west press, 2011
2	Andrew K.S.Jardine & Albert H.C. Tsang, ―Maintenance, Replacement and Reliability‖ , Taylor and Francis, 2006.

Reference Books:

1	Sharma S.C., ―Inspection Quality Control and Reliability‖, Khanna Publishers, 1998.
2	Bikas Badhury & Basu S K, ―Tero Technology: Reliability Engineering and Maintenance Management‖, Asian Books, 2003.
3	Mishra R C and Pathak K., ―Maintenance Engineering and Management‖, PHI,2012
4	Venkataraman. K ―Maintancence Engineering and Management‖, PHI Learning, Pvt. Ltd., 2007

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	3	1	-	2	2	2	-	2	-	-	2	-	1	1
CO 2	2	2	1	-	1	-	1	-	2	1	-	1	-	2	1
CO 3	3	1	1	-	2	3	1	1	2	1	2	1	-	-	1
CO 4	1	2	1	-	1	1	1	-	1	-	1	-	-	1	1
CO 5	2	1	1	-	1	1	1	1	1	1	-	1	-	1	1
Avg	2	1.8	1		1.4	1.75	1.2	1	1.6	1	1.5	1.25		1.25	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

ME19B12	WAREHOUSING AUTOMATION	Category	L	T	P	C
		PE	3	0	0	3

Objectives: The main learning objective of this course is

- To learn the basics of warehousing automation
- To describe the warehousing decisions
- To describe inventory management
- To solve the transportation network models
- To illustrate about MCDM models

UNIT-I **Introduction** **9**

Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

UNIT-II **Warehousing Decisions** **9**

P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods. Decision Making without Probabilities

UNIT-III **Inventory Management** **9**

Dynamic Lot sizing Methods, Inventory Models: Deterministic Demand -Economic Order Quantity (EOQ) Model,- Quantity Discounts for the EOQ Model - Economic Production Lot Size Model -Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.

UNIT-IV **Transportation Network Models** **9**

Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.

UNIT-V **MCDM Models** **9**

Analytic Hierarchy Process (AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.

Total Contact Hours : 45

Course Outcomes: Upon completion of the course students should be able to:

- To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

Text Books:

1. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.

Reference Books:

1. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
2. Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan,Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.
3. Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	-	2	1	1	2	1	1	1	-	-	-	-	1	1
CO 2	1	-	1	1	1	1	1	1	1	-	-	-	-	-	1
CO 3	1	-	-	1	1	-	1	1	1	-	-	-	-	-	-
CO 4	1	-	1	1	1	1	-	1	1	-	-	-	-	-	1
CO 5	1	-	2	1	1	2	1	1	1	-	-	-	-	-	-
AVG	1		1.5	1	1	1.5	1	1	1					1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

ME19B13	OPERATIONS MANAGEMENT	Category	L	T	P	C
		PE	3	0	0	3

Objectives: The students can be able to

- To understand the basics of production and operations management and its role in product design and
- To understand the various aspects of process planning and other controlling operations .
- To learn about the plant location and its layout
- To learn the activities of Materials and inventory management
- To learn about the quality concept and various quality control techniques

UNIT-I **INTRODUCTION TO OPERATIONS MANAGEMENT** 9

Operations Management – Introduction , Nature, Importance, historical development - Understanding similarities and difference among Products, Goods and Services and their interrelationships - Value Analysis – Production & Operations Strategy for Competitive Advantage; Types of Production System - Recent Trends in Production and Operations Management. Role of Operations in Strategic Management. Production and Operations strategy – Elements and Competitive Priorities. Nature of International Operations Management - Product Design – New Product Development, Make or Buy Decisions.

UNIT-II **PLANNING AND CONTROL OF OPERATIONS** 9

Process Planning – Process Redesigning, Procedure for designing a process - Production Planning and Control– Objectives, Elements, Stages of PPC - Demand Forecasting – Need, Types, Objectives and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning – Long range, Types, Rough cut plan, Capacity Requirements Planning (CRP) - Aggregate Planning – Approaches, costs - Overview of MRP, MRP II and ERP

UNIT-III **PLANT LOCATION AND LAYOUT** 9

Facility Location – Factors influencing Plant Location, Break even Analysis. Plant Layout – Classification of Layout, Layout Design Procedures – CRAFT, ALDEP, CORELAP. Line Balancing – Objectives of Assembly Line Balancing, Ranked Positional Weight Method, COMSOAL

UNIT-IV **MATERIALS MANAGEMENT AND INVENTORY CONTROL** 9

Materials Management – Objectives, Planning, Budgeting and Control. Overview of Materials Management Information Systems (MMIS). Purchasing – Objectives, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding - Overview of JIT . Inventory – Types of Inventory - Deterministic demand model – EOQ - Continuous and Periodic review Inventory models - Selective Inventory Control – ABC, VED, FSN Techniques

UNIT-V **QUALITY MANAGEMENT** **9**

Definitions of quality, The Quality revolution, quality gurus; TQM philosophies; Quality management tools, - Quality Control – Objectives, Importance, Quality Control Techniques – Control Charts - certification and awards. Lean Management - philosophy, elements of JIT manufacturing, continuous improvement. Six sigma - Human factors in job design – Ergonomics – Work Environment and Workers Safety-

Total Contact Hours : 45

Course Outcomes: Upon completion of this course, the students will be able to:

CO1	Understand the concept of production and operations management and its role in product design and
CO2	Analyze the various aspects of process planning and other controlling operations .
CO3	Understand the plant location and its layout
CO4	Understand the activities of Materials and inventory management
CO5	Learn about the quality concept and various quality control techniques

Text Books:

1. Jay Heizer, Barry Render (2014), Operations Management, 11th Edition, Pearson Education
2. Robert S.Russell, Bernard W.Taylor, (2013), Operations Management, 8th edition, Wiley.
3. Collier, Evans, Ganguly(2016), OM-Operations Management , Cengage Learning

Reference Books(s) :

1. Mahadevan B, Operations management: Theory and practice. Pearson Education India; 2015
2. E.S. Buffa, (2007), Modern Production / Operation Management, 8th edition, Wiley
3. R. B. Kanna, Production and Operations Management, PHI Learning Private Ltd, 2nd edition, 2015.
4. S. N. Chary, Production and Operations Management, Tata McGraw Hill Education Private Limited, 4th edition, 2009

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	1	1	1	-	1	2	1	1	2	3	2	3
CO 2	3	3	2	1	1	1	1	1	2	1	1	2	3	2	3
CO 3	3	3	2	1	1	1	1	1	2	1	1	2	3	2	3
CO 4	3	3	2	1	1	1	-	1	2	1	1	2	3	2	3
CO 5	3	3	2	1	1	1	-	1	2	1	1	2	3	2	3
AVG	3	3	2	1	1	1	1	1	2	1	1	2	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19B16	PRODUCTION PLANNING AND CONTROL	PE	3	0	0	3

Objectives: The students can able	
	To familiarize with various types of production and aspects of new product development.
	To understand the concepts and steps involved in work study.
	To identify various steps involved in product and process planning.
	To understand various components and functions of production scheduling.
	To understand inventory control and recent trends like JIT, MRPII and ERP.

UNIT-I	Introduction To Production Planning And Control	9

Objectives and benefits of production planning -Functions of production control-Types of productions–job shop, batch and continuous, Product Analysis – Marketing aspects, Product characteristics – Functional aspects –Operational aspects–Durability, dependability and aesthetic aspects, Production aspects-General approach to DFM–Guidelines for the selection of production processes-Guidelines for specific processes like casting, forming, machining and assembly.

UNIT-II	Workstudy	9

Method study, basic procedure –Selection-Recording of process - Critical analysis, Development - Implementation -Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study -Production study – Work sampling- Synthesis from standard data–pre-determined motion time standards.

UNIT-III	Product Planning And Process Planning	9

Product planning and information-Value Analysis-Problems in lack of product planning-Process planning and routing-Information needed for process planning- Steps in process planning- Quantity determination in batch production-Machine capacity, balancing-Analysis of process capabilities in a multi-product system.

UNIT-IV	Production Scheduling	9

Production Control Systems-Loading and scheduling- Master Scheduling-Scheduling rules-Gantt charts-Perpetual Loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing–Production Control systems-
Periodic batch control-MRPI-Kanban–Dispatching-Progress
reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT-V	Inventory Control And Recent Trends In PPC	9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures,
Two bin system-Ordering cycle system-Determination of Economic order quantity and economic lot size-ABC analysis-Recorder
Procedure-Introduction to computer integrated production planning systems, Elements of JIT, Fundamentals of MRPII and ERP.

	Total Contact Hours	45

Course Outcomes: At the end of this course, students can have the	
	Ability to distinguish the types of production and aspects of new product development.
	Ability to construct the various charts / diagrams and eliminate unnecessary movements and delays, also to calculate standard time to complete the assigned job.
	Ability to carry out value analysis of a product, prepare routing chart, also analyze process capabilities in a multi-product system.
	Ability to generate a better scheduling and line balancing, also to apply techniques for aligning completion times and due dates.

	Ability to adopt different methods of planning to control inventory in a manufacturing organization and to implement recent trends like JIT, MRPII, and ERP systems

Text Books:	
1	Mart and Telsang, ―Industrial Engineering and Production Management‖, First edition, S.Chand Company, 2000.
2	James .B. Dilworth, ―Operations management–Design, Planning and Control for manufacturing a services‖, Mc-graw Hill International Edition, 1992.

Reference Books(s)/ Web links:	
1	Elwood S. Buffa, and Rakesh K. Sarin, ―Modern Production/ Operations Management‖, 8th Editio John Wiley and Sons, 2000.
2	Kanishka Bedi, ―Production and Operations management‖, 2 Edition, Oxford University Press, 2007.
3	Norman Gaither, G. Frazier, ―Operations Management‖, 9th edition, Thomson learning IE, 2007.
4	Upendra Kachru, ―Production and Operations Management– Text and cases‖, 1 Edition, Excel books, 2007.
5.	Chary.S.N., ―Theory and Problems in Production & Operations Management‖, Tata McGraw Hil 1995.

WEBLINKS:

1. https://www.slideshare.net/sudhirpawar12/production-planning-control-ppt
2. https://www.youtube.com/watch?v=eHCfgC5rqW8
3. https://www.youtube.com/watch?v=JExh2DhqCG0
4. https://www.techtarget.com/searcherp/definition/production-planning
5. https://www.ddegjust.ac.in/2017/Uploads/11/POM-326.pdf

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	1	-	-	-	-	-	-	1	1	2	-	1
CO2	2	2	2	1	-	-	-	-	-	-	1	1	2	-	1
CO3	2	2	2	1	-	-	-	-	-	-	1	1	2	-	1
CO4	2	2	2	1	-	-	-	-	-	-	1	1	2	-	1
CO5	2	2	2	1	-	-	-	-	-	-	1	1	2	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19B17	OPERATIONS RESEARCH	PE	3	0	0	3

Objectives: The students can able

□	To create awareness about optimization techniques in utilization of resources and to formulate the linear programming model for industrial applications based on the constraints and availability of the resources.
□	To provide knowledge and training in Transportation and other production models and to obtain the optimal solution to maximize the profit.
□	To provide knowledge about the Network models and to furnish the solution for the failure of item.
□	To understand the deterministic and stochastic inventory models and to plan, manage the stocks to meet the customer demands.
□	To understand the Queuing models, queue discipline and to explore the ways to give better customer service.

UNIT-I	**Linear Programming Models**	**9**

Introduction to Operations Research-Scope, objectives, phases, models and limitations. Linear programming–formulation of LPP-Graphical method–Simplex algorithm–Artificial variables–Big M method–Two phase method –Duality formulation.

UNIT-II	**Transportation Models**	**9**

Transportation Models-Finding basic feasible solution–LCM, NWC and VAM methods–Optimal solution using MODI method–Unbalanced model and Degeneracy.
Assignment Models – Hungarian method for optimal solution - Unbalanced problem - Traveling Salesman problem. Sequencing Models-Processing Jobs through Machines, Jobs through Machines, and Jobs through Machines using Johnson algorithm.

UNIT-III	**Network And Replacement Models**	**9**

Networks models: Network logic – Ford - Fulkerson's rule – Shortest route – Project network – CPM and PERT networks–Critical path scheduling– Types of Floats and calculations. Replacement models: Types of failures-Present value factor-Replacement of items that deteriorate with time, Items that fail suddenly –Individual and Group replacement policies.

UNIT-IV	**Inventory Models**	**9**

Need for Inventory–Types of Inventories–Inventory costs-Economic order quantity–Deterministic Inventory models
–with and without shortages-Quantity discount models–Stochastic inventory models–Multi product models–Inventory control – P and Q systems – Determination of Buffer stock and Reorder level.

UNIT-V	**Queueingmodels**	**9**

Queueing models - Queueing systems and structures – Notation parameter – Poisson input – Exponential service – Single server and multi-server models—Constant rate service–Infinite population–Simulation–Monte Carlo technique–Inventory and Queuing problems.

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

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

□	Formulate are al-world mathematical linear programming model, select the constraints based on the availability of the resources and determine the optimal solution.
□	Build and solve specialized Transportation, Assignment and Sequencing problems with optimum results.
□	Investigate the nature of the project/failure and give suggestions towards decision making.
□	Know about the maintenance of inventory level, Plan the manufacturing policies and manage the stocks according to the customer demands.
□	Model a dynamic system as a queuing model and compute important performance measures for better customer service.

Text Books:	
1	Hamdy A Taha, ―Operations Research: An Introduction‖, 10th edition, PHI/Pearson education, 2017.
2	Wayne L. Winston, Jeffrey B. Goldberg, ―Operations Research Applications and Algorithms‖, Thomson Brooks/Cole, 2004.

Reference Books(s)/ Web links:	
1	Prem kumar Gupta and D.S. Hira, ―Problems in Operations Research‖, S.Chand, 2009.
2	Sharma JK, ―Operations Research: Theory and Applications‖, 5th edition, Macmillan India, 2013.
3	Pannerselvam R, ―Operations Research‖, 2nd edition, PHI, 2009.
4	Srinivasan G, ―Operations Research: Principles and Applications‖, 3rd edition EEEPHI, 2017.
5.	Tulsian and Pasdey V., ―Quantitative Techniques‖, Pearson Asia, 2002.

WEBLINKS:

1. https://www.coursera.org/courses?query=operations%20research
2. https://onlinecourses.nptel.ac.in/noc22_ma48/preview
3. https://www.classcentral.com/course/swayam-operations-research-14219
4. https://unacademy.com/course/introduction-to-operation-research/1V3SWDSO
5. https://www.theorsociety.com/training/

PO-PSO	POs												PSOs		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2
CO2	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2
CO3	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2
CO4	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2
CO5	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name(Theory course)	Category	L	T	P	C
ME19B18	SUPPLY CHAIN AND LOGISTICS MANAGEMENT	PE	3	0	0	3

Objectives: The students can able to

- Describe the role and drivers of supply chain management in achieving competitiveness.
- Understand about Supply Chain Network Design.
- Illustrate the issues related to Logistics in Supply Chain.
- Appraise about Sourcing and Coordination in Supply Chain.
- Understand the application of Information Technology and Emerging Concepts in Supply Chain.

UNIT-I	Introduction To Supply Chain And Logistics Management	9

Supply Chain and Logistics Management: Scope and Importance - Evolution of Supply Chain – Examples of supply Chains - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles–Relationship of Logistics to Supply Chain Management.

UNIT-II	Supply Chain Network Design	9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network- Distribution Network in Practice - Role of network Design in Supply Chain – Framework for networkDecisions–ImpactofuncertaintyonNetworkDesign– Networkdesigndecisions– Networkdesigndecisionsusing Decision Trees.

UNIT-III	Logistics In Supply Chain	9

Role of transportation in supply chain – Factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation - 3PL- 4PL- Global Logistics – Reverse Logistics: Reasons, Activities and issues.

UNIT-IV	Sourcing And Coordination In Supply Chain	9

Role of Sourcing in supply chain - Supplier selection, assessment and contracts - Design Collaboration – Sourcing, Planning and Analysis - Supply chain co-ordination - Bull whip effect – Effect of lack of coordination in supply chain and obstacles –Building strategic partnerships and trust within a supply chain.

UNIT-V	IT And Emerging Concepts In Supplychain	9

The role IT in supply chain-The supply chain IT framework-Customer Relationship Management- Internal Supply Chain Management –Supplier Relationship Management –Future of IT in supply chain–E-Business in supply chain -Risks in Supply Chain- Lean supply Chains- Sustainable supply Chains.

	Total Contact Hours	:	45

Course Outcomes: Upon completion of this course, students will acquire the

- Ability to understand the scope of Supply Chain & Logistics Management and the drivers of Supply Chain performance.
- Ability to design suitable Supply Chain network for a given situation.
- Ability to analyze and solve the issues related to Logistics in SCM.
- Ability to understand Sourcing, Coordination and current issues in SCM.
- Ability to appraise about the applications of IT in SCM and apply SCM concepts in selected enterprises.

Text Books:	
1	Sunil Chopra, Peter Meindl and D.V. Kalra, ―Supply Chain Management: Strategy, Planning and Operation", Pearson Education, 2016.
2	Dr. Shila Bootwala, Raisa Shaikh, Mohd Fazil Shareef ,‖Supply Chain and Logistics Management‖ Nirali Prakashan Publications, 2018 edition.

Reference Books(s)/ Web links:	
1	Ravi Ravindran A, Donald P. Warsing, Jr, ―Supply Chain Engineering: Models and Applications‖, CRC Press, 2012.
2	Srinivasan G.S, ―Quantitative models in Operations and Supply Chain Management‖, PHI, 2010.
3	Janat Shah, ―Supply Chain Management: Text and Cases‖, Pearson Education India, 2016.
4	Ashley McDonough, ―Operations and Supply Chain Management‖ Vibrant Publishers-2019 Edition
5	Khalid Zidan ,‖ Supply Chain Management‖ Create space Independent Publication, 2016 Edition

WEBLINKS:

1. https://onlinecourses.nptel.ac.in/noc23_mg71/preview
2. https://www.oxfordhomestudy.com/courses/supply-chain-courses-online/free-online-courses-in-logistics-and-supply-chain
3. https://www.coursera.org/learn/supply-chain-logistics
4. https://www.shiksha.com/online-courses/logistics-and-supply-chain-management-course-grlel96
5. https://www.linkedin.com/learning/supply-chain-foundations-2014

PO-PSO	POs												PSOs		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	1	1	1	1	-	-	1	-	-	2	-	-	2
CO2	2	1	1	1	1	1	-	-	1	-	-	2	-	-	2
CO3	2	1	1	1	1	1	-	-	1	-	-	2	-	-	2
CO4	2	1	1	1	1	1	-	-	1	-	-	2	-	-	2
CO5	2	1	1	1	1	1	-	-	1	-	-	2	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19B19	DATA SCIENCE	PE	3	0	0	3

Objectives: The students can able

	To understand the techniques and processes of data science.
	To apply descriptive data analytics.
	To visualize data for various applications.
	To understand inferential data analytics.
	To analysis and build predictive models from data.

UNIT-I	Introduction	9

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model– presenting findings and building applications - Data Mining - Data Warehousing – Basic Statistical descriptions of Data

UNIT-II	Describing Data	9

Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores

UNIT-III	Describing Relationships	9

Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean

UNIT-IV	Python Libraries For Data Wrangling	9

Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables

UNIT-V	Data Visualization	9

Importing Mat plot lib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Base map - Visualization with Sea born.

	Total Contact Hours	45

Course Outcomes: Upon completion of this course, students will be able to

CO1	Define the data science process
CO2	Express the different types of data description for data science process
CO3	Attain the knowledge on relationships between data
CO4	Utilize the Python Libraries for Data Wrangling
CO5	Apply visualization Libraries in Python to interpret and explore data

Text Books:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, ―Introducing Data Science‖, Mann Publications, 2016. (Unit I)
2. Robert S. Witte and John S. Witte, ―Statistics‖, Eleventh Edition, Wiley Publications, 2017. (U II and III)
3. Jake Vander Plas, ―Python Data Science Handbook‖, O‘Reilly, 2016. (Units IV and V)

Reference Books(s)/Web links:	
1	Allen B. Downey, ―Think Stats: Exploratory Data Analysis in Python‖, Green Tea Press,2014.
2	Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, ―Fundamentals of Data Science‖, C Press, 2022.
3	Chirag Shah, ―A Hands-On Introduction to Data Science‖, Cambridge University Press,2020.
4	Vineet Raina, Srinath Krishnamurthy, ―Building an Effective Data Science Practice: A Framewor to Bootstrap and Manage a Successful Data Science Practice‖, Apress, 2021.
5	Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.

WEBLINKS:

1. https://onlinecourses.nptel.ac.in/noc21_cs69/preview
2. https://onlinecourses.nptel.ac.in/noc21_cs69/preview
3. https://www.youtube.com/watch?v=GYRz3RAu4Bk
4. https://www.linkedin.com/pulse/top-10-data-science-certifications-from-beginner-enamul-haque
5. https://www.learndatasci.com/best-data-science-online-courses/

PO-PSO	POs												PSOs		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1	2	2	-	-	-	1	1	1	2	-	-	2
CO2	2	1	-	1	1	-	-	-	2	1	1	2	-	-	2
CO3	2	2	1	2	2	1	1	-	1	2	1	3	-	-	2
CO4	3	2	2	1	2	-	-	-	1	1	2	2	-	-	2
CO5	2	2	1	2	2	-	-	-	1	1	1	2	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

VERTICAL 3
ROBOTICS

MT19C11	AUTONOMOUS MOBILE ROBOTS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To introduce the fundamentals of mobile robotics
●	To expose the student to kinematics of mobile robots
●	To expose the sensors used in mobile robots
●	To study the methods used for planning and navigation of mobile robots

UNIT-I	LOCOMOTION	10
Introduction, Key issues for locomotion, Legged Mobile Robots, Leg configurations and stability, Examples of legged robot locomotion, Wheeled Mobile Robots, Wheeled locomotion: the design space, Wheeled locomotion: case studies		
UNIT-II	**MOBILE ROBOT KINEMATICS**	8
Kinematic Models and Constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Robot kinematic constraints, Examples: robot kinematic models and constraints, Mobile Robot Maneuverability, Degree of mobility, Degree of steerability, Robot maneuverability, Mobile Robot Workspace, Degrees of freedom, Motion Control- Open loop control (trajectory-following), Feedback control		
UNIT-III	**SENSORS FOR MOBILE ROBOTS**	9
Sensor classification, characterizing sensor performance, Wheel/motor sensors, Heading sensors, Ground-based beacons, Active ranging, Motion/speed sensors, Vision-based sensors, Representing Uncertainty, Statistical representation, Error propagation: combining uncertain measurements		
UNIT-IV	**MOBILE ROBOT LOCALIZATION**	9
The Challenge of Localization: Noise and Aliasing ,1 Sensor noise, Sensor aliasing, Effector noise, An error model for odometric position estimation, Localization-Based Navigation versus Programmed Solutions, Belief Representation, Map Representation, Probabilistic Map-Based Localization, Autonomous Map Building –the stochastic map technique		
UNIT-V	**PLANNING AND NAVIGATION**	9
Competences for Navigation: Planning and Reacting, Path planning, Obstacle avoidance, Navigation Architectures, Modularity for code reuse and sharing, Control localization, Techniques for decomposition, Case studies: tiered robot architectures		
	Total Contact Hours :	**45**

Course Outcomes: On completion of course students will be able to	
CO 1	Design wheeled robots
CO 2	Control mobile robots of different geometry
CO 3	Select and device suitable sensors for any mobile robots
CO 4	Identify and map the location of mobile robots
CO 5	Navigate mobile robots by avoiding obstacles

Text Books:	
1	Jared Kroff,“ Modern Perspectives of Mobile Robot Systems”, Clanrye International,USA,2015
2	Todd, D.J, Walking Machines, an Introduction to Legged Robots. Springer ,2012

Reference Books / Web links:	
1	Borenstein, J., Everet,t H.R., Feng, L., Navigating Mobile Robots, Systems and Techniques. A.K. Peters, Ltd.,USA, 1996
2	Cox, I.J., Wilfong, G.T. (editors), Autonomous Robot Vehicles. New York, SpingerVerlag, 1990
3	Craig, J.J., “Introduction to Robotics: Mechanics and Control”, Pearson Education India,2008
4	Mason, M., Mechanics of Robotics Manipulation. Cambridge, MA, MIT Press, 2001
5	Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, MIT Press Cambridge, England,2004

MT19C12	SOFT AND MICROROBOTICS	PC	L	T	P	C
			3	0	0	3

Objectives: This course enables the students	
●	To understand the basics and manufacturing techniques for Soft microrobots.
●	To design the soft robot mechanism for simple applications.
●	To infer the importance of materials for soft robotics.
●	To understand the basics, classification of microrobots.
●	To analyze the fabrication techniques, sensors and actuators for microrobots.

UNIT-I	**Introduction to Soft Microrobots**	**9**
Introduction – Science and History of Soft Robots - Robotics at the microscale – Materials for soft robotics – Manufacturing techniques for soft microrobots – Actuation Strategies – Applications of Soft microrobots – Hard Soft and Biohybrid Soft Microrobots.		
UNIT-II	**Design for Soft Robots Mechanism**	**9**
Soft Mechanisms: Deformable Mechanism: Concepts, Function, process of deformation, Soft/Rigid deforming, typical soft mechanisms. Biological Mechanism: Robotics inspired Biology, Musculoskeletal System. – Soft Robot Hands – Continuum Arm.		
UNIT-III	**Materials for Soft Robotics**	**9**
Basics of Polymer – Morphology and physical properties of polymer – structure and classification of polymers – Soft materials – Fabrication of soft robot parts		
UNIT-IV	**Introduction to Microrobotics**	**9**
Introduction – Microrobotic Applications – Classification – Drive Principles – Manipulation of Microobjects – Micromanipulators – Microassembly with the help of microrobots – flexible microrobots.		
UNIT-V	**Fabrication, Sensors and Actuators for Microrobots**	**9**
Two photon stereo lithography – Wafer-level Processes – Pattern Transfer – Surface Functionalization – precision microassembly – self-assembly – Miniature Cameras – Microscale Principles – Piezoelectric actuation – SMA based Actuation – Polymer Actuation - Magneto and Electrorheological Fluid actuators.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of this course the students will be able to	
CO 1	Examine the manufacturing techniques for soft robotics.
CO 2	Compare the working of different mechanisms for soft robots.
CO 3	Analyze the materials suitable for soft robotics.
CO 4	Describe the importance of Microrobotics for engineering applications.
CO 5	Construct the design process for fabrication of microrobots

Text Book (s):	
1	Kenjiro Fukuda, Kohei Nakajima, Koichi Suzumori, Ryuma Niiyama, The Science of Soft Robots Design, Materials and Information Processing, Springer Nature Singapore, 2023.
2	Sergej Fatikow, Ulrich Rembold, Microsystem Technology and Microrobotics, Springer Berlin Heidelberg, 2013.
3	Metin Sitti, Mobile Microrobotics, MIT Press, 2017.

Reference Books(s) / Web links:	
1	Filippo Rossi, Luca Magagnin, Soft Robotics, Elsevier Science, 2021.
2	Islam S.M. Khalil, Anke Klingner, Sarthak Misra, Mathematical Modeling of Swimming Soft Microrobots, Elsevier Science, 2021
3	Hideko Koshima, Mechanically Responsive Materials for Soft Robotics, Wiley, 2020.
4	Anak Agung Julius, Minjun Kim, U Kei Cheang, Microbiorobotics Biologically Inspired Microscale Robotic Systems, Elsevier Science, 2017.

MT19C13	MEDICAL ROBOTICS	PC	L	T	P	C
			3	0	0	3

Objectives: This course enables the students	
•	To describe the different types of medical robots and their potential applications
•	To understand the basic concepts in kinematics, dynamics and control relevant to medical robotics
•	To develop analytical skills necessary to design and implement robotic assistance for minimally invasive surgery.
•	To familiarize the concepts of applied medical robotics and medical robotics research.
•	To understand the various roles that robotics can play in healthcare.

UNIT-I	**INTRODUCTION TO MEDICAL ROBOTS**	**9**
Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – State of 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 FOR MEDICAL ROBOTS**	**9**
Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security.		
UNIT-IV	**SURGICAL ROBOTS**	**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 REHABILITATION AND MEDICAL CARE**	**9**
Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - Assistive robots – Robots in Physiotherapy - case studies		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of this course the students will be able to	
CO1	Compare various medical robots and their potential applications.
CO2	Describe the process of position tracking and hybrid systems
CO3	Apply robotics and its concepts in medical field.
CO4	Simulate a MIS procedure in surgical robotics
CO5	Design a medical robotic system given the specific requirement for rehabilitation and medical care.

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

Reference Books(s) / 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.

MT19C14	HUMANOID ROBOTICS	PC	L	T	P	C
			3	0	0	3

Objectives: This course enables the students	
●	To understand the classification, working of humanoid robots
●	To analyze the kinematic constraints of humanoid robots.
●	To derive the dynamic constraints of humanoid robots
●	To develop balance control strategies for humanoid robots
●	To infer the working of motion control and generation process in humanoid robots.

UNIT-I	**INTRODUCTION TO HUMANOID ROBOTS**	**9**
Introduction – Definition – Levels of Anthropomorphicity – Overview of Selester Humanoid Robot Platforms – Simulators used for Evolution of Humanoid Robots – Trends in Humanoid Robot Design – Characteristics of Humanoid Robots.		
UNIT-II	**KINEMATICS FOR HUMANOID ROBOTS**	**9**
Kinematic Structure – Forward, Inverse and Differential kinematics – Manipulability Ellipsoid – Kinematic redundancy – Motion Contracts through contacts - Differential Kinematics of chains with closed loops – differential motion relations of a humanoid robot.		
UNIT-III	**DYNAMICS FOR HUMANOID ROBOTS**	**9**
Underactuated Robot Dynamics – Dynamics models of a fixed base manipulator – Spatial Momentum of a Humanoid Robot – Constraint – Force Elimination Methods – Inverse Dynamics		
UNIT-IV	**BALANCE CONTROL FOR HUMANOID ROBOTS**	**9**
Dynamic Postural Stability – Inverted Pendulum on Foot Stability Analysis – ZMP Manipulation – Capture Point Based Analysis and Stabilization – Balance Control based on spatial momentum and its rate of change.		
UNIT-V	**MOTION GENERATION AND CONTROL**	**9**
ICP Based Gait generation and walking control – Biped walk on stand – Gait generation for irregular terrain and VRP GI Based walking control.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of this course the students will be able to	
CO1	Describe the characterization, levels of integrity of humanoid robots.
CO2	Analyze the kinematic constraints of humanoid robots
CO3	Analyze the dynamic constraints of humanoid robots
CO4	Develop control strategies for balance control in humanoid robots.
CO5	Apply motion generation techniques for simple applications.

Text Book (s):	
1	Malachy Eaton, Evolutionary Humanoid Robotics, Springer Berlin Heidelberg, 2015.
2	Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, Humanoid Robots Modeling and Control, Elsevier Science, 2018.

Reference Books(s) / Web links:	
1	Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, Humanoid Robots Modeling and Control, Elsevier Science, 2018.
2	Shuuji Kajita, Hirohisa Hirukawa, Kensuke Harada, Kazuhito Yokoi, Introduction to Humanoid Robotics, Springer Berlin Heidelberg, 2014
3	Bernd Henze, Whole-Body Control for Multi-Contact Balancing of Humanoid Robots Design and Experiments, Springer International Publishing, 2021.

MT19C15	PROGRAMMING FOR ROBOT OPERATING SYSTEM	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To be familiar with robot operating system programming
•	To understand the application of OOPS concepts in robot programming.
•	To know python programming for robotics application.
•	To understand robots and sensors supporting ROS system.
•	To learn about programming embedded boards.

UNIT-I	UBUNTU LINUX FOR ROBOTICS	10
GNU/Linux – Installing Ubuntu - Installing VirtualBox - Playing with the Ubuntu – Useful Ubuntu Applications - Shell Commands.		
UNIT-II	**C++ FOR ROBOTICS PROGRAMMING**	9
Started with C++ C/C++ in Ubuntu Linux – Learning OOP Concepts – Building a C++ Project.		
UNIT-III	**PYTHON FOR ROBOTICS PROGRAMMING**	9
Python - Timeline: The Python Language – Python in Ubuntu Linux – Introduction to Python Interpreter – Installing Python on Ubuntu 16.04 LTS – Verifying Python Installation - Writing First Code – Understanding Python Basics		
UNIT-IV	**KICK-STARTING ROBOT PROGRAMMING USING ROS**	9
Robot Programming - The ROS Equation - Robot Programming Before and After ROS Installing ROS - Robots and Sensors Supporting ROS – Popular ROS Computing Platforms – ROS Architecture and Concepts		
UNIT-V	**PROGRAMMING WITH ROS**	8
Programming Using ROS – Creating a ROS Workspace and Package - Using ROS Client Libraries – Programming Embedded Boards		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
CO1	Work with Ubuntu and Linux operating systems
CO2	Use C++ for programming Robot Operating System
CO3	Use Python for programming Robot Operating System
CO4	Program ROS Libraries.
CO5	Create ROS workspace and package

Text Books:	
1	Lentin Joseph, "Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy", Apress, 2018.

Reference Books / Web links:	
1	Aaron Martinez, Enrique Fernández, "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013.
2	Anis Koubaa, "Robot Operating System (ROS): The Complete Reference", Volume 3, Springer, 2018.
3	Morgan Quigley, "Programming Robots with Ros: A Practical Introduction to The Robot Operating System", Shroff Publishers & Distributors Pvt Ltd, 2016

MT19C16	AGRICULTURAL ROBOTICS AND AUTOMATION	PC	L	T	P	C
			3	0	0	3

Objectives: This course enables the students	
●	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, and Harvesting, 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 Rate Applications 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 models, Traction predictor spread sheet, 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		
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.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of this course the students will be able to	
CO1	Describe the areas in agricultural process where robotics can be applied
CO2	Integrate sensor and system for a required specific process in agricultural applications.
CO3	Apply Mechanics to the design various robot parameters
CO4	Convert various mechanisms into robot by providing actuation at specific links and joints of the mechanism.
CO5	Develop suitable robotic system for specific agricultural tasks.

Text Book (s):	
1	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.
2	Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2019.

Reference Books(s) / Web links:	
1	Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.
2	Stephen L 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, 2005.
4	Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2021.

MT19C17	UNDERWATER ROBOTICS	PC	L	T	P	C
			3	0	0	3

Objectives: This course enables the students	
●	To describe the role of underwater robots in engineering applications
●	To explain the various techniques for planning and navigation of Underwater robots.
●	To understand the procedure for prediction and control of motion for underwater robot
●	To illustrate the strategies for control of underwater robots.
●	To comprehend the importance of AUV in research.

UNIT-I	**INTRODUCTION TO UNDERWATER ROBOTICS**	**9**
Robotics in Water - Basics Representation of Underwater Robot - Types and Classification of Underwater Robotics - Differentiating Aerial and Underwater Robotics - Overview about Environmental Factors affecting object in water.		
UNIT-II	**PLANNING AND NAVIGATION**	**9**
Algorithms for SLAM, fault detection/tolerance systems; multiple coordinated vehicle; and networked vehicle. Signature detection, analysis, and optimization; sensor networks for radars, sonar and navigation; design of propulsion system; and trajectory measurements and simulations. Design and analysis of thrusters for AUGs/AUVs.		
UNIT-III	**MOTION PREDICTION AND CONTROL**	**9**
Motion prediction and control system, and co-operative adaptive sampling techniques. Design of variable buoyancy systems for UVs. Design of DCDM based controllers for UVs. Remote sensing and environmental monitoring with AUGs/AUVs, underwater vehicle-manipulator system, bio-mimetic underwater robotics, and bio-inspired robotics systems. Case studies from India, Republic of Korea, Japan and USA.		
UNIT-IV	**CONTROLLER TECHNIQUES FOR UNDERWATER ROBOTS**	**9**
Control System and Types of Control Systems in Underwater Robotics - Sensors Connected with the Underwater Robotics - Introduction to Underwater Manipulators - Introduction to Hydraulics on Underwater Vehicles - Applications of Underwater Vehicles.		
UNIT-V	**AUTONOMOUS UNDERWATER SYSTEMS:**	**9**
Introduction to AUVS - Development of AUVs, ROV in Market - Case Study on AUV Control System Basics - Case Study on Subsea Manipulator - Case Study on Technologies Used.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of this course the students will be able to	
CO1	Describe the working of different types of underwater robots
CO2	Illustrate the process of planning and navigation for underwater robots.
CO3	Predict the type of motion control for Underwater robot using various methodologies.
CO4	Analyze the parameters used for controller in underwater robots.
CO5	Emphasize the importance of AUV in research

Text Book (s):	
1	Gianluca Antonelli, ―Underwater Robots, Springer, 2014.
2	G. Griffiths, "Technology and applications of autonomous underwater vehicles", Ocean science and technology, vol. 2, CRC Press, USA, 2002.
Reference Books(s) / Web links:	
1	T. Fossen, "Guidance and control of ocean vehicles", Chichester New York, USA, 1994
2	R. Suttons, G Roberts, "Advances in unmanned marine vehicles", IEEE Control Series, Institution of Engineering and Technology, USA, 2006.
3	Cares & Dickmann, Operations Research for Unmanned Systems. Wiley, 2016
4	Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs. Que Publishing,2016.

MT19C18	ROBOTS AND SYSTEMS IN SMART MANUFACTURING	PC	L	T	P	C
			3	0	0	3

Objectives: This course enables the students	
●	To get a knowledge of working on Industrial robots and their load handling capacity
●	To enlist with an application of robots in various operation
●	To familiar with a material handling system
●	To impart the knowledge on robotic welding
●	To obtain the knowledge on various type of robot welding operation

UNIT-I	**INTRODUCTION**	**9**
Types of industrial robots - Load handling capacity - general considerations in Robotic material handling-material transfer - machine loading and unloading - CNC machine tool loading – Robot centered cell		
UNIT-II	**SELECTION OF ROBOTS AND OTHER APPLICATIONS**	**9**
Factors influencing the choice of a robot - robot performance testing - economics of robotization - Impact of robot on industry and society. Application of Robots in continuous arc welding – Spot welding - Spray painting -assembly operation - cleaning - robot for underwater applications.		
UNIT-III	**MATERIAL HANDLING**	**9**
concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems(ASRS) - bar code technology – radio frequency identification technology -Introduction to Automation Plant design software.		
UNIT-IV	**ROBOTIC WELDING**	**9**
Robotic welding system, Programmable and flexible control facility –Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding		
UNIT-V	**APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES**	**9**
Application of robot in manufacturing: Exploration of practical application of robots in welding: Robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of this course the students will be able to	
CO1	Describe various concepts of Industrial Robot.
CO2	Compare the different manufacturing procedure for Robots
CO3	Apply various manufacturing process in Robot manufacturing.
CO4	Illustrate the Welding operations related to Programming
CO5	Produce a manufacturing plan for developing a robot

Text Book (s):	
1	Richard D Klafter, Thomas Achmielewski, MickaelNegin , "Robotic Engineering – An integrated Approach", Prentice Hall India, New Delhi, 2006.
2	Mikell P Groover , "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, New York, 2019.
3	Pires J N, Loureiro A, Bolmsjo G, "Welding Robots: Technology, System Issues and Application", Springer, London, 2010.

Reference Books(s) / Web links:	
1	Parmar R S , "Welding Processes and Technology", Khanna Publishers, New Delhi, 2nd Edition, 2013.
2	John A. piotrowski, William T. Randolph , "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987.
3	Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, AshishDutta , "Industrial Robotics (SIE): Technology, Programming and Applications", 2nd Edition, McGraw Hill Education India Pvt Ltd, 2012.
4	YoramKoren , "Robotics for Engineers", McGraw-Hill, 1987.

ME19C11	DRONE TECHNOLOGIES	Category	L	T	P	C
		PE	3	0	0	3

Objectives:

1	To learn and understand the fundaments of design, fabrication and programming of drone
2	To learn and understand the fundaments of design, fabrication and programming of drone
3	To impart the knowledge on flying and operation of drone
4	To know about the Drone Design Mechanism For Various applications
5	To understand the safety risks and guidelines of fly safely

UNIT-I INTRODUCTION TO DRONE TECHNOLOGY **9**

History of Drone - Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT- DRONE DESIGN, FABRICATION AND PROGRAMMING **9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- Payload - The energy sources- Level of autonomy- Drones configurations - Drone Programming and Simulation – Multi rotor stabilization.

UNIT- DRONE FLYING AND OPERATION **9**

Concept of operation for drone -Flight modes- Flight control system –- Drone controls Flight operations –Management tool - Operate a small drone in a controlled environment –Sensors- Lidar, sonar, IMU, Optical flow and other sensors - Onboard storage capacity - Removable storage devices- Linked mobile devices and applications – Drone Computing

UNIT- DESIGN OF DRONE MECHANISM FOR COMMERCIAL APPLICATIONS **9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in defence – Drones in Healthcare - Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT-V FUTURE DRONES AND SAFETY **9**

Drones - Safety risks- Guidelines to fly safely -Specific aviation regulation and standardization - Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

Total Contact Hours : 45

Course Outcomes: Upon completion of the course students should be able to:

CO1	Know about a various type of drone technology,
CO2	Drone fabrication and programming and execute the suitable operating procedures for functioning a drone
CO3	Select appropriate sensors and actuators for Drones
CO4	Develop a drone mechanism for specific applications
CO5	Create the programs for various drones

Text Books:

1	Daniel Tal and John Altschuld, ―Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation‖, 2021 John Wiley & Sons, Inc.
2	Terry Kilby and Belinda Kilby, ―Make: Getting Started with Drones ―, Maker Media, Inc, 2016

Reference Books(s) / Web links:

1	John Baichtal, ―Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs‖, Que Publishing, 2016
2	Ales Zavrsnik, ―Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance‖, Springer, 2018

VERTICAL 4
SMART MANUFACTURING

MT19D11	CNC TECHNOLOGY AND APPLICATIONS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	Understand evolution and principle of CNC machine tools
●	Describe constructional features of CNC machine tools
●	Explain drives and positional transducers used in CNC machine tools
●	Write simple programs for CNC turning and machining centres
●	Describe tooling and work holding devices for CNC machine tools

UNIT-I	**INTRODUCTION TO CNC MACHINE TOOLS**	9
Evolution of CNC Technology, principles, features, advantages, applications - CNC and DNC concept, classification of CNC Machines turning centre, machining centre, grinding machine, EDM - Types of control systems - CNC controllers, characteristics, interpolators - Computer Aided Inspection.		
UNIT-II	**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.		
UNIT-III	**DRIVES AND CONTROLS**	9
Spindle drives - DC shunt motor, 3 phase - AC induction motor - Feed drives - Stepper motor – Servo principle - DC and AC servomotors - Open loop and closed loop control - Axis measuring system -synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosysn, laser interferometer.		
UNIT-IV	**CNC PROGRAMMING**	9
Coordinate system - Structure of a part program - G & M Codes - Tool length compensation – Cutter radius and tool nose radius compensation - Do loops, subroutines, canned cycles, mirror image, parametric programming - Machining cycles and programming for machining - Generation of CNC codes from CAM packages.		
UNIT-V	**TOOLING AND WORK HOLDING DEVICES**	9
Introduction to cutting tool materials: Carbides, Ceramics, CBN, PCD inserts classification - PMK, NSH, qualified, semi qualified and preset tooling - Tooling system for machining centre and turning centre - Work holding devices for rotating and fixed work parts - Economics of CNC – maintenance of CNC machines.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
CO 1	Recall the evolution, principles, classification and applications of CNC machine tools
CO 2	Realise the basic structure, construction, working and control of CNC machines
CO 3	Identify the fundamentals of drive system and control modules of CNC technology
CO 4	Develop program for CNC machines
CO 5	Compare and select suitable tooling and working holding devices of CNC

Text Books:	
1	HMT, "Mechatronics", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017
2	Warren S.Seamers, "Computer Numeric Control", Fourth Edition, Cengage Learning, 2007.
3	Ken Evans, John Polywka & Stanley Gabrel, "Programming of CNC Machines", Second Edition – Industrial Press Inc, New York, 2002
Reference Books / Web links:	
1	Berry Leathan – Jones, "Introduction to Computer Numerical Control", Pitman, London, 1987.
2	Mike Mattson, "CNC Programming: Principles and Applications", Delmar; First edition, 2013.
3	Peter Smid, "CNC Programming Hand book", Industrial Press Inc., 2000

ME19D11	DESIGN FOR X	Category	L	T	P	C
		PE	3	0	0	3

Objectives:

	To introduce the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
	To learn the design consideration principles of forming in the design of extruded, stamped, and forged products
	To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
	To learn design consideration principles of welding in the design of welded products.
	To learn design consideration principles in additive manufacturing.

UNIT-I	INTRODUCTION	9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric Tolerances - Assembly limits -Datum features - Tolerance stacks. Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

UNIT-II	FACTORS INFLUENCING FORM DESIGN	9

Working principle, Material, Manufacture, Design - Possible solutions - Materials choice –Influence of materials on form design - form design of welded members, forgings and castings.

UNIT-III	COMPONENT DESIGN - MACHINING CONSIDERATION	9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

UNIT-IV	COMPONENT DESIGN – CASTING CONSIDERATION	9

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT-V	DESIGN FOR ADDITIVE MANUFACTURING	9

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.

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

Course Outcomes: At the end of this course, students can have the

CO 1	Ability to Elaborate the design principles for manufacturability
CO 2	Ability to discuss the factors influencing in form design.
CO 3	Ability to apply the component design features of various machine
CO 4	Ability to discuss the design consideration principles of welding in the design of welded products.
CO 5	Ability to discuss the design consideration principles of additive manufacturing.

Text Books:

1	James G. Bralla, —Design for Manufacturability Handbook‖, McGraw Hill Professional, 1998.
2	O. Molloy, E. A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.

Reference Books(s) / Web links:

1	CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2	David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3	Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4	Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
5	Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994

MT19D13	PRODUCT DESIGN AND DEVELOPMENT	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To introduce the ideas of process management and product development
●	To study product architecture and CAD/CAM tool integration
●	To impart knowledge on design process and To create awareness on design for manufacturing

UNIT-I	INTRODUCTION	10
Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behavior analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications		
UNIT-II	**CONCEPT GENERATION AND SELECTION**	8
Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits		
UNIT-III	**PRODUCT ARCHITECTURE**	9
Implications – Product change – variety – component standardization – product performance –manufacturability – product development management – establishing the architecture – creation –clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications		
UNIT-IV	**INDUSTRIAL DESIGN**	9
Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools –Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process –investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design		
UNIT-V	**DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT**	9
Definition – Estimation of manufacturing cost – reducing the component costs and assembly costs –Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes –Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
CO 1	Comprehend product design development process
CO 2	Generate and select suitable concepts for developing various products
CO 3	Recognize product architecture
CO 4	Reduce the cost of industrial product design
CO 5	Control and accelerate industrial design projects

Text Books:	
1	Karl T.Ulrich and Steven D.Eppinger, ”Product Design and Development”, McGraw-Hill International 2009
2	Staurt Pugh, ”Tool Design –Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, New york,1991

Reference Books / Web links:	
1	Anil Mital, Anoop Desai, Anand Subramanian, Aashi Mital,” Product Development: A Structured Approach to Consumer Product Development, Design, and Manufacture”, Elsevier, 2014
2	Geoffrey Boothroyd, “Product design for manufacture and assembly”, CRC Press; 3 editions, 2010
3	Stephen Rosenthal, “Effective Product Design and Development”, Irwin Publishing house, 1999
4	James G. Bralla, “Handbook of Product Design for Manufacturing: A Practical Guide to Low-cost Production”, McGraw-Hill Inc.,US, 1986

Course code	Course 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 product development/ prototyping requirements using AM.
- To learn the Liquid and Solid based AM processes.
- To study the 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 EngineeredNet 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 demonstrate the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
- Ability to apply the process of transforming a concept/existing product into 3D model used in AM technology.
- Ability to differentiate Liquid and Solid based AM processes.
- Ability to enumerate Powder and Wax based processes.
- Ability to evaluate the advantages, limitations, applications and use of Bio Additive manufacturing and 4D printing.

Text Books:	
1	Andreas Gebhardt and Jan-Steffen Hötter ―Additive Manufacturing: 3D Printing for Prototyping Manufacturing‖, Hanser publications, United States, 2015.
2	Ian Gibson, David W. Rosen and Brent Stucker ―Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing‖, 2nd edition, Springer., United States, 2015.
Reference Books(s)/Weblinks:	
1	Amit Bandyo padhyay and SusmitaBose, ―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 prototype development‖, CRC Press., United States, 2011.
5.	Milan Brandt, ―Laser Additive Manufacturing: Materials, Design, Technologies, and Applications‖, Wood head Publishing., United Kingdom, 2016.

WEBLINKS:

1. https://archive.nptel.ac.in/courses/112/103/112103306/
2. https://www.nist.gov/el/applied-economics-office/manufacturing/topics-manufacturing/additive-manufacturing
3. https://www.coursera.org/learn/additive-manufacturing-3d-printing
4. https://www.udemy.com/course/learn-3d-printing-additive-manufacturing/
5. https://www.linkedin.com/company/additive-manufacturing3d/about/

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	-	-	-	-	1	-	-	-	-	2	-	-	2
CO2	1	2	2	-	-	-	1	-	-	-	-	2	2	-	2
CO3	1	2	-	-	-	-	1	-	-	-	-	2	2	-	2
CO4	1	2	-	-	-	-	1	-	-	-	-	2	2	-	2
CO5	1	2	-	-	-	-	1	-	-	-	-	2	2	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

MT19D14	ADVANCED MANUFACTURING TECHNOLOGY	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the concepts of forming and sheet metal working of metals with its different types of operations and simultaneously to know about various non-traditional machining processes, surface finishing and surface hardening processes with its types and various applications
●	To understand the work and tool holding devices with its principles and its industrial applications

UNIT-I	SHEET METAL WORKING OF METALS	9
Hot and Cold Working- rolling, forging, wire drawing, extrusion-types-forward, backward & tube extrusion. Blanking-blank size calculation, draw ratio, drawing force, piercing, punching, trimming, stretch forming, tube bending, tube forming -embossing & coining-explosive forming electro hydraulic forming-electromagnetic forming		
UNIT-II	**NON TRADITIONAL MACHINING**	9
Ultrasonic machining (USM) – process and description of USM-applications and limitations- Electron Beam Machining (EBM)-Process principles of EBM-applications-process principles- Laser Beam Machining (LBM)-Laser beam production-applications-laser beam welding-Plasma Arc Machining (PAM)-Generation of plasma arc-process parameters-applications		
UNIT-III	**SURFACE FINISHING AND SURFACE HARDENING PROCESS**	9
Grinding process, various types of grinding machine-grinding wheel-types-selection of grinding wheel for different applications-selection of cutting speed and work speed- mounting of grinding wheel-galvanizing, electroplating, anodising. Surface hardening- carburizing, carbonitriding, cyaniding, nitriding, ion nitriding, boronizing, laser hardening, thin film coating (PVD, CVD)		
UNIT-IV	**EDM AND ECM**	9
Electrical Discharge Machining (EDM) - Description of EDM equipment-electrical circuits - electrolyte-metal removal rate-applications-EDWC - process principles – equipments - applications. Electro Chemical Machining (ECM) - Description of the equipment-electrolyte-metal removal rate -accuracy and surface finish obtained. Electro Chemical grinding (ECG) – Chemical machining-electro chemical grinding equipment-application-electro chemical deburring - honing applications		
UNIT-V	**JIGS AND FIXTURES**	9
Jigs-Locating and Clamping devices-principles-elements-mechanical-pneumatic and hydraulic actuation-types of Jigs-general consideration in Jig design-jig bushing, types- methods of construction. Fixtures-types of fixtures- fixture for machine tools –lathe, milling, boring, broaching, grinding-assembly inspection of welding fixture design		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
CO 1	Recall the basics and working principles of various sheet metal working and forming processes
CO 2	Recognise various non-traditional machining processes with its applications
CO 3	Identify suitable surface finishing and surface hardening process
CO 4	Compare the concept of EDM and ECM with its characteristics and application
CO 5	Select suitable work and tool holding devices used for different machine tools

Text Books:	
1	Rao P.N., “Manufacturing Technology, Metal cutting and Machine Tools”, Tata McGraw Hill, 2013
2	Sharma .P.C., “A text book of Production Technology- vol I &II ”, S.Chand & Company Ltd, New Delhi, 2014

Reference Books / Web links:	
1	Donaldson. C. “Tool design”, Tata McGraw Hill Co. Ltd.,2003
2	HajraChoudhary.S.K. and Hajra Choudhary.A.K, “workshop Technology”, Vol-I&Vol-II”, Media Publishers 2008
3	H.M.T Bangalore "Production Technology" Tata McGraw Hill, 2016

Course Code	Course Name(Theory course)	Categor	L	T	P	C
ME19E17	ELECTRONICS MANUFACTURING TECHNOLOGY	PE	3	0	0	3

Objectives:	
	To impart knowledge on wafer preparation and PCB fabrication
	To introduce Through Hole Technology (THT) and Surface Mount Technology (SMT) with various types of electronic components
	To elaborate various steps in Surface Mount Technology (SMT)
	To be acquainted with various testing and inspection methods of populated PCBS
	To generate outline repair, rework and quality aspects of Electronic assemblies.

UNIT-I	Introduction To Electronics Manufacturing	9
History, definition, wafer preparation by growing, machining and polishing, diffusion, microlithography, etching and cleaning, Printed circuit board–fabrication, types, single sided, double sided, multi-layer and flexible printed circuit board.		
UNIT-II	**Components And Packaging**	**7**
Introduction to packaging, types - Through hole technology(THT) and Surface mount technology (SMT), Through hole components – axial, radial, multi leaded, odd form Surface-mount components - active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends		
UNIT-III	**Surface Mount Technology**	**9**
SMT Process, SMT equipment and material handling systems, handling of components and assemblies –moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - solder paste material, storage and handling, stencils and squeegees, process parameters, quality control. Component placement –equipment type, flexibility, accuracy of placement, throughput, packaging of components for automated assembly, soldering - wave soldering, reflow process, process parameters, profile generation and control, adhesive, underfill and encapsulation process.		
UNIT-IV	**Inspection And Testing**	**9**
Inspection techniques, equipment and principle - AOI, X-ray. Defects and Corrective action-stencil printing process, component placement process, reflow soldering process, electrical testing of PCB assemblies –In circuit test, functional testing, fixtures and jigs.		
UNIT-V	**Repair, Rework, Quality And Reliability Of Electronics Assemblies**	**11**
Repair and rework of PCB – Coating removal, base board repair, conduct or repair, thermo-mechanical effects and thermal management, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, reworkability, testing, reliability, and environment.		
	Total Contact Hours	**45**

Course Outcomes: At the end of this course, the students should be able to:	
	Perceive wafer preparation and PCB fabrication
	Recognize the importance of Through Hole Technology (THT) and Surface Mount Technology (SMT)
	Demonstrate various steps in Surface Mount Technology (SMT)

	Identify various testing and inspection methods of populated PCBS
	Discuss various techniques in repair, rework, quality and reliability of electronic Assemblies

Text Books:	
1	Prasad R.,—Surface Mount Technology –Principles and practice‖, 2ndEdition, Chapman and Hall., New York, 1997, ISBN0-41-12921-3.
2	Tummala.R.R., —Fundamentals of micro system packaging‖, Tata McGraw Hill Co. Ltd., NewDelhi, 2001, ISBN00-71-37169-9.

Reference Books(s)/Web links:	
1	Harper C.A., —Electronic Packaging and Interconnection Handbook‖ 2nd Edition, McGraw HillInc., New York, N.Y., 1997, ISBN0-07-026694-8.
2	Lee N.C., —Reflow Soldering Process and Trouble Shooting SMT, BGA, CSP and Flip Chip Technologies‖, Elsevier Science, United Kingdom, 2001.
3	Puligandla Viswanadham and Pratap Singh., —Failure Modes and Mechanisms in Electronic Packages‖, Chapman and Hall, New York, 1997, N.Y. ISBN 0-412-105591-8. Science and Technology, UnitedKingdom, 1997, ISBN0750698756.
4	Totta P., Puttlitz K. and Stalter K., —Area Array Interconnection Handbook‖, Kluwer Academic Publishers, Norwell, MA, UnitedStates, 2001, ISBN0-7923-7919-5.
5.	Zarrow P. and Kopp D., —Surface Mount Technology Terms and Concepts‖, Elsevier, 1997.

WEBLINKS:

1. https://www.edx.org/learn/manufacturing 2.https://onlinecourses.nptel.ac.in/noc22_me61/preview 3.https://www.deskera.com/blog/electronic-manufacturing-process/ 4.https://link.springer.com/book/10.1007/978-94-011-3130-8

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO3	3	-	1	-	-	-	-	-	-	-	-	2	-	-	-
CO4	3	-	1	-	-	1	-	-	-	-	-	2	-	-	-
CO5	3	-	1	-	-	2	-	-	-	-	-	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Name(Theory course)	Category	L	T	P	C
ME19E19	NON-DESTRUCTIVE TESTING AND EVALUATION	PE	3	0	0	3

Objectives:	
	To create the students for understanding the importance of NDT in quality assurance.
	To imbibe the students about the basic principles of various NDT techniques, its applications, limitations, codes and standards.
	To equip the students with proper competencies to locate a flaw in various materials and products.
	To train the students to be ready to useNDT techniques for in-situ applications too.
	To inculcate the knowledge of selection of the right NDT technique for a given application.

UNIT-I	Introduction & Visual Inspection Methods	9
NDT versus Mechanical testing, Need for NDT, Relative merits and limitations, various physical characteristics of materials and their applications in NDT. Visual Inspection-Unaided, Aided-Bore scopes-Video scopes, Special features in Bore scopes, bore scopes, Optical sensors, Microscopes & replication Microscopy Technique and applications, Holography-Case study.		
UNIT-II	**Liquid penetrant testing & Magnetic particle testing**	**9**
LPT - Principle, types, Procedures, Penetrants and their characteristics, Emulsifiers, Solvent Cleaners / Removers, Developers- properties and their forms, Equipment's, Advantages and limitations, Inspection and Interpretation, Applications and case study. MPT-Principle, Theory of Magnetism, Magnetising current, Magnetisation methods, Magnetic particles, Procedure, Interpretation, Relevant and Non-relevant indications, Residual magnetism, Demagnetisation–need, methods, Advantages and Limitations, Applications, Magnetic Rubber Inspection, Magnetic Printing, Magnetic Painting –Case study.		
UNIT-III	**Thermography & Eddy current testing**	**9**
Thermography–Introduction, Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods and applications - Case study. Eddy current Testing – Principle, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Advantages& Limitations, Interpretation of Results & applications- Case study.		
UNIT-IV	**Ultrasonic testing & Acoustic Emission Testing**	**9**
Ultrasonic Testing- Principle , Basic Equipment, Transducers, Couplants, Ultrasonic wave, Variables in UT, Transmission and Pulse-echo method, Straight beam and angle beam, A-Scan, B- Scan & C-Scan, Phased Array Ultrasound& Time of Flight Diffraction, Advantages & Limitations, Interpretation of Results& Applications - Case study. Acoustic Emission Technique –Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications-Case study.		
UNIT-V	**Radiography**	**9**
Introduction, Principle, X-ray Production, Gamma ray sources, Tubing materials, X-ray tubing characteristics, Interaction of X-ray with matter, Imaging, Film techniques, Filmless techniques, Types and uses of filters and screens, Real time radiography, Geometric factors, Inverse square law, Characteristics of film, graininess, density, speed, contrast, characteristic curves, Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy-Xero-Radiography, Digital Radiography– Film Digitisation, Direct Radiography & Computed Radiography, Computed Tomography, Gamma ray Radiography, Safety in X-ray and Gamma Ray radiography-Case study.		
	TotalContact Hours	**45**

Course Outcomes: At the end of this course,	
	The students will be able to compare the differences between various visual inspection techniques and apply the same to the components to be inspected.
	The students will be able to recognize the importance of Penetrant testing in NDT with the understanding of the procedures involved in the Penetration methods.
	The students will be able to interpret the images and the results obtained from the Thermographic technique and the Eddy current testing.
	The students will be able to evaluate and interpret the results obtained in the Ultrasonic inspection and Acoustic Emission technique.
	The students will be able to explain the techniques involved in the Radiographic testing and the various advancements in Radiography.

TextBooks:	
1	ASM Metals Handbook, —Non-Destructive Evaluation and QualityControl‖, American Society of Metals, Metals Park,Ohio, USA, 200, Volume-17.
2	PaulEMix,—IntroductiontoNon-destructive testing: a training guide‖, Wiley, 2 edition NewJersey, 2005.

ReferenceBooks(s)/Weblinks:	
1	BaldevRaj,T.Jayakumar,M.Thavasimuthu,—PracticalNon-Destructive Testing‖, Narosa Publishing House, 2009.
2	ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5,ElectromagneticTesting, Vol.6, Acoustic Emission Testing,Vol. 7,Ultrasonic Testing.
3	Charles,J.Hellier,—HandbookofNon-destructiveevaluation‖,McGrawHill,NewYork,2001.
4	RaviPrakash,—Non-Destructive Testing Techniques‖, New Age International Publishers, 1st Revised edition, 2010.
5.	Hellier, Chuck,‖Handbook of Nondestructive Evaluation, 3E‖ New York, N.Y. : McGraw-Hill Education, Third edition.(2020)

WEBLINKS:

1. https://nptel.ac.in/courses/113106070/
2. https://www.udemy.com/course/understanding-nondestructive-testing-and-evaluation-ndtnde/
3. https://www.uti.edu/blog/education/what-is-non-destructive-testing
4. https://www.aerospacetestinginternational.com/features/introduction-to-non-destructive-testing.html
5. https://onlinecourses.nptel.ac.in/noc24_mm14/preview
6. https://www.twitraining.com/home/programmes-and-courses/non-destructive-testing

PO-PSO	POs												PSOs		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-
CO2	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-
CO3	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-
CO4	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-
CO5	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19D16	PROCESS PLANNING AND COST ESTIMATION	PE	3	0	0	3

Objectives:

- To create a process plan for a given Product.
- To understand the purpose, functions and procedure for Estimating.
- To determine cost elements, overheads and depreciation for a given Product.
- To estimate cost for the casting, forging and welding processes.
- To calculate the machining times and costs for various machining processes.

UNIT-I	Introduction To Process Planning	10

Outlining to process planning - Drawing interpretation –Material selection process and methods, Selection of Production Processes – standardization, simplification –Break even analysis –Factors to be considered in selecting: Process Sequencing; Operation Sequencing; Process parameters Equipment & Tool Selection; Tool Material evaluation -Selection of jigs and fixtures –Computer Aided Process Planning – Manual, Retrieval CAPP and Generative CAPP - Case Study in Process Planning.

UNIT-II	Fundamental Of Estimating	7

Concept and Purpose of Estimating, Functions of Estimating department, Costing versus Estimating, Types of Estimates, Importance of Estimates, Estimating Procedure, Case Study in Estimating.

UNIT-III	Fundamental Of Costing	10

Aims, Functions and Importance of costing–methods of costing-elements of cost estimation – Cost Estimators and their Qualifications, Principal Constituents in a Cost Estimate – Allocation of Cost Elements –Material Cost, Labour Cost, Expenses and Cost of Product (Ladder Cost), Distribution of Overhead Cost and Methods to Calculate the Depreciation.

UNIT-IV	Cost Estimation Of Casting, Forging & Welding Costs	9

Estimation of cost for various production processes - Estimation of Forging Shop– Losses in forging –Forging cost, Estimation of Welding Shop– Electric welding cost – Gas Welding cost, Estimation of Foundry Shop– Pattern cost - Casting cost.

UNIT-V	Estimation Of Machining Time And Costs	9

Estimation of Machining Time - Importance of Machine Time Calculation- Machining Time Calculation for the Conventional Machining Processes-Calculation of Machining Time and Cost for Lathe operations, Drilling, Boring, Milling and Grinding.

	Total Contact Hours	45

Course Outcomes: At the end of this course, students can have the

- Dexterity to make a standard and detailed process plan for a given product.
- Ability to differentiate estimation and costing.
- Capacity to allocate cost elements, distribute over heads and calculate depreciation for a given Product.
- Agility to estimate cost for various production processes like casting, forging and weldi processes for a given product.
- Ability to calculate the machining times and costs for various conventional machining processes

Text Books:

1. Adithan, M, ―Process Planning and Cost Estimation‖, New Age International Publishers, 2020.
2. Peter Scallan, ―Process Planning, The Design/Manufacture Interface‖, Butterworth Heinemann, 2018.

Reference Books(s) / Web links:

1	Chitale A. K., and Gupta R. C., ―Product Design and manufacturing‖, Prentice Hall of India, Ne Delhi, 2016.
2	Gideon Halevi, ―Process and operation planning‖, Kluwer academic publishers (Printed ebook), 2015.
3	Narang G.B.S. & Kumar. V, ―Production and Costing‖, Khanna Publishers, 2017.
4	Phillip F. Ostwald & Jairo Munoz, ―Manufacturing Processes and Systems‖, 9th Edition, Wiley student edition, 2016.
5.	Robert Creese, Adithan M. &Pabla B. S., ―Estimating and Costing for the Metal Manufacturing Industries‖, Marcel Dekker, 2015.
6	https://onlinecourses.nptel.ac.in/noc23_ce59/preview
7	https://www.youtube.com/watch?v=11ShbDNcqhI&list=PLFQ4-HFt2IjT8oFa7xpMioJPofxfU1 ux

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	1	1	2	-	-	-	-	-	1	2	2	.	1
CO2	3	3	2	2	1	-	-	-	-	-	1	2	2	.	1
CO3	3	3	2	2	1	-	-	-	-	-	1	2	2	.	1
CO4	3	3	2	2	1	-	-	-	-	-	1	2	2	.	1
CO5	3	3	2	2	1	-	-	-	-	-	1	2	2	.	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

VERTICAL 5
AUTOMATION

MT19E11	VLSI AND FPGA	Category	L	T	P	C
			3	0	0	3

Objectives :	
•	To introduce the features of programmable logic devices
•	To learn the features of various FPGAs and FPAA
•	To understand the concepts of synchronous and asynchronous FSMs
•	To provide the system design experience with FSMs using PLDs
•	To introduce pulse mode approach to asynchronous FSM

UNIT – I	**PROGRAMMABLE LOGIC DEVICES**	**9**
Logic implementation options - Technology trends - Design with Field Programmable devices - ROM, PLA, PAL - CPLD - XC9500 family - Erasable Programmable Logic Devices - MAX5000, MAX7000 families.		
UNIT – II	**FPGA AND FPAA**	**9**
Programming Technology, Logic blocks, routing architectures of SRAM-Programmable FPGA Architectures - XC2000, XC3000, XC4000 – Anti-fuse Programmed FPGAs - Routing Architecture of the Actel FPGAs - ProASIC plus - Design Applications - Current FPGA Technologies - FPAA architecture and its reconfiguration.		
UNIT – III	**SYNCHRONOUS FSM DESIGN**	**9**
Choice of Components to be Considered - Architecture Centered around Nonregistered PLDs - State Machine Designs - Centered around a Shift Register, Centered around a Parallel Loadable Up/Down Counter - One hot design method - Use of Algorithmic State Machine, Application of one hot design to serial 2's complementer, parallel to serial adder/subtractor controller- System-level design: controller, data path, and functional partition.		
UNIT – IV	**ASYNCHRONOUS STATE MACHINES**	**9**
Features and need for Asynchronous FSMs - Lumped path delay models for asynchronous FSMs -Excitation table, state diagrams, K-maps, and state tables - Design of the basic cells by using the LPD model - design examples - Hazards in Asynchronous FSMs - One-hot design of asynchronous state machines - Design of fundamental mode FSMs by using PLDs.		
UNIT – V	**PULSE MODE APPROACH TO ASYNCHRONOUS FSM DESIGN**	**9**
Pulse Mode Models and System Requirements - Choice of Memory Elements - Other Characteristics of Pulse Mode FSMs - Design Examples - Analysis of Pulse Mode FSMs - One-Hot Programmable Asynchronous Sequencers.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
CO 1	Implement the digital designs with programmable logic devices
CO 2	Analyze the architectural features of FPGA and FPAA
CO 3	Make the system level designs using synchronous and asynchronous FSMs
CO 4	Design the fundamental mode FSMs using PLDs
CO 5	Apply pulse mode approach to FSM Design

TEXT BOOKS:	
1	Stephen M. Trimberger, Edr.,"Field Programmable Gate Array Technology",Springer Science Business media, LLC, 2012.
2.	Richard F. Tinder, "Engineering Digital Design, Revised Second Edition", Academic Press, 2000.

REFERENCES:	
1	Roger Woods, John McAllister, Gaye Light body and Ying Yi, "FPGA-based implementation of Signal Processing Systems", A John Wiley and Sons, Ltd., Publication, 2008.
2	John V. Oldfield, Richard C.Dorf, "Field Programmable Gate Arrays - Reconfigurable logic for rapid prototyping and implementation of digital systems", John Wiley & Sons, Reprint, 2008
3	P. K .Chan& S. Mourad, "Digital Design Using Field Programmable Gate Array", Prentice Hall, 1994
4	Thomas L. Floyd, "Electronic Devices", Pearson Education Ltd., 8th Edition, 2008.

MT19E12	TOTAL INTEGRATED AUTOMATION	Category	L	T	P	C
		PC	3	0	0	3

Objectives:

- Understand the principles and components of integrated automation systems.
- Develop proficiency in designing, configuring, and troubleshooting Human-Machine Interface (HMI) systems.
- Master the concepts and applications of Supervisory Control and Data Acquisition (SCADA) systems.
- Gain knowledge of communication protocols used in industrial automation and learn to interface SCADA systems with various devices.
- Analyze real-world applications of PLCs, SCADA, and DCS in industrial automation and compare their architectures and functionalities.

UNIT-I **TOTAL INTEGRATED AUTOMATION** **9**

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

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 502 and 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 – User administration – 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 course students will be able to

CO 1	Identify and explain the components, advantages, and applications of integrated automation systems.
CO 2	Demonstrate proficiency in configuring various types of HMIs, integrating them with other automation components, and resolving issues related to HMI systems.
CO 3	Develop the ability to design, develop, and implement SCADA applications, configure alarm logging, tag logging, and generate reports using SCADA systems.
CO 4	Demonstrate proficiency in configuring communication protocols such as OLE/OPC, DDE, and server/client communication, and interfacing SCADA systems with various industrial devices.
CO 5	Analyze case studies of machine automation, process automation, and industrial control systems, and compare and contrast SCADA and DCS systems based on their architecture, programming, and application domains.

Text Books:

1. John. W. Webb& Ronald A. Reis, “Programmable logic controllers: Principles and Applications”, Prentice Hall India, 2009.
2. Michael P. Lukas, “Distributed Control systems”, “Van Nostrand Reinfold Company”1995 .

Reference Books / 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

MT19E13	VIRTUAL INSTRUMENTATION	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	The principle and applications of virtual instruments are introduced in mechatronics systems.
•	To introduce virtual instruments programming techniques.
•	To understand the integration of analog and digital instruments.
•	To know the common instrument interfaces.
•	To understand the common analysis tools.

UNIT-I	REVIEW OF VIRTUAL INSTRUMENTATION	10
Historical perspectives, advantages, block diagram and architecture of a virtual instrument, data -flow techniques, graphical programming in data flow, comparison with conventional programming.		
UNIT-II	**VI PROGRAMMING TECHNIQUES**	9
VIS and sub-VIS loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.		
UNIT-III	**DATA ACQUISTION BASICS**	9
AOC.OAC. 010. Counters & timers. PC Hardware structure, timing. Interrupts OMA, software and hardware installation.		
UNIT-IV	**COMMON INSTRUMENT INTERFACES**	9
Current loop, RS.232C/RS.485, GPIB, System buses, interface buses: USB, PCMCIA, VXI, SCXI, PXI, networking basics for office &. Industrial applications, Visa and IVI, image acquisition and processing, Motion control.		
UNIT-V	**USE OF ANALYSIS TOOLS**	8
Fourier transforms, power spectrum correlation methods, windowing & filtering, VI application in various fields.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
CO 1	Recall the basic concepts of Virtual Instruments.
CO 2	Implement various bus interfaces
CO 3	Program and simulate systems using LabVIEW.
CO 4	Acquire data using DAQ and implement various interfaces.
CO 5	Use LabVIEW for various application

Text Books:	
1	Gupta," Virtual Instrumentation Using Lab view" 2ndEdition, Tata McGraw-Hill Education, 2010

Reference Books / Web links:	
1	Gary Jonson, "Labview Graphical Programming", Second Edition, McGraw Hill, New York, 1997.
2	Gupta.S., Gupta.J.P., "PC interfacing for Data Acquisition & Process Control", Second Edition, Instrument Society of America, 1994.
3	Sokoloff; "Basic concepts of Labview 4", Prentice Hall Inc., New Jersey 1998.

MT19E14	MOTION CONTROL SYSTEM	Category	L	T	P	C
		PC	3	0	0	3

Course Objectives:

- To introduce the basics in motion control system
- To knowledge about on architecture of motion control system
- To understand the features and specifications in motion control drives
- To learn about intelligent motors and integrated drive
- To ability to know about the programming of motion controller

UNIT-I **INTRODUCTION TO MOTION CONTROL SYSTEM** **9**

Introduction to Motion Control System – Dynamic System Modeling – Control System Design Fundamentals – Parameters in Control – Actuators and Measurement in Motion Control Systems -Multi-Body Dynamics – Need for Motion Controller – Specification of Motion Control

UNIT - II **ARCHITECTURE OF MOTION CONTROL SYSTEM** **9**

Introduction to Motion Controller – Programmable Automation Controllers – Features & Specification of Motion Controllers – Digital I/O – Analog I/O – Standards in I/O – I/O Specific to Sensors – Modular and Expansion Concepts – Drives

UNIT-III **MOTION CONTROL DRIVES** **9**

Programmable Automation controllers – Features & Specification of motion controllers- Digital I/O- Analog I/O – Standards in I/O- I/O specific to sensors- Modular and Expansion concepts – Drivers.

UNIT-IV **INTELLIGENT MOTORS WITH INTEGRATED DRIVE** **9**

Intelligent motors – intelligent drives – features of drives – programmable I/Os- communication protocols – features – Software - Programming – current, position and speed loops – Application in robots and portable systems

UNIT-V **PROGRAMMING OF MOTION CONTROLLER** **9**

IEC 61131 standards and Its Programming Languages overview- CoDeSys Platform - status Diagram – PLC Open - Motion Planer - PID - Servo Tuning – Position- velocity, Acceleration and Torque Profiling – CAM Profiling – Multi- Axis Motion Controllers – CNC Machines – Robot case study.

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

CO 1	Understand the fundamentals of motion control systems, including their architecture and design principles
CO 2	Analyze and design motion control systems, including drives and integrated motors, to solve engineering problems
CO 3	Utilize modern tools and software for motion control system analysis and programming
CO 4	Work effectively in both individual and team settings to solve motion control system-related problems
CO 5	Communicate technical concepts related to motion control systems through presentations and reports

Text Books:

1	M. Nakamura .S. Gata & N. Kyura, Mechatronic Servo System Control, Springer, 2004.
2	Sabanovic Asif, Motion Control Systems, John Wiley & Sons Inc, 2011

Reference Books / Web links:

1	Model 4000 indexer user Guide, Parker Hannifin Corporation, 1994.
2	2-Axis Motion Controller User Guide, Parker Hannifin Corporation, 1995.
3	Operating instructions Compax3 T30 Programmable motion control according to IEC61131-3, Parker Hannifin Corporation, 2008.
4	Programming with Easy Motion Studio – User's Manual, online, technosoftmotion.com
5	Technical Reference, IPOS4808 BX-CAT-STO Intelligent Servo Drive for Step, DC, Brushless DC and AC Motors, Techno soft, 2022.
6	https://controlsystemsacademy.com/articles2.html

MT19E15	INTERNET OF THINGS FOR MECHATRONICS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the basics of Internet of Things
●	To understand different applications of Internet of Things
●	To understand the fundamental aspects of IoT

UNIT-I	INTRODUCTION	9
Definitions and Functional Requirements –Motivation – Architecture - IoT architecture and platforms - IoT Devices vs. Computers - Trends in the Adoption of IoT - Societal Benefits of IoT – IoT Information Security		
UNIT-II	**EMBEDDED AND SENSORS SYSTEMS**	9
Embedded Systems. Sensing methods - Sensors types – Active, Passive sensors – Environmental sensing methods. Sensor Fusion		
UNIT-III	**IOT SENSORS**	9
Evolving Sensor Technologies - Leveraging Sensor Fusion for the IoT - IoT Sensor Manufacturers - IoT Sensor Data Platforms		
UNIT-IV	**CONTROLLERS**	9
Basics of Controllers - Interfacing methodologies - Controller's selection – GPIO interfaces – SPI interfaces – I2C interfaces – RTC interfaces – IDE usage – Bootloader – Memory utilization (EEPROM /Flash)		
UNIT-V	**PROGRAMMING**	9
Basic programing of controllers – Controllers Expansion boards (breakouts). Hardware Platforms - Intel Galileo, Edison, Arduino, Beagle bone Black & Raspberry Pi. Software Platforms - Intel XDK, Node-RED, VISUINO, Fritzing, 123d Circuits, Scratch		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
CO 1	Explain the basic architecture and platform of IoT
CO 2	Explain the working principle of IoT
CO 3	Develop, test & analyse a new IoT system
CO 4	Design systems for Real-Time Processing
CO 5	Program for IoT applications

Text Books:	
1	Maciej Kranz, "Building Internet of Things", John Wiley and Sons, 2016
2	Peter Waher, "Learning Internet of Things", Packt Publishing, 2015

Reference Books / Web links:	
1	Michael Miller, "The Internet of Things", Que Publishing, 2015
2	Samuel Greengard, "The Internet of Things", Second Edition, MIT Press, 2015

Course Code	Course Name(Theorycourse)	Category	L	T	P	C
ME19E18	DIGITAL TWIN AND INDUSTRY 4.0	PE	3	0	0	3

COURSEOBJECTIVES:
To understand the basics concepts in digital twin
To Introduce the concepts in digital twin in a discrete Industry
To Introduce the concepts in digital twin in a process Industry
To obtain the knowledge in Industry 4.0
To know about the advantages in Industry 4.0

UNIT– I Introduction	9
Digital twin– definition, types of Industry and its key requirements, Importance, Application of Digital Twin in process, product, service industries, History of Digital Twin, DTT role in industry innovation, Technologies/tools enabling Digital Twin – Virtual CAD Models – controlParameters-Realtimesystems–controlParameters–HandshakingThroughInternet–cyber physical systems	
UNIT– II Digital Twin In a Discrete Industry	**9**
Basics of Discrete Industry, Trends in the discrete industry, control system requirements in a discrete industry, Digital Twin of a Product, Digital Thread in Discrete Industry, Data collection & analysis for product & production improvements, Automation simulation, Digital Enterprise	
UNIT–III Digital Twin In a Process Industry	**9**
Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise	
UNIT– IV Industry 4.0	**9**
Industrial Revolutions, Industry 4.0 – Definition, principles, Application of Industry 4.0 in process & discrete industries, Benefits of Industry 4.0, challenges in Industry 4.0, Smartmanufacturing,InternetofThings4.0,IndustrialGateways,BasicsofCommunicationrequirem ents– cognitivesystems4.0	
UNIT– V Advantages Of Digital Twin	**9**
Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.	
	Total Periods :45

COURSEOUTCOMES
Upon successful completion of the course, students should be able to:
Analyzethebasicsconceptsindigitaltwin
Developthe concepts in digital twin in a discrete Industry
Illustrate the concepts in digital twin in a process Industry
Articulate theknowledge inindustry 4.0
Transfertheadvantagesin industry4.0with various applications

PO-PSO	POs												PSOs		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-
CO2	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-
CO3	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-
CO4	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-
CO5	1	2	1	2	1	-	-	-	-	-	1	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

TEXTBOOKS:

1. Alp Ustundag and Emre Cevikcan, ―Industry 4.0: Managing The Digital Transformation‖,Springer SeriesinAdvancedManufacturing.,Switzerland,2018
2. AndrewYehChrisNee,FeiTao,andMengZhang,―DigitalTwinDrivenSmartManufacturing‖,Elsev ier Science.,UnitedStates,2019

REFERENCES:

2. Alasdair Gilchrist,―Industry4.0:TheIndustrialInternetofThings‖,Apress.,UnitedStates ,2015.
3. Christoph JanBartodziej,―TheConceptIndustry4.0anEmpiricalAnalysisofTechnologies and Applications in Production Logistics‖, Springer Gambler., Germany,2017.
4. Ibrahim Garbie, ―Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0‖,Springer.,Switzerland,2016.
5. RonaldR.YagerandJordanPascualEspada,―NewAdvancesintheInternetofThings‖,Springer.,Swit zerland,2018
6. Ulrich Sendler, ―The Internet of Things, Industries 4.0 Unleashed‖, Springer., Germany,2018

WEBLINKS:

1.https://www2.deloitte.com/xe/en/insights/focus/industry-4-0/digital-twin-technology-smart- factory.html

2. https://www.toobler.com/blog/industry-4-0-and-digital-twin

3.https://gradhoc.com/Art%C3%ADculo/digital-twin-requirements-in-the-context-of-industry-4- 0/

4. https://www.intechopen.com/books/12041

5. https://www.titanteal.com/unraveling-the-future-with-digital-twin-Industry-4-0-and-5-0

6. https://www.ibm.com/topics/industry-4-0

MT19E16	WIRELESS NETWORKS FOR INDUSTRIAL AUTOMATION	Category	L	T	P	C
		PC	3	0	0	3

Objectives:

	Understand the standards, types, and topologies of wireless networks, including antenna technology.
	Familiarize with Wireless Local Area Networks (WLAN), Wireless Personal Area Networks (WPAN), WiMAX, and convergence of voice and data networks.
	Learn about the types, challenges, and design considerations of security in Wireless Sensor Networks (WSN), and the transition to Internet of Things (IoT).
	Explore cyber security and safety measures in industrial settings, common attack methods, and standards such as ISO/IEC 27001 for information security.
	Analyze the requirements, political considerations, and various wireless technologies such as WiFi, Bluetooth, Zigbee, Wireless HART, and 5G for industrial automation.

UNIT-I	WIRELESS NETWORK TECHNOLOGY	9

Standards – Proprietary or Non-Standard Wireless Networks – Wireless Versus Wired Networks – Antenna Technology – Wireless Network topologies

UNIT - II	WIRELESS NETWORK STANDARDS	9

Wireless Local Area Networks – Wireless Personal Area Networks – WMAN, WiMAX – Wireless Telephony – Convergence of Voice and Data Networks

UNIT-III	SECURITY IN WIRELESS SENSOR NETWORK (WSN)	9

Overview, Types and Challenges. Design of Wireless Sensor Network for emerging scenarios. Design analysis of transition from WSN to IoT.

UNIT-IV	INDUSTRIAL NETWORK SECURITY	9

Cyber Security and Safety – Common Industrial Targets – Common Attack Methods – Weaponized Industrial Cyber Threats – Attack Trends – Dealing with Infection. ISO/IEC 27001 standard for information security

UNIT-V	APPLICATION OF WIRELESS NETWORKS FOR INDUSTRIAL AUTOMATION	9

Industrial Automation Requirements – Politics of Wireless – WiFi – Bluetooth – Zigbee – Wireless HART – 5G for Automation

	Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

CO 1	Explain the standards, advantages, and limitations of wireless networks and analyze different wireless network topologies.
CO 2	Demonstrate proficiency in understanding and comparing various wireless network standards and their applications in different scenarios.
CO 3	Identify security challenges in WSN, design secure wireless sensor networks for emerging scenarios, and analyze the transition from WSN to IoT from a security perspective.
CO 4	Understand cyber security threats in industrial environments, common attack methods targeting industrial systems, and strategies for dealing with cyber threats and infections.
CO 5	Analyze industrial automation requirements and evaluate the suitability of different wireless technologies such as WiFi, Bluetooth, Zigbee, Wireless HART, and 5G for industrial automation applications.

Text Books:

1	Dick Caro, Wireless Networks for Industrial Automation, ISA; 4th edition, 2013
2	R Budampati, S Kolavennu, Industrial Wireless Sensor Networks: Monitoring, Control and Automation, Woodhead Publishing Ltd (2015)

Reference Books / Web links:

1	Ling Lyu, Xinping Guan, Nan Cheng, Xuemin Sherman Shen, Advanced Wireless Technologies for Industrial Network Systems (Wireless Networks), Springer International Publishing AG, 2023
2	Christos Koulamas, Mihai T Lazarescu, Real-Time Sensor Networks and Systems for the Industrial IoT, Mdpi AG, 2020

MT19E17	INTELLIGENT CONTROL SYSTEMS	Category	L	T	P	C
		PC	3	0	0	3

Objectives:

	Understand the history, characteristics, and basic models of neural networks, including McCulloch Pitts model, Perceptron, and Adaline model.
	Explore the architecture and learning algorithms of artificial neural networks (ANN), including feed-forward networks and backpropagation.
	Introduce the fundamental concepts of fuzzy logic, including fuzzy sets, membership functions, linguistic variables, and fuzzy rule-based systems.
	Delve into the mathematics behind fuzzy control, including membership functions, fuzzification, and defuzzification.
	Investigate the integration of neural networks and fuzzy logic controllers in neuro-fuzzy systems for decision making and control.

UNIT-I	INTRODUCTION TO NEURAL NETWORKS	9

History of neural network research, characteristics of neural networks terminology, models of neuron Mc Culloch Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture

UNIT - II	ANN TECHNIQUES	9

Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, backpropagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning. Radial basis function networks, and recurrent networks, Self-organized maps.

UNIT-III	INTRODUCTION TO FUZZY LOGIC	9

Fuzzy sets, Membership functions, linguistic variables, Fuzzy Logic operators, Fuzzy rule-based systems Fuzzification, defuzzification.

UNIT-IV	MATHEMATICS OF FUZZY CONTROL	9

Fuzzy sets, Membership Functions- Piecewise Linear MF- Nonlinear Smooth MF- Sigmoidal MF- Polynomial or Spline Based Functions-Irregular Shaped MF, Linguistic Variables, Fuzzification, Defuzzification.

UNIT-V	NEURO FUZZY CONTROL	9

Introduction, Neural Networks and Architectures, Combination of Neural Networks and Fuzzy controllers- NN for correcting FLC-NN for Learning Rules - NN for Determining MFs - NN for learning/Tuning scaling parameters, Scaling parameters of PD- PI fuzzy controller, Multi-resolution learning.

	Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

CO 1	Describe the historical development and characteristics of neural networks and explain the functioning of basic neuron models.
CO 2	Demonstrate proficiency in designing and training artificial neural networks, including single-layer and multilayer perceptrons, using backpropagation.
CO 3	Apply fuzzy logic concepts to model uncertainty and imprecision in decision-making processes, using fuzzy sets, linguistic variables, and fuzzy rule-based systems.
CO 4	Analyze and design fuzzy control systems using mathematical techniques for membership functions, fuzzification, and defuzzification.
CO 5	Develop skills in integrating neural networks and fuzzy logic controllers to create neuro-fuzzy systems for complex decision-making and control tasks.

Text Books:

1	Simon Haykin, "Neural Networks and Learning Machines", Pearson Education, 3rd Edition, 2008
2	Timothy J. Ross, "Fuzzy Logic with Engineering Applications", John Wiley & Sons, 3rd Edition, 2010

Reference Books / Web links:

1	Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", Prentice Hall, 1st Edition, 1997
2	Simon Haykin, "Neural Networks: A Comprehensive Foundation", Pearson Education, 2nd Edition, 1999
3	Masao Mukaidono, "Fuzzy Logic for Beginners", Springer, 1st Edition, 2009

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19C17	SMART MOBILITY AND INTELLIGENT VEHICLES	PE	3	0	0	3

Objectives:	
	To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
	To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
	To learn Basic Control System Theory applied to Autonomous Automobiles.
	To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
	To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology

UNIT-I	Introduction To Automated, Connected, And Intelligent Vehicles	9
Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicle.		
UNIT-II	**Sensor Technology For Smart Mobility**	**9**
Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems		
UNIT-III	**Connected Autonomous Vehicle**	**9**
Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.		
UNIT-IV	**Vehicle Wireless Technology & Networking**	**9**
Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.		
UNIT-V	**Connected Car & Autonomous Vehicle Technology**	**9**
Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
	Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles

	Assess the concept of remote sensing and the required sensor technologies essential for its implementation.
	Acquainted with the concept of fully autonomous vehicles
	Apply the basic concepts of wireless communications and wireless data networks
	Analyze the concept of the connected vehicle and its role in automated vehicles

Text Books:	
1	Intelligent Transportation Systems and Connected and Automated Vehicles‖, 2016, Transportation Research Board.
2	Radovan Miucic, ―Connected Vehicles: Intelligent Transportation Systems‖, 2019, Springer.

Reference Books(s) / Web links:	
1	Tom Denton, ―Automobile Electrical and Electronic systems, Roultedge‖, Taylor & Francis Group,5th Edition,2018.
2	https://professional.mit.edu/course-catalog/transportation-networks-and-smart-mobility- methods-and-solutions.
3	https://engineering.purdue.edu/CE/Academics/Graduate/Online/smart-mobility

PO-PSO / **CO**	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1
CO2	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1
CO3	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1
CO4	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1
CO5	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

VERTICAL 6
DIVERSIFIED 1

MT19F11	ADVANCED MICROPROCESSORS AND MICROCONTROLLERS	Category	L	T	P	C
			3	0	0	3

Objectives :	
•	To familiarize with the features, specifications, and features of modern microprocessors.
•	To gain knowledge about the architecture of Intel 32 and 64-bit microprocessors and salient features associated with them.
•	To familiarize with the features, specifications, and features of modern microcontrollers.
•	To gain knowledge about the 32-bit microcontrollers based on ARM architectures
•	To learn about PIC32 architectures

UNIT – I	FEATURES OF MODERN MICROPROCESSORS	9
Evolution of microprocessors - Data and Address buses – clock speed – memory interface - multi-core architectures – cache memory hierarchy – operating modes – super scaler execution – dynamic execution – overclocking – integrated graphics processing - performance benchmarks.		
UNIT – II	**HIGH PERFORMANCE CISC ARCHITECTURES**	**9**
Introduction to IA 32 bit architecture – Intel Pentium Processors family tree – Memory Management – Branch prediction logic - Superscalar architecture – Hyper threading technology – 64 bit extension technology – Intel 64 bit architecture - Intel Core processor family tree – Turbo boost technology – Smart cache - features of Nehalem microarchitecture		
UNIT – III	**HIGH PERFORMANCE RISC ARCHITECTURE**	**9**
ARM 9 RISC architecture merits and demerits – The programmer's model of ARM Architecture – 3- stage pipeline ARM organization - 3-stage pipeline ARM organization – ARM instruction execution – Salient features of ARM instruction set - ARM architecture profiles (A, R and M profiles)		
UNIT – IV	**FEATURES OF MODERN MICROPROCESSORS**	**9**
Introduction to microcontrollers – microcontroller vs microprocessors – microcontroller architecture - Processor Core – Memory interfaces– Communication interfaces (SPI,I2C, USB and CAN) – ADC - PWM – Watchdog timers – Interrupts – Debugging interfaces		
UNIT – V	**HIGH PERFORMANCE MICROCONTROLLER ARCHITECTURES**	**9**
Introduction to the Cortex-M Processor Family - ARM 'Cortex-M3' architecture for microcontrollers – Thumb 2 instruction technology – Internal Registers - Nested Vectored Interrupt controller - Memory map - Interrupts and exception handling – Applications of Cotex-M3 architecture		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course students should be able to:	
CO 1	To explain the features and important specifications of modern microprocessors
CO 2	To explain the salient features CISC microprocessors based on IA-32 bit and IA-64 bit architectures
CO 3	To explain the salient features RISC processors based on ARM architecture and different application
CO 4	To explain the features and important specifications of modern microcontrollers
CO 5	To explain about ARM – M3 architecture and its salient features
TEXT BOOKS:	
1	Intel Inc, "Intel 64 and IA-32 Architectures Developer's Manual", Volume-I, 2016
2.	Barry. B. Breg," The Intel Microprocessors" , PHI,2008.

REFERENCES:	
1.	Gene .H.Miller ." Micro Computer Engineering ," Pearson Education , 2003.
2.	Joseph Yiu, "The Definitive Guide to the ARM ® Cortex-M3", Newnes, 2010.
3.	Scott Mueller, "Upgrading and Repairing PCs", 20th edition, Que.
4.	Steve Furber, ' ' ARM System –On –Chip architecture "Addision Wesley , 2000.
5.	Trevor Martin, "The Designer's Guide to the Cortex-M Processor Family", Newnes, 2013.

MT19F12	INTERNET TOOLS AND JAVA PROGRAMMING	Category	L	T	P	C
		PC	3	0	0	3

Objectives:

	Gain knowledge of major internet services and protocols including Net Telephony, Internet Relay Chat, Newsgroups, FTP, Remote Login, Telnet, Gopher, and Veronica Clients.
	Learn fundamental concepts of object-oriented programming in Java including data types, operators, declarations, control structures, arrays, strings, classes, methods, constructors, inheritance, and composition.
	Understand advanced concepts in Java such as abstract classes, abstract functions, method overloading, method overriding, wrapper classes, packages, access protection, importing packages, interfaces, and variables in interfaces.
	Familiarize with exception handling principles, types of exceptions, try-catch blocks, nested try statements, throwing and catching exceptions, as well as multi-threaded programming concepts like thread model, synchronization, messaging, and interthread communication.
	Explore concepts of I/O operations, stream classes, reading/writing console input, applet fundamentals, GUI components, Java scripts, AWT/Swings, internet addresses, internet protocols, DNS, socket programming, UDP, TCP, and JDBC for database programming.

UNIT-I	INTERNET TOOLS	9

Major Internet Services – Net Telephony – Internet Relay Chat – Newsgroups – File Transfer Protocol (FTP) – Remote Login – Telnet, Gopher, and Veronica Clients.
OBJECT ORIENTATION IN JAVA: Introduction - Data Types - Operators - Declarations – Control Structures - Arrays and Strings – Input / Output. Java Classes - Fundamentals - Methods - Constructors - Scope rules - this keyword - object based Vs oriented programming. Inheritance-Reusability - Composing class.

UNIT - II	ABSTRACT FUNCTIONS AND PACKAGES	9

Abstract classes - Abstract Functions – Method Overloading and Method Overriding- Wrapper Classes. Packages - Access protection - Importing packages - Interface - Defining and Implementing Interface - Applying Interface - Variables in Interfaces.

UNIT-III	EXCEPTION HANDLING	9

Fundamentals - Exception types - Uncaught Exception - Using Try and Catch - Multiple catch clauses - Nested Try statements - Throw - Throws - Java Built-in Exception - Creating your own subclasses. MULTI THREADED PROGRAMMING: Java thread model - Priorities - Synchronization - Messaging - Thread class and runnable Interface - Main thread - Creating the Thread - Synchronization - Interthread Communication - Deadlock.

UNIT-IV	I/O, APPLETS	9

I/O basics - Stream - Stream Classes - Predefined stream - Reading/Writing console input - Applet fundamentals - Native methods - GUI Components - Applets - Java Scripts – AWT / Swings.

UNIT-V	INTRODUCTION TO NETWORK PROGRAMMING	9

Fundamentals - Internet Addresses - Internet Protocols - DNS - Internet Services - Socket programming, UDP, TCP. JAVA DATABASE PROGRAMMING: JDBC –Database Connection and Table Creation – Execution of Embedded SQL Statements – Result Set and Result Set Meta Data – Examples.

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

Course Outcomes: On completion of course students will be able to

CO 1	Students will be able to explain the functionalities and applications of major internet services and protocols.
CO 2	Students will demonstrate the ability to design and implement object-oriented Java programs, utilizing various concepts like classes, methods, inheritance, and composition effectively.
CO 3	Students will be capable of designing and organizing Java programs using abstract classes, interfaces, and packages to enhance code modularity and reusability.
CO 4	Students will develop skills in identifying and handling exceptions appropriately and implementing multi-threaded programs for efficient concurrent execution.
CO 5	Students will exhibit competence in performing I/O operations, creating Java applets, and developing network programming functionalities for client-server communication and database interactions.

Text Books:

1	Herbert Schildt, "Java: The Complete Reference", McGraw-Hill Education, 11th Edition, 2018
2	Cay S. Horstmann, "Big Java: Early Objects", Wiley, 7th Edition, 2016
3	

Reference Books / Web links:

1	Kathy Sierra, Bert Bates, "Head First Java", O'Reilly Media, 2nd Edition, 2005
2	Bruce Eckel, "Thinking in Java", Prentice Hall, 4th Edition, 2006

MT19F13	IMMERSIVE TECHNOLOGIES AND HAPTICS	Category	L	T	P	C
		PC	3	0	0	3

Objectives:

	Understand and apply concepts of Virtual Reality, Augmented Reality, Mixed Reality, and Extended Reality, along with their applications and devices.
	Proficiently use Unity and Unreal Engine, develop coding skills in C# for Unity, and explore Blueprint programming in Unreal Engine.
	Utilize AR Software Development Kits (SDKs) for Unity, focusing on developing and building AR applications.
	Explore VR SDKs for Unity and Unreal Engine, gaining hands-on experience in developing immersive VR applications.
	Understand Extended Reality concepts, delve into Haptics, and explore custom device development and integration within the context of Extended Reality.

UNIT-I	INTRODUCTION TO IMMERSIVE TECHNOLOGIES	9

Introduction on Virtual reality - Augmented reality - Mixed reality - Extended reality - VR Devices - AR Devices – Applications.

UNIT-II	SOFTWARE TOOLS	9

Intro to Unity - Unity editor workspace - Intro to C# and visual studio - Programming in Unity -Intro to Unreal Engine - UE4 Editor workspace - Intro to Blueprint programming - Programming in Ue4.

UNIT-III	BUILDING AR APPLICATION WITH UNITY	9

AR SDKs for unity and unreal engine - Working with SDKs for unity - Developing AR application in unity- Building AR application.

UNIT-IV	BUILDING VR APPLICATION WITH UNREAL ENGINE	9

VR SDKs for unity and unreal engine - Developing VR application in Ue4 - Building VR application.

UNIT-V	HAPTIC PERCEPTION AND EXTENDED REALITY	9

Extended Reality - Introduction to Haptics - Devices and possibilities - Custom Device development - Device Integration.

Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

CO 1	Differentiate VR, AR, MR, and XR; understand devices and applications.
CO 2	Proficiently use Unity, Unreal Engine, C#, and Blueprint programming.
CO 3	Use AR SDKs, develop AR apps in Unity, and demonstrate building AR applications.
CO 4	Implement VR SDKs, develop VR apps in Unreal Engine, and demonstrate VR application building.
CO 5	Understand Extended Reality, explore Haptic technology, and develop custom devices for XR integration.

Text Books:

1	Aukstakalnis, S., Blatner, D., "Silicon Mirage: The Art and Science of Virtual Reality", Peachpit Press, 1st Edition, 1992.
2	Burdea, G., Coiffet, P., "Virtual Reality Technology", Wiley-Interscience, 2nd Edition, 2003.
3	Oculus Documentation Team, "Oculus Rift Development Essentials", Packt Publishing, 1st Edition, 2017.

Reference Books / Web links:

1	Unity Technologies, "Unity in Action: Multiplatform Game Development in C#", Manning Publications, 2nd Edition, 2018.
2	Linowes, J., "Virtual Reality Blueprints", Packt Publishing, 1st Edition, 2016.
3	Gabel, A., "Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile", O'Reilly Media, 2nd Edition, 2019.
4	Stein, J., Wyman, C., "Unity Virtual Reality Projects", Packt Publishing, 1st Edition, 2015.
5	Parisi, T., "Augmented Human: How Technology Is Shaping the New Reality", O'Reilly Media, 1st Edition, 2017.

MT19F14	SYSTEMS MODELLING AND SIMULATION METHODS	Category	L	T	P	C
		PC	3	0	0	3

Objectives:

- Master fundamental simulation concepts and apply them to practical examples
- Comprehend mathematical models, including statistical concepts and queueing models. Develop skills in generating and testing pseudo-random numbers for simulations.
- Learn techniques for input modeling, data collection, hypothesis testing, and output analysis. Acquire knowledge of terminating simulations in steady-state scenarios.
- Build, verify, and validate simulation models, including calibration and validation processes.
- Utilize simulation tools for modeling computer systems, compare systems via simulation, and develop simulation models through case studies.

UNIT-I	INTRODUCTION TO SIMULATION	9

Introduction – Simulation Terminologies- Application areas – Model Classification – Types of Simulation- Steps in a Simulation study- Concepts in Discrete Event Simulation - Simulation Examples

UNIT - II	MATHEMATICAL MODELS	9

Statistical Models - Concepts – Discrete Distribution- Continuous Distribution – Poisson Process- Empirical Distributions- Queueing Models – Characteristics- Notation – Queueing Systems – Markovian Models- Properties of random numbers- Generation of Pseudo Random numbers- Techniques for generating random numbers-Testing random number generators- Generating Random-Variates- Inverse Transform technique – Acceptance- Rejection technique – Composition & Convolution Method.

UNIT-III	ANALYSIS OF SIMULATION DATA	9

Input Modeling - Data collection - Assessing sample independence – Hypothesizing distribution family with data Parameter Estimation - Goodness-of-fit tests – Selecting input models in absence of data- Output analysis for a Single system – Terminating Simulations – Steady state simulations.

UNIT-IV	VERIFICATION AND VALIDATION	9

Model Building – Verification of Simulation Models – Calibration and Validation of Models – Validation of Model Assumptions – Validating Input – Output Transformations.

UNIT-V	SIMULATION OF COMPUTER SYSTEMS AND CASE STUDIES	9

Simulation Tools – Model Input – High level computer system simulation – CPU – Memory Simulation – Comparison of systems via simulation – Simulation Programming techniques - Development of Simulation models.

Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

CO 1	Analyze simulation terminologies, types, and application areas.
CO 2	Utilize statistical models (discrete and continuous distributions) for simulation scenarios.
CO 3	Demonstrate proficiency in input modeling, data collection, and output analysis for a single system.
CO 4	Build, verify, and calibrate simulation models, ensuring the validation of model assumptions.
CO 5	Employ simulation tools to model computer systems, including CPU and memory simulation. Develop simulation models for real-world case studies.

Text Books:

1	Law, A.M., Kelton, W.D., "Simulation Modeling and Analysis", McGraw-Hill Education, 5th Edition, 2014.
2	Banks, J., Carson, J.S., Nelson, B.L., Nicol, D.M., "Discrete-Event System Simulation", Pearson, 5th Edition, 2019.
3	Ross, S.M., "Simulation", Academic Press, 6th Edition, 2013.

Reference Books / Web links:

1	Law, A.M., "Simulation Modeling and Analysis with ARENA", Wiley, 1st Edition, 2019.
2	Ayyub, B.M., McCuen, R.H., "Probability, Statistics, and Reliability for Engineers and Scientists", CRC Press, 2nd Edition, 2003.
3	Banks, J., "Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice", Wiley, 1st Edition, 1998.
4	Robinson, S., "Simulation: The Practice of Model Development and Use", Wiley, 1st Edition, 2004.
5	Law, A.M., "Simulation Modeling and Analysis with Expertfit Software", McGraw-Hill Education, 5th Edition, 2018.
6	AnyLogic: Simulation Modeling Software Tools & Solutions for Business, Simulation and modeling of natural processes | Coursera

MT19F15	APPLIED SIGNAL PROCESSING	Category	L	T	P	C
		PC	3	0	0	3

Objectives:

- Master fundamentals of signals and systems, including operations and classification in continuous and discrete time. Differentiate between CT and DT systems.
- Apply advanced mathematical tools for the analysis of continuous time systems, including Fourier series, Fourier Transform, and Laplace transform.
- Utilize Fourier Transform techniques for the analysis of discrete time signals and systems, including DTFT, DFT, FFT, and Z Transform. Assess system stability using Z Transform.
- Apply design techniques for digital filters, including IIR and FIR filters, through frequency and bilinear transformations.
- Understand TMS320C54xx DSP architecture and apply DSP in various applications, including signal compression, generators, noise generators, tone detection, echo cancellation, and speech enhancement.

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 APPLICATIONS** **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: On completion of course students will be able to

CO 1	Analyze and represent signals in continuous and discrete time. Classify signals and understand system properties.
CO 2	Apply Fourier series, Fourier Transform, Laplace transform, and analyze CT systems.
CO 3	Explore DTFT, DFT, FFT, Z Transform, and analyze stability of systems.
CO 4	Review analog filter design, apply frequency transformation, and design IIR and FIR filters.
CO 5	Understand TMS320C54xx DSP architecture, programming, and apply DSP in signal processing applications.

Text Books:

1	Oppenheim, A.V., Willsky, A.S., S. Hamid, "Signals and Systems", Pearson, 3rd Edition, 2022.
2	Proakis, J.G., Manolakis, D.G., "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 5th Edition, 2021.
3	Hayes, M.H., "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2nd Edition, 2023.
4	Mitra, S.K., "Digital Signal Processing: A Computer-Based Approach", McGraw-Hill Education, 5th Edition, 2022.

Reference Books / Web links:

1	Proakis, J.G., "Digital Signal Processing using MATLAB", Cengage Learning, 5th Edition, 2023.
2	Oppenheim, A.V., Schafer, R.W., Buck, J.R., "Discrete-Time Signal Processing", Pearson, 4th Edition, 2021.
3	Lyons, R.G., "Understanding Digital Signal Processing", Pearson, 4th Edition, 2022.
4	Tan, L., Jiang, Y., "Digital Signal Processing: Fundamentals and Applications", Academic Press, 2nd Edition, 2023.
5	Gold, B., "Digital Processing of Speech Signals", Prentice Hall, 3rd Edition, 2020.
6	Digital Signal Processing Specialization [4 courses] (EPFL) | Coursera, DSP System Toolbox - MATLAB (mathworks.com)

MT19F16	NEURAL NETWORKS AND FUZZY SYSTEMS	Category	L	T	P	C
		PC	3	0	0	3

Objectives:

- Understand ANN fundamentals, neurons, and applications.
- Familiarize with essential ANN components, solve numerical problems.
- Comprehend supervised learning networks and implement Radial Basis Function.
- Explore classical and fuzzy sets, their operations, and relations.
- Master fuzzy logic components and apply them in decision-making systems.

UNIT-I ARTIFICIAL NEURAL NETWORKS **9**

Introduction, Biological Neuron, Artificial Neuron, Basic concepts of Neural Networks, Basic Models of ANN Connections, McCulloch-Pitts Model, Characteristics of ANN, Applications of ANN.

UNIT - II ESSENTIALS OF ARTIFICIAL NEURAL NETWORKS **9**

Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Learning Strategies (Supervised, Unsupervised, Reinforcement), Learning Rules, Numerical problems, Types of Application

UNIT-III SUPERVISED LEARNING NETWORKS **9**

Perceptron Network, Perceptron Learning Rule, Architecture, Perceptron Training Algorithm, ADALINE, MADALINE, Back Propagation Network, BP Learning Rule, Input Layer Computation, Hidden Layer Computation, Output Layer Computation, Radial Basis Function Demonstration through MATLAB.

UNIT-IV CLASSICAL & FUZZY SETS **9**

Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.

UNIT-V FUZZY LOGIC SYSTEM COMPONENTS **9**

Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods, Applications.

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

CO 1	Analyze introduction, biological and artificial neurons, basic concepts, and characteristics of ANN. Understand McCulloch-Pitts Model and ANN applications.
CO 2	Understand artificial neuron model, activation functions, ANN architectures, classification taxonomy, and learning strategies.
CO 3	Analyze perceptron networks, ADALINE, MADALINE, Back Propagation Network (BP), and demonstrate Radial Basis Function through MATLAB.
CO 4	Understand classical and fuzzy sets, operations, relations, and properties.
CO 5	Explore fuzzification, membership assignment, rule base development, and defuzzification methods in fuzzy logic.

Text Books:

1	Haykin, S.S., "Neural Networks and Learning Machines", Pearson, 3rd Edition, 2009.
2	Bishop, C.M., "Pattern Recognition and Machine Learning", Springer, 1st Edition, 2006.
3	Marsland, S., "Machine Learning: An Algorithmic Perspective", Chapman and Hall/CRC, 2nd Edition, 2014.
4	Zurada, J.M., "Introduction to Artificial Neural Systems", Jaico Publishing House, 3rd Edition, 2007.

Reference Books / Web links:

1	Duda, R.O., Hart, P.E., Stork, D.G., "Pattern Classification", Wiley, 2nd Edition, 2000.
2	Bezdek, J.C., "Pattern Recognition with Fuzzy Objective Function Algorithms", Springer, 1st Edition, 1981.
3	Kosko, B., "Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence", Prentice Hall, 1st Edition, 1992.
4	Klir, G.J., Yuan, B., "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice Hall, 1st Edition, 1995.
5	Jang, J.-S.R., Sun, C.-T., Mizutani, E., "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", Prentice Hall, 1st Edition, 1997.
6	https://www.deeplearning.ai/

Subject Code	Subject Name	Category	L	T	P	C
MT19F17	COMPUTER VISION AND DEEP LEARNING	PC	3	0	0	3

Objectives:

- Understand the fundamentals of image formation and camera calibration, including sampling theorem and geometric image formation models.
- Explore 3-D structure and motion analysis techniques, such as computational stereopsis and visual motion estimation.
- Learn about active and robot vision technologies, including LIDAR construction, visual tracking, and visual SLAM.
- Introduce neural networks and their applications in computer vision, covering topics like backpropagation and multi-layer perceptrons.
- Delve into deep learning concepts, including convolutional neural networks (CNNs), architectures, training methodologies, and popular frameworks.

UNIT-I IMAGE FORMATION AND CAMERA CALIBRATION **9**

Basics: Sampling Theorem – Numerical Differentiation – Singular Value Decomposition Introduction to Vision, Terminologies of Fields, Comparison of Biological and Computer Vision, Projective Geometry Basics, Modelling of Geometric Image Formation, Modelling of Camera Distortion, Camera Calibration.

UNIT-II 3-D STRUCTURE AND MOTION **9**

Computational Stereopsis – Geometry, Parameters – Correspondence Problem, Epipolar Geometry, Essential Matrix And Fundamental Matrix, Eight Point Algorithm – Reconstruction by Triangulation, Visual Motion – Motion Field of Rigid Objects – Optical Flow – Estimation of Motion Field – 3D Structure and Motion from Sparse and Dense Motion Fields – Motion Based Segmentation – Image Processing.

UNIT-III ACTIVE AND ROBOT VISION **9**

LIDAR - Construction, Working Principle, Specifications and Selection Criteria. Point Cloud Data Processing. Visual Tracking – Kalman Filtering – Visual SLAM, Solutions, Visual Servoing, Types and Architecture.

UNIT-IV INTRODUCTION TO NEURAL NETWORKS **9**

Introduction to Neural Networks, Philosophy and Types of Networks, Back propagation, Numerical Problems for Back Propagation, Multi-Layer Perceptrons, Numerical Problems Based on Perceptron, Conventional Neural Networks vs. Deep Learning in the Context of Computer Vision, Loss Function Gradient Descent

UNIT-V DEEP LEARNING **9**

Convolutional Neural Networks - Convolution, Pooling, Activation Functions, Initialization, Dropout, Batch Normalization, Deep Learning Hardware - CPU, GPU and TPU -Tuning Neural Networks, Best Practices, Training Neural Networks, Update Rules, Ensembles, Data Augmentation, Transfer Learning, Popular CNN Architectures for Image Classification – Alexnet, VGG, Resnet, , Inception, CNN Architectures for Object Detection – RCNN and Types – Yolo - Semantic Segmentation - FCN, Instance Segmentation - Mask RCNN – Deep Learning frameworks.

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

CO 1	Ability to apply image formation and camera calibration techniques to model geometric image formation and correct camera distortion.
CO 2	Proficiency in analyzing 3-D structure and motion from sparse and dense motion fields using computational techniques.
CO 3	Competence in implementing active and robot vision technologies, including LIDAR processing and visual tracking.
CO 4	Understanding of neural networks and their applications in computer vision tasks, including classification and object detection.
CO 5	Capability to design and implement deep learning models using CNN architectures for various computer vision tasks, including image classification, object detection, and semantic segmentation.

Text Books:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 1st Edition, 2010
2. Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", Cambridge University Press, 2nd Edition, 2004
3. Joseph Howse, Joe Minichino, and Villemin Laurent, "Learning OpenCV 4 Computer Vision with Python 3: Get to grips with tools, techniques, and algorithms for computer vision and machine learning", Packt Publishing, 1st Edition, 2019

Reference Books / Web links:

1. Rajalingappaa Shanmugamani, "Deep Learning for Computer Vision", Packt Publishing, 1st Edition, 2018
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly Media, 2nd Edition, 2019
3. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer, 1st Edition, 2018

Subject Code	Subject Name	Category	L	T	P	C
MT19F18	PROJECT MANAGEMENT	PC	3	0	0	3

Objectives:

- Understand the fundamentals of project management, including its life cycle and organizational structures.
- Develop skills in project initiation, including idea generation, project charters, and stakeholder communication.
- Master time management techniques such as work breakdown structures, Gantt charts, and critical path analysis.
- Gain proficiency in resource and cost management, including resource balancing and cost optimization strategies.
- Explore risk management processes and Agile methodologies to anticipate and adapt to project uncertainties.

UNIT-I OVERVIEW OF PROJECT MANAGEMENT **9**

Definition - Project Life Cycle- Objectives of Project management-Project knowledge areas organization structure-roles of project management group-project management office and its role- ISO 21500:2012: Guidance on project management.

UNIT-II PROJECT INITIATION **9**

Generation and Screening of PM ideas- Triple Constraint – Time, Cost and Scope - TOR/ Project Charter/ SOW (Statement of Work)-Project Presentation & Approval- Technology transfer: PPP – case study

UNIT-III TIME MANAGEMENT **9**

Work break down structure- Gantt Charts, Milestone chart – Project Network- Fulkerson's rules – Activity-On-Arrow and Activity- On -Node networks - Critical path method (CPM) - Project updating and monitoring- Program Evaluation & Review Technique (PERT)-case study

UNIT-IV RESOURCE & COST MANAGEMENT **8**

Types of resources- Balancing of resource- Resource Smoothing Technique-Resource levelling technique-case study Types of cost –Cost Slope- Variation of Cost with time- Crash time and crash cost- Optimize project cost for time and resource-case study

UNIT-V RISK MANAGEMENT AND AGILE **10**

Risk Identification-Risk management process – Failure modes- FMEA - Project Closure- Project Report- Agile Project management- case study

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

CO 1	Describe project management concepts and roles within project management organizations.
CO 2	Apply project initiation techniques to develop project charters and obtain project approvals.
CO 3	Create project schedules using time management tools and analyze critical paths for project completion.
CO 4	Manage project resources effectively and optimize project costs to meet project objectives.
CO 5	Identify and mitigate project risks while applying Agile principles to adapt to changing project requirements.

Text Books:

1	Project Management Institute, "A Guide to the Project Management Body of Knowledge (PMBOK® Guide)", Project Management Institute, 6th Edition, 2017
2	Clifford F. Gray and Erik W. Larson, "Project Management: The Managerial Process", McGraw-Hill Education, 7th Edition, 2019
3	Jeffrey K. Pinto, "Project Management: Achieving Competitive Advantage", Pearson, 5th Edition, 2015

Reference Books / Web links:

1	Robert K. Wysocki, "Effective Project Management: Traditional, Agile, Extreme", Wiley, 7th Edition, 2019
2	John M. Nicholas and Herman Steyn, "Project Management for Engineering, Business and Technology", Routledge, 5th Edition, 2017
3	Jim Highsmith, "Agile Project Management: Creating Innovative Products", Addison-Wesley Professional, 2nd Edition, 2009

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19F17	ADVANCED ENERGY STORAGE TECHNOLOGIES	PE	3	0	0	3

Objectives:	
	To understand the various types of energy storage technologies and its applications.
	To study the various modeling techniques of energy storage systems using TRNSYS.
	To learn working concepts and types of batteries.
	To make the students to get understand the concepts of Hydrogen and Biogas storage.
	To provide the insights on super capacitor, Fly wheel and compressed energy storage system.

UNIT-I	Introduction	9
Necessity of energy storage–types of energy storage–comparison of energy storage technologies–Applications.		
UNIT-II	**Thermal Storage System**	**9**
Thermal storage–Types–Modelling of thermal storage units–Simple water and rock bed storage system–pressurized water storage system–Modelling of phase change storage system –Simple units, packed bed storage units – Modelling using porous medium approach, Use of TRNSYS software.		
UNIT-III	**Electrical Energy Storage**	**9**
Fundamental concept of batteries–measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel– Cadmium, Zinc Manganese di oxide and modern batteries for example(i)zinc-Air(ii)Nickel Hydride (iii)Lithium Battery.		
UNIT-IV	**Hydrogen And Biogas Storage**	**9**
Hydrogen storage options–compressed gas–liquid hydrogen–Metal Hydrides, chemical Storage, Cryofuel storage and handling - Biogas storage-comparisons. Safety and management of hydrogen and Biogas storage-Applications.		
UNIT-V	**Alternate Energy Storage Technologies**	**9**
Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of the course students should be able to:	
	Identify the energy storage technologies for suitable applications
	Analyze the energy storage systems using TRNSYS.
	Summarise the concepts and types of batteries.
	Examine the principle of operation of Hydrogen and Biogas storage systems.
	Explain the working of super capacitor, Flywheel and compressed energy storage systems

Text Books:	
1	Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2010
2	Robert Huggins, Energy Storage: Fundamentals, Materials and Applications,2nd edition, Springer,2015.

Reference Books(s) / Web links:	
1	Viswanathan, Fuel cell principle and applications university press, 2006.
2	Luisa F.Cabeza, Advances in Thermal Energy Storage Systems: Methods and Applications, Elsevier Wood head Publishing, 2015.
3	Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications,2012
4	National Energy Technology Laboratory, U.S. Department of Energy, Fuel Cell Handbook (Seventh Edition).
5	https://energystorage.org/why-energy-storage/technologies/
6	https://invenergy.com/what-we-do/advanced-energy-storage
7	Sutton, G.P, Rocket Propulsion elements, John Wiley & Sons Inc., New York, Ninth Edition, 2017.

PO-PSO	POs												PSOs		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	2	-	-	-	-	-		-	-	-	-	-
CO2	2	-	3	3	-	-	-	-	-		-	-	-	-	-
CO3	2	-	1	2	-	-	-	-	-		-	-	-	-	-
CO4	2	-	1	2	-	-	-	-	-		-	-	-	-	-
CO5	2	-	1	2	-	-	-	-	-		-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

VERTICAL 7
DIVERSIFIED 2

MT19P55	AUTOMOBILE ENGINEERING	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the construction and working principle of various parts of an automobile
●	To understand the working and types of engine auxiliary systems
●	To provide knowledge about the working and types of transmission systems
●	To understand the construction and working principle of steering, brakes and suspension systems
●	To have the knowledge about alternative sources of energy

UNIT-I	**VEHICLE STRUCTURE AND ENGINES**	9
Types of automobiles, vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines –components function and materials, variable valve timing (VVT)		
UNIT-II	**ENGINE AUXILIARY SYSTEMS**	9
Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three-way catalytic converter system, Emission norms (Euro and BS)		
UNIT-III	**TRANSMISSION SYSTEMS**	9
Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive		
UNIT-IV	**STEERING, BRAKES AND SUSPENSION SYSTEMS**	9
Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control		
UNIT-V	**ALTERNATIVE ENERGY SOURCES**	9
Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
CO 1	Demonstrate a basic understanding of engine functions, performance, and design methodology for frame, chassis etc
CO 2	Understand the various fuel supply, ignition and performance improvement methods in IC engines and environmental issues
CO 3	Demonstrate the knowledge of various parts of transmission systems and its mechanism
CO 4	Understand the working of steering, brake and suspension systems
CO 5	Demonstrate an understanding of technological, environmental, and social impacts of alternative energy sources

Text Books:	
1	Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Standard Publishers, New Delhi, 2014
2	William H.Crouse and Donald L.Angline "Automotive Mechanics", Tata McGraw-Hill, 2017

Reference Books / Web links:	
1	Jain K.K. and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2012
2	Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2017
3	Srinivasan, "Automotive Mechanics", McGraw-Hill, 2004
4	Ed May, "Automotive Mechanics", Tata McGraw-Hill,2017

MT19G11	SMART SENSORS AND MICRO ELECTRO MECHANICAL SYSTEMS	Category	L	T	P	C
			3	0	0	3

Objectives:	
	Understand material aspects of MEMS, including silicon, metal films, polymers, and smart materials.
	Explore various MEMS sensors, such as mechanical, thermal, magnetic, and micro-opto electromechanical systems.
	Analyze MEMS actuators, including mechanical, thermal, magnetic, and micro-opto electromechanical systems.
	Learn micromachining techniques for MEMS fabrication, including etching and assembly methods.
	Investigate MEMS applications in computing, healthcare, consumer products, and emerging technologies.

UNIT-I	MATERIAL ASPECTS OF MEMS	9
Overview of MEMS & Laws of MEMS - Intrinsic Characteristics of MEMS, Material Aspects – Silicon and its compounds – Thin metal films – Review of Electrical and Mechanical concepts in MEMS - Semiconductor – Optical properties – Polymers – Smart materials.		
UNIT-II	SENSORS	**9**
MEMS Sensors – Mechanical Sensors – Thermal Sensors – Magnetic Sensors – Micro-opto Electromechanical Systems – Radio Frequency (RF) MEMS - Microfluidic Systems; Chemical and Biomedical Microsystems.		
UNIT-III	ACTUATORS	**9**
MEMS Actuators – Mechanical Actuators – Thermal Actuators – Magnetic Actuators – Micro-opto electromechanical Systems – Radio Frequency (RF) MEMS - Microfluidic Systems; Chemical and Biomedical Microsystems.		
UNIT-IV	MICROMACHINING	**9**
Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching– Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Ant restriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process		
UNIT-V	MEMS APPLICATIONS	**9**
Applications in Computer Industry – Making of ICs and Microprocessors – Data storage devices - Safety and Stability Control. Health care - Lab-on-a-Chip. Consumer Products; Micro reactor; Micro-bots; MOEMS; Molecular machines.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
CO 1	Describe material properties relevant to MEMS technology.
CO 2	Demonstrate proficiency in designing MEMS sensors for diverse applications.
CO 3	Apply knowledge to design and analyze MEMS actuators for specific tasks.
CO 4	Gain hands-on experience in micromachining processes for MEMS fabrication.
CO 5	Identify and analyze potential MEMS applications in various industries and fields.

Text Books:	
1	Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology", CRC Press, 3rd Edition, 2011
2	Tai-Ran Hsu, "MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering", Wiley, 2nd Edition, 2018
3	Nadim Maluf and Kirt Williams, "Introduction to Microelectromechanical Systems Engineering", Artech House, 2nd Edition, 2004

Reference Books(s) / Web links:	
1	Reza Ghodssi and Pinyen Lin, "MEMS Materials and Processes Handbook", Springer, 2nd Edition, 2011
2	Sergey Edward Lyshevski, "MEMS and Microsystems: Principles and Applications", CRC Press, 2nd Edition, 2013
3	Gregory T. A. Kovacs, "Micromachined Transducers Sourcebook", McGraw-Hill Education, 1st Edition, 1998

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19F14	HYBRID AND ELECTRIC VEHICLES	PE	3	0	0	3

Objectives:	
	To introduce the concept of hybrid and electric drive trains
	To elaborate on the types and utilization of hybrid and electric drive trains.
	To expose different types of AC and DC drives for electric vehicles.
	To learn and utilize different types of energy storage systems
	To introduce concept of energy management strategies and drive sizing

UNIT-I	Introduction	9
Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.		
UNIT-II	**Hybrid Electric Drive Trains**	**9**
Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.		
UNIT-III	**Control Of AC & DC Drives**	**9**
Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.		
UNIT-IV	**Energy Storage**	**9**
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.		
UNIT-V	**Drive Sizing And Energy Management Strategies**	**9**
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of the course students should be able to:	
	Discuss, Characterize and configure hybrid drivetrains requirement for a vehicle
	Design and apply appropriate hybrid and electric drive trains in a vehicle
	Design and install suitable AC and DC drives for electric vehicles.
	Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle

	Apply energy management strategies to ensure better economy and efficiency

Text Books:	
1	Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, Third Edition, 2021
2	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, Second Editio 2012

Reference Books(s) / Web links:	
1	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric a Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2	Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec | 6 June 2012
3	Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar | February 2011
4	Hybrid Electric Vehicle Design and Control: Intelligent Omni directional Hybrids (MECHANICAL ENGINEERING) by Yangsheng Xu , Jingyu Yan, et al. | 16 December 2013
5	https://archive.nptel.ac.in/courses/108/103/108103009/

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	1	-		2	-		-		-	-	-
CO2	3	2	1	1	1	-		2	-		-		-	-	-
CO3	3	2	1	1	1	-		2	-		-		-	-	-
CO4	3	2	1	1	1	-		2	-		-		-	-	-
CO5	3	2	1	1	1	-		2	-		-		-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

MT19G12	BATTERY MANAGEMENT SYSTEM	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
•	Understand Li-ion battery formats, chemistries, and key characteristics.
•	Design battery packs, considering peak power, temperature, and smart charging.
•	Learn various battery modeling methods, including Equivalent Circuit Models and Neural Network Models.
•	Master State of Charge (SOC) estimation for single cells and series batteries using different algorithms.
•	Explore Battery Management Systems (BMS), ASICs, Wireless BMS MCUs, and communication modules.

UNIT-I	ADVANCED BATTERIES	9
Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics - SOC, DOD, SOH. Balancing - Passive Balancing Vs Active Balancing. Other Batteries - NCM and NCA Batteries. NCR18650B specifications.		
UNIT-II	**BATTERY PACK**	**9**
Battery Pack - design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods - relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.		
UNIT-III	**BATTERY MODELLING**	**9**
Battery Modelling Methods - Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models - Introduction. Battery Modelling software/simulation frameworks		
UNIT-IV	**BATTERY STATE ESTIMATION**	**9**
SOC Estimation - Definition, importance, single cell Vs series batteries SOC. Estimation Methods - Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.		
UNIT-V	**BMS ARCHITECTURE AND REAL TIME COMPONENTS**	**9**
Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC - CC2662R-Q1 Wireless BMS MCU. Communication Modules - CAN Open - Flex Ray - CANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model Based Design.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
CO 1	Acquire knowledge of different Li-ion Batteries performance.
CO 2	Design a Battery Pack and make related calculations.
CO 3	Demonstrate a Battery Model or Simulation.
CO 4	Estimate State-of-Charges in a Battery Pack
CO 5	Approach different BMS architectures during real world usage

Text Books:	
1	Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles’’, Wiley, 2015.
2	Davide Andrea ,“Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.

Reference Books(s) / Web links:	
1	Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper

MT19G13	ADVANCED DRIVER ASSISTANCE SYSTEMS	Category	L	T	P	C
		PE	3	0	0	3

Objectives:	
•	Understand automotive power, running, and comfort systems.
•	Master automotive sensor types, characteristics, and applications.
•	Learn basics of ADAS, sensor fusion, and vehicle prognostics.
•	Explore advanced driver assistance features in mechatronics.
•	Gain insights into ADAS display and impaired driver tech.

UNIT-I	AUTOMOTIVE FUNDAMENTALS	9
Power System - Running System - Comfort System – Engine Components – Drive train – Suspension system, ABS, Steering System.		
UNIT-II	**AUTOMOTIVE SENSORS**	**9**
Knock sensors, oxygen sensors, crankshaft angular position sensor, temperature sensor, speed sensor, pressure sensor, mass air flow sensor, manifold absolute pressure sensors, crash sensor, coolant level sensors, brake fluid level sensors – operation, types, characteristics, advantage and their applications. RADAR, Ultrasonic SONAR Systems, LIDAR Sensor Technology and Systems, Camera.		
UNIT-III	**OVERVIEW OF DRIVER ASSISTANCE TECHNOLOGY**	**9**
Basics of Theory of Operation, Applications, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion. Vehicle Prognostics Technology		
UNIT-IV	**ADVANCED DRIVER ASSISTANCE SYSTEMS**	**9**
Advanced Driver Assistance Systems - Lane Departure (LDW), Active Cruise Control (ACC), Blind Spot Detection, Parking Assist, Autonomous Emergency Braking (AEB), Night Vision, Traffic Sign Recognition (TSR), Intelligent High beam Assistant (IHC), Tire Pressure Monitoring (TPMS), Front Collision Warning System (FCWS), Front Vehicle Departure Warning (FVDW), Adaptive Lighting, Driver Drowsiness Detection, Hill Decent Control, Rear Cross Traffic.		
UNIT-V	**ADAS DISPLAY & IMPAIRED DRIVER TECHNOLOGY**	**9**
Center Console Technology, Gauge Cluster Technology, Heads-Up Display Technology and Warning Technology – Driver Notification. Impaired Driver Technology -Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
CO 1	Understand automotive fundamentals, including power systems, engine components, and vehicle systems
CO 2	Analyze and explain various automotive sensors and advanced technologies
CO 3	Comprehend the theory and integration of Advanced Driver Assistance Systems
CO 4	Evaluate and design ADAS, including safety features and systems
CO 5	Demonstrate knowledge of ADAS display technologies and Impaired Driver Technology

Text Books:	
1	Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group, 5th Edition,2018
2	William B Ribbens, "Understanding Automotive Electronic: An Engineering Perspective", Elsevier Science,8th Edition,2017.

Reference Books(s) / Web links:	
1	"Intelligent Transportation Systems and Connected and Automated Vehicles", Transportation Research Board, 2016.
2	Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", Springer, 2019.

MT19G14	SINGLE BOARD COMPUTERS	Category	L	T	P	C
			3	0	0	3

Objectives:	
•	Understand the role and evolution of Single Board Computers (SBCs) in embedded systems.
•	Evaluate CPU architectures, memory systems, and peripheral interfaces in SBCs.
•	Install and configure Linux, Windows IoT, and RTOS on SBCs, and engage in application development.
•	Set up development environments, work with IDEs, and complete projects, including LED blinking, sensor interfacing, and home automation.
•	Learn networking, wired/wireless connectivity, and integrate IoT technologies for cloud connectivity and data sharing.

UNIT-I	INTRODUCTION TO SINGLE BOARD COMPUTERS	9
Introduction to Embedded Systems - Historical development and key milestones - Role of SBCs in embedded systems - Evolution of Single Board Computers		
UNIT-II	**ARCHITECTURE AND COMPONENTS OF SBCS**	**9**
CPU Architectures in SBCs - ARM, x86, RISC-V, and other architectures - Selection criteria based on application requirements - Memory Systems in SBCs - RAM, Flash memory and storage options - Impact of memory configuration on SBC performance - Peripheral Interfaces in SBCs - Graphics and Multimedia Support		
UNIT-III	**OVERVIEW OF OPERATING SYSTEMS**	**9**
Linux, Windows IoT, RTOS (Real-Time Operating Systems) - Installing and Configuring Operating Systems - Basics of OS installation on an SBC - Configuring network and peripheral settings - Application Development on SBCs - Programming languages for SBCs - Cross-compilation and native development		
UNIT-IV	**PRACTICAL IMPLEMENTATION AND PROJECTS WITH SBCS**	**9**
Setting up Development Environments - Introduction to IDEs (Integrated Development Environments) - Establishing a toolchain for cross-compilation - Building Basic Projects with SBCs - LED blinking project - Sensor interfacing and data acquisition - Advanced Projects with SBCs - Home automation system - Edge computing applications		
UNIT-V	**NETWORKING AND CONNECTIVITY WITH SBCS**	**9**
Wired and Wireless Connectivity - Ethernet, Wi-Fi, Bluetooth - Setting up network connections on SBCs - Internet of Things (IoT) Integration - MQTT, CoAP, and other IoT protocols - Cloud connectivity for data sharing using SBCs		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
CO 1	Understand embedded systems, their role, and the evolution of Single Board Computers (SBCs).
CO 2	Analyze and select CPU architectures for specific applications, considering memory configurations.
CO 3	Install and configure operating systems (Linux, Windows IoT, RTOS) on SBCs, and develop applications using various programming languages.
CO 4	Set up development environments, use IDEs, and build basic/advanced projects with SBCs, including IoT applications.
CO 5	Gain proficiency in networking, wired/wireless connectivity, and integrate IoT technologies for cloud connectivity and data sharing.

Text Books:	
1	Gabriele Manduchi and Ivan CibrarioBertolotti, “Real-Time Embedded Systems: OpenSource Operating Systems”, CRC Press, 2

Reference Books(s) / Web links:	
1	Guttag, John. “Introduction to Computation and Programming Using Python”, MIT Press, 2021.
2	David Beazley and Brian K. Jones, “Python Cookbook”, O'Reilly Media, 2014

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19G15	PRINCIPLES OF MANAGEMENT	PE	3	0	0	3

Objectives:
To understand the evolution and basic concepts of management and its theories.
To understand how the managerial tasks of planning can be executed.
To understand how the managerial tasks of organizing can be executed.
To understand how the managerial tasks of directing can be executed.
To understand how the managerial tasks of controlling can be executed.

UNIT-I	Introduction To Management And Organizations	9
Definition of management -science or art - Manager Vs Entrepreneur- types of managers - managerial roles and skills - Evolution of management -Scientific, human relations, system and contingency approaches- Types of business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and environment – Current trends and issues in management.		
UNIT-II	**Planning**	9
Nature and purpose of planning - Planning process - Types of planning - Objectives – Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.		
UNIT-III	**Organising**	9
Nature and purpose - Formal and informal organization - Organization chart – Organization structure - Types - Line and staff authority - Departmentalization - delegation of authority -Centralization and decentralization - Job design - Human resource management – HR planning, recruitment, selection,		

training and development, performance Management, career planning and management.		
UNIT-IV	**Directing**	9
Foundations of individual and group behavior - Motivation - Motivation theories – Motivational techniques – Job satisfaction - Job enrichment - Leadership - types and theories of leadership- Communication - Process of communication - Barriers in communication – Effective communication - Communication and IT.		
UNIT-V	**Controlling & International Management**	9
System and process of controlling - Budgetary and non - Budgetary control techniques - Use of computers and IT in management control - Productivity problems and management – Control and performance - Direct and preventive control – Reporting. International management - stages of internationalism - the multinational company - reasons - modes of foreign investment - problems faced by international managers - management functions in international operations.		
Total Contact Hours:45		

Course Outcomes: Upon successful completion of the course, the student will be able to
understand the basic concepts of management and its theories.
understand the management concept of planning.
understand the management concept of organizing.
understand the management concept of directing.
understand the management concept of controlling and international management.

Text Book(s):
1. Harold Koontz and Heinz Weihrich —Essentials of Management‖, Tata McGraw Hill, 1998.
2. Stephen P. Robbins and Mary Coulter, — Management‖, Prentice Hall (India)Pvt. Ltd.,10th Edition, 2009.

Reference Books(s) / Web links:
1. Robert Kreitner and Mamata Mohapatra, —Management‖, Biztantra, 2008.
2. Stephen A. Robbins, David A. Decenzo and Mary Coulter, —Fundamentals of Management‖, Pearson Education,7th Edition, 2011.
3. Tripathy PC and Reddy PN, —Principles of Management‖, Tata Mcgraw Hill, 1999.

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	-	-	-	-	1	-	2	3	2	1	1	-	-	2
CO2	1	-	-	-	-	1	-	2	3	2	1	1	-	-	2
CO3	1	-	-	-	-	1	-	2	3	2	1	1	-	-	2
CO4	1	-	-	-	-	1	-	2	3	2	1	1	-	-	2
CO5	1	-	-	-	-	1	-	2	3	2	1	1	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19G16	ENTREPRENEURSHIP DEVELOPMENT	PE	3	0	0	3

Objectives:
To understand the types and characteristics of entrepreneurship and its role in economic development.
To understand the theories of motivation and the principles of entrepreneurship development programs.
To select the appropriate form of business ownership in setting up an enterprise.
To mobilize and manage initial and working capital for the enterprise.
To identify sickness in industry, select the appropriate corrective measures and identify the growth strategies forthe enterprise.

UNIT-I	Entrepreneur And Entrepreneurship	9
Entrepreneurship – definition and characteristics - characteristics of entrepreneur - classification entrepreneurs – Danhofi‘s classification - other classifications - Functions of entrepreneurs – role entrepreneurship in economic development and job creation - Emergence of entrepreneurial class India – Entrepreneurship in ancient period - Entrepreneurship in pre-Independence era Entrepreneurship in post-Independence period.		
UNIT-II	**Entrepreneurial Motivation**	9
Theories of entrepreneurship – sociological theories, economic theories, cultural theories a psychological theories - Entrepreneurial motivation: Theories of motivation - Entrepreneur competencies – Entrepreneurship development Programs – need, objectives - Time managemen Stress management.		
UNIT-III	**Business**	9
Small Enterprises – Definition, characteristics, project identification and selection – Feasibility a profitability analysis – Formulation of project report– significance and content - Types of busine ownership structures– suitability -Expansion, diversification, forward and backward integration.		
UNIT-IV	**Financing And Profitability**	9
Financing: Need, capital structure– Sources of finance – internal and external sources of financ break even analysis – Capital budgeting - simple problems – Introduction to balance sheet and pr and loss statement – Importance of profitability – sustainability - Working capital manageme significance, assessment, factors, sources, management.		
UNIT-V	**Support To Entrepreneurs And Case Studies**	9
Sickness in small business: concept, signals, symptoms, magnitude, causes and consequenc corrective measures – Government policy for small scale enterprises – Growth strategies in sm scale enterprise – Institutional support to entrepreneurs: need and support – Taxation benefits to sm scale industry. Case studies in entrepreneurship.		
Total Contact Hours:45		

Course Outcomes: Upon successful completion of the course, the student will be able to
Analyse the types, characteristics of entrepreneurship and its role in economic development.
Apply the theories of motivation and the entrepreneurial competencies.
Select the appropriate form of business ownership in setting up an enterprise.
Mobilise and manage initial and working capital for the enterprise.
Identify sickness in industry, select the appropriate corrective measures and identify t growth strategies inenterprise.

Text Book(s):
1.Kurahko & Hodgetts, ―Entrepreneurship – Theory, Process and Practices‖, 6th edition, Thomson learning, 2009.
2.S.S. Khanka, ―Entrepreneurial Development‖, S.Chand & Co. Ltd., New Delhi, 1999.

Reference Books(s) / Web links:
Sangram Kesari Mohanti, ―Fundamentals of Entrepreneurship‖, PHI Learning Private Ltd., Delhi, 2006.
Charantimath, P. M., ―Entrepreneurship Development and Small Business Enterprises‖, Pearson, 2006.
3. Hisrich R D and Peters M P, ―Entrepreneurship‖, 5th Edition, Tata McGraw-Hill, 2002.
Kabindra N. Kanungo, ―Entrepreneurship and Innovation‖, Sage Publications, New Delhi, 1998.
Singh, A. K., ―Entrepreneurship Development and Management‖, University Science Press, 2009.

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	-	-	-	-	1	1	1	2	-	2	2	-	-	2
CO2	1	-	-	-	-	1	1	1	2	-	2	2	-	-	2
CO3	1	2	2	2	2	1	1	1	2	-	3	2	-	-	2
CO4	1	-	-	-	-	1	1	1	2	-	3	2	-	-	2
CO5	1	-	-	-	-	1	1	1	2	-	3	2	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19G18	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	PE	3	0	0	3

Objectives:
To inculcate the importance of research methodology.
To understand how to undergo the literature review and write a technical paper.
To inculcate the importance of Intellectual Property Rights and aware of the rights for the protection of theinvention.
To understand the patent rights and recent developments in IPR.
To understand the industrial design and geographical indication procedures to get patents, copy right, trademarksand designs.

UNIT-I	**Fundamentals Of Research**	9
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations, analysis of qualitative andmixed-methods research.		
UNIT-II	**Review Of Literature And Technical Writing**	9
Effective literature studies approach, analysis Plagiarism, Research ethics, Effective technical writing, how to writereport, Paper Developing a Research Proposal.		
UNIT-III	**Intellectual Property Rights**	9
Nature of Intellectual Property: Patents, Designs, Trade and Copyright, copyright registration in India Process of Patenting and Development: technological research, innovation, patenting and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under Patent Cooperation Treaty.		
UNIT-IV	**Patent Rights And Recent Developments In IPR**	9
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases.Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies.		
UNIT-V	**Industrial Designs And Geographical Indications**	9
Industrial designs and IC Layout design, Registrations of designs, conditions and procedures of industrial designs Cancellation of Registration, International convention of design- types and functions. Semiconductor Integrated circuits and layout design Act- Geographical indications- potential benefits of Geographical Indications.		
		Total Contact Hours:45

Course Outcomes: Upon successful completion of the course, the student will be able to
Apply knowledge on research problem formulation and analyze research related information
write the literature review and technical paper.
apply IPR concept to important place in growth of individuals & nation.
Apply patent right to new products developed.
describe the procedure and the tools to get patent copy right for their innovative work.

Text Book(s):
1. Neeraj Pandey and Khushdeep Dharni, ―Intellectual Property Rights‖, First edition, PHI learning Pvt. Ltd., Delhi,2014.
2. Uma Sekaran and Roger Bougie, ―Research methods for Business‖, 5th Edition, Wiley India, New

Reference Books(s) / Web links:
Stuart Melville and Wayne Goddard, ―Research Methodology: An Introduction For Science & EngineeringStudents‖,2nd edition, Juta Academic, 2001.
Ramakrishna B & Anilkumar H S, ―Fundamentals of Intellectual Property Rights‖, 1st edition, Notio Press, 2017.
William G Zikmund, Barry J Babin, Jon C.Carr, Atanu Adhikari,Mitch Griffin, ―Business Researc methods: ASouth Asian Perspective, 8th Edition, Cengage Learning, New Delhi, 2012.

PO-PSO	**POs**												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	-	-	2	-	-	-	-	-	1	3	1	-	2
CO2	3	1	-	-	-	-	-	2	-	-	1	3	-	-	2
CO3	3	1	-	-	-	-	-	-	-	-	1	3	-	-	2
CO4	3	1	-	-	2	1	-	-	-	-	1	3	-	-	3
CO5	3	1	-	-	-	-	-	-	-	-	1	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)