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

DEPARTMENT OF MECHATRONICS ENGINEERING
CURRICULUM AND SYLLABUS REGULATIONS – 2019
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.	GE19141	Programming using C	ES	6	2	0	4	4
4.	EE19241	Basic Electrical Engineering	ES	5	3	0	2	4
5.	GE19201	Engineering Mechanics	ES	3	2	1	0	3
PRACTICALS								
6.	MT19221	Computer Aided Drawing Lab	ES	2	0	0	2	1
7.	GE19122	Engineering Practices- Electrical and Electronics	ES	2	0	0	2	1
NON-CREDIT - MANDATORY COURSE								
8.	MC19102	Indian Constitution and Freedom Movement	MC	3	3	0	0	0
			TOTAL	**30**	**16**	**2**	**12**	**21**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA19355	Transforms and Applications	BS	4	3	1	0	4
2	GE19301	Life Science for Engineers	ES	3	3	0	0	3
3	MT19301	Analog Devices and Circuits	ES	3	3	0	0	3
4	MT19302	Digital System Design	PC	3	3	0	0	3
5	MT19303	Fluid mechanics and thermal sciences	PC	4	3	1	0	4
6	MT19304	Mechanics of Solids	PC	3	3	0	0	3
PRACTICALS								
7	MT19311	Digital System Design Lab	PC	3	0	0	3	1.5
8	MT19312	Strength of Materials and Fluid Mechanics Lab	PC	3	0	0	3	1.5
NON-CREDIT - MANDATORY COURSE								
9	MC19301	Essence of Indian Traditional Knowledge	**MC**	2	2	0	0	0
			TOTAL	28	20	2	6	23

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA19455	Statistics and Numerical Methods	BS	3	3	1	0	4
2.	GE19304	Fundamentals of Management for Engineers	HS	3	3	0	0	3
3.	MT19401	Manufacturing Technology	PC	3	3	0	0	3
4.	MT19402	Microcontrollers and Embedded Systems	PC	3	3	0	0	3
5.	MT19403	Sensors and Instrumentation	PC	3	3	0	0	3
6.		Open Elective - I	OE	3	3	0	0	3
PRACTICALS								
7.	MT19421	Manufacturing Technology lab	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 Lab	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	CS19342	Object Oriented Programming Paradigm	PC	7	3	0	4	5
2	MT19501	Industrial Electronics	PC	3	3	0	0	3
3	MT19502	Theory of Machines and Mechanisms	PC	4	3	1	0	4
4	MT19503	System Dynamics and Control	PC	3	3	0	0	3
5		Open Elective - II	OE	3	3	0	0	3
6		Professional Elective -I	PE	3	3	0	0	3
PRACTICALS								
7	MT19511	Theory of Machines lab	PC	3	0	0	3	1.5
8	MT19512	Industrial Electronics lab	PC	3	0	0	3	1.5
9	GE19521	Soft Skills - II	EEC	2	0	0	2	1
			TOTAL	**31**	**18**	**1**	**12**	**25**

SEMESTER VI

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MT19601	Design of Mechatronics System	PC	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 Lab	PC	3	0	0	3	1.5
8	MT19721	Project Work - Phase 1	EEC	2	0	0	2	1
9	MT19722	Comprehension in Mechatronics Engineering	EEC	2	0	0	2	1
			TOTAL	**25**	**15**	**0**	**10**	**20**

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	16	0	0	16	8
			TOTAL	**22**	**6**	**0**	**16**	**14**

TOTAL NO. OF CREDITS: 165

PROFESSIONAL ELECTIVES (PE)*

SEMESTER V ELECTIVE I

S.N	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	MT19P51	CNC Technology and Applications	PE	3	3	0	0	3
2	MT19P52	Introduction to Finite Element Analysis	PE	3	3	0	0	3
3	MT19P53	Medical Mechatronics	PE	3	3	0	0	3
4	MT19P54	Advanced Manufacturing Technology	PE	3	3	0	0	3
5	ME19701	Automobile Engineering	PE	3	3	0	0	3

SEMESTER VI ELECTIVE II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AE19741	Avionics	PE	3	3	0	0	3
2	MT19P61	Internet of Things for Mechatronics	PE	3	3	0	0	3
3	MT19P62	Quality Control and Reliability Engineering	PE	3	3	0	0	3
4	MT19P63	Autonomous Mobile Robots	PE	3	3	0	0	3
5	MT19P64	Product Design and Development	PE	3	3	0	0	3

SEMESTER VII ELECTIVE III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	ME19P76	Process Planning and Cost Estimation	PE	3	3	0	0	3
2	MT19P71	Smart Sensors and Micro Electro Mechanical Systems	PE	3	3	0	0	3
3	MT19P72	Automated Material Handling Systems	PE	3	3	0	0	3
4	MT19P73	Artificial Intelligence for Mechatronics	PE	3	3	0	0	3
5	MT19P74	Wireless Networks for Industrial Automation	PE	3	3	0	0	3

SEMESTER VIII ELECTIVE IV

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	MT19P81	Intelligent Control Systems	PE	3	3	0	0	3
2	MT19P82	Virtual Instrumentation	PE	3	3	0	0	3
3	MT19P83	Programming for Robot	PE	3	3	0	0	3

		Operating System						
4	MT19P84	Maintenance Engineering and condition Monitoring	PE	3	3	0	0	3
5	MT19P85	Project Management	PE	3	3	0	0	3

SEMESTER VIII ELECTIVE V

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	GE19P72	Entrepreneurship Development	PE	3	3	0	0	3
2	ME19P86	Research Methodology and Intellectual Property Rights	PE	3	3	0	0	3
3	MT19P87	Data analytics for mechatronics	PE	3	3	0	0	3
4	MT19P88	Optimization Techniques for Mechatronics Engineers	PE	3	3	0	0	3
5	ME19P79	Non-Destructive Testing and Evaluation	PE	3	3	0	0	3

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	0	0	3	0	0	0	0	6	3.6
2.	Basic Sciences (BS)	8	8	4	4	0	0	0	0	24	14.5
3.	Engineering Sciences (ES)	5	13	6	0	0	0	0	0	24	14.5
4.	Professional Core (PC)	0	0	13	13	18	15	15	0	74	44.8
5.	Professional Electives (PE)	0	0	0	0	3	3	3	6	15	9.1
6.	Open Electives (OE)	0	0	0	3	3	0	0	0	6	3.6
7.	Project Work/ Employability Enhancement Course (PR/EEC)	0	0	0	1	1	4	2	8	16	9.7
	TOTAL	**16**	**21**	**23**	**24**	**25**	**22**	**20**	**14**	**165**	
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	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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 LABORATORY – Civil & 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	Gas welding practice.
Basic Machining:	
8	Simple Turning and Taper turning
9	Drilling Practice
Sheet Metal Work:	
10	Forming & Bending:
11	Model making – Trays and funnels
12	Different type of joints.
Machine Assembly Practice:	
13	Study of centrifugal pump
14	Study of air conditioner

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

Course Outcomes:	
●	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	PO 1	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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

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	PO 1	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

MA 19355	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

GE 19301	LIFE SCIENCE FOR ENGINEERS	ES	L	T	P	C
			3	0	0	3

Objectives:	
•	Broad objective of this course is to give an introduction of life science to engineering students.
•	The course helps students to familiarize with human physiology, life style diseases and their management and basic diagnostic aspects.

UNIT-I	**OVERVIEW OF CELLS AND TISSUES**	**9**
Introduction to Bacteria, virus, fungi and animal cells. Organization of cells into tissues and organs. Functions of vital organs.		
UNIT-II	**HEALTH AND NUTRITION**	**9**
Balanced diet, Importance of RDA, BMR, and diet related diseases. Role of antioxidants PUFA, DHA, Essential amino acids, Essential fatty acids in diet. Water and its significance for human health. Physical and Mental health – Significance of exercise and yoga.		
UNIT-III	**UNHEALTHY PRACTICES AND THEIR IMPACT ON HEALTH**	**9**
Drug induced toxicity, Unhealthy practices - Drug abuse/Narcotics/Smoking/Alcohol/Self-medication/Undue usage of electronic gadgets.		
UNIT-IV	**COMMON DISEASES AND LIFESTYLE DISORDERS**	**9**
Prevention and management of food, water and airborne illness (Common cold, dehydration, food poisoning etc.). Lifestyle disorders – obesity, diabetes, stroke, heart attack, ulcer, renal calculi, cancer, AIDS, hepatitis-prevention and management.		
UNIT-V	**DIAGNOSTIC TESTS AND THEIR RELEVENCE**	**9**
Normal range of biochemical parameters, significance of organ function tests, organ donation.		
	Total Contact Hours : 45	

Course Outcomes: After the successful completion of the course, the student will be able to:	
•	Classify the living organisms and relate the functions of vital organs
•	Demonstrate the importance of balanced diet and plan methods for healthy living
•	Analyse the hazards of unhealthy practices and take preventive measures
•	Categorise the various life style disorders and recommend ways to manage the common diseases
•	Evaluate and interpret biochemical parameters and their significance

Text Books:	
1	Diseases of human body , Carol D Tamparo, Marcia A Lewis , Marcia A, Lewis ,EdD, RN, CMA-AC, F.A Davis Company, 2011.
2	Textbook of Medical Biochemistry ,Chatterjea ; Rana Shinde.

Reference Books(s) / Web links:	
1	Biology for Engineers, Arthur.T.,Johnson, CRC Press, Taylor and Francis, 2011.
2	Cell Biology and Genetics, Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008.
3	https://nptel.ac.in/courses/122103039/

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE 19301.1	3	1	2	2	2	3	1	1	1	-	-	-	2	1	3
GE 19301.2	3	1	2	2	2	3	1	1	1	-	-	-	2	1	3
GE 19301.3	3	1	2	2	2	3	1	3	1	-	-	-	2	1	3
GE 19301.4	3	1	2	2	2	3	1	1	1	-	-	-	2	1	3
GE 19301.5	3	1	2	2	3	3	1	1	1	-	-	-	2	1	3
Avg	3	1	2	2	2.2	3	1	1.4	1	-	-	-	2	1	3

MT 19301	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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

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

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

UNIT-I	LOGIC GATES AND MINIMIZATION TECHNIQUES	9
Gates, Logic circuits using gates – Multi level gate implementations – Boolean Postulates and Laws – Boolean Expressions – Minimization of Boolean expressions – SOP, POS – Karnaugh map Minimization – Don't 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	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

MT 19303	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	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

MT 19304	**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

MT 19311	DIGITAL SYSTEM DESIGN LAB	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	**:**	

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

MT 19312	**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
1	Conducting experiments and drawing the characteristic curves of reciprocating pump.

13	
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
MT 19312.1	2	1	1	-	-	-	-	-	-	-	-	-	-	3	-
MT 19312.2	2	2	1	-	-	-	-	-	-	-	-	-	-	3	-
MT 19312.3	3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
MT 19312.4	3	3	1	-	-	-	-	-	-	-	-	-	-	-	-
MT 19312.5	3	3	2	2	-	-	1	-	1	-	-	1	-	3	1
Avg	2.6	2.4	1.4	2	-	-	1	-	1	-	-	1	-	3	1

MC 19301	Essence Of Indian Traditional Knowledge	MC	L	T	P	C
			2	0	0	0

Objectives:

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

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

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

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

Text Book (s):	
1	V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014.
2	Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan.
3	Swami Jitatmanand, *Holistic Science and Vedant*, Bharatiya Vidya Bhavan.
4	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

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

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**
ME 19401.1	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
ME 19401.2	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
ME 19401.3	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
ME 19401.4	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
ME 19401.5	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2
Avg	3	1	1	-	-	1	2	-	-	-	1	3	-	1	2

MT19402	**MICROCON0TROLLERS 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

MT19421	MANUFACTURING TECHNOLOGY LAB	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

MT 19411	Microprocessors & 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	PO1	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	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming is effective and learners generate ideas quickly and freely. The 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.

SEMESTER V

CS19342	OBJECT ORIENTED PROGRAMMING PARADIGM (Lab Oriented Theory Course)	Category	L	T	P	C
		PC	3	0	4	5

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Objectives:	
●	To understand Object Oriented Programming concepts and characteristics of Java
●	To know the principles of classes, abstraction and inheritance
●	To create packages, define exceptions and use strings
●	To use I/O streams and collections in applications
●	To design and build simple GUI programs using generics, AWT, Swings and JDBC

UNIT-I	INTRODUCTION TO OOP AND JAVA FUNDAMENTALS	9
Introduction to Object Oriented Programming – Basic concepts of OOP - An overview of Java - Java Architecture - Data Types - Variables- Arrays- Operators - Control Statements - Command Line Arguments.		
UNIT-II	**CLASSES AND INHERITANCE**	**9**
Defining Classes in Java: Methods, Constructors, Garbage Collection - Access Specifiers - Method Overloading – Inheritance: Super keyword, this keyword, Method Overriding, Abstract Classes – Static Members -Final Method and Class.		
UNIT-III	**PACKAGES, EXCEPTION HANDLING AND STRINGS**	**9**
Packages – Interfaces - Exceptions – Exception Hierarchy – Throwing and Catching Exceptions – Built-in Exceptions, User defined Exceptions, Stack Trace Elements – Strings - String Buffer.		
UNIT-IV	**I/O AND COLLECTIONS**	**9**
Input / Output Basics – Streams – Byte streams and Character streams – Reading and Writing Console – Reading and Writing Files – Collection Interfaces – Collection Classes.		
UNIT-V	**GENERIC PROGRAMMING, MULTITHREADING AND EVENT DRIVEN PROGRAMMING**	**9**
Generic Programming – Generic Classes – Generic Methods - Multithreading: Thread Life Cycle, Thread Creation, Thread Synchronization- Swings – Layout Management - Accessing Databases with JDBC.		
	Total Contact Hours : 45	

List of Experiments	
1	Simple programs using command line arguments
2	Programs using control structures
3	Programs using arrays
4	Programs using Programs using classes and objects.
5	Programs using inheritance and interfaces
6	Programs using packages and abstract class
7	Programs to handle different types of exceptions
8	Programs using strings and string buffer
9	Programs using I/O streams
10	Programs using files
11	Programs using collections
12	Programs using multithreading
13	Programs using Generics
14	Programs using swings
15	Simple applications using database connectivity
	Contact Hours : 60
	Total Contact Hours : 105

Course Outcomes:	
On completion of the course, the students will be able to	
●	Develop Java programs using OOP principles.
●	Develop Java programs with the concepts inheritance.
●	Build Java applications using exceptions and strings.
●	Develop Java applications using I/O and collections.
●	Develop interactive Java applications using GUI components.

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

Reference Books(s):	
1	Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3rd Edition, Pearson, 2015.
2	Steven Holzner, "Java 2 Black book", Dreamtech press, 2011.
3	Timothy Budd, "Understanding Object-oriented programming with Java", Updated Edition, Pearson Education, 2000.
4	SCJP Sun Certified Programmer for Java 6 Study Guide. 6th edition, McGrawHill.

Web links for Theory & Lab:	
1	https://www.javatpoint.com/java-tutorial

CO - PO – PSO matrices of course

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CS19342.1	3	2	1	-	1	-	-	-	1	-	-	1	1	1	1
CS19342.2	3	1	1	-	1	-	-	-	1	-	-	1	2	1	1
CS19342.3	3	1	1	-	1	-	-	-	2	-	-	1	2	2	2
CS19342.4	3	2	1	-	1	-	-	-	2	-	-	2	3	2	2
CS19342.5	3	2	2	2	1	-	-	-	3	1	3	2	3	2	3
Average	3.0	1.6	1.2	2.0	1.0	-	-	-	1.8	1.0	3.0	1.4	2.2	1.6	1.8

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	-

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

MT19511	**THEORY OF MACHINES LAB**	**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 LAB	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

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

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

Learning and Teaching Strategy:

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

		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.	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	-	-	-	-	-	-	-	-	-	3	-	1	-	-	1
GE 19521.2	-	-	-	-	-	-	-	-	-	3	-	1	-	-	1
GE 19521.3	-	-	-	-	-	-	-	-	-	3	-	1	-	-	1
GE 19521.4	-	-	-	-	-	-	-	-	-	3	-	1	-	-	1
GE 19521.5	-	-	-	-	-	-	-	-	-	3	-	1	-	-	1
Avg	-	-	-	-	-	-	-	-	-	3	-	1	-	-	1

SEMESTER VI

MT19601	DESIGN OF MECHATRONICS SYSTEMS	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

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		

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:	
1.	https://www.hydraulicspneumatics.com/fluid-power-basics
2.	http://mech01-iitg.virtual-labs.ac.in/
3.	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	1	2	2

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

	Design Thinking
	Introduction to Design Thinking - What Is Design Thinking? - The Good Kitchen Story - Business 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 and if possible with an industry. 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 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							
Review I	Review II	Review III	End semester Examinations				
			Project Report Submission (30)		Viva-Voce(50)		
			Internal	External	Supervisor	Internal	External
5	7.5	7.5	15	15	15	20	15
					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 LAB**	**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

MT 19712	**INDUSTRIAL AUTOMATION LAB**	**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 control with PLC programming			
4	Water level control with HMI			
5	Temperature control with PLC programming			
6	Temperature control with HMI			
7	Belt conveyor control with PLC programming			
8	Belt conveyor control with HMI			
9	Stepper motor control for linear applications using PLC programming			
10	Stepper motor control for linear applications using HMI			
11	Stepper motor control for Rotary applications using PLC programming			
12	Stepper motor control for Rotary applications using HMI			
13	Create a New SCADA for Temperature control application			
14	Create a New SCADA for Water level control application			
		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

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 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

Review I	Review II	Review III	End semester Examinations				
			Project Report Submission (30)		Viva-Voce(50)		
			Internal	External	Supervisor	Internal	External
5	7.5	7.5	15	15	15	20	15

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

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
•	Demonstrating the function of the fabricated model
•	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	1	1	1	3	2	3	3	3	3	1

GE 19721.2	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1
GE 19721.3	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1
GE 19721.4	3	3	3	3	3	1	1	1	3	2	3	3	3	3	1
GE 19721.5	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

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	The students will be assessed 100% internally through weekly test with objective type questions on all the subject related topics		
	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 life long 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

Review I	Review II	Review III	End semester Examinations				
			Project Report Submission (30)		Viva-Voce(50)		
			Internal	External	Supervisor	Internal	External
5	7.5	7.5	15	15	15	20	15

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)*

SEMESTER V
ELECTIVE I

MT19P51	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	
●	Recall the evolution, principles, classification and applications of CNC machine tools
●	Realise the basic structure, construction, working and control of CNC machines
●	Identify the fundamentals of drive system and control modules of CNC technology
●	Develop program for CNC machines
●	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

MT19P52	INTRODUCTION TO FINITE ELEMENT ANALYSIS	PE	L	T	P	C
			3	0	0	3

Objectives:

- To introduce the concepts of Mathematical Modeling of Engineering Problems
- To appreciate the use of FEM to a range of Engineering Problems

UNIT-I	**INTRODUCTION**	9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT-II	**ONE-DIMENSIONAL PROBLEMS**	9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

UNIT-III	**TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS**	9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems.

UNIT-IV	**TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS**	9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations.

UNIT-V	**ISOPARAMETRIC FORMULATION**	9

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements –One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques - Introduction to Analysis Software.

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

Course Outcomes:

On completion of course students will be able to

- Derive Governing Differential Equation for any engineering problem
- Use 1-D bar, beam elements to solve one dimensional thermal, solid mechanics problems
- Use 2D elements to solve heat transfer, torsion problems
- Use Triangular elements to solve plane stress, plane strain problems
- Perform isoparametric element formulation to solve problems

Text Books:

1	Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005
2	Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007

Reference Books / Web links:

1	Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013)
2	Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 1990
3	Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002

MT19P53	MEDICAL MECHATRONICS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand how to measure biochemical parameters and various physiological information.
●	To study the need and technique of electrical safety in Hospitals
●	To study the use of radiation for diagnostic and therapy
●	To study about recorders and advanced equipment in medicine

UNIT-I	INTRODUCTION	9
Cell structure – electrode – electrolyte interface, electrode potential, resting and action potential – electrodes for their measurement, ECG, EEG, EMG – machine description – methods of measurement – three equipment failures and trouble shooting.		
UNIT-II	**TRANSDUCERS FOR BIO-MEDICAL INSTRUMENTATION**	9
Basic transducer principles Types – source of bioelectric potentials – resistive, inductive, capacitive, fiber-optic, photoelectric and chemical transducers – their description and feature applicable for biomedical instrumentation – Bio & Nano sensors & application.		
UNIT-III	**SIGNAL CONDITIONING, RECORDING AND DISPLAY**	9
Input isolation, DC amplifier, power amplifier, and differential amplifier – feedback, op-Amp-electrometer amplifier, carrier Amplifier – instrument power supply. Oscillagraphic – galvanometric - X-Y, magnetic recorder, storage oscilloscopes – electron microscope – PMMC writing systems – Telemetry principles – Bio telemetry.		
UNIT-IV	**MEDICAL SUPPORT**	9
Electrocardiograph measurements – blood pressure measurement: by ultrasonic method – plethysonography – blood flow measurement by electromagnetic flow meter cardiac output measurement by dilution method – phonocardiography – vector cardiography. Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – Bio-telemetry – laser equipment and application – cardiac pacemaker – DC– defibrillator patient safety - electrical shock hazards. Centralized patent monitoring system.		
UNIT-V	**BIO-MEDICAL DIAGNOSTIC INSTRUMENTATION**	9
Introduction – computers in medicine – basis of signal conversion and digital filtering data reduction technique – time and frequency domain technique – ECG Analysis.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Explain different measurement techniques used in physiological parameters measurement
●	Describe the sensors and signal conditioning circuits used in biomedical engineering
●	Exemplify various amplifiers, recording and display devices
●	Differentiate the working of recorders and explain the advanced systems used in medicine
●	Explain various Bio- medical diagnostics instrumentation

Text Books:	
1	Arumugam M., “Bio Medical Instrumentation”, Anuradha agencies Pub., 2003
2	Cromwell, Weibell and Pfeiffer, “Biomedical Instrumentation and Measurements”, 2nd Edition, Printice Hall of india , 2012
3	Siamak Najarian “ Mechatronics in Medicine – A Bio medical engg approach", McGraw – Hill Education, 2011

Reference Books / Web links:	
1	Geddes L.A., and Baker, L.E., “Principles of Applied Bio-medical Instrumentation”, 3rd Edition, John Wiley and Sons, 2010
2	Khandpur, R.S., “Handbook of Biomedical Instrumentation”, TMH, 2009
3	Tompkins W.J., “Biomedical Digital Signal Processing”, Prentice Hall of India, 1998

MT19P54	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	
●	Recall the basics and working principles of various sheet metal working and forming processes
●	Recognise various non-traditional machining processes with its applications
●	Identify suitable surface finishing and surface hardening process
●	Compare the concept of EDM and ECM with its characteristics and application
●	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

ME19701	AUTOMOBILE ENGINEERING	PE	L	T	P	C
	(Common to Mech and MCT)		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	
●	Demonstrate a basic understanding of engine functions, performance, and design methodology for frame, chassis etc
●	Understand the various fuel supply, ignition and performance improvement methods in IC engines and environmental issues
●	Demonstrate the knowledge of various parts of transmission systems and its mechanism
●	Understand the working of steering, brake and suspension systems
●	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

SEMESTER VI
ELECTIVE II

AE19741	AVIONICS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To introduce the basic of avionics and its need for civil and military aircrafts
●	To impart knowledge about the avionic architecture and various avionics data buses
●	To gain more knowledge on various avionics subsystems

UNIT-I	INTRODUCTION TO AVIONICS	9
Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to Microprocessor and memories		
UNIT-II	**DIGITAL AVIONICS ARCHITECTURE**	8
Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629		
UNIT-III	**FLIGHT DECKS AND COCKPITS**	9
Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS		
UNIT-IV	**INTRODUCTION TO NAVIGATION SYSTEMS**	10
Radio navigation – VOR/DME, Hyperbolic navigation-LORAN and OMEGA, Landing system-ILS, MLS, Inertial Navigation Systems (INS)- INS block diagram – Satellite navigation systems – GPS		
UNIT-V	**SOFTWARE ASSESSMENT AND AUTO PILOT**	9
Fault tolerant systems -Software Assessment and Validation -Civil and Military standards - Certification of Civil Avionics. Auto pilot – Basic principles, Longitudinal and lateral auto pilot		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Understand the concept of designing avionics systems
●	Understand the principle of digital avionics systems
●	Know the practical and working of flight deck equipment's
●	Understand the principle and working of navigation system
●	Understand the air data systems and auto pilot

Text Books:	
1	Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 1996
2	Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1993

Reference Books / Web links:	
1	Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004
2	Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989
3	Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000
4	Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Longman Scientific
5	Jim Curren, "Trend in Advanced Avionics", IOWA State University, 1992

MT19P61	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	
●	Explain the basic architecture and platform of IoT
●	Explain the working principle of IoT
●	Develop, test & analyse a new IoT system
●	Design systems for Real-Time Processing
●	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

MT19P62	QUALITY CONTROL AND RELIABILITY ENGINEERING	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To introduce the concept of SQC and control charts
●	To understand process control charts and their application
●	To understand acceptance sampling procedure and their application
●	To learn the concept of reliability , maintainability and availability
●	To understand the quality and reliability in Product design and analysis

UNIT-I	INTRODUCTION TO STATISTICAL QUALITY CONTROL	10
Introduction and definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation –Theory of control chart- uses of control chart – Control chart for variables – X chart and R chart - process capability analysis . Six sigma concepts		
UNIT-II	**PROCESS CONTROL FOR ATTRIBUTES**	8
Control chart for attributes –control chart for non-conforming – p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study		
UNIT-III	**ACCEPTANCE SAMPLING**	9
Lot by lot sampling – types – probability of acceptance Single sampling plans for attributes – double sampling - multiple sampling - sequential sampling - Military standards - The Dodge Roming sampling plans – Random sampling – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD		
UNIT-IV	**LIFE TESTING – RELIABILITY**	9
Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves		
UNIT-V	**QUALITY AND RELIABLITY**	9
Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles. Risk assessment – FMEA and Fault tree analysis		
Note: Use of approved statistical table permitted in the examination.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
●	To apply the concept of SQC in process control for component production
●	To draw the process control charts for attributes
●	To understand the concepts of acceptance sampling for AQL and LTPD
●	To understand the concept of reliability, maintainability, availability and OC curves
●	To understand the various reliability improvement techniques, Product life cycle and FMEA

Text Books:	
1	Douglas.C. Montgomery, "Introduction to Statistical quality control", 4th edition, John Wiley 2001
2	Srinath. L.S., "Reliability Engineering", Affiliated East west press, 1991

Reference Books / Web links:	
1	John.S. Oakland. "Statistical process control", 5th edition, Elsevier, 2005
2	Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 1993
3	Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 1996
4	Monohar Mahajan, "Statistical Quality Control", Dhanpat Rai & Sons, 2001

MT19P63	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	
●	Design wheeled robots
●	Control mobile robots of different geometry
●	Select and device suitable sensors for any mobile robots
●	Identify and map the location of mobile robots
●	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

MT19P64	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	
●	Comprehend product design development process
●	Generate and select suitable concepts for developing various products
●	Recognize product architecture
●	Reduce the cost of industrial product design
●	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
4	Stephen Rosenthal, "Effective Product Design and Development", Irwin Publishing house, 1999

SEMESTER VII ELECTIVE III

ME19P76	PROCESS PLANNING AND COST ESTIMATION	PE	L	T	P	C
			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**	8
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**	9
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:	
On completion of course students will be able to	
●	Dexterity to make a standard and detailed process plan for a given product.
●	Capability to differentiate estimation and costing.
●	Capacity to allocate cost elements, distribute over heads and calculate depreciation for a given Product.
●	Ability to estimate cost for various production processes like casting, forging and welding 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, 2007.
2	Peter Scallan, "Process Planning, The Design/Manufacture Interface", Butterworth Heinemann, 2003.

Reference Books / Web links:	
1.	Chitale A. K., and Gupta R. C., "Product Design and manufacturing", Prentice Hall of India, New Delhi, 1997.
2.	Gideon Halevi, "Process and operation planning", Kluwer academic publishers (Printed ebook), 2003.
3.	Narang G.B.S. & Kumar. V, "Production and Costing", Khanna Publishers, 2000.
4	Phillip F. Ostwald & Jairo Munoz, "Manufacturing Processes and Systems", 9th Edition, Wiley, 2002.
5	Robert Creese, Adithan M. &Pabla B. S., "Estimating and Costing for the Metal Manufacturing Industries", Marcel Dekker, 1992.

MT19P71	SMART SENSORS AND MICRO ELECTRO MECHANICAL SYSTEMS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To study about the internal composition of smart sensors
●	To study about the working of smart sensors
●	To gain knowledge on MEMS

UNIT-I	**ACOUSTIC, MAGNETIC AND MECHANICAL SENSORS**	9
Acoustic waves, piezoelectric materials Acoustic sensing, saw sensors Sensor applications and future trends Magnetic sensors: effects and materials Integrated Hall sensors Magneto transistors, other magnetics transistor and future trends Mechanical sensors: piezo resistivity Piezoresistive sensors Capacitive sensors		
UNIT-II	**RADIATION, THERMAL AND CHEMICAL SENSORS**	9
Radiation basics HgCdTe infrared sensors Visible-light color sensors, high-energy photodiodes Heat transfer, thermal structures Thermal-sensing elements Thermal and temperature sensors Thin-film sensors		
UNIT-III	**BIOSENSORS, ELECTRONIC INTERFACE AND INTEGRATED SENSORS**	9
Immobilization of biological elements Transduction principles Lab-on-chip sensors Integrated sensors: system organization and functions Interface electronics Universal transducer interface Micro technologies: methods and tools, constructive and connective techniques		
UNIT-IV	**MICRO-AND NANOTECHNOLOGIES OR SENSORS**	9
MEMS fabrication technologies: bulk micromachining Surface micromachining High-aspect-ratio (LIGA and LIGA-Like) technology microfluidics microsystem components Microfluidics Nanotechnology: product prospects - application trends Procedures and techniques:		
UNIT-V	**APPLICATIONS**	9
The making of ultrathin films Creation of lateral nanostructures, nanocrystalline materials and principles of self-organization and Future trends		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
●	Compare the characteristics of Acoustic magnetic and Mechanical Sensors
●	Analyze the different thermal, chemical and Radiation sensors
●	Understand the working of Biosensors and its interfaces
●	Explain the Micro and Nano technologies in the field of smart sensors
●	Understand the applications of sensors in industries

Text Books:	
1.	Gerard Meijer, “Smart Sensor Systems: Emerging Technologies and Applications”, Wiley, 2014
2.	Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs, and Applications”, Springer; 5th ed. 2016

Reference Books / Web links:	
1	Gopel W, J. Hesse, J. N. Zemel, “Sensors A Comprehensive Survey” Vol. 9, Wiley-VCH, 1995
2	Sze S. M., “Semiconductor Sensors”, Wiley-Interscience,1994

MT19P72	AUTOMATED MATERIAL HANDLING SYSTEMS	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce the concepts of material handling equipment.
•	To expose the student automated assembly and storage systems.

UNIT-I	MATERIAL HANDLING	9
Overview of material handling equipment – Considerations in material handling system design – 10 principles of material handling, Mechanism of part handling - Industrial trucks, Cost Criteria for Equipment Decisions.		
UNIT-II	**CONVEYOR SYSTEM**	9
Conveyor's systems – Cranes and Hoists – Analysis of Material transport systems. Storage system performance – storage location strategies – Conventional storage methods and equipment's – Automated storage systems.		
UNIT-III	**AUTOMATED STORAGE AND ASSEMBLYSYSTEMS**	9
Engineering Analysis of Automated storage systems - AS/RS – Quantitative analysis- Carousel storage system. Fundamentals of Automated Assembly systems – Design for Automated Assembly – Bar-code techniques – Robotics in material handling system.		
UNIT-IV	**OVERHEAD AND SURFACE TRANSPORTATION EQUIPMENT**	9
Overhead Trolley Conveyors, Cableways, Aerial Tramways, Trackless Equipment, Narrow Gauge Equipment, Cross Handling Equipment.		
UNIT-V	**MODERN MATERIALS HANDLING EQUIPMENT**	9
AGV systems – mobile Robots – Mono Rails, manipulators, storage systems, elevators, racks, bins, and other Rail Guided Vehicles.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of course students will be able to	
●	Select appropriate of material handling equipment.
●	Design and develop conveyor system.
●	Implement suitable storage system.
●	Select appropriate of overhead material handling equipment.
●	Select modern material handling equipment.

Text Books:	
1.	Charles D Reese, "Material Handling Systems", Taylor And Francis, 2011.
2.	Edward H. Frazelle, "World-Class Warehousing and Material Handling", McGraw-Hill Education, 2016.

Reference Books / Web links:	
1	Agarwal, G.K "Plant Layout and material handling", Jain Brothers, Delhi, 2011.
2	Kant. Vajpayee, "Principles of Computer Integrated Manufacturing", Prentice Hall of India Pvt. Ltd., 2016.
3	Kulwiec R.A." Material Handling Hand book" 2nd Edition, John Wiley & Sons Inc., New York, 2012.
4	Mikell.P.Groover, "Automation, Production System and Computer integrated manufacturing", Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

MT19P73	ARTIFICIAL INTELLIGENCE FOR MECHATRONICS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To understand the different search strategies in AI
●	To understand the various characteristics of intelligent agents
●	To represent knowledge in solving AI problems and understand the different ways of designing software agents

UNIT-I	INTRODUCTION	9
Introduction -Definition - Future of Artificial Intelligence - Characteristics of Intelligent Agents -Typical Intelligent Agents - Problem Solving Approach to Typical AI problems		
UNIT-II	**PROBLEM SOLVING METHODS**	9
Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems - Constraint Propagation - Backtracking Search - Game Playing - Optimal Decisions in Games - Alpha - Beta Pruning - Stochastic Games		
UNIT-III	**KNOWLEDGE REPRESENTATION**	9
First Order Predicate Logic - Prolog Programming - Unification - Forward Chaining-Backward Chaining - Resolution - Knowledge Representation - Ontological Engineering-Categories and Objects - Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information		
UNIT-IV	**SOFTWARE AGENT**	9
Architecture for Intelligent Agents - Agent communication - Negotiation and Bargaining -Argumentation among Agents - Trust and Reputation in Multi-agent systems		
UNIT-V	**APPLICATIONS**	9
AI applications - Language Models - Information Retrieval- Information Extraction - Natural Language Processing - Machine Translation - Robot - Hardware - Perception - Planning - Moving		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Represent a problem using first order and predicate logic
●	Select appropriate search algorithms for any AI problem
●	Choose the apt agent strategy to solve a given problem
●	Design software agents to solve a problem
●	Design applications for Natural Learning Process that uses Artificial Intelligence

Text Books:	
1	David L. Poole and Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010
2	Bratko, Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

Reference Books / Web links:	
1	Gerhard Weiss, Multi Agent Systems, Second Edition, MIT Press, 2013.
2	M. Tim Jones, Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2008

MT19P74	WIRELESS NETWORKS FOR INDUSTRIAL AUTOMATION	PE	L	T	P	C

Objectives:	
•	To understand the technologies used in wireless networks
•	To study the standards of wireless networks
•	To understand the application of wireless networks in Automation
•	To study the usage of radio waves in wireless communication
•	To study the hacking methods of Industrial Networks

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	**Application of Wireless Networks for Industrial Automation**	**9**
Industrial Automation Requirements – Politics of Wireless – WiFi – Bluetooth – Zigbee – Wireless HART – 4G for Automation		
UNIT-IV	**Radio Frequency Tagging**	**9**
Types of Tags – Tag Encoding – Alternative RFID Standards- RF Database Tag – RF Tag Recommendations		
UNIT-V	**Hacking Industrial Network**	**9**
Cyber Security and Safety – Common Industrial Targets – Common Attack Methods – Weaponized Industrial Cyber Threats – Attack Trends – Dealing with Infection		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
•	Explain the standards of the Wireless Networks
•	Predict the technologies used for Wireless Networks
•	Select suitable wireless network for Industrial Automation
•	Predict the working of Radio waves in Industrial Networks
•	Identify the different types of hacking in Wireless Networks

Text Books:	
1	Dick Caro, “Wireless Networks for Industrial Automation”, International Society of Automation, 2012
2	Eric D Knapp, Joel Thomas Langill “Industrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control Systems”, Syngress, 2010

Reference Books / Web links:	
1	Sudip K. Mazumder, “Wireless Networking Based Control”, Springer, 2012
2	Danny Briere, Pat Hurley, “Wireless Network Hacks and Mods” John Wiley & Sons, 2014

SEMESTER VIII
ELECTIVE IV

MT19P81	INTELLIGENT CONTROL SYSTEMS	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To introduce the ideas of artificial neural network, fuzzy sets and fuzzy logic
•	To study basics of control-theoretic foundations such as stability and robustness in the frame work of intelligent control.
•	To impart knowledge on various control techniques
•	To create awareness of the application areas of intelligent technique
•	To introduce the ideas of optimization in fuzzy logic controller

UNIT-I	INTRODUCTION TO NEURAL NETWORKS	10
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	**GENETIC ALGORITHM**	9
Introduction to Genetic Algorithms, Search Operators: Crossover, mutation, Crossover for real-valued representations, mutation for real-valued representations, combinatorial GA, Selection Schemes: Fitness proportional selection and fitness scaling, ranking, tournament selection, selection pressure and its impact on evolutionary search.		
UNIT-V	**FUZZY LOGIC CONTROLLER**	8
Parametric optimization of fuzzy logic controller using genetic algorithm - System identification using neural and fuzzy neural networks - Lyapunov stability theory. Adaptive control using neural and fuzzy neural networks, Direct and Indirect adaptive control, and Self-tuning PID Controllers- Applications to pH reactor control, robot manipulator dynamic control, under actuated systems such as inverted pendulum and inertia wheel pendulum control		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Select appropriate neural network.
●	Apply supervised and unsupervised ANN system.
●	Implement fuzzy logic technique.
●	Implement genetic algorithm for optimization problem.
●	Design optimization based fuzzy logic control system.

Text Books:	
1.	Kevin M. Passino and Stephen Yurkovich, Fuzzy Control, Addison Wesley Longman, Menlo Park,1998.
2.	Poznyak A.S., E. N. Sanchez and Wen Yu, Differential Neural Networks for Robust Nonlinear Control, World Scientific, 2001.

Reference Books / Web links:	
1	ErdalKayacan, MojtabaAhmadiehKhaneswar, “Fuzzy neural networks for Real time control applications”, Elsevier, 2015
2	LaureneFauseett, “Fundamentals of Neural Networks”, Prentice Hall India, New Delhi, 2012
3	Timothy J. Ross, “Fuzzy Logic with Engineering Applications”,Wiley; Fourth edition,2016.

MT19P82	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	
●	Recall the basic concepts of Virtual Instruments.
●	Implement various bus interfaces
●	Program and simulate systems using LabVIEW.
●	Acquire data using DAQ and implement various interfaces.
●	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.

MT19P83	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 - InstallingVirtualBox - 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	
●	Work with Ubuntu and Linux operating systems
●	Use C++ for programming Robot Operating System
●	Use Python for programming Robot Operating System
●	Program ROS Libraries.
●	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

MT19P84	MAINTENANCE ENGINEERING AND CONDITION MONITORING	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand various types of defects and failures.
•	To know about maintenance activities in industries.
•	To understand operating procedures and record maintenance.
•	To know about usage of computers for maintenance management.
•	To know about usage of computers in various condition monitoring techniques.

UNIT-I	DEFECTS AND FAILURE ANALYSIS	10
Defect generation-types of failures-Defects reporting and recording-Defect analysis-Failure analysis-Equipment down time analysis-Breakdown analysis-FTA, FMEA		
UNIT-II	MAINTENANCE SYSTEMS	9
Planned and un-planned maintenance - Breakdown maintenance - Corrective maintenance - Opportunistic maintenance - Routine maintenance - Preventive maintenance, Predictive maintenance - Condition based maintenance system selection of maintenance system.		
UNIT-III	SYSTEMATIC MAINTENANCE	9
Codification and Cataloguing-Instruction manual and operating manual-Maintenance manual and Departmental Manual-Maintenance time standard-Maintenance work order and work permit - Feedback and control-Maintenance records and documentation.		
UNIT-IV	COMPUTERIZED MAINTENANCE SYSTEM	9
Selection and scope of computerization-Equipment Classification-Codification of breakdown, material and facilities- - Material management module-Captive Engineering module.		
UNIT-V	CONDITION MONITORING	8
Condition monitoring techniques-Visual Monitoring-Temperature monitoring-vibration monitoring- Lubricant Monitoring-Cracks monitoring-Thickness monitoring-Noise and sound monitoring- condition monitoring of hydraulic system. Machine diagnostics-Objectives-Monitoring strategies- Examples of monitoring and Diagnosis		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Analyze the defects and failures encountered in manufacturing system
●	Classify the maintenance system and select suitable one based on requirement.
●	Explain the documentation and record updation involved in maintenance systems
●	Explain the scope of computers in maintenance system
●	Establish monitoring strategies according to system characteristics

Text Books:	
1.	Don Nyman and Joel Levitt, Maintenance Planning, Scheduling and Coordination, Industrial Press Inc., New York, 2010.
2.	Sushil Kumar Srivastava, Industrial Maintenance Management, S. Chand and Company Ltd, New Delhi, 2006.

Reference Books / Web links:	
1.	Davies, Handbook of Condition Monitoring, Chapman & Hall, 1996.
2.	Garg M. R., Industrial Maintenance, S. Chand & Co., 1986.
3.	Higgins L. R., Maintenance Engineering Hand book, McGraw Hill, 5th Edition, 1988.
4.	Mishra R. C. and Pathak K., Maintenance Engineering and Management, PHI Learning Pvt.Ltd., New Delhi, 2009.

MT19P85	PROJECT MANAGEMENT	PE	L	T	P	C

Objectives:	
•	To understand the Importance of Project Management
•	To study the methods of Project Initiation
•	To study time constraints of Management Process
•	To study about the resources and cost of the Management Process
•	To study about the Risk factors and agile in Project Management

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	
•	Explain the importance of project management.
•	Describe the ways of Project Initiation
•	Determine the project duration and time estimates by Gantt Chart and Network techniques
•	Optimize resources and crash the project to its bare minimum value and obtain the optimum time – minimum cost relationships
•	Describe about risk assessment process, project closure and agile techniques

Text Books:	
1	Erik W. Larson, Clifford F. Gray, "Project Management The Managerial Process", McGraw-Hill/Irwin, Fifth Edition, 2011.

Reference Books / Web links:	
1	A Guide to the Project Management Body of Knowledge (PMBOK® Guide)—Fifth Edition, Project Management Institute.
2	Punmia B. C. and Khandelwal K.K., "Project Planning and Control with PERT/CPM", Laxmi publications, New Delhi, 2011.
3	NPTEL – Online course on Project Management
4	https://www.pmi.org
5	https://www.iso.org/standard

SEMESTER VIII
ELECTIVE V

GE19P72	ENTREPRENEURSHIP DEVELOPMENT	PE	L	T	P	C
			3	0	0	3

Objectives:	
•	To understand the meaning of Entrepreneur
•	To know different motivation techniques
•	To be familiarized with business opportunities
•	To have knowledge about source of finance and analysis
•	To know various supports for business

UNIT-I	**ENTREPRENEURSHIP**	10
Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.		
UNIT-II	**MOTIVATION**	9
Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.		
UNIT-III	**IDENTIFICATION OF BUSINESS**	9
Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.		
UNIT-IV	**FINANCING AND ACCOUNTING**	9
Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.		
UNIT-V	**SUPPORT TO ENTREPRENEURS**	8
Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course, students will be able to	
•	Explain the meaning of Entrepreneur
•	Comprehend different motivation techniques
•	Describe various business opportunities
•	Identify sources of finance and to analyse
•	Know various supports for business development

Text Books:	
1	Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.
2	Donald F Kuratko, "Entrepreneurship – Theory, Process and Practice", 9 th Edition, Cengage Learning, 2014.

Reference Books / Web links:	
1	Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.
2	Mathew J Manimala, "Entrepreneurship theory at cross roads: paradigms and praxis" 2nd Edition, Dream tech, 2005.
3	Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.
4	Jain P C, "A Hand Book for New Entrepreneurs", Oxford University Press, 2010.

ME19P86	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	PE	L	T	P	C
			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 the invention.
•	To understand the patent rights and recent developments in IPR.
•	To understand the industrial design and geographical indication procedures to get patents, copy right, trademarks and 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 and mixed-methods research.		
UNIT-II	**REVIEW OF LITERATURE AND TECHNICAL WRITING**	10
Effective literature studies approach, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal.		
UNIT-III	**INTELLECTUAL PROPERTY RIGHTS**	10
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**	7
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: At the end of this course, students can have the	
•	Ability to Apply knowledge on research problem formulation and analyze research related information.
•	Ability to write the literature review and technical paper.
•	Ability to apply IPR concept to important place in growth of individuals & nation.
•	Ability to Apply patent right to new products developed.
•	Ability to describe the procedure and the tools to get patent copy right for their innovative work.

Text Books:	
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 Delhi, 2012.

Reference Books / Web links:	
1	Stuart Melville and Wayne Goddard, “Research Methodology: An Introduction For Science & Engineering Students”,2nd edition, Juta Academic, 2001.
2	Ramakrishna B & Anilkumar H S, “Fundamentals of Intellectual Property Rights”, 1st edition, Notion Press,

	2017
3	William G Zikmund, Barry J Babin, Jon C.Carr, Atanu Adhikari,Mitch Griffin, "Business Research methods: A South Asian Perspective, 8th Edition, Cengage Learning, New Delhi, 2012.

MT19P87	**DATA ANALYTICS FOR MECHATRONICS**	PE	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Objectives:	
●	To introduce the concepts of linear modeling of optimization problems
●	To expose the student to network models of optimization problems
●	To expose the inventory, queuing and non-linear models

UNIT-I	**Data Engineering**	9
Data Modelling – Data Storage – Data Access - Data Analytics – Data Visualization – Data Standards and Data Quality - Legal, Policy and Ethics.		
UNIT-II	Data Challenges	9
Big data – Big Data Analytics vs Business Intelligence - Big data characteristics – Types of available Data – Data Sources – Big Data Tools –Programming in R and python -Use cases.		
UNIT-III	**Data Analytics – Analytics Process Model**	9
Analytical Model Requirements - Types of Data Analytics. **Predictive Analytics** – Ensemble Methods – Multiclass Classification Techniques – Evaluating Predictive Models – Case study for any health care system.		
UNIT-IV	**Text and Web Analytics**	9
Text Analytics Methods – Text Analytics Metrics – Linguistic Analysis – Text Summarization - Sentiment analysis – Case study for text data generation system. Web Analytics – Key Performance Indicators – Intelligence Analysis – Dashboards – Social Media Analytics – Case Study for social media data analytics.		
UNIT-V	**Real Time Analytics**	9
Stream Computing – Terminologies – Streaming Applications – Case Study for video data analytics.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Identify the big data environment for performing data quality analysis on large data sets.
●	Apply NoSQL data models for unstructured data
●	Perform predictive analytics for text and streaming data
●	Interpret machine learning methods and strategies for data analysis
●	Perform video data analytics using stream computing

Text Books:	
1	Bart Baesens, "Analytics in a Big Data World", The Essential Guide to Data Science and its Applications, Wiley, First edition, 2014.
2	Thomas H. Davenport, Jeanne G. Harris, "Competing on Analytics: The New Science of Winning", Harvard Business Review Press, First edition, 2007.

Reference Books / Web links:	
1	Paul C. Zikopoulos, Chris Eaton, "Understanding Big Data", McGraw-Hill, 2012 (eBook from IBM).

MT19P88	OPTIMIZATION TECHNIQUES FOR MECHATRONICS ENGINEERS	PE	L	T	P	C
			3	0	0	3

Objectives:	
●	To introduce the concepts of linear modeling of optimization problems
●	To expose the student to network models of optimization problems
●	To expose the inventory, queuing and non-linear models

UNIT-I	LINEAR MODELS	9
The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis		
UNIT-II	**TRANSPORTATION MODELS AND NETWORK MODELS**	9
Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models		
UNIT-III	**INVENTORY MODELS**	9
Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice		
UNIT-IV	**QUEUEING MODELS**	9
Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation		
UNIT-V	**NON LINEAR MODELS**	9
Elimination methods-Fibonacci Method and Golden Section Method, interpolation methods-Quadratic Interpolation Method and Cubical Interpolation Method, Unconstrained Minimization Method-Univariate method and Constrained Optimization Techniques- Zoutendijk's method		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Formulate and solve the linear model optimization problems
●	Able to control the projects and manage the resources
●	Implement suitable inventory models to various factories
●	Formulate optimum service stations for different queuing systems
●	Solve all non linear optimization models

Text Books:	
1	Hillier and Libeberman, "Operations Research", McGraw-Hill Higher Education, New York, 2010
2	Taha H.A., "Operations Research", Sixth Edition, Pearson, India, 2016

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

ME19P79	NON-DESTRUCTIVE TESTING AND EVALUATION	PE	L	T	P	C
	(Common to Mech and MCT)		3	0	0	3

Objectives:	
●	To make the students understand the importance of NDT in quality assurance.
●	To imbibe the students 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 make the students to be ready to use NDT 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	7
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- Borescopes -Video scopes, Special features in Borescopes, Selection of borescopes, Optical sensors, Microscopes & replication Microscopy Technique and applications, Holography - Case study.		
UNIT-II	**LIQUID PENETRANT TESTING& MAGNETIC PARTICLE TESTING**	8
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 AND EDDY CURRENT TESTING (ET)**	10
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**	10
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 (RT)**	10
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.		
	Total Contact Hours : 45	

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

●	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.

Text Books:	
1	ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2	Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd edition New Jersey, 2005.

Reference Books / Web links:	
1	Baldev Raj, T.Jayakumar, M.Thavasimuthu, "Practical Non-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, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.
3	Charles, J. Hellier," Handbook of Non-destructive evaluation", McGraw Hill, New York, 2001.
4	Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, 1st Revised edition, 2010.
5	https://nptel.ac.in/courses/113106070/