P.S.R. ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Sevalpatti (P.O), Sivakasi – 626140.

B.E. Mechanical Engineering

CURRICULUM
AND
SYLLABI

UG
Regulations 2019

Department of Mechanical Engineering

CANDIDATES ADMITTED DURING 2019-2020 AND ONWARDS

Regulation 2019

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Vision

- To provide broad-based education and training in mechanical engineering and its applications to enable the graduates to meet the demands in a rapidly changing needs in industry, academia and society.

Mission

- To impart high quality technical education and training that encompasses both theory and practices with human and social values
- To equip the students to face tomorrows technology embedded global changes
- To create, explore, and develop innovations in mechanical engineering research

Programme Educational Objectives (PEOs)

- Lead a professional career by acquiring the basic knowledge in the field of specialization and allied Engineering.
- Assess the real life problems and deal with them confidently relevance to the society.
- Engage in lifelong learning by pursuing higher studies and participating in professional organizations.
- Exhibit interpersonal skills and able to work as a team for success.

Programme Specific Outcomes (PSOs)

- Apply the concepts of mathematics and science in mechanical systems.
- Design and analyze components and systems for mechanical engineering applications
- Synthesis data and technical concepts for application to mechanical engineering software.
- Apply manufacturing and management practices in industries.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **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.
d. **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.
e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
f. **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.
g. **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.
h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multi disciplinary settings.
j. **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.
k. **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.
l. **Lifelong 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.

P.S.R. ENGINEERING COLLEGE, SIVAKASI-626 140
U.G REGUALTION-2019 (CBCS)
B.E. MECHANICAL ENGINEERING
CURRICULUM
[I – VIII SEMESTER]

Total Credits:160

SEMESTER – I

S.No.	Course Code	Course Title	Hours Per week			Credits	Category
			L	T	P		
THEORY							
1.	191HS11	Communicative English	2	0	0	2	HSMC
2	191HS12	Calculus and Linear Algebra	3	1	0	4	BSC
3	191HS13	Engineering Physics	2	0	0	2	BSC
4	191HS14	Engineering Chemistry	2	0	0	2	BSC
5	191CSF1	Programming For Problem Solving	3	0	0	3	ESC
THEORY CUM PRACTICAL							
6	191MEF7	Mechanical Workshop	1	0	4	3	ESC
PRACTICAL							
7	191HS17	Physics and Chemistry Laboratory - I	0	0	2	1	BSC
8	191CSF7	C Programming Laboratory	0	0	2	1	ESC
Total						**18**	

SEMESTER –II

S.No.	Course Code	Course Title	Hours Per week			Credits	Category
			L	T	P		
THEORY							
1.	191HS21	Technical English	2	0	0	2	HSMC
2	191HS22	Differential Equations and Numerical Methods	3	1	0	4	BSC
3	191HS23	Physics of Materials	2	0	0	2	BSC
4	191HS24	Environmental Science	2	0	0	2	BSC
5	191EEF1	Basic Electrical and Electronics Engineering	3	0	0	3	ESC
		THEORY CUM PRACTICAL					
6	191MEF1	Engineering Graphics	1	0	4	3	ESC
PRACTICAL							
7	191HS27	Physics and Chemistry Laboratory - II	0	0	2	1	BSC
8	191EEF7	Basic Electrical and Electronics Laboratory	0	0	2	1	ESC
Total						**18**	

SEMESTER – III

S.No.	Course Code	Course Title	Hours Per week			Credits	Category
			L	T	P		
THEORY							
1.	191HS31	Transforms and Discrete Mathematics	2	1	0	3	BSC
2	191BS31	Biology for Engineers	3	0	0	3	BSC
3	191ME31	Engineering Mechanics	3	0	0	3	ESC
4	191ME32	Engineering Thermodynamics	3	1	0	4	PC
5	191ME33	Engineering Metrology and Measurements	3	0	0	3	PC
THEORY CUM PRACTICAL							
6	191ME34	Manufacturing Processes	3	0	2	4	PC
PRACTICAL							
7	191ME37	Engineering Metrology and Measurements Laboratory	0	0	2	1	PC
8	191ME38	Computer Aided Drafting Laboratory	0	0	2	1	PC
9	191HS37	Communication Skills – I	0	0	2	-	HSMC
10		Value added course - I	1	0	0	-	VC
Total						**22**	

SEMESTER – IV

S.No.	Course Code	Course Title	Hours Per week			Credits	Category
			L	T	P		
THEORY							
1.	191HS42	Probability and Statistics	2	1	0	3	BSC
2	191ME41	Fluid Mechanics and Machinery	3	0	0	3	PC
3	191ME42	Mechanics of Materials	3	1	0	4	PC
4	191ME43	Materials Engineering	3	0	0	3	PC
5	191ME44	Kinematics of Machinery	3	1	0	4	PC
THEORY CUM PRACTICAL							
6	191ME45	Manufacturing Technology	3	0	2	4	PC
PRACTICAL							
7	191ME47	Fluid Mechanics and Machinery Laboratory	0	0	2	1	PC
8	191ME48	Materials Testing Laboratory	0	0	2	1	PC
9	191HS47	Communication Skills – II	0	0	2	-	HSMC
10		Mandatory course - I	1	0	0	-	MC
Total						**23**	

SEMESTER – V

S.No.	Course Code	Course Title	Hours Per week			Credits	Category
			L	T	P		
THEORY							
1	191ME51	Dynamics of Machinery	3	0	0	3	PC
2	191ME52	Thermal Engineering	3	0	0	3	PC
3	191ME53	Applied Hydraulics & Pneumatics	3	1	0	4	PC
4	191ME54	Electronics Instrumentation and Control	3	0	0	3	PC
5		Programme Elective - I	3	0	0	3	PC
THEORY CUM PRACTICAL							
6	191ME55	Machine Design and Drawing	3	0	2	4	PC
PRACTICAL							
7	191ME57	Dynamics Laboratory	0	0	2	1	PC
8	191ME58	Thermal Engineering Laboratory	0	0	2	1	PC
9	191HS57	Business English	0	0	2	-	HSMC
10		Value added course - II	1	0	0	-	VC
Total						**22**	

SEMESTER – VI

S.No.	Course Code	Course Title	Hours Per week			Credits	Category
			L	T	P		
THEORY							
1	191ME61	Automation in Manufacturing	3	0	0	3	PC
2	191ME62	Design of Transmission Systems	3	1	0	4	PC
3	191ME63	Automobile Engineering	3	0	0	3	PC
4	E1	Programme Elective –II	3	0	0	3	PE
5	E2	Open Elective –I	3	0	0	3	OE
THEORY CUM PRACTICAL							
6	191ME64	Heat and Mass Transfer	3	0	2	4	PC
PRACTICAL							
7	191ME67	CAD/ CAM Laboratory	0	0	2	1	PC
8	191ME69	Mini Project	0	0	2	1	PROJ
9	191HS67	Career English	0	0	2	-	HSMC
10		Mandatory course - II	1	0	0	-	MC
Total						**22**	

SEMESTER – VII

S.No.	Course Code	Course Title	Hours Per week			Credits	Category
			L	T	P		
THEORY							
1	191ME71	Total Quality Management	3	0	0	3	PC
2	191ME72	Gas Dynamics and Jet Propulsion	3	0	0	3	PC
3	191ME73	Finite Element Analysis	3	1	0	4	PC
4		Programme Elective –III	3	0	0	3	PE
5		Open Elective –II	3	0	0	3	OE
THEORY CUM PRACTICAL							
6	191ME74	Mechatronics	3	0	2	4	PC
PRACTICAL							
7	191ME77	Simulation and Analysis Laboratory	0	0	2	1	PC
8	191ME79	Project - I	0	0	4	2	PROJ
9		Value added course - III	1	0	0	-	VC
Total						**23**	

SEMESTER – VIII

S.No.	Course Code	Course Title	Hours Per week			Credits	Category
			L	T	P		
THEORY							
1	-	Programme Elective –IV	3	0	0	3	PE
2	-	Open Elective –III	3	0	0	3	OE
PRACTICAL							
3	191ME89	Project – II	0	0	12	6	PROJ
Total						**12**	

HS – Humanity Science, BS – Basic Science, ES – Engineering Science, PC – Programme Core,
PE – Programme Elective, OE – Open Elective, EEC – Employment Enhancement Course, MC – Mandatory Course

List of Programme Electives

S.No.	Code	Course Title	L-T-P	C	Category
1.	191HSEA	Professional Ethics in Engineering	3-0-0	3	HSMC
2.	191MEEA	Additive Manufacturing	3-0-0	3	PE
3.	191MEEB	Composite Materials and Engineering	3-0-0	3	PE
4.	191MEEC	Computational Fluid Dynamics	3-0-0	3	PE
5.	191MEED	Computer Integrated Manufacturing	3-0-0	3	PE
6.	191MEEE	Fireworks Safety	3-0-0	3	PE
7.	191MEEF	Fundamentals of Nano Technology	3-0-0	3	PE
8.	191MEEG	Hybrid and E-Vehicles	3-0-0	3	PE
9.	191MEEH	Industrial Engineering and Management	3-0-0	3	PE
10.	191MEEI	Product Design and Development	3-0-0	3	PE
11.	191MEEJ	Internet Of Things for Manufacturing	3-0-0	3	PE
12.	191MEEK	Modern Machining Processes	3-0-0	3	PE
13.	191MEEL	Rapid Prototyping	3-0-0	3	PE
14.	191MEEM	Power Plant Engineering	3-0-0	3	PE
15.	191MEEN	Process Planning and Cost Estimation	3-0-0	3	PE
16.	191MEEO	Production Planning and Control	3-0-0	3	PE
17.	191MEEP	Refrigeration and Air Conditioning	3-0-0	3	PE
18.	191MEEQ	Welding Technology	3-0-0	3	PE

List of Open Electives Offered by Mechanical Department

S.No.	Code	Course Title	L-T-P	C	Category
1	191OE6A	Maintenance Engineering	3-0-0	3	OE
2	191OE6B	Non-Destructive Testing and Materials	3-0-0	3	OE
3	191OE6C	Operations Research and Management	3-0-0	3	OE
4	191OE6D	Renewable Sources of Energy	3-0-0	3	OE
5	191OE6E	Robotics	3-0-0	3	OE

Mandatory Courses					
S. No.	Code	Name of the Course	L–T–P	C	Category
1	191MC01	Design Thinking	2–0–0	0	MC
2	191MC02	Essence of Indian Traditional Knowledge	2–0–0	0	MC
3	191MC03	Indian Constitution	2–0–0	0	MC
4	191MC04	Universal Human Values	2–0–0	0	MC
5	191MC05	Yoga	2–0–0	0	MC

191HS11	COMMUNICATIVE ENGLISH				L-T-P	C
					2-0-0	2
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**I**	**Category:**	**HSMC**	
Prerequisites:	Acquire Language proficiency.					
Aim:	To acquire basic Language Skills in order to communicate with English Language Speakers.					

Course Outcomes:

The Students will be able to

CO1: Develop the basic reading and writing skills.
CO2: Listen actively and grasp the contents of the speech.
CO3: Develop their speaking skills and speak fluently in real contexts.
CO4: Develop vocabulary of a general kind by developing their reading skills.
CO5: Use the grammar effectively to exhibit their speaking and writing skill.
CO6: Speak in English with clarity.

UNIT 1 SHARING INFORMATION RELATEDTO ONESELF, FAMILY AND FRIENDS.	**6**

Reading – Short comprehension passages, Practice in skimming and scanning. Writing – Sentence structures, Developing Hints. Listening – Short texts, Short formal and informal conversations. Speaking – Introducing oneself, Exchanging personal information. Language Development – WH questions, Asking and answering YES or NO questions, Parts of Speech. Vocabulary Development – Prefixes & Suffixes, Subject verb Agreement.

UNIT 1I	**GENERAL READING AND FREE WRITING**	**6**

Reading – Comprehension – Pre-reading & Post-reading. Comprehension questions (Multiple choice questions, Short questions, Open-ended questions), Short narratives and Descriptions from Newspapers including Dialogues. Writing – Paragraph writing, Use of Phrases and Clauses in sentences, Listening Telephonic conversations. Speaking – Sharing information of a personal kind, Greetings.
Language Development – Noun Pronoun agreement. Vocabulary Development – The Concept of Word Formation. (Norman Lewis' *Word Power Made Easy*)

UNIT 1II	**GRAMMAR AND LANGUAGE DEVELOPMENT**	**6**

Reading – Short texts & Longer passages (Cloze reading). Writing – Importance of proper punctuation, Jumbled sentences. Listening – Listening to longer texts and filling up the table, Product description, Narratives from different sources. Speaking – Asking about routine actions and Expressing opinions.
Language Development – Degrees of Comparison, Pronouns. Vocabulary Development – Misplaced modifiers, Relative clauses.

UNIT 1V	**READING AND LANGUAGE DEVELOPMENT.**	**6**

Reading- Comprehension. Reading longer texts- reading different types of texts. Writing- letter Writing, informal or personal letters-Achieving Coherence. Listening- listening to dialogues or conversations and completing exercises based on them. Speaking- Speaking about oneself- Speaking about one's friend. Language Development- Articles. Vocabulary Development – Root words from foreign languages and their use in English.

UNIT V	**EXTENDED WRITING**	**6**

Reading- Longer texts- close reading. Writing- Organizing principles of paragraphs in documents. Listening – Listening to talks, conversations. Speaking – Participating in conversations, short group conversations. Language Development - Cliches, Tenses. Vocabulary Development - Prepositions.

Total Periods:	**30**

Text books:

1. Board of Editors. *Fluency in English: A course book for Engineering and Technology*. Orient Blackswa Hyderabad: 2016.
2. Kumar, Sanjay and Pushp Lata. *Communication Skills: A Workbook*. New Delhi: OUP, 2018

References:

1. www.oxfordonlineenglish.com
2. www.ielts.up.com
3. www.ted.com
4. www.testpreppractice.com
5. www.beccambridgeenglish.org

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1										3		3				
CO2										3		2				2
CO3										3		3				2
CO4					2					3		3				
CO5										3		3				
CO6										3		2				

191HS12	CALCULUS AND LINEAR ALGEBRA			L-T-P	C
				3-1-0	4
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**I**	**Category:**	**BSC**
Prerequisites:	Matrices, Differentiation and Integration.				
Aim:	The course is aimed at developing the basic mathematical skills of engineering students,				

Course Outcomes:

The students will be able to

CO1: Find the inverse and the positive powers of a square matrix

CO2: Apply the concept of orthogonal reduction to diagonalise the given matrix

CO3: Determine the evolute of curves, Beta and Gamma Functions.

CO4: Apply Lagrangian multiplier method for finding maxima and minima of an unconstrained problem

CO5: Apply the concepts of Differentiation and Integration in Vectors.

CO6: Predict an analytic function, when its real or Imaginary part is known.

UNIT 1	**MATRICES**	**12**

Characteristic equation - Eigen Values and Eigen vectors of a real matrix - Properties of Eigen values - Cayley-Hamilton Theorem (without proof) and its application - Orthogonal Transformation of a Symmetric matrix to diagonal form - Quadratic form - Orthogonal reduction to canonical form.

UNIT 1I	**CALCULUS**	**12**

Radius of Curvature - Cartesian and Parametric Coordinates - Circle of Curvature - Involutes and Evolutes – Beta and Gamma functions and their properties.

UNIT 1II	**MULTIVARIABLE CALCULUS**	**12**

Partial Derivatives - Total Derivative - differentiation of Implicit function – Jacobian - Taylor's Expansion - Maxima/Minima for function of two variables - Method of Lagrange's multipliers.

UNIT 1V	**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 parallelepiped.

UNIT V	**COMPLEX VARIABLE – DIFFERENTIATION**	**12**

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy– Riemann equation and Sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function(without proof) – Harmonic conjugate – Construction of analytic functions – Conformal mapping : w = z + c, cz, 1/z, and bilinear transformation.

	Total Periods:	**60**

Text books:

1. B.S. Grewal, "**Higher Engineering Mathematics**", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th edition, Pearson, Reprint, 2002

References:

1. Veerarajan.*T.,* "**Engineering Mathematics for first year**", Fourth Edition, Tata Mc-Graw – Hill, New Delhi, 2008.
2. Erwin *Kreyszig*, **Advanced Engineering Mathematics**, 9th Edition, John Wiley & Sons, 2006.
3. G.B. Thomas and R.L. Finney, "**Calculus and Analytic Geometry**" 9th Edition, Pearson, Reprint,2002.
4. N.P. Bali and Manish Goyal, "**A text book of Engineering Mathematics**", Laxmi Publications, Reprint, 2
5. B.S. Grewal, "**Higher Engineering Mathematics**", Khanna Publishers, 36th Edition, 2010.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3		1								2		2	1	
CO2	2	3		2								1				1
CO3	3	3										3	2			
CO4	1	1													2	
CO5	3	2		1										2		
CO6	2	2		1								3	2			2

191HS13	ENGINEERING PHYSICS			L-T-P	C
				2-0-0	2
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**I**	**Category:**	**BSC**
Prerequisites:	School Level Physics				
AIM:	To endow the students with the fundamentals of Physics and apply new ideas in the field of Engineering and Technology.				

Course Outcomes:

The Students will be able to

CO1: Understand the theory and various crystal structures.

CO2: Know about the basic configuration of a Laser, types of lasers and the industrial applications of Laser.

CO3: Understand principle behind fiber optic communication and the electronic devices involved in the transmission and reception of data.

CO4: Know about basics of properties of matter and its applications,

CO5: Gain knowledge about basic equations of Quantum mechanics and its applications.

CO6: Understand the basic concepts of acoustics and ultrsonics.

UNIT 1	**SOLID STATE PHYSICS**	**6**

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Crystal Defects-point, Line and surface defects - burger vector.

UNIT 1I	**WAVE OPTICS**	**6**

LASERS: Introduction – Principle of Spontaneous emission and stimulated emission. Population inversion, pumping. Einsteins A and B coeffcients – Derivation- Types of lasers – CO_2, Nd-YAG - Industrial Applications - Lasers in welding, cutting and Soldering **FIBER OPTICS:** Optical Fiber-Classification- Principle and propagation of light in optical fibres- Numerical aperture and Acceptance angle-Fibre optical communication system- Sensors (Active and passive) –Displacement and Temperature Sensors.

UNIT 1II	**PROP ERTIES OF MATTER**	**6**

Elasticity–Stress - strain diagram and its uses -factors affecting elastic modulus and tensile strength –torsional stress and deformations – twisting couple- torsion pendulum: theory and experiment -bending of beams - bending moment –cantilever: theory and experiment–uniform and non-uniform bending: theory and experiment – I shaped girders - stress due to bending in beams.

UNIT 1V	**QUANTUM PHYSICS**	**6**

Black body radiation – Planck's theory -Photoelectric effect - Matter waves – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box.

UNIT V	**ACOUSTICS AND ULTRASONICS**	**6**

ACOUSTICS: Classification of sound - loudness and intensity - Weber-Fechner Law - standard intensity and intensity level - decibel - reverberation - reverberation time - Sabine's formula - absorption coefficient and its determination – factors affecting acoustics of buildings: focusing, interference, echo, Echelon effect, resonance - noise and their remedies. **Ultrasonics**: Ultrasonics - production - magnetostriction and piezoelectric methods - acoustic grating - industrial applications - NDT.

	Total Periods	**30**

Text books:

1. Gaur R. K., Gupta S. C., "Engineering Physics" Dhanpat Rai Publications, New Delhi (2016)
2. Avadhanulu M. N., Kshirsagar, P. G., "A Text book of Engineering Physics", S.Chand and company, Ltd., New Delhi, 2017.

References:

1. Serway and Jewett., "Physics for Scientists and Engineers with Modern Physics",6th Edition, Thomson Brooks/Cole, Indian reprint (2016)
2. Arither Beiser, Concepts of Modern Physics, Tata Mc Graw Hill, NewDelhi (2015)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1		2		3					2	1	1		
CO2	3	2	2	2			3					2	1	1		
CO3	2	2					3					1	1	1		
CO4	3	2	2	2			2					2	1	1		
CO5	3	2	2				2					2	1	1		
CO6	3	2	2	2			2					2	1	1		

191HS14	ENGINEERING CHEMISTRY			L-T-P	C
				2-0-0	2
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	I	**Category:**	BSC
Prerequisites:	Basic Science				
Aim:	To impart a sound knowledge on the principles of chemistry involving the different application oriented topics required for all engineering branches.				

Course Outcomes:

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

CO1: Demonstrate the essential concept of water and their properties and applications.
CO2: The treatment of water for potable and industrial purposes
CO3: Understand the operating principles and the reaction involved in electrochemistry.
CO4: Know the principles and application of spectroscopy
CO5: Learn the basic ingredients required for paint formulation
CO6: Know the preparation techniques of consumer products

UNIT 1	WATER TECHNOLOGY	6

Hardness -Types and Estimation by EDTA method- alkalinity –types of alkalinity and determination -Domestic water treatment –disinfection methods – Boiler feed water– internal conditioning– external conditioning – desalination and reverse osmosis.

UNIT 1I	ELECTROCHEMISTRY	6

Electrochemical cells – reversible and irreversible cells – EMF –measurement of emf – Single electrode potential – Nernst equation– reference electrodes –Standard Hydrogen electrode – Calomel electrode – Ion selective electrode – glass electrode and measurement of pH – electrochemical series

UNIT 1II	SPECTROSCOPIC TECHNIQUES AND APPLICATIONS	6

Introduction of UV-Visible and IR spectroscopy and selection rules- principles and instrumentation of UV-Visible (electronic) spectroscopy – IR (vibrational) spectroscopy - its applications. Fluorescence spectroscopy and its applications in medicine-colorimetry – estimation of iron by colorimetry .

UNIT 1V	INORGANIC & ORGANIC COATINGS	6

Paint–Definition–Components of Paints and their functions–Varnish–Definition–Preparation of Oil Varnish–Differences between Paint and Varnish–Special Paints–Luminescent Paints, Fire Retardant Paints- Aluminium Paints - Distemper. corrosion control– electroplating (Au) and electroless (Ni) plating.

UNIT V	PREPARATION OF CONSUMER PRODUCTS	6

Washing Powder- Cleaning powder - phenoyls (white, Black & coloured)- Shampoo- liquid blue- inks - blue –red - green inks – Soap - bathing & detergent – oils - Face powder and bleaching powder.

	Total Periods:	**30**

Text books:

1. P. Kannan, A. Ravikrishnan, “Engineering Chemistry”, Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009.
2. P.C.Jain and Monica Jain, “Engineering Chemistry” Dhanpat Rai Pub, Co., New Delhi (2002)

References:

1. S.S. Dara, S.S. Umare, “Engineering Chemistry”, S. Chand & Company Ltd., New Delhi 2010.
2. B.K.Sharma, “Engineering chemistry” Krishna Prakasan Media (P) Ltd., Meerut (2001).
3. B.Sivasankar, “Engineering chemistry” Tata McGraw Hill Publishing Company (P) Ltd., New Delhi, 2006

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2		2	3			2		3	1	3		2
CO2	3	2		2	2	3		1	2		2	2	2	2		3
CO3				2			2					2	3	3		3
CO4	2	1	2	2	1		2					1	2	2		
CO5	3	2	2	1	2	1			2			2	3	3		2
CO6	3	3	3	2		2	3			2		3	2	3		3

191CS21	PROGRAMMING FOR PROBLEM SOLVING	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. Common to all Branches	Sem:	1	Category:	ES

Aim: To provide an awareness to Computing and Programming.

Course Objectives:

- Learn the organization of a digital computer.
- Gain knowledge of software types and development steps.
- Learn to think logically and write pseudo code or draw flow charts for problems.
- Exposed to the syntax of C.
- Be familiar with programming in C.
- Learn to use arrays, strings, functions, pointers, structures and unions in C.

Course Outcomes: The Students will be able to

CO1: Understand the basic terminologies of Computer and various Problem-solving techniques.
CO2: Write, compile and debug programs in C language.
CO3: Use different data types in a computer program.
CO4: Design programs involving decision structures, loops and functions.
CO5: Understand the dynamics of memory by the use of pointers.
CO6: Use different data structures and create/update basic data files.

UNIT 1	INTRODUCTION	9

Generation and Classification of Computers - Basic Organization of a Computer - Number System - Binary - Decimal - Conversion - Problems. Software - Types, Development Steps. Algorithm - Pseudo code - Flow Chart. Problem formulation - Problem Solving.

UNIT 1I	C PROGRAMMING BASICS	9

Introduction to Unix Operating System - Introduction to ' C' programming - fundamentals - structure of a 'C' program - compilation and linking processes - Constants, Variables - Data Types - Expressions using operators in 'C' - Managing Input and Output operations - Decision Making and Branching - Looping statements - solving simple scientific and statistical problems.

UNIT 1II	ARRAYS AND STRINGS	9

Arrays - Initialization - Declaration - One dimensional and Two-dimensional arrays. String - String operations - String Arrays. Simple programs – Bubble Sort – Linear Search - Matrix Operations.

UNIT 1V	FUNCTIONS AND POINTERS	9

Function - Definition of function - Declaration of function - Pass by value - Pass by reference - Recursion - Pointers - Definition - Initialization - Pointers arithmetic - Pointers and arrays - Example Problems.

UNIT V	STRUCTURES AND FILES	9

Introduction - need for structure data type - structure definition - Structure declaration - Structure within a structure - Union - Programs using structures and Unions - File Manipulation - Storage classes - Pre-processor directives.

	Total Periods	45

Text Books:

1. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2017.
2. Balagurusamy E, "Programming in ANSI C", Tata Mcgraw-Hill Education, 2016
3. Reema Thareja, "Computer Fundamentals and Programming in C", 2e, Oxford University Press, 2016.

References:

1. Byron S Gottfried, "Programming with C", Schaum's Outlines, 3rd Edition, McGraw-Hill, 2017.
2. Dromey R.G., "How to Solve it by Computer", Pearson Education, 4th Reprint, 2007.
3. Kernighan.B.W and Ritchie,D.M, "The C Programming language", 2nd Edition, Pearson Education, 2006.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2											3			
CO2	3	2											3	3		
CO3	3	3	2	1						1				3		
CO4	3	2	1										2			
CO5	2	2	3	2										2		
CO6	2	2			1									2	2	
CO7	2	2	2	2	1									3		1

191ME17	MECHANICAL WORKSHOP			L-T-P	C
				1-0-3	2
Programme:	B.E./B.Tech. Common to all branches	**Sem:**	**I / II**	**Category:**	**ES**
Prerequisites:	Nil				
Aim:	To Provide exposure to the students with hands on experience on various basic Engineering Practices				

Course Outcomes:

The students will be able to

CO1. Make the square fitting, vee & step fitting

CO2. Produce simple wooden joints using wood working tools

CO3. Fabricate tray and funnel in sheet metal

CO4. Create simple lap, butt and tee joints using arc welding equipments

CO5. Identify the various pipe joints

CO6. Make the pipe connections

UNIT 1	**FITTING OPERATIONS & POWER TOOLS**	**12**

Preparation of square fitting, vee & step – fitting models

UNIT 1I	**CARPENTRY**	**12**

Study of the joints in roofs, doors, windows and furniture; Hands-on-exercise: Dismantling & Assembling of various wooden furniture; Preparation of T Joint, dove tail joint

UNIT 1II	**SHEET METAL FORMING**	**12**

Preparation of tray and funnel

UNIT 1V	**WELDING**	**12**

Preparation of arc welding of butt joints and lap joints

UNIT V	**PLUMBING**	**12**

Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings; Hands-on-exercise - basic pipe connections – Mixed pipe material connection – Connections with different joining components

	Total Periods:	**60**

LIST OF EQUIPMENTS (For a batch of 30 students)

1. Fitting vice (fitted to work bench) - 15Nos
2. Fitting Tools – 15 set
3. Carpentry vice (fitted to work bench) - 15 Nos.
4. Models of industrial trusses, door joints, furniture joints - 5 Nos.
5. Standard woodworking tools - 15 Sets
6. Hand Shear - 01
7. Standard tools and calipers for sheet metal work - 05
8. Arc welding transformer with cables and holders - 5Nos.
9. Welding booth - 5 Nos.
10. Welding accessories like welding shield, chipping hammer, Wire brush, etc., - 5Sets
11. Assorted components for plumbing consisting of metallic pipes, Plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings - 15 Sets.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	3				3				2			3
CO2	2	2	3	3	3				3				2			3
CO3	2	2	3	3	3				3				2			3
CO4	2	2	3	3									2			3
CO5	2	2	3	3									2			3
CO6	2	2	3	3	3				3							1

191HS17	PHYSICS AND CHEMISTRY LABORATORY-I				L-T-P	C
					0-0-2	1
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**I**	**Category:**	**BSC**	
Pre/Corequisites:	Engineering Physics & Engineering Chemistry					
AIM:	To introduce the basic Physics concepts through experiments and to impart the basic analysis in chemistry.					

Course Outcomes:

The Students will be able to

CO1: Understand the laser light propagation in optical fibre and the rigidity modulus of the materials
CO2: Understand the velocity of sound in liquid and propagation light in the medium
CO3: know about the stress analysis and thermal conductivity of the material
CO4: Gain knowledge of water quality parameter of potable water
CO5: Determine the unknown concentrations of chemicals
CO6: Apply the instrumental technique for calculating the amount of unknown substance

LIST OF EXPERIMENTS - PHYSICS PART (A minimum of five experiments shall be offered)		
S.No	**NAME OF THE EXPERIMENT**	
1)	(a) Determination of Particle Size using Diode LASER. (b) Determination of wavelength of the LASER source. (c) Determination of Acceptance angle and Numerical aperture of an optical fibre.	3
2)	Torsional pendulum – Determination of rigidity modulus	3
3)	Determination of Velocity of sound and compressibility of liquid - Ultrasonic Interferometer.	3
4)	Determination of Dispersive power of a prism using Spectrometer.	3
5)	Determination of Young's modulus of the material - Non uniform bending	3
6)	Determination of thermal conductivity of a bad conductor - Lee's Disc method	3

LIST OF EXPERIMENTS – CHEMISTRY PART		
S.No	**NAME OF THE EXPERIMENT**	
1)	Estimation of Total Hardness of their home town Water by EDTA method.	3
2)	Estimation of Alkalinity of Water sample	3
3)	Estimation of Chloride ion in water sample by Argentometric method.	3
4)	Estimation of Ferrous Ion by Potentiometric Titrations.	3
5)	Conductometric Titration of strong acid Vs strong base	3

References

1) Text book of Quantitative Inorganic Analysis, A.I.Vogel, ELBS,London,(2006)
2) "Practical A. Ravikrishnan Engineering Chemistry", Sri Krishna Publications, Chennai (2002)
3) Engineering Physics Laboratory Manual
4) Engineering Chemistry Laboratory Manual

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1		2		1					1	1	1		
CO2	1	2	2				1					1	1	1		
CO3	2	1	3		2		2					2	1	1		
CO4	2	1	3		2		2					2				
CO5	2	2	1		1		2					1				
CO6	3	2	1	2	2		1					2				

191CS27	C PROGRAMMING LABORATORY				L	T	P	C
					0	0	2	1
Programme:	B.E./B.Tech. Common to all Branches	**Sem:**	**1**	**Category:**			**ES**	
Prerequisites:								

Aim To provide practical knowledge in developing C Programming.

Course Objectives:

- Be familiar with the use of Office software.
- Be exposed to presentation and visualization tools.
- Gain knowledge of software types and development steps.
- Be familiar with programming in C.
- Learn to use Arrays, strings, functions, structures and unions.

Course Outcomes: The Students will be

CO1: Able to have fundamental concept on basics commands in Linux.
CO2: Able to write, compile and debug programs in C language.
CO3: Able to formulate problems and implement algorithms in C.
CO4: Able to effectively choose programming components that efficiently solve computing problems in real-world.
CO5: Able to design application-oriented programs in C.
CO6: Structures and unions through which derived data types can be formed.

LIST OF EXPERIMENTS:

1.	Draw a flowchart for various algorithms using Raptor
2.	C Programming using Simple statements and expressions.
3.	Scientific problem-solving using decision making and looping.
4.	Simple programming for one dimensional and two-dimensional arrays.
5.	Solving problems using String functions.
6.	Programs with user defined functions - Includes Parameter Passing.
7.	Program using Recursive Function and conversion from given program to flow chart.
8.	Programs using pointers
9.	Program using structures and unions.
10.	Program using files.
	Total Periods **60**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Standalone desktops with C compiler 30 Nos.

(or)

Server with C compiler supporting 30 terminals or more.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2						2				3	1	1	
CO2	3	2	2						2				3	2	2	
CO3	3	2	3						2				3	3	2	
CO4	2	3	2						2				3	2	2	2
CO5	3		2						2				3	2	1	
CO6	2		2										2	2	1	

191HS21	TECHNICAL ENGLISH			L-T-P	C
				2-0-0	2
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**II**	**Category:**	**HSMC**
Prerequisites:	Acquire Proficiency in Technical Communication				
Aim:	To develop the students' intellectual, personal & Professional abilities.				

Course Outcomes:

The Students will be able to
CO1: Remember words and its meanings for the specific purpose.
CO2: Understand the basic nuances of language
CO3: Apply written communication methodologies at workplace.
CO4: Develop Listening skill to respond and to gather information.
CO5: Interpret the text using comprehending skill.
CO6: Involve in professional correspondences confidently.

UNIT 1	INTRODUCTION TO TECHNICAL ENGLISH	6

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises. Speaking – Asking for and giving directions. Reading – reading short technical texts, Newspapers. Writing - Purpose statements, Extended definitions, Writing Instructions & Recommendations, Checklists. Vocabulary Development - Technical Vocabulary. Language Development – Subject Verb Agreement.

UNIT 1I	READING AND STUDY SKILLS	6

Listening - Listening to longer technical talks and completing exercises based on them. Speaking – Describing a process. Reading – Reading longer technical texts, Newspapers identifying various transitions in a text-paragraphing. Writing - Techniques for writing Precisely. Vocabulary Development -vocabulary used in formal letters/emails and reports. Language Development - Personal & Impersonal Passive voice, Numerical adjectives.

UNIT 1II	TECHNICAL WRITING AND GRAMMAR	6

Listening - Listening to classroom lectures on Engineering / Technology. Speaking – Introduction to Technical presentations. Reading – Reading longer texts both general and Technical, practice in rapid reading. Writing- Describing a process, Use of sequence words, Causes and Effects Vocabulary Development - Sequence words, Nominal compounds, Misspelled words. Language Development - Embedded sentences.

UNIT 1V	REPORT WRITING	6

Listening- Listening to documentaries and Making notes. Speaking – Mechanics of presentations. Reading – Reading for detailed comprehension. Writing - Job application, cover letter, Resume preparation. Vocabulary Development - Finding suitable synonyms, Paraphrasing. Language Development – Clauses, If conditionals.

UNIT V	GROUP DISCUSSION AND JOB APPLICATIONS	6

Listening - TED/Ink talks. Speaking – Participating in a Group discussion. Reading – Reading and Understanding Technical articles. Writing – Writing reports, Minutes of Meeting, Introduction and Conclusion. Vocabulary Development - Verbal analogies. Language Development - Reported speech.

	Total Periods:	**30**

Text books:

1. Sudharshana,N.P. and C.Savitha. English for Technical Communication. New Delhi: Oxford University Press, 2017.

References:

1. **www.bbc.co.uk/learning english**
2. **www.bec cambridge english.**org
3. **www.englishenglish101.com**
4. **www.islcollective.com**

Extensive Reading

1. Kalam, Abdul. *The Wings of Fire*. Hyderabad: UP, 1999. Print.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		2		3		1		2	3	3	3	3				
CO2						2		3	3	3	3	3				3
CO3		3		2	3	2	3	2	3	3	2	3				
CO4										2		3				
CO5									3	3	2	3				
CO6			2	2								3				

191HS22	DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS					L-T-P	C
						3-1-0	4
Programme:	**B.E. / B.Tech. (Common to all branches)**	**Sem:**	**II**		**Category:**		**BSC**
Prerequisites:	Calculus and Linear Algebra						
Aim:	To analyze the engineering problems using the techniques and the mathematical skills acquired by studying ODE and PDE uses numerical methods.						

Course Outcomes:

The students will be able to

CO1: Use suitable method to solve higher order Differential Equations

CO2: Use suitable method to solve higher order PDE

CO3: Interpolate discrete data by means of continuous function.

CO4: Discover Numerical integration using Trapezoidal and Simpson's 1/3rd rules

CO5: Find the solution for the IVPs in ODE using single step and Multistep methods

CO6: Find the solution of BVPs in PDE using finite difference methods

UNIT 1 ORDINARY DIFFERENTIAL EQUATIONS	**12**
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 1I PARTIAL DIFFERENTIAL EQUATIONS	**12**
Formation of partial differential equations – Lagrange's linear equation – Solutions of standard types of first order partial differential equations (without reducing the standard type) – Linear homogenous partial differential equations of second and higher order with constant coefficients.	
UNIT 1II SOLUTION OF EQUATION & INTERPOLATION, NUMERICAL DIFFERENTIATION	**12**
Solutions of Polynomial and transcendental equations – Newton Raphson method - Interpolation using Newton's forward and backward difference formulae - Interpolation with unequal intervals- Newton's divided difference and Lagrange's formulae - Numerical differentiation using Newton's forward and backward difference formula - Numerical Integration – Trapezoidal rule and Simpson's 1/3rd rule.	
UNIT 1V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS	**12**
Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge - Kutta method – Milne's predictor – corrector methods for solving first order equations – Finite difference methods for solving second order equation.	
UNIT V BOUNDARY VALUE PROBLEMS OF PARTIAL DIFFERENTIAL EQUATIONS	**12**
Finite differences solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations.	
Total Periods:	**60**

Text books:

1. B.S. Grewal, 'Higher Engineering Mathematics', Thirty Sixth Edition, Khanna Publishers, Delhi, 2005.
2. Grewal B.S. and Grewal J. S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2004).

References:

1. 2. Greenberg. *M.D*. "Advanced Engineering Mathematics, Second Edition, Pearson Education Inc., 2002
3. Venkataraman. M.K., "Engineering Mathematics", Volume I and II Revised enlarged Fourth Edition, The National Publishing Company, Chennai, 2004.
3. Kreyszig, E., Advanced Engineering Mathematics, 8th edition, John Wiley Sons, 2001.
4. Chapra S.C. and Canale R.P., "Numerical Methods for Engineers", Tata Mc-Graw Hill, New Delhi, 2007.
5. Gerald C.F., and Wheatley P.O., "Applied Numerical Analysis", Pearson Education Asia, New Delhi, (2006).

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3		3								3		2	1	
CO2	2	3		3								3				1
CO3	1	2		3								3	2			
CO4	1	1		1										2	2	
CO5	1	1										1				
CO6	2	2											2			2

191HS24	APPLIED MATERIALS SCIENCE			L-T-P	C
				2-0-0	2
Programme:	**B.E/B. Tech. (MECH, CIVIL & BIO-TECH)**	**Sem:**	**II**	**Category:**	**BSC**
Prerequisites:	Engineering Physics				
AIM:	To endow the students with the fundamentals of physics, materials and apply new ideas in the field of Engineering and Technology.				

Course Outcomes:

The Students will be able to

CO1: Understand the theory and processing of conducting, superconducting materials.
CO2: Acquire knowledge of polymer and ceramic materials.
CO3: Gain knowledge about composites materials and applications.
CO4: Enhance the knowledge new materials.
CO5: Understand about some exciting properties of nanomaterials
CO6: Know about Characterization Techniques of materials

UNIT 1	CONDUCTING MATERIALS	6

Conductors: classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – Draw backs of classical theory –Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals.
Super Conductors: properties - Types of super conductors - Applications of superconductors – SQUID, cryotron, magnetic levitation.

UNIT 1I	POLYMER AND CERAMIC MATERIALS	6

Polymers–Types of polymers–Thermal, Mechanical and Electrical Properties–Conducting Polymers, Bio-Polymers and High temperature polymers - applications
Ceramics–Properties and applications–ZrO_2, Al_2O_3, SiC,

UNIT 1II	COMPOSITE MATERIALS	6

Definition–function of matrix and reinforcement in composites–classification of composites based on reinforcement–types of composite materials–polymers, metallic and ceramic matrix composites. Law of mixtures. Comparison with conventional materials. Fabrication of metal matrix and ceramic matrix composites–properties and uses

UNIT 1V	NEW MATERIALS	6

Metallic glasses: Preparation, properties and applications. **Shape memory alloys (SMA):** Characteristics - Properties of NiTi alloy – Applications -Advantages and disadvantages of SMA. **Bio Materials :** Classification – Properties – Applications

UNIT V	NANO MATERIALS AND CHARACTERISATION TECHNIQUES	6

Nanomaterials: synthesis – chemical vapour deposition– ball milling - properties of nanoparticles and applications- Carbon nanotubes- types
Characterization: Principle, Characterization and applications of X- Ray diffraction – Scanning Electron Microscope – Transmission Electron Microscope.

	Total Periods	**30**

Text books:

1. William D. Callister, Jr., **"Material Science and Engineering",** John Wiley & Sons Inc., Seventh Edition, New Delhi (2017).
2. Ragavan, V., **"Material science and Engineering"**, Prentice Hall of India (2004).

References:

1. Koch C., **"Nanostructured materials: processing, properties and applications",** William Andrew Pub (2011).
2. Charles P. Poole and Frank J.Ownen., **"Introduction to Nanotechnology"**, Wiley India (2007)
3. Charles Kittel., **"Introduction to solid state Physics"**, John Wiley & Sons, 7th editions, Singapore (2012)
4. Kasap, S.O. **"Principles of Electronic Materials and Devices**", McGraw -Hill Education, 2016.
5. Umesh K Mishra & Jasprit Singh, "**Semiconductor Device Physics and Design**", Springer,2014.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	1		1					1	1	1	1	1
CO2	3	1	2	1	1		1					1	1	1	1	1
CO3	3	1	1	2	1		1					1	1	1	1	1
CO4	3	2	2	2	2		2					1	1	1	1	1
CO5	3	2	2	3	2		1					2	1	1	1	2
CO6	3	2	2	1	2		1					2	2	1	1	2

191HS25	ENVIRONMENTAL SCIENCE			L-T-P	C
				2-0-0	2
Programme:	**B.E. / B.Tech. (Common to all branches)**	**Sem:**	II	**Category:**	BSC
Prerequisites:	Basic Science				
Aim:	To Impart the social groups and individuals to acquire knowledge of pollution and environmental degradation				

Course Outcomes:

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

CO1: Understand the basic concepts of environment and energy resources

CO2: Get knowledge about the ecosystem

CO3: Identify and analyze causes, effects and control measures of various types of pollution.

CO4: Get the knowledge about types of disaster and mitigation measures

CO5: Understand the impact of social issues and climate change

CO6: Understand to create the green environment.

UNIT 1	**ENVIRONMENT AND ENERGY RESOURCES**	**6**
Environment- definition, scope and importance – Need for public awareness – Forest resources-deforestation– Energy resources: Growing energy needs, renewable (solar energy and wind energy) and non-renewable energy sources- Nuclear energy – fission and fusion reactions and light water nuclear reactor for power generation (block diagram only), Petroleum processing and fractions		
UNIT 1I	**ECOSYSTEM**	**6**
Concept of an ecosystem – Structure and function of an ecosystem: Producers, consumers and decomposers, Energy flow in the ecosystem-Nitrogen cycle, Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the Forest ecosystem and Aquatic ecosystems (lake and rivers)		
UNIT 1II	**ENVIRONMENTAL POLLUTION**	**6**
Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Marine pollution (d) Noise pollution. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution –Disaster management: floods- landslides.		
UNIT 1V	**SOCIAL ISSUES AND EARTH'S CLIMATE SYSTEM**	**6**
Population-variation among nation-Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting– climate change, global warming, acid rain, Ozone layer depletion.		
UNIT V	**GREEN CHEMISTRY**	**6**
Introduction to green chemistry- 12 principles of green chemistry-toxicology and green chemistry- energy and green chemistry-education in green chemistry. Reuse and recycling technologies-material selection for green design- recycled water technology.		
	Total Periods:	**30**

Text books:

1. A. Ravikrishnan, "Environmental Science and Engineering, Sri Krishna Hitech Publishing Company Private Limited, 2010.
2. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.

References:

1. Anubha Kaushik, C.P. Kaushik, "Environmental Science and Engineering", New Age International Publishers, 2016.
2. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill Publishing Company Ltd, New Delhi, ISBN: 0070601690, 2006.
3. Raman Sivakumar, *Introduction to Environmental Science and Engineering,* Tata McGraw Hill Education Private Limited, New Del2010.
4. P.Meenakshi, Elements of Environmental Science and Engineering, PHI learning (P) Ltd., India.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	1			1		2		1	2	2		
CO2		2	1	1			1	1	1	2	1	1	2	2		
CO3	2	1		2				1		1		1	3	3		3
CO4	1	2	1		2							1	1			
CO5	2	3	2		2			2		2	1	2	2			2
CO6	3	2	3		2			2		2	1	3	3	2		3

191EE11	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING			L-T-P	C
				3-0-0	3
Programme:	**B.E., (CIVIL, MECH, BIO-TECH)**	**Sem:**	**II**	**Category:**	**ES**
Prerequisites:	Algebra, calculus and electrostatics				
Aim:	To provide comprehensive idea about AC and D C circuit analysis, working principles and applications of basic machines in electrical engineering and protection schemes in power system.				

Course Outcomes:

The Students will be able to

CO1: Analyze DC circuits using basic laws.
CO2: Analyze AC circuits using basic laws.
CO3: Understand the operation of DC machines and its applications.
CO4: Demonstrate about AC machines and its applications.
CO5: Know the construction, working and characteristics of the semiconductor devices.
CO6: Design basic combinational and sequential logic circuits.

UNIT 1	ELECTRICAL CIRCUITS	9
Ohm's Law – Kirchhoff's Laws –Reduction of series and parallel circuits-Mesh and Nodal Analysis of DC circuits – Introduction to AC Circuits - RMS Value, Average value, Form factor and peak factor phasor representation – Single Phase AC series circuits with R, RL, RC - Power and Power factor. Introduction to three phase circuits- Star and delta connected balanced load.		
UNIT 1I	**DC MACHINES & TRANSFORMER**	**9**
DC Generators - construction, principle of operation, Types, EMF equations and applications. DC Motors - operation, Types, Speed and torque equation – speed control of DC shunt motors. Single Phase Transformer - Constructional details and operation, Types, EMF equation, transformation ratio.		
UNIT 1II	**AC MACHINES**	**9**
Single phase induction motor - construction, operation and applications, Three phase induction motor – Types, Construction and operation, Torque equation, slip torque characteristics, Synchronous generators - construction and operation, EMF equation - Synchronous motors – principle of operation.		
UNIT 1V	**SEMICONDUCTOR DEVICES**	**9**
Introduction to semiconductors-PN Junction Diode – characteristics, breakdown effect and applications - Half wave and Full wave rectifiers, Zener Diode - characteristics and voltage regulator. Bipolar Junction Transistor – operation of NPN and PNP, characteristics of CB, CE, CC configurations.		
UNIT V	**DIGITAL ELECTRONICS**	**9**
Number System – Binary, octal, hexadecimal, Logic Gates, Half and Full Adders – Flip-Flops –RS, JK, T and D - Counters – synchronous up counter, synchronous down counter, asynchronous up counter, asynchronous down counter, shift registers – shift right and shift left register		
	Total Periods	**45**

Text books:

1. Muthusubramanian R, Salivahanan S, "Basic Electrical, Electronics and Computer Engineering", McGraw Hill, New Delhi, 2009.
2. B L Theraja, AK Theraja,'A Text book of Electrical Technology: Volume 2 AC and DC Machines', S.Chand; Twenty Third edition, 2006.

References:

1. V N Mittle, Arvind Mittle "Basic Electrical Engineering", McGraw Hill, New Delhi, 2005.
2. Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford University press (2012).
3. V K Mehta, Rohitmehta "Principles of Electronics", S.Chand& Company Ltd, (2015).
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, (2014).
5. R.S. Sedha, "A Textbook of Applied Electronics" S. Chand & Co., 2008.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	1							3	2		
CO2	2	2		2		2								1	2	3
CO3	2	2		2									2		2	
CO4	2	2	3		1											2
CO5	2	2	3		1											2

191HS27	PHYSICS AND CHEMISTRY LABORATORY-II			L-T-P	C
				0-0-2	1
Programme:	B.E/B.Tech (Common to all Branches)	**Sem:**	**II**	**Category:**	**BSC**
Prerequisites:	Engineering Physics & Engineering Chemistry				
AIM:	To introduce the basic Physics concepts through experiments and to impart knowledge on the application of chemistry in engineering branches.				

Course Outcomes:

The Students will be able to

CO1: Learn the interference of light and young's modulus of the materials

CO2: Understand the properties of flow of the liquid.

CO3: Know the band gap of material and resistance of the given coil.

CO4: Determine the quantity of unknown solution by instrumental technique.

CO5: Determine the concentration of an identified analyte by volumetric analysis

CO6: Analyze the characteristics of water.

LIST OF EXPERIMENTS - PHYSICS PART (A minimum of five experiments shall be offered)		
S.No	**NAME OF THE EXPERIMENT**	
1)	Determination of thickness of thin wire – Air wedge method	3
2)	Determination of Young's modulus of the material – Uniform bending	3
3)	Determination of viscosity of liquid – Poiseuille's method.	3
4)	Determination of wavelength of mercury spectrum- Spectrometer Grating.	3
5)	Determination of Band Gap of a semiconductor material.	3
6)	Determination of specific resistance of a given coil of wire – Carey Foster Bridge.	3

LIST OF EXPERIMENTS – CHEMISTRY PART		
S.No	**NAME OF THE EXPERIMENT**	
1)	Estimation of HCl by pH metry	3
2)	Estimation of Copper in brass by EDTA method.	3
3)	Estimation of iodine in iodized salt with thiosulfate	3
4)	Determination of percentage of calcium in limestone by EDTA method	3
5)	Determination of DO in water (Winkler's method)	3

191EE17	ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY			L-T-P	C
				0-0-4	1
Programme:	B.E. Electrical and Electronics Engineering	**Sem:**	**II**	**Category:**	**ES**
AIM:	To expose the students to basic laws, characteristics of diodes and operation of D.C. machines and transformers and give them experimental skill.				

Course Outcomes:

The Students will be able to

CO1. Apply the circuit theory concepts and analyze the outcome.

CO2. Examine the characteristics of diodes.

CO3. Analyse characteristics of transistor.

CO4. Explain the operation of rectifiers.

CO5. Obtain various characteristics of DC Machines.

CO6. Obtain various characteristics of AC Machines.

LIST OF EXPERIMENTS

1. Verification of Ohms law
2. Verification of Kirchhoff's voltage and current laws
3. V – I characteristics of P-N Junction Diode and Zener Diode
4. Input and Output characteristics of CE configuration of NPN transistor
5. Half wave Rectifier
6. Full wave Rectifier
7. Speed Control of D.C. Shunt Motor
8. Load Test on Single phase transformer
9. Load Test on three phase squirrel cage induction motor
10. Open Circuit characteristic of an Alternator

Total Periods	**45**

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2		2					2				2	3	3	3
CO2		2	3	2					2					2		3
CO3	2	2		2					2				2	3	3	
CO4	2	2		2					2				1	2	3	
CO5	1	2		2					2				1	2	3	
CO6		2	3	2					2					2		3

191HS31	TRANSFORMS AND DISCRETE MATHEMATICS				L-T-P	C
					3-0-0	3
Programme:	**B.E. / B.Tech. (Common to all branches)**	**Sem:**	**III**	**Category:**	**BSC**	
Aim:	To introduce basic mathematical ideas such as reasoning techniques, basic counting techniques and their applications.					

Course Outcomes:

The students will be able to

CO1: Apply Laplace transform to solve first and second order differential equations with elementary function.

CO2: Explain the Fourier transform and with their properties.

CO3: Determine Z-inverse transform using convolution theorem and partial fraction method.

CO4: Apply mathematical induction and prove a relation.

CO5: Invent Eulerian and Hamiltonian paths to find shortest paths

CO6: Make use of graph theoretic models to solve basic problems in networks.

UNIT 1	LAPLACE TRANSFORMS	9
Laplace transform —Properties of Laplace Transforms – Laplace Transform of periodic functions –Inverse Laplace transforms by partial fraction method and Convolution theorem (excluding proof) – Solving ODE using Laplace transformation techniques.		
UNIT 1I	**FOURIER TRANSFORMS**	**9**
Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.		
UNIT 1II	**Z-TRANSFORMS**	**9**
Z-transforms – Elementary properties – Inverse Z-transform – Convolution theorem – Formation of difference equations – Solution of difference equations using Z-transform.		
UNIT 1V	**INTRODUCTION TO COUNTING**	**9**
Decision problems on Propositional logic – Basic counting techniques – inclusion & exclusion- Pigeonhole principle –Permutations and combinations-Recurrence relations-Solving Linear recurrence relations and generating functions		
UNIT V	**INTRODUCTION TO GRAPHS**	**9**
Graphs and their basic properties – Graph terminology and special types of graphs - Representing graphs and graph isomorphism – Euler and Hamilton paths.		
	Total Periods:	**45**

Text Book

1. B.S. Grewal, 'Higher Engineering Mathematics', Thirty Sixth Edition, Khanna Publishers, Delhi, 2005.
2. Grewal B.S. and Grewal J. S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2004).

Reference

1. Greenberg. *M.D*. "Advanced Engineering Mathematics, Second Edition, Pearson Education Inc. (First Indian reprint), 2002
2. Venkataraman. M.K., "Engineering Mathematics", Volume I and II Revised enlarged Fourth Edition, The National Publishing Company, Chennai, 2004.
3. Trembly J. P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw–Hill Pub. Co. Ltd, NewDelhi, 30thRe-print (2007).
4. Dr.P.Kandasamy,Dr.K.Thilagavathy,Dr.K.Gunavathy, **"**Transforms and Partial Differential Equation", S.Chand & Company Ltd. Ram Nagar,New Delhi.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2		2					2				2	3	3	3
CO2		2	3	2					2					2		3
CO3	2	2		2					2				2	3	3	
CO4	2	2		2					2				1	2	3	
CO5	1	2		2					2				1	2	3	
CO6		2	3	2					2					2		3

191BT31	BIOLOGY FOR ENGINEERS				L-T-P	C
					3-0-0	3
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**3**	**Category:**		**BSC**
Prerequisites:	Basic science					
Aim:	To understand basic and fundamental engineering knowledge from biology.					

Course Outcomes:

The Students will be able to

CO1: Understand various biochemical interactions and the structure and function of various biological molecules

CO2: Explain basic concepts of thermodynamics and energy transactions.

CO3: Discuss different aspects of molecular computing

CO4: Demonstrate an understanding of Mendelian laws of inheritance.

CO5: Describe cellular architecture and utilize these concepts to design an engineering system.

CO6: Understand fundamental concepts in sensory physiology analogy with communication systems.

I UNIT 1	**NTRODUCTION.**	**9**

Biological analogy in engineering science, Biological elements-Carbohydrate, protein, amino acids, lipids and nucleic acids structure and function. Primary, secondary, tertiary and quaternary structure of protein. Protein as enzymes, transporter, receptors and structural elements.

UNIT 1I	**METABOLISM AND ENGINEERING**	**9**

Engineering aspects in thermodynamics of energy transactions, exothermic and endothermic versus endergonic and exergonic reactions. ATP as an energy source, glycolysis, Krebs cycle and photosynthesis. Energy yielding and energy consuming reactions. Enzymes classification, mechanism of enzyme action, enzyme kinetics and kinetic parameters

UNIT 1II	**GENETICS AND TRANSFORMATION TECHNOLOGY**	**9**

Molecular basis of information transfer. DNA as a genetic material. Concept of genetic code. Mendal's laws, concept of segregation and independent assortment. Concept of allele, Gene mapping, Gene interaction, Epistasis, concepts of recessiveness and dominance and their relativeness to programming. Cell multiplication. Phenotype and genotype. Single gene disorders in humans and human genetics.

UNIT 1V	**CLASSIFICATION AND SYSTEM ENGINEERING**	**9**

Structure, function and relativeness to engineering of prokaryotes and eukaryotes. Habitats- aquatic or terrestrial. Molecular taxonomy-three major kingdoms. Microbial species and strains. Identification and classification of microorganisms. Industrial application of microorganisms. Sterilization and media compositions. Growth kinetics.

UNIT V	**SENSOR BIOLOGY AND COMMUNICATION SYSTEMS**	**9**

Sensory system, circulatory system and excretory system and their relativeness to communication engineering. Hormonal regulation. General defense mechanism in human. Major human disorder and diseases.

	Total Periods:	**45**

Text Book

1. Arthur T. Johnson, "*Biology for Engineers"*, CRC Press, New York2011
2. Thyagarajan.S. et.al., "*Biology for Engineers"*, Tata McGraw-Hill, New Delhi, 2012

References

1. Rajiv Singal, Gaurav Agarwal, Ritu Bir, Biology for Engineers, CBS Publisher,2019
2. Raven Johnson, Biology, 11th Edition, Mc Graw Hill Publication, 2017
3. Charles Molnar.et.al. Concepts of Biology-1st Canadian Edition, Opens tax Publication,2013

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2		2					2				2	3	3	3
CO2		2	3	2					2					2		3
CO3	2	2		2					2				2	3	3	
CO4	2	2		2					2				1	2	3	
CO5	1	2		2					2				1	2	3	
CO6		2	3	2					2					2		3

191ME31	ENGINEERING MECHANICS			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**III**	**Category:**	**ES**
Prerequisites:	Engineering Physics				
Aim:	To impart a sound knowledge on the applied physics laws in different engineering applications				

Course Outcomes:

The students will be able to

CO1. Recite the laws of forces and principle of transmissibility

CO2. Describe the types of supports and equilibrium of rigid bodies in three dimensions

CO3. Explain the parallel axis theorem and perpendicular axis theorem

CO4. Determine moment of inertia and polar moment of inertia of various sections

CO5. Solve the displacement, velocity and acceleration problems and their relationship with work energy equation of particles

CO6. Explain the various Frictional forces and general plane motion of rigid bodies

UNIT 1	**BASICS & STATICS OF PARTICLES**	**9**

Introduction – Units and Dimensions – Laws of Mechanics – Lame's theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force

UNIT 1I	**EQUILIBRIUM OF RIGID BODIES**	**9**

Free body diagram – Types of supports and their reactions – requirements of 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 – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT 1II	**PROPERTIES OF SURFACES AND SOLIDS**	**9**

Determination of Areas and Volumes – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, - Angle section, Hollow section by using standard formula – second and product moments of plane area –Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia - Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

UNIT IV	**DYNAMICS OF PARTICLES**	**9**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's law – Work Energy Equation of particles

UNIT V	**FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS**	**9**

Frictional force – Laws of Coloumb friction – simple contact friction – Rolling resistance – Belt friction. Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion

	Total Periods:	**45**

Text books

1. Beer F.P. and Johnson Jr. E.R., "Vector Mechanics for Engineers", Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, (2012)
2. Palanichamy M.S., Nagam S., "Engineering Mechanics–Statics & Dynamics", Tata McGraw-Hill, (2004)

References

1. Hibbeller R.C., "Engineering Mechanics", Pearson Education Asia Pvt. Ltd., (2010)
2. Irving H. Shames, "Engineering Mechanics – Statics and Dynamics", Pearson Education Asia Pvt. Ltd., (2006)
3. Kottiswaran N., "Engineering Mechanics Statics & Dynamics", Balaji Publications (2016)
4. Rajasekaran S., Sankarasubramanian G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd., (2009)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2		2					2				2	3	3	3
CO2		2	3	2					2					2		3
CO3	2	2		2					2				2	3	3	
CO4	2	2		2					2				1	2	3	
CO5	1	2		2					2				1	2	3	
CO6		2	3	2					2					2		3

191ME32	ENGINEERING THERMODYNAMICS				L-T-P	C
					3-1-0	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**III**	**Category:**	**PC**	
Prerequisites:	Engineering Physics					
Aim:	To learn the basic concepts of Thermodynamics and its application					

Course Outcomes:

The students will be able to

CO1. Describe the thermodynamics basic principles and different processes

CO2. Explain the laws of thermodynamics

CO3. Introduce the engines, refrigeration and air conditioning concepts

CO4. Ensure the working principle of Steam power cycles

CO5. Realize the ideal, real gases concepts and thermodynamic relations

CO6. Explain the principles of psychrometric processes and cooling load calculation in Air conditioner

UNIT 1	**BASIC CONCEPT AND FIRST LAW OF THERMODYNAMICS**	**12**

Basic concepts – concept of continuum, macroscopic approach, Thermodynamic systems – closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics – concept of temperature and heat. Concept of ideal and real gases. First law of thermodynamics – application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipments

UNIT 1I	**SECOND LAW AND THIRD LAW OF THERMODYNAMICS**	**12**

Second law of thermodynamics – Kelvin's and Clausius statements of second law. Reversibility and irreversibility – Carnot theorem, Carnot cycle, reversed carnot cycle, efficiency, COP – Thermodynamic temperature scale, Clausius inequality, Third law of thermodynamics – change of entropy for solids, liquids and gases. Exergy and Anergy: Available (Exergy) and Unavailable energy (Anergy) - Irreversibility

UNIT 1II	**PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE**	**12**

Properties of pure substances – Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam. Estimation of workdone and heat transfer in non-flow and flow processes – Standard Rankine cycle, Reheat and regenerative cycle

UNIT 1V	**IDEAL AND REAL GASES AND THERMODYNAMIC RELATIONS**	**12**

Gas mixtures – properties ideal and real gases, equation state, Avagadro's Law, Vander Waal's equation of state, compressability factor, compressability chart – Dalton's law of partial pressure, exact differentials, T-D relations, Maxwell's relations, Clausius Clapeyron equations, Joule – Thomson coefficient

UNIT V	**PSYCHROMETRY**	**12**

Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric process – Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling

Total Periods: 60

Text Books

1. Cengel, "Thermodynamics–An Engineering Approach", Tata McGraw Hill, New Delhi (2015)
2. Nag P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, (2017)

References

1. Ganesan V., "Thermodynamics – Basic and Applied", Tata McGraw Hill, New Delhi, (2018)
2. Khurmi R.S., "Steam Tables", S.Chand publication, New Delhi (2014)
3. Natarajan E., "Engineering Thermodynamics", Anugraham Publication, (2015)
4. Gupta S.K., "Engineering Thermodynamics", S. Chand Publishers, New Delhi, (2019)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3		1						2			3	2		
CO2	3	3		1						2			3			
CO3	3	3	2	3	2		2					2	3	3		2
CO4	2	2		3	2	1	1							2		1
CO5	3	3	1	2									2			
CO6	3	3	2	1	1							1		2		1

191ME33	ENGINEERING METROLOGY AND MEASUREMENTS				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**III**	**Category:**	**PC**	
Prerequisites:	Nil					
Aim:	To understand the principles, methods and applications of measurements					

Course Outcomes:

The students will be able to

CO1. Understand the basic concepts of measurements

CO2. Classify various linear, angular measuring equipments

CO3. Compare the working principles of various form measuring equipments

CO4. Explain the applications of laser in measurements

CO5. Describe the uses of coordinate measuring instruments and computer aided inspection

CO6. Analyze the methods of measuring power, torque, flow and temperature

UNIT 1	**INTRODUCTION**	**9**

General concept – generalized measurement system – units and standards – measuring instruments – sensitivity, stability, range, accuracy and precision – static and dynamic response – repeatability – systematic and random errors – correction, calibration – Introduction to Dimensional and Geometric Tolerance – interchangeability

UNIT 1I	**LINEAR MEASUREMENT**	**9**

Definition of metrology – Linear measuring instruments – Vernier caliper, micrometer, Slip gauges and classification – Tool Makers Microscope – interferometry – optical flats – Comparators – limit gauges – Mechanical, pneumatic and electrical comparators, applications –

UNIT 1II	**ANGULAR AND FORM MEASUREMENT**	**9**

Angular measurements – Sine bar, Sine center, bevel protractor and Angle Dekkor - Measurement of screw threads – Thread gauges, floating carriage micrometer – measurement of gear tooth thickness – constant chord and base tangent method – Gleason gear testing machine – radius measurements – surface finish – equipment and parameters, straightness, flatness and roundness measurements

UNIT 1V	**MEASUREMENT OF MECHANICAL PARAMETERS**	**9**

Force, torque, power – Mechanical, pneumatic, hydraulic and electrical type – Pressure measurement — Temperature – bimetallic strip, thermocouples, pyrometer, electrical resistance thermometers and thermistor

UNIT V	**ADVANCES IN METROLOGY**	**9**

Precision instruments based on laser – Principles – laser interferometer – application in measurements and machine tool metrology – Coordinate measuring machine – need, construction, types, applications – Computer aided inspection

	Total Periods:	**45**

Text Books

1. Jain R.K., **"Engineering Metrology",** Khanna Publishers, (2012)
2. Gupta S.C, **"Engineering Metrology",** Dhanpat rai Publications, (2013)

References

1. Beckwith, Marangoni, Lienhard, **"Mechanical Measurements",** Pearson Education, (2010)
2. Bewoor A.K. and Kulkarni V.A., **"Metrology and Measurements",** Tata McGraw-Hill, (2009)
3. Jayal A.K., **"Instrumentation and Mechanical Measurements",** Galgotia Publications, (2011)
4. Alan S. Morris, **"The Essence of Measurement",** Prentice Hall of India, (2007)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1		3				2			3				3
CO2	2	2	2		2											3
CO3	2	2	1		1				3			2				3
CO4	2	2	2		2											3
CO5	2	2	2		2											3
CO6	2	2	2		2				3							2

191ME34	MANUFACTURING PROCESSES			L-T-P	C
				3-0-2	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**III**	**Category:**	**PC**
Prerequisites:	Nil				
Aim:	To introduce the basic concepts and methods of the production / fabrication of a component				

Course Outcomes:

The students will be able to

CO1. Do sand moulding and casting

CO2. Perform the various types of joining processes used in engineering industries

CO3. Recall the latest welding techniques

CO4. Differentiate between the hot working and cold working process of metals

CO5. Fabricate the various products using sheet metal operations

CO6. Explain different moulding methods of plastics

THEORY

UNIT 1	**METAL CASTING PROCESSES**	**9**

Patterns – Types – Patterns & materials – Pattern allowances – Types of Moulding sand – Properties – Core making – Methods of Sand testing – Steps involved in making a green sand mould - Moulding machines – Types of moulding machines – Melting furnaces – Procedural steps and applications of Permanent mould casting processes – Shell, investment casting , Ceramic mould casting.– Pressure die casting – Centrifugal casting – CO_2 process – Casting defects – Inspection methods

UNIT 1I	**JOINING PROCESSES**	**9**

Fusion welding processes – Types of Gas welding – Equipments used – Flame characteristics – Arc welding equipments – Electrodes – Principles of Resistance, Spot/butt, seam, Percusion, Gas metal arc welding – Gas Tungsten Arc welding – Submerged arc welding – Electro slag welding – Plasma arc welding – Thermit welding – Electron beam welding – Friction welding – Diffusion welding – Weld defects – Brazing and soldering process – Filler materials and fluxes

UNIT 1II	**BULK DEFORMATION PROCESSES**	**9**

Hot working and cold working of metals – Forging processes – Open and closed die forging – Types of Forging Machines – Typical forging operations – Rolling of metals – Types of Rolling mills – Flat strip rolling – Shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing – Tube drawing — Principles of Extrusion – Types of Extrusion – Hot and Cold extrusion

UNIT 1V	**SHEET METAL PROCESSES**	**9**

Sheet metal characteristics – Typical shearing operations, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods – Working principle and application of special forming processes – Hydro, Rubber pad, Explosive, Magnetic pulse, Peen, and Super plastic forming – Metal spinning

UNIT V	**MANUFACTURING OF PLASTIC COMPONENTS**	**9**

Plastics, general properties and applications of thermo plastics and thermosets. - Characteristics of the forming and shaping processes - Moulding of Thermoplastics – Working principles and typical applications of – Injection moulding – Plunger and screw machines – Compression, Transfer, Blow, Rotational moulding – Film blowing – Extrusion – Thermoforming – Typical industrial applications.

	Total Periods:	**45**

Text books

1. Sharma P.C., **"A text book of Production Technology",** S. Chand and company, (2014)
2. Hajra Choudhury, **"Elements of Workshop Technology",** Vol. I, Media Promotors, Mumbai, (2015)

References

1. Magendran Parashar B.S. & Mittal R.K., **"Elements of Manufacturing Processes",** Prentice Hall of India, (2003)
2. Gowri S., Hariharan, Pand Suresh Babu A., **"Manufacturing Technology-I",** Pearson Education, (2008)
3. Rao P.N., **"Manufacturing Technology",** Tata McGraw-Hill Publishing Limited, (2009)
4. Begman **"Manufacturing Process",** John Wiley & Sons, (2005)

PRACTICAL

LIST OF EXPERIMENTS

PREPARATION OF SAND MOULD

Mould with solid, split patterns

Mould with loose-piece pattern

Mould with Core

WELDING EXERCISES

Demonstration on Horizontal, Vertical and Overhead welding

Hands on exercise: Vee joint, L-joint and Tee joint

Demonstration on Gas Cutting, Gas Welding and Brazing

SMITHY EXERCISES

Round to square

Hands on exercise: 'U' clamp

LIST OF EQUIPMENTS

(For a batch of 30 students)

1. **Sand moulding Facility**
   - Moulding Table — 05
   - Moulding boxes, tools and patterns — 05 sets
2. **Welding**
   - Arc welding machine — 04
   - Gas welding machine — 01
   - Brazing machine — 01
3. **Smithy**
   - Hearth furnace — 01
   - Anvil — 01
   - Smithy tools — 01 Set

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1		3				2			3				3
CO2	2	2	2		2											3
CO3	2	2	1		1				3			2				3
CO4	2	2	2		2											3
CO5	2	2	2		2											3
CO6	2	2	2		2				3							2

191ME37	METROLOGY AND MEASUREMENTS LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E. Mechanical Engineering	**Sem:**	**III**	**Category:**	**PC**
Prerequisites:	Nil				
Aim:	To learn the methods of handling different measuring instruments				

Course Outcomes:

The students will be able to

CO1. Calibrate linear and angular measurement

CO2. Check straightness, flatness using dial gauge

CO3. Measure screw and gear parameters

CO4. Handle vibration and displacement measuring instrument

CO5. Use the force and torque measuring tools

CO6. Learn different temperature measuring techniques

LIST OF EXPERIMENTS

1. Calibration of Vernier, Micrometer and Dial Gauge
2. Measurements using linear measurement tools – Vernier, Inside Micrometer, Depth gauge, Height Gauge (Checking Dimensions of part using slip gauges)
3. Measurements of Gear Tooth dimensions
4. Measurement of Angle using sine bar, sine center and tool maker's microscope
5. Measurement of straightness and flatness
6. Measurement of thread parameters
7. Inspection using Mechanical comparators
8. Measurement of Temperature using Thermocouple
9. Measurement of Displacement
10. Measurement of Force Measurement of Torque Measurement of Vibration / Shock

Total Periods: 45

LIST OF EQUIPMENTS (For a batch of 30 students)

1. Micrometer - 5 Nos.
2. Vernier Caliper - 5 Nos.
3. Vernier Height Gauge - 2 Nos.
4. Vernier Depth Gauge - 2 Nos.
5. Slip Gauge Set - 1 No.
6. Gear Tooth Vernier - 1 No.
7. Sine Bar - 2 Nos.
8. Bevel Protractor - 1 No.
9. Floating Carriage Micrometer - 1 No.
10. Profile Projector - 1 No.
11. Mechanical Comparator - 1 No.
12. Temperature Measuring Setup - 1 No.
13. Displacement Measuring Setup - 1 No.
14. Force Measuring Setup - 1 No.
15. Torque Measuring Setup - 1 No.
16. Vibration / Shock Measuring Setup - 1 No.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3												3			
CO2	2	1	3		2				1			1	3		1	1
CO3	2								1				3			1
CO4	1								1			1	2			
CO5	1								1			1	2			
CO6	2	1		2	2				1				3		2	1

191ME38	COMPUTER AIDED DRAFTING LABORATORY				L-T-P	C
					0-0-2	1
Programme:	B.E. Mechanical Engineering	**Sem:**	**III**	**Category:**	**ES**	
Prerequisites:	Engineering Graphics					
Aim:	To gain more knowledge in 2D & 3D drawings by using relevant software					

Course Outcomes:

The students will be able to

CO1. Demonstrate the fundamentals of drafting techniques
CO2. Outline the basic shapes and modeling
CO3. Understand the drawing from different perspective
CO4. Convert Isometric to orthographic projections & from orthographic to isometric of simple objects
CO5. Draw simple 3D models using extrude and revolve
CO6. Assemble machine elements

Drawing Standards

Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys and fasteners – Selection of standard components like bolts, nuts, screws, keys etc. with the help of design data book

2-D Drawings

Limits, Fits – Tolerance of individual dimensions – Specification of Fits – Preparation of production drawings and reading of part and assembly drawings.

Basic commands used in Drafting Packages

Drawing, Editing, Plotting, Layering Concepts, Hatching, Detailing, Assembly, Solids, Rendering, Shading, basic principles of GD&T (geometric dimensioning & tolerance), Preparation of Bill of materials.

List of Exercises

- Drawing of curves like parabola, spiral, involute of square and circle
- Drawing of front view and top view of simple solids like bolt & Nut, welded joints
- Drawing sectional views of simple machine elements
- Drawing of Orthographic view from Isometric view
- Drawing of Isometric view from Orthographic view
- Drawing of simple 3D objects using Extrude and Revolve command
- Assembly drawing – Sleeve and Cotter joint
- Assembly drawing – Knuckle joint
- Assembly drawing – Flange Coupling
- Assembly drawing – Universal Coupling

NOTE: Practical examination duration is Three hours. Students will carry out one exercise in assembly drawing and one exercise in simple objects.

SYSTEM REQUIREMENTS (For a batch of 30 Students)

Hardware:

1. Intel i3 core due processor with 4GB ram with 500GB hard disk – 30 Nos.
2. Laser Printer – 1 No.

Software:

1. Drafting package – AutoCAD – Adequate license (Open source)

Total Periods: 45

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1		1				2			3			3	3
CO2	3	2	1		1				2			2			3	3
CO3	3	2	1		1				3			2			3	3
CO4	3	2	2		2				3	2		2			3	3
CO5	3	3	2		2				3	2		3			3	3
CO6	3	3	2		2				3	2		3			3	3

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

191HS42	PROBABILITY AND STATISTICS			L-T-P	C
				2-1-0	3
Programme:	**B.E. / B.Tech. (CIVIL, CSE, EEE, MECH, BIO-TECH & BIO-MEDICAL)**	**Sem:**	**IV**	**Category:**	**BSC**
Prerequisites:					
Aim:	To analyze the engineering problems using the techniques and the mathematical skills acquired by studying ODE and PDE uses numerical methods.				

Course Outcomes:

The students will be able to

CO1: Classify the discrete and continuous random variables.

CO2: Analyze the binomial, Poisson, geometric, uniform, exponential and normal distribution.

CO3: Understanding the Two-Dimensional Random Variables.

CO4: Analyze the differences between means & standard deviations

CO5: Test the independence of attributes for small samples

CO6: Classify the tests for single variance and equality of variances

UNIT 1	PROBABILITY AND RANDOM VARIABLES	9

Probability spaces – Conditional probability – Bayes rule - Discrete and continuous random variables – Moments - Moment generating functions and their properties.

UNIT 1I	DISCRETE AND CONTINOUS PROBABILITY DISTRIBUTION	9

Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and normal distributions – Function of Random Variable

UNIT 1II	TWO DIMENSIONAL RANDOM VARIBLES	9

Joint distributions - Marginal and conditional distributions – Covariance - Correlation and Regression - Transformation of random variables - Central limit theorem (for 2-D random variables)

UNIT 1V	STATISTICS	9

Curve fitting by the method of least squares – fitting of Straight lines, Second degree parabolas and more general curves – Test of significance – Large sample test for single proportion, difference of proportions, single mean, difference of means and difference of standard deviations.

UNIT V	TESTING OF HYPOTHESIS	9

Sampling distributions – Testing of hypothesis for mean, variance, proportions and differences using Normal, t, Chi-square and F distributions - Tests for independence of attributes and Goodness of fit.

	Total Periods:	**45**

Text Book

1. B.S. Grewal, 'Higher Engineering Mathematics', Thirty Sixth Edition, Khanna Publishers, Delhi, 2005.
2. Grewal B.S. and Grewal J. S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2004).

Reference

1. Greenberg. *M.D*. "Advanced Engineering Mathematics, Second Edition, Pearson Education Inc. (First Indian reprint), 2002
2. Venkataraman. M.K., "Engineering Mathematics", Volume I and II Revised enlarged Fourth Edition, The National Publishing Company, Chennai, 2004.
3. Kreyszig, E., Advanced Engineering Mathematics, 8th edition, John Wiley Sons, 2001.
4. Chapra S.C. and Canale R.P., "Numerical Methods for Engineers", Tata Mc-Graw Hill, New Delhi, (2007).
5. Gerald C.F., and Wheatley P.O., "Applied Numerical Analysis", Pearson Education Asia, New Delhi, (2006).

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3		1								2		2	1	
CO2	2	3		2								1				1
CO3	3	3										3	2			
CO4	1	1													2	
CO5	3	2		1										2		
CO6	2	2		1								3	2			2

191ME41	FLUID MECHANICS AND MACHINERY				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**IV**	**Category:**	**PC**	
Prerequisites:	Engineering Mechanics					
Aim:	To understand the characteristics of fluids and working of hydraulic machines					

Course Outcomes:

The students will be able to

CO1. List the various fluid properties and to apply control volume analysis to fluid mechanics' problems

CO2. Apply the concepts of mass and momentum conservation and the Bernoulli equation to solve problems

CO3. Differentiate the various losses that occur in fluid flow through pipes and to estimate the head losses

CO4. Construct the hydraulic gradient and total energy lines for flow through pipes

CO5. Manipulate dimensional analysis for various fluid parameters and complex problems

CO6. Describe the various types, principle and working of positive displacement machines and roto dynamic machines

UNIT 1	**BASIC CONCEPTS AND PROPERTIES**	**9**

Units & Dimensions – Properties of fluids – Specific gravity, specific weight, viscosity, compressibility – capillarity and surface tension – Flow characteristics: concepts of system and control volume – Application of control volume to continuity equation – energy equation, momentum equation Pascal's law, measurement of pressure, manometers, Hydrostatic law

UNIT 1I	**FLOW THROUGH PIPES**	**9**

Laminar flow though circular conduits and circular annuli – Boundary layer concepts – Boundary layer thickness – Hydraulic and energy gradient – Darcy, Weisbach equation – Friction factor and Moody diagram –Minor losses – Flow through pipes in series and in parallel – loss of energy in pipes – Equivalent pipes - Buoyancy and stability of floating bodies

UNIT 1II	**DIMENSIONAL ANALYSIS**	**9**

Dimension and units – Buckingham's Π theorem – Discussion on dimensionless parameters – Models and similitude – Applications of dimensionless parameters

UNIT 1V	**HYDRAULIC TURBINES**	**9**

Force exerted on moving plate vanes – Definition and classifications – Pelton, Francis, Propeller and Kaplan turbine: Working principles – Velocity triangle – Work done – specific speed – efficiencies – Performance curve for turbines

UNIT V	**HYDRAULIC PUMPS**	**9**

Definition and classifications – Centrifugal and Reciprocating Pumps: Working principles – Indicator diagram – Specific speed – efficiency and performance curves – Cavitations in pumps

	Total Periods:	**45**

Text Books

1. Bansal R.K., **"A Text book of Fluid Mechanics and Hydraulics Machines",** Laxmi Publication, India, (2015)
2. Rajput R.K., **"Fluid Mechanics and Hydraulic Machines",** S.Chand & Company Ltd., New Delhi, (2013)

References

1. Modi P.N., & Seth S.M., **"Hydraulics and Fluid Mechanics including Hydraulic Machines",** Standard book house, (2012)
2. Kumar K.L., **"Engineering Fluid Mechanics",** S. Chand Publishing (P) Ltd., New Delhi, (2014)
3. Streeter V. L., and Wylie E.B., **"Fluid Mechanics",** McGraw Hill, (2008)
4. White F.M., **"Fluid Mechanics",** Tata McGraw-Hill, New Delhi, (2010)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3		2	1					1		2	3	2		2
CO2	2	2		2	2					1		2	2	2		2
CO3	2	2		2	1					1		2	3	1		2
CO4	2	2		2	2					1		2	2	1		2
CO5	2	2		2	1					1	2	2	3	2		2
CO6	3	3		2	2					1	1	1	3	2		2

191ME42	MECHANICS OF MATERIALS				L-T-P	C
					3-1-0	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**IV**	**Category:**	**PC**	
Prerequisites:	Engineering Mechanics					
Aim:	To understand the stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres					

Course Outcomes:

The students will be able to

CO1. Apply mathematics to obtain analytical solutions in solid mechanics
CO2. Visualize the concept of stress, strain, bending of beams
CO3. Calculate the torsion stress and deflections on the springs
CO4. Recognize the deflection of beam when the stress is acted
CO5. Analyze the stress on columns & thin cylinders
CO6. Know the application of theories of failure

UNIT 1	**STRESS, STRAIN AND DEFORMATION OF SOLIDS**	**12**

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress

UNIT 1	**TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM**	**12**

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 stress distribution

UNIT 1II	**TORSION**	**12**

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs

UNIT 1V	**DEFLECTION OF BEAMS**	**12**

Double Integration method – Macaulay's method – Area moment Theorems for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems

UNIT V	**COLUMNS, THIN CYLINDERS AND SPHERES**	**12**

Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns. Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theory – Application of theories of failure

	Total Periods:	**60**

Text Books

1. Ramamrutham S., **"Strength of Materials",** Dhanpatrai Publishing company, (2012)
2. Bansal R.K., **"A Text book of strength of material",** Laxmi publication, New Delhi, (2014)

References

1. Popov E.P., **"Engineering Mechanics of Solids",** Prentice-Hall of India, New Delhi, (2010)
2. Beer F.P. and Johnston R., **"Mechanics of Materials",** McGraw-Hill Book Co, (2012)
3. Timoshenko Gere, **"Mechanics of Materials",** D.Van Nostrand company , New York, (2009)
4. Don H. Morris, William F. Riley and Leroy D. Sturges, **"Mechanics of Materials",** John Wiley and Sons Inc., (2008)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2								2	3	2		1
CO2	3	2	1	2								2	3	2		1
CO3	3	2	1	2			2					2	3	2		1
CO4	3	1	2	1								2	3	2		1
CO5	3	1	2	1								2	3	2		1
CO6	3	1	2	1			2					2	3	2		1

191ME43	MATERIALS ENGINEERING				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**IV**	**Category:**	**PC**	
Prerequisites:	Engineering Physics					
Aim:	To impart the knowledge on properties and the applications of materials					

Course Outcomes:

The students will be able to

CO1. Construct a phase diagram and identify the material in various phases
CO2. Illustrate the various types of heat treatment processes
CO3. Construct a TTT diagram by changes that takes place during the cooling processes
CO4. Explain the plastic deformation and testing of materials
CO5. Learn the properties and applications various ferrous and non-ferrous metals
CO6. Recognize the properties and applications of non-metallic materials

Review (Not for Exam): **2**

Crystal structure – BCC, FCC and HCP structure – unit cell – crystallographic planes and directions, tions, miller indices – crystal imperfections, point, line, planar and volume defects – grain size, ASTM grain size number

UNIT 1 CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS **7**

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectoid, eutectic, peritectic, and peritectroid reactions, Iron – Iron carbide equilibrium diagram – Classification of steel and cast Iron, microstructure, properties and applications

UNIT 1I HEAT TREATMENT **9**

Definition – Full annealing, stress relief, recrystallization and spheroidizing – normalizing, hardening and tempering of steel – isothermal transformation diagrams – cooling curves superimposed on T.T.Diagram , CCR – Hardenability, Jominy and quench test – Austempering, martempering – case hardening – Carburizing, Nitriding, cyaniding, carbonitriding, flame and induction hardening

UNIT 1II MECHANICAL TESTING OF MATERIALS **9**

Mechanism of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Impact test – Izod and Charpy, Fatigue and creep tests, fracture toughness tests.- Non-destructive testing (NDT) - Types

UNIT 1V FERROUS AND NON-FERROUS METALS **9**

Effect of alloying elements on steel (Mn, Si, Cr, Mo, V, Ti & W) – stainless and tool steels – HSLA – maraging steels – Cast Irons – Grey, White malleable, spheroidal – Graphite, Alloy cast irons, Copper and Copper alloys – Brass, Bronze and Cupronickel – Aluminum and Al-Cu alloy – precipitation hardening – Bearing alloys

UNIT V NON-METALLIC MATERIALS **9**

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE Polymers – Urea and Phenol Formaldehydes – Engineering Ceramics – Introduction to Fibre reinforced plastics

Total Periods: 45

Text Books

1. Khanna O.P., "A text book of Materials Science and Metallurgy", Khanna Publishers, (2013)
2. William D. Callister, and David G.R., "Material Science and Engineering", John Wiley, (2014)

References

1. Kenneth G. Budinski and Michael K.Budinski "Engineering Materials", PHI Private Limited, (2012)
2. Raghavan V., "Materials Science and Engineering", PHI India Pvt., Ltd., New Delhi (2015)
3. Charles Gilmore, "Materials Science and Engineering Properties", Cengage Learning, USA (2013)
4. George Ellwood Dieter and David Bacon., "Mechanical Metallurgy", McGraw Hill Book Company, (2013)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2								2	3	2		1
CO2	3	2	1	2								2	3	2		1
CO3	3	2	1	2			2					2	3	2		1
CO4	3	1	2	1								2	3	2		1
CO5	3	1	2	1								2	3	2		1
CO6	3	1	2	1			2					2	3	2		1

191ME44	KINEMATICS OF MACHINERY				L-T-P	C
					3-1-0	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**IV**	**Category:**	**PC**	
Prerequisites:	Engineering Mechanics					
Aim:	To impart knowledge of motion characteristics of mechanisms and machines and to make the students to develop new mechanisms					

Course Outcomes:

The students will be able to
CO1: Explain the concepts of machines, mechanisms and related terminologies
CO2: Analyze planar mechanism for displacement, velocity and acceleration graphically
CO3: Utilize analytical method for analysis of given mechanism
CO4: Perform the kinematic analysis of a given cam mechanism
CO5: Analyze various motion transmission elements like gears, gear trains
CO6: Recognize friction and its effects in mechanical components

UNIT 1	**MECHANISMS AND MACHINES**	**12**
Definitions – Link, Kinematic pair, Kinematic chain, Mechanism, and Machine – Degree of Freedom – Mobility – Kutzbach criterion – Grashoff's law – Kinematic Inversions of four bar chain and slider crank chain – Mechanical Advantage – Transmission angle – quick return mechanisms, Toggle mechanism, Ratchets and pawl mechanisms – Indexing Mechanisms		
UNIT 1I	**KINEMATIC ANALYSIS**	**12**
Analysis of simple mechanisms – Graphical Methods for displacement, velocity and acceleration – Coriolis acceleration – Analytical method of analysis of slider crank mechanism and four bar mechanism – Approximate analytical expression for displacement, Pantograph, Straight line mechanism, approximate straight line motion mechanism.		
UNIT 1II	**KINEMATICS OF CAMS**	**12**
Classifications – Displacement diagrams – Parabolic, Simple harmonic and Cycloidal motions – Graphical construction of displacement diagrams and layout of plate cam profiles – circular arc and tangent cams – Pressure angle and undercutting		
UNIT 1V	**GEARS AND GEAR TRAINS**	**12**
Classification of gears – Gear tooth terminology – Fundamental Law of toothed gearing and involute gearing – Length of path of contact and contact ratio – Interference and undercutting – Gear trains – Simple, compound and Epicyclic gear trains – Differentials		
UNIT V	**FRICTION IN MACHINE ELEMENTS**	**12**
Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Friction clutches – Belt and rope drives – Friction in brakes- Band and Block brakes		
	Total Periods:	**60**

Text Books

1. Rattan S.S., **"Theory of Machines",** Tata McGraw-Hill, (2014)
2. Khurmi R.S., Gupta J.K., **"Theory of Machines",** Eurasia Publishing House, (2014)

References

1. Norton R.L., **"Kinematics and Dynamics of Machinery",** Tata McGraw Hill, (2009)
2. Sadhu Singh, **"Theory of Machines",** Pearson Education, (2010)
3. Bansal R.K. Brar.J.S**., "A Text Book of Theory of Machines",** Lakshmi Publication, (2015)
4. Uicker (Jr) J.J., Pennock G.R. and Shigley J.E., **"Theory of Machines and Mechanisms"** Oxford International Student Edition, (2009)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3		1					1	3	2		2
CO2	3	3	2	1	2							2	2	3		1
CO3	2	2	3	2	1		1					1	2	2		1
CO4	3	2	2	1	1	1						2	3	2		2
CO5	3	1	2	2	2						1	2	2	3	1	1
CO6	2	3	2	2	2		2					1	3	2	1	1

191ME45	MANUFACTURING TECHNOLOGY			L-T-P	C
				3-0-2	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**IV**	**Category:**	**PC**
Prerequisites:	Manufacturing Processes				
Aim:	To understand the basic principles and working of various machine tools				

Course Outcomes:

The students will be able to

CO1. Know the principle of metal cutting process

CO2. Learn the basic operation of centre lathe

CO3. Recognize the parts and working of special purpose lathe

CO4. Familiarize the working principle of reciprocating machine tools

CO5. Explain the hole making process

CO6. Introduce the various methods of Grinding and Gear cutting process

THEORY

UNIT 1	**THEORY OF METAL CUTTING**	**9**

Introduction: material removal processes, types of machine tools– theory of metal cutting: chip formation, orthogonal cutting, cutting tool materials, properties and applications - tool wear, Variables affecting tool life - cutting fluids- force measurement

UNIT 1I	**CENTRE LATHE AND SPECIAL PURPOSE LATHES**	**9**

Centre lathe, constructional features, cutting tool geometry, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation – Capstan and turret lathes – automats – single spindle, swiss type, automatic screw type, multi spindle – Turret Indexing mechanism, Bar feed mechanism

UNIT 1II	**SPECIAL MACHINES**	**9**

Reciprocating machine tools: shaper, planer, slotter machine types, mechanism and operations – Milling: types, milling cutters, operations – Hole making: drilling – Quill mechanism, Reaming, Boring, Tapping – Broaching machines – Types- Operations

UNIT 1V	**ABRASIVE PROCESSES AND GEAR CUTTING**	**9**

Introduction, Classification, working of grinding machines, Grinding wheel (Abrasives & Bond), Selection of Grinding wheel, Process parameters - cutting speed, feed, DOC & machining time - Types of grinding machines - honing, lapping, super finishing, polishing and buffing, – Gear cutting, forming, generation, shaping, hobbing.

UNIT V	**MICRO AND NANO MACHINING**	**9**

Introduction - Micro-electromechanical Systems (MEMS) - Micro-fabrication Technologies – Micro turning – Micro drilling – Micro Milling - Silicon Layer Processes - LIGA Micro-fabrication Process - Applications - Nano-Machining – Focused beam lithography – Nano imprint lithography – Chemical vapour deposition – Nano finishing processes - Applications

	Total Periods:	**45**

Text Books

1. Hajra Choudry, **"Elements of Work Shop Technology – Vol. II",** Media Promoters, (2015)
2. Sharma P.C., **"A Text Book of Production Engineering",** S. Chand and Co. Ltd, (2013)

References

1. Helmi A. Youssef and Hassan El-Hofy, "**Machining Technology: Machine Tools and Operations",** CRC Press, Florida, USA (2008)
2. .Jain V.K., "**Micro Manufacturing Processes"**, CRC Press, Florida, USA (2013).
3. Rajput R.K., "**A Textbook of Manufacturing Technology",** Laxmi puplication, New Delhi, (2014)
4. Rao P.N., **"Manufacturing Technology - Metal Cutting and Machine Tools**", Tata McGraw Hill, New Delhi, (201)

PRACTICAL

LIST OF EXPERIMENTS

1. Exercise on centre lathe
    - Facing,
    - Plain turning,
    - Step turning,
    - Taper turning,
    - Knurling
    - Thread cutting
2. Exercises in Shaper
    - Round to square
    - Dovetail groove making
3. Exercise in Slotter – Internal keyway cutting
4. Exercises in Drilling machine – Drilling and Tapping
5. Exercise in Milling Machine – External keyway milling
6. Exercises in Grinding / Abrasive machining – Surface grinding
7. Exercise in Gear Hobbing

LIST OF EQUIPMENTS

(For a batch of 30 students)

1.	Centre Lathe	15 Nos.
2.	Turret and Capstan Lathe	1 No.
3.	Horizontal Milling Machine	1 No.
4.	Vertical Milling Machine	1 No.
5.	Surface Grinding Machine	1 No.
6.	Cylindrical Grinding Machine	1 No.
7.	Shaper	2 Nos.
8.	Slotter	1 No.
9.	Planner	1 No.
10.	Radial Drilling Machine	1 No.
11.	Tool Dynamometer	1 No.
12.	Gear hobbing machine	1 No.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		1			2	1		2			2				3
CO2	3		1			2	1		2			2				3
CO3	3		1			2	1		2			2				3
CO4	3		1			2	1		2			2				3
CO5	3		1			2	1		2			2				3
CO6	3		1			2	1		2			2				2

191ME47	FLUID MECHANICS LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E. Mechanical Engineering	**Sem:**	**IV**	**Category:**	**PC**
Prerequisites:	Fluid Mechanics and Machinery				
Aim:	To impart knowledge of characteristics of fluids				

Course Outcomes:

The students will be able to

CO1. To measure the coefficient of discharge orifice and venturimeter
CO2. To analyses the characteristics of centrifugal pump
CO3. Predict the pressure loss due to friction and minor losses in pipe flow
CO4. Perform the operations and plot the characteristics curves of various pumps
CO5. To determine the efficiency of the Pelton turbine
CO6. Do experiments in various turbines

LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturimeter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump / submergible pump
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

LIST OF EQUIPMENTS

(For a batch of 30 students)

1. Orifice meter setup
2. Venturi meter setup
3 Rotameter setup
4. Pipe Flow analysis setup
5. Centrifugal pump/submergible pump setup
6. Reciprocating pump setup
7. Gear pump setup
8. Pelton wheel setup
9. Francis turbine setup
10. Kaplan turbine setup

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		3						2	1	2	3	2		2
CO2	3	2		3						2	1	2	3	2		2
CO3	3	2		3						2		2	3	2		3
CO4	2		3						2	1	2	3	2		2	
CO5	2		3						2	1	2	3	2	2		1
CO6	2		3						2		2	3	2			2

191ME48	MATERIAL TESTING LABORATORY				L-T-P	C
					0-0-2	1
Programme:	B.E. Mechanical Engineering	**Sem:**	**IV**	**Category:**	**PC**	
Prerequisites:	Materials Engineering					
Aim:	To impart knowledge of motion characteristics of mechanisms and machines and to make the students to develop new mechanisms					

Course Outcomes:

The students will be able to

CO1. Justify the behavior of structural elements, such as bars, beams and columns subjected to tension, compression, shear, bending, and torsion by means of experiments.

CO2. Represent the concepts of hardening and determine the hardness of the material

CO3. Identify with the tension and compression test on springs

CO4. Predict the hardness of metals

CO5. Perform the compression test on spring

CO6. Do microscopic examination of metal samples

LIST OF EXPERIMENTS

1. Tension test on a mild steel rod
2. Double shear test on Mild steel
3. Torsion test on mild steel rod
4. Impact test on metal specimen
5. Hardness test on metals – Brinell and Rockwell Hardness Number
6. Deflection test on helical springs
7. Compression test on helical springs
8. Deflection test on beams
9. Microscopic Examination of Hardened samples and Hardened and tempered samples.

LIST OF EQUIPMENTS
(For a batch of 30 students)

1. Universal Tensile Testing machine with double shear attachment – 40 Ton Capacity
2. Torsion Testing Machine (60 N/M Capacity)
3. Impact Testing Machine (300 J Capacity)
4. Brinell Hardness Testing Machine
5. Rockwell Hardness Testing Machine
6. Spring Testing Machine for tensile and compressive loads (2500 N)
7. Metallurgical Microscopes
8. Muffle Furnace (800^0C)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		3						2	1	2	3	2		2
CO2	3	2		3						2	1	2	3	2		2
CO3	3	2		3						2	1	2	3	2		2
CO4	3	3		2							1	2	2	2		1
CO5	3	3		2							1	2	2	2		1
CO6	3	3		2							1	2	2	2		1

191ME51	DYNAMICS OF MACHINERY				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**V**	**Category:**		**PC**
Prerequisites:	Kinematics of Machinery					
Aim:	To understand the method of static and dynamic force analysis of mechanisms and to study the undesirable effects of unbalances in rotors, engines and the principles of governors and gyroscopes.					

Course Outcomes:

The students will be able to

CO1. Understand the method of static force analysis and dynamic force analysis of mechanisms
CO2. Know the undesirable effects of unbalances in rotors and engines
CO3. Interpret the concept and basics of free vibratory systems and their analysis
CO4. Recognize the whirling and critical speed of shafts
CO5. Examine the forced vibratory systems and their analysis
CO6. Analyze the principles of governors, gyroscopes and vibration sensor

UNIT 1	FORCE ANALYSIS AND FLYWHEELS	12

Static force analysis – D'Alembert's principle – Inertia force and Inertia torque – Dynamic force analysis – Dynamic Analysis in Reciprocating Engines – Crank shaft Torque – Engine shaking Forces – Turning moment diagrams – Flywheels of engines**.**

UNIT 1I	BALANCING	12

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder Engine – Primary and secondary unbalanced forces – Balancing Multi – cylinder Engines.

UNIT 1II	SINGLE DEGREE OF FREEDOM SYSTEMS – FREE VIBRATION	12

Basic features of vibratory systems – Basic elements and lumping of parameters – Degrees of freedom – Single degree of freedom – Free vibration – Formulation of equations of motion – natural frequency – Types of Damping – Damped free vibration – Whirling of shafts and critical speed – Torsional systems – Natural frequency of two and three rotor systems.

UNIT 1V	SINGLE DEGREE OF FREEDOM SYSTEMS – FORCED VIBRATION	12

Response to periodic forcing – Harmonic Forcing – Forced vibration – damping ratio – logarithmic decrement – Support motion – Force transmissibility and amplitude transmissibility – Vibration isolation, Vibration sensors.

UNIT V	MECHANISMS FOR CONTROL	12

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling Force – Quality of governors – hunting – Gyroscopes – Gyroscopic couple – Gyroscopic stabilization – Gyroscopic effects in Automobiles and ships.

Total Periods:	**60**

Text Books

1. Thomas Bevan, **"Theory of Machines",** CBS Publishers and Distributors, (2005)
2. Rattan S.S., **"Theory of Machines",** McGraw Hill, (2014)

References

1. Shigley J.E., and Uicker J.J., **"Theory of Machines and Mechanisms",** McGraw-Hill, (2009)
2. Rao J.S. and Dukkipati R.V., **"Mechanism and Machine Theory",** Wiley-Eastern Limited, New Delhi, (2015)
3. Singh V.P., **"Theory of Machines",** DhanpatRai Publishing Company (P) Limited, (2010)
4. Khurmi R.K., Gupta J.K., **"Theory of Machines",** Eurasia Publishing House, New Delhi, (2014)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3		2							1	2	2	2		1
CO2	3	3		2							1	2	2	2		1
CO3	3	3		2							1	2	2	2		1
CO4	3	3		2							1	2	2	2		1
CO5	3	3		2							1	2	2	2		1
CO6	3	3		2							1	2	2	2		1

191ME52	THERMAL ENGINEERING			L	T	P	C
				3	0	0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**5**	**Category: PC**			
Prerequisites:							
Aim:	To acquire the basic knowledge, and thermodynamic concept into various thermal applications						

Course Outcomes:

The students will be able to

CO1. Describe the classification of air standard efficiency
CO2. Know the concepts of PV diagram of four stroke and two stroke engines
CO3. Examine about the performance calculation of petrol and diesel engine
CO4. Analyze the flow of steam through nozzles and to draw the velocity diagram
CO5. Calculate the isentropic efficiency of multistage compressor
CO6. Demonstrate the principle and practice of thermal comfort and alternate refrigerants

UNIT 1 GAS POWER CYCLES 9

Air standard cycles – Otto, Diesel, Dual and Brayton cycles – air-standard efficiency – mean effective pressure – P-V and T-s diagrams – Actual cycles

UNIT 1I INTERNAL COMBUSTION ENGINES 9

Classification – Components and their function – working principle of 2 stroke and 4 stroke cycle – I.C Engine – valve and port timing diagrams – Comparison of two stroke and four stroke engines – Carburetor system, Diesel pump and injector system – Comparison of petrol and diesel engine – Lubrication system and Cooling system – Battery and Magneto Ignition System – Performance calculation

UNIT 1II STEAM NOZZLES AND TURBINES 9

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow, Impulse and Reaction principles, compounding, velocity diagram for simple and multi-stage turbines, speed regulations – Governors

UNIT 1V AIR COMPRESSOR 9

Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors, Multistage air compressor and inter cooling – work of multistage air compressor – Operating principle of rotary compressor

UNIT V REFRIGERATION AND AIR CONDITIONING 9

Vapour compression refrigeration cycle – super heat, sub cooling – Performance calculations – working principle of vapour absorption system – Comparison between vapour compression and absorption systems – Air conditioning system: Types, Working Principles – Psychometry, Psychometric chart – Cooling Load calculations

Total Periods:45

Text Books:

1. Rajput R.K., “Thermal Engineering”, S.Chand Publication, (2014)
2. Ballaney P.L, “Thermal Engineering”, Khanna Publishers, (2010)

References:

1. Arora C.P, “Refrigeration and Air Conditioning”, Tata McGraw-Hill Publishers, (2012)
2. Sarkar B.K., “Thermal Engineering”, McGraw Hill Publication, (2001)
3. Rudramoorthy R., “Thermal Engineering”, Tata McGraw-Hill, New Delhi, (2009)
4. Khurmi R.S. & Gupta J.K., “Refrigeration and Air Conditioning”, S.Chand Publication, (2006)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2										3	2			
CO2		2	3	3								3		3		
CO3			3		2							1				2
CO4		3		1	2							3		3		
CO5		3	2									1			2	
CO6				1	2							3				3

191ME53	APPLIED HYDRAULICS AND PNEUMATICS				L-T-P	C
					3-1-0	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**V**	**Category:**	**PC**	
Prerequisites:	Fluid Mechanics and Machinery					
Aim:	To know the advantages and applications of fluid power system in automation of machine tools and other equipments.					

Course Outcomes:

The students will be able to

CO1. Understand the fundamentals of hydraulic and pneumatic systems
CO2. Determine proper hydraulic cylinders for specific applications
CO3. Identify various components of pneumatic system used in simple applications
CO4. Illustrate the electronic circuits used in pneumatic systems
CO5. Design the hydraulic circuits with various components
CO6. Know the schematic diagrams to construct pneumatic circuits

UNIT 1	FLUID POWER SYSTEMS AND FUNDAMENTALS	9

Introduction to fluid power, Advantages and application – Types of fluid power systems – General types of fluids, Maintaining and disposing of fluids – Fluid power Symbols – Basics of hydraulics – Applications of pascal's law.

UNIT 1I	HYDRAULIC SYSTEMS & COMPONENTS	9

Fluid power actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, double acting hydraulic cylinders special cylinders like tanden, rodless, telescopic and cushioning devices, Rotary actuators – Fluid gear, Vane and piston motors-Hydraulic Powerpacks.

UNIT 1II	PNEUMATIC SYSTEMS AND COMPONENTS	9

Properties of air – Compressors – Filter, Regulator, Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators – Fluid power circuit design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design for simple applications using cascade method- Robotic circuits-Pneumatic Powerpacks.

UNIT 1V	DESIGN OF HYDRAULIC CIRCUITS	9

Directional control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, relays, ladder diagram – Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of intensifier – Intensifier circuit – simple problems- Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications.

UNIT V	DESIGN OF PNEUMATIC CIRCUITS	9

Servo systems – Hydro Mechanical, Electro hydraulic servo systems and proportional valves – Introduction to fluidic devices, simple circuits – Introduction to electro hydraulic pneumatic logic circuits, ladder diagrams– Fluid power circuits – Installation and maintenance of hydraulic and pneumatic power packs – failure and troubleshooting- Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools.

	Total Periods:	**45**

Text Books

1. Anthony Esposito, **"Fluid Power with Applications",** Pearson Education, (2014)
2. Srinivasan.R, **"Hydraulic and Pneumatic Controls",** Vijay Nicole, (2015)

References

1. Majumdar S.R., **"Oil Hydraulics Systems–Principles and Maintenance",** Tata McGraw-Hill, (2010)
2. Shanmugasundaram.K, **"Hydraulic and Pneumatic Controls",** Chand & Co, (2011)
3. Majumdar S.R., **"Pneumatic Systems – Principles and Maintenance",** Tata McGraw Hill, (2013)
4. Anthony Lal, **"Oil Hydraulics in the Service of Industry",** Allied publishers, (2012)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2								2	2			
CO2	2		3									2		3		
CO3		2	3	3	2							1		3		
CO4	2	1		2								1			2	
CO5	2	1	1	1								2			2	
CO6		2	2	1	2							1				3

191ME54	ELECTRONICS INSTRUMENTATION AND CONTROL				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**V**	**Category:**	**PC**	
Prerequisites:	Nil					
Aim:	To understand the principles, methods and applications of measurements					

Course Outcomes:

The students will be able to

CO1. Understand the basic concepts of measurements

CO2. Familiarize the displacement measurement instrumentation

CO3. Explain the applications of transducers in measurements

CO4. Describe the elements of control system

CO5. Analyze the time response

CO6. Practice the stability analysis

UNIT 1	**BASIC MEASUREMENT CONCEPTS**	**9**

Significance of Measurements systems - units and standards of measurements -Classification of measuring Instruments– moving coil, moving iron meters – multimeters Errors in measurement -Types of errors, Effect of component errors.

UNIT 1I	**SENSORS AND TRANSDUCERS**	**9**

Displacement Measurement –LVDT, Digital Transducers (optical encoder), – Strain Measurement- gauge factor- Strain gauge based load cells and torque sensors - - Pressure Measurement - Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, Amplification – Filtering – Sample and Hold circuits

UNIT 1II	**SYSTEMS AND REPRESENTATION**	**9**

Basic elements in control systems: – Open and closed loop systems – Mathematical modelling of control systems, concept of transfer function - AC and DC servomotors – Block diagram reduction techniques.

UNIT 1V	**TIME RESPONSE**	**9**

Time response: – Time domain specifications – Types of test input – I and II order system response – Error coefficients - Effects of P, PI, PID modes of feedback control –Time response analysis.

UNIT V	**STABILITY ANALYSIS**	**9**

Introduction to concepts of stability - The Routh criteria for stability - Experimental determination of frequency response - Stability analysis using Bode plot - Process control systems, ON-OFF control. P-I-D Control and its applications

	Total Periods:	**45**

Text Books

1. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017
2. Sawhney, A.K "A Course in Electrical & Electronic Measurements & Instrumentation" ,Dhanpat Rai and Co, New Delhi, 2010.

References

1. David A Bell, "Electronic Instrumentation and Measurements", Oxford University Press, 2013.
2. Helfrick A.D.and W.D.Cooper, "Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall India Private Ltd., 2010.
3. Nagoor kani A. "Control system Engineering" 3rd Edition RBA Publication 2011.
4.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2								2	3	2		1
CO2	3	2	1	2								2	3	2		1
CO3	3	2	1	2			2					2	3	2		1
CO4	3	1	2	1								2	3	2		1
CO5	3	1	2	1								2	3	2		1
CO6	3	1	2	1			2					2	3	2		1

191ME55	MACHINE DESIGN AND DRAWING				L-T-P	C
	(PSG Design Data Book is permitted)				3-0-2	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**V**	**Category:**	**PC**	
Prerequisites:						
Aim:	To study the design principles and procedures of Machine Elements					

Course Outcomes:

The students will be able to

CO1. Select suitable materials and evaluate the failure of machine elements
CO2. Investigate the strength of shafts & coupling
CO3. Design screw jack with suitable thread
CO4. Choose the temporary and permanent joints depends on application
CO5. Design suitable spring for automobile applications
CO6. Implement the bearing design in their project work

UNIT 1	STEADY AND VARIABLE STRESSES IN MACHINE PARTS	12

Introduction to design process – Selection of materials – Fits and tolerances – Direct, Bending and torsional stress equations – Application of Principal stresses in designing machine members – Factor of safety – Theories of failure – Stress concentration due to holes and notches – Gerber, Goodman & Soderberg relations

****Manual Drawing:** Tolerance zone, Types of fits & Stress concentration - Industrial drawing and blueprint, Geometrical dimensions and tolerance

UNIT 1I	SHAFTS AND COUPLINGS	12

Design of solid shafts based on strength, rigidity and critical speed – Design of keys – Design of rigid & flexible couplings – Applications

****Manual Drawing:** Flange Coupling & Bushed pin type coupling

UNIT 1II	POWER SCREWS AND LEVERS	12

Introduction of screw threads in power screws – Types of threads – Overhauling, Self-locking screws – Design of screw jack – Introduction of levers – Design of a lever – Hand levers, foot levers, safety valve levers & rocker arm – Applications

****Manual Drawing:** Screw Jack & Rocker arm for exhaust valve

UNIT 1V	TEMPORARY AND PERMANENT JOINTS	12

Design of Knuckle joint – Design of socket and spigot joint, sleeve and cotter joint – Design of pipe – Applications – Design of welded joints, Welding symbols – Applications – Design of riveted joints, Types of rivet heads – Applications

****Manual Drawing:** Knuckle joint & Pipe joints

UNIT V	SPRINGS AND BEARINGS	12

Design of helical springs – compression & tension springs – Leaf spring – Belleville spring – Applications – Sliding contact bearings – Design of hydrodynamic bearings – McKee's Equation, Sommerfield Number – Selection of lubrication – Rolling contact bearings – Life of bearings – Selection of Rolling Contact bearings – Applications

****Manual Drawing:** Leaf spring & Bearings

Lecture: 45 Practice: 15 Total Periods: 60

Text Books:

1. Gupta J.K., "A Textbook of Machine Design", Eurasia Publishing House, (2014)
2. Narayanan K.L., "Machine Design", Khanna Publishers, (2014)

References: New References are added

1. Bhandari V.B., "Design of Machine Elements", Tata McGraw-Hill Book Co, (2016)
2. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
3. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
4. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2						2		2	2	3		2
CO2	3	3	3	2						2		2	2	3		3
CO3	3	3	3	2						2		2	3	3		3
CO4	3	3	3	2						2		2	3	1		3
CO5	3	3	3	2						2		2	3	3		3
CO6	3	2	3	2						2		2	3	3		3

191ME57	DYNAMICS LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E. Mechanical Engineering	**Sem:**	**V**	**Category:**	**PC**
Prerequisites:					
Aim:	To educate the students to apply the kinetic solutions to various experiments				

Course Outcomes:

The students will be able to

CO1. Know the functions of kinematic links and its mechanisms
CO2. Interpret the fundamentals of the natural frequency of free vibration of fixed beam
CO3. Find the gyroscopic effect
CO4. Determine the basic concepts of governor apparatus
CO5. Identify the different cam profile mechanisms

LIST OF EXPERIMENTS

1. Study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2. Study of kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
3. Determination of Mass moment of inertia of Fly wheel and Axle system.
4. Determination of Mass Moment of Inertia of axis symmetric bodies using Turn Table apparatus.
5. Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
6. Determination of gyroscopic effect and couple.
7. Determination of range sensitivity, effort etc., for Watts, Porter and Proell Governors.
8. Cam profile and Motion curve drawings
9. Determination of natural Frequency and verification of Laws of springs in Single degree of
10. freedom Spring Mass System.
11. Determination of torsional natural frequency of single and Double Rotor systems.
12. Vibration of Equivalent Spring mass system.
13. Determination of critical speeds of shafts.
14. Balancing of rotating masses
15. Transverse vibration of fixed beam – with and without concentrated masses.

Total Periods: 45

LIST OF EQUIPMENTS

(For a batch of 30 students)

1. Cam analyzer	1 No.
2. Motorized gyroscope	1 No.
3. Governor apparatus - Watt, Porter, Proell and Hartnell governors	1 No.
4. Whirling of shaft apparatus	1 No.
5. Static and dynamic balancing machine	1 No.
6. Vibrating table	1 No.
7. Vibration test facilities apparatus	1 No.
8. Gear Model	1 No.
9. Kinematic Models to study various mechanisms	1 No

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		2					3			2		3	1	3
CO2	3	2		3					3			2		3	2	3
CO3	2	3		2					3			2		2		3
CO4	3	3		2					3			2		2		2
CO5	3	3		2					3			2		3		3
CO6	3	2		3					3			2		2		3

191ME58	THERMAL ENGINEERING LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E. Mechanical Engineering	**Sem:**	**5**	**Category:**	**PC**
Prerequisites:					
Aim:	To obtain the basic knowledge about internal combustion engine and its performance				

Course Outcomes:

The students will be able to

CO1. Draw the valve timing and port timing diagram for petrol & diesel engine
CO2. Find the flash point / fire point and viscosity for the given sample
CO3. Determine the performance and efficiency of petrol / diesel engine
CO4. Identify the performance difference of various engines
CO5. Draw the heat balance sheet for SI/CI engine

LIST OF EXPERIMENTS

1. Valve Timing and Port Timing Diagrams
2. Performance Test on 4-stroke Diesel Engine
3. Heat Balance Test on 4-stroke Diesel Engine
4. Morse Test on Multi cylinder Petrol Engine
5. Retardation Test to find Frictional Power of a Diesel Engine
6. Determination of Viscosity – Red Wood Viscometer
7. Determination of Flash Point and Fire Point
8. Study of Steam Generators and Turbines

Total Periods: 45

LIST OF EQUIPMENTS
(For a batch of 30 students)

1.	I.C Engine – 2 Stroke and 4 Stroke model	1 set
2.	Red Wood Viscometer	1 No.
3.	Apparatus for Flash and Fire Point	1 No.
4.	4-Stroke Diesel Engine with mechanical loading	1 No.
5.	4-Stroke Diesel Engine with hydraulic loading.	1 No.
6.	4-Stroke Diesel Engine with electrical loading	1 No.
7.	Multi-cylinder Petrol Engine	1 No.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2		2	1			1		1	2	3		1
CO2	2	2	2	2		2	2			1		2	2	3		1
CO3	2	3	2	2		2	2			1		2	2	3		1
CO4	2	3	2	2		2	2			1		2	2	3		1
CO5	2	3	2	2		2	2			1		2	2	3		1
CO6	2	2	2	1		2	2			1		2	2	3		1

191ME61	AUTOMATION IN MANUFACTURING				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**V**	**Category:**	**PC**	
Prerequisites:						
Aim:	To gain the knowledge about the Advanced and computerized Manufacturing Techniques followed in the Shop floor of the Industries					

Course Outcomes:

The students will be able to

- CO1. Understand the concept of CIM
- CO2. Explain the components of CIM
- CO3. Recognize the Group Technology and CAPP
- CO4. List out the various techniques in shop floor control
- CO5. Know the concept of FMS
- CO6. Familiarize the computer aided planning and control

UNIT 1 BASICS OF CIM **9**

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control – Introduction to CAD/CAM – Concurrent Engineering – CIM concepts – Computerized elements of CIM system – Types of production – Typical CAD command structure, wire frame modeling, surface modeling and solid modeling (concepts only) in relation to popular CAD packages

UNIT 1I COMPONENTS OF CIM **9**

CIM as a concept and a technology, CASA/SME model of CIM, CIM II, benefits of CIM, communication matrix in CIM, fundamentals of computer communication in CIM – CIM data transmission methods – serial, parallel, asynchronous, synchronous, modulation, demodulation, simplex and duplex – Types of communication in CIM – point to point (PTP), star and multiplexing. Computer networking in CIM – the seven layer OSI model, LAN model, MAP model, network topologies – star, ring and bus, advantages of networks in CIM

UNIT 1II GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING **9**

History Of Group Technology – role of G.T. in CAD/CAM Integration – part families – classification and coding – DCLASS and MICLASS and OPTIZ coding systems – facility design using G.T. – benefits of G.T. – cellular manufacturing – Process planning – role of process planning in CAD/CAM Integration – approaches to computer aided process planning – variant approach and generative approaches

UNIT 1V SHOP FLOOR CONTROL AND FMS **9**

Shop floor control – phases – factory data collection system – automatic identification methods – Bar code technology – automated data collection system – FMS – components of FMS – types – FMS workstation – material handling and storage system – FMS layout – computer control systems – applications and benefits

UNIT V COMPUTER AIDED PLANNING, CONTROL AND MONITORING **9**

Production planning and control – cost planning and control – inventory management – material requirements planning (MRP) – Lean and Agile Manufacturing – Types of production monitoring systems – structure model of manufacturing – process control and strategies – Direct Digital Control

Total Periods: 45

Text Books

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education (2013)
2. Mikell P. Groover, Emory Zimmers Jr., "CAD/CAM", Prentice Hall of India Pvt. Ltd., (2006)

References

1. James A. Regh and Henry W.Kreabber, "Computer Integrated Manufacturing", Pearson Education, (2005)
2. Chris McMahon and Jimmie Browne, "CAD CAM Principles, Practice and Manufacturing Management", Pearson Education, (2005)
3. Ranky Paul G., "Computer Integrated Manufacturing", Prentice Hall of India Pvt. Ltd., (2005)
4. Yorem Koren, "Computer Integrated Manufacturing", McGraw Hill, (2005)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1				2	1	2			2	2	3		3	3	3
CO2	1				3	2	2			2		3		3	2	3
CO3					3	2	2			2		3		3	2	3
CO4					3	2	2			3		3		3	2	3
CO5	2			1	3	2	3			3		3		3	2	3
CO6		3	3	2	2	2	2			2		3		3	1	3

191ME62	DESIGN OF TRANSMISSION SYSTEMS			L-T-P	C
				3-1-0	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**VI**	**Category:**	**PC**
Prerequisites:					
Aim:	To study the design principles and procedures of Transmission systems				

Course Outcomes:

The students will be able to

CO1. Gain basic concepts of various power transmission systems
CO2. Select and design flat, V belt drives and chain drives
CO3. Power transmission between parallel shafts and design spur & helical gears
CO4. Visualize transmission between intersecting shafts and design the bevel & worm gears
CO5. Prepare kinematic layout and structural arrangement of the gear boxes
CO6. Design clutches and brakes for the automobile components.

UNIT 1	**DESIGN FOR FLEXIBLE ELEMENTS**	**9**

Selection of V belts and pulleys – selection of flat belts and pulleys – wire ropes and pulleys – selection of transmission chains and sprockets – Design of pulleys and sprockets

UNIT 1I	**SPUR & HELICAL GEARS**	**9**

Gear Terminology – spur gears – speed ratio and number of teeth – force analysis – factor of safety – gear materials – power rating calculations based on strength and wear considerations – helical gears – pressure angle in the normal and transverse plane – equivalent number of teeth – force analysis

UNIT 1II	**BEVEL & WORM GEARS**	**9**

Straight bevel gear – tooth terminology, tooth forces and stresses, equivalent number of teeth – estimating the dimensions of pair of straight bevel gears – worm gear – merits and demerits – terminology

UNIT 1V	**DESIGN OF GEAR BOXES**	**9**

Geometric progression – standard step ratio – ray diagram, kinematics layout – design of sliding mesh gear box – constant mesh gear box – design of multi speed gear box

UNIT V	**DESIGN OF CAM CLUTCHES AND BRAKES**	**9**

Cam Design – types – pressure angle and under cutting base circle determination – forces and surface stresses – design of plate clutches – axial clutches – cone clutches – internal expanding rim clutches – internal and external shoe brakes

	Total Periods:	**45**

Text Books:

1. Khurmi R.S., Gupta J.K., "A Textbook of Machine Design", Eurasia Publications, (2014)
2. Sundararajamoorthy T.V. and Shanmugam N., "Machine Design", Anuradha Publications, (2013)

References:

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
3. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998
4. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	2						2		2	2	3		2
CO2	3	3	3	2						2		2	2	3		3
CO3	3	3	3	2						2		2	3	3		3
CO4	3	3	3	2						2		2	3	1		3
CO5	3	3	3	2						2		2	3	3		3
CO6	3	2	3	2						2		2	3	3		3

191ME63	AUTOMOBILE ENGINEERING			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**VI**	**Category:**	**PC**
Prerequisites:					
Aim:	To understand the construction and working principle of various parts of an automobile and practice assembling and dismantling of engine parts and transmission system				

Course Outcomes:

The students will be able to

CO1. Describe vehicle construction, chassis, frame, body and engine components
CO2. Classify the various types of fuels used in automobiles
CO3. Identify the method of controlling pollution
CO4. Describe the transmission systems, wheels and tyre
CO5. Demonstrate the concepts of steering, braking and suspension systems
CO6. Explain electronically controlled gasoline, diesel injection systems and other electrical circuits used in automobiles

UNIT 1 VEHICLE STRUCTURE AND ENGINE COMPONENTS 9

Types of automobiles, Vehicle construction and different layouts, Chassis, Frame and Body, Resistances to vehicle motion, Components of Engine – their forms, functions and materials, Flywheel –needs, Carburetor – Simple carburetor &Solex carburetor, Super chargers & Turbo chargers

UNIT 1I ENERGY SOURCES 9

Important qualities of fuel, Rating of fuels, Properties – conventional fuels, Alternative fuels – Compressed Natural Gas, Liquefied Petroleum Gas, Alcohols, Bio-diesel and Hydrogen, Engine emission control by three way catalytic converter system, Electric and Hybrid Vehicles, Fuel Cell

UNIT 1II TRANSMISSION SYSTEM, WHEELS AND TYRES 9

Clutch – types and construction, Need for a gearbox, Types of gear boxes – manual and automatic (epicyclic gear box), Over drive, Transfer box, Fluid flywheel – Torque converter, Propeller shaft, Universal joints, Final drive and Differential, Rear axle drive – Hotchkiss Drive and Torque Tube Drive – Wheels – Disc wheel, Wire wheel & Cast wheel, Tyres – Designations – Types – Tubed tyres& Tubeless tyres

UNIT 1V FRONT AXLE, STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Front Axle – Types of Front Axle, Steering geometry, Steering mechanism – Ackermann, Types of steering gear box & Steering ratio, Power Steering, Braking Systems – Drum brakes & Disc brakes, Antilock Braking System, Regenerative brake system, Suspension Systems – Types of Suspension Spring – Coil springs, Leaf springs & Torsion bars – Shock absorbers

UNIT V AUTOMOTIVE ELECTRICAL & ELECTRONIC SYSTEMS 9

Lead acid battery – Construction, working & maintenance, Electronically controlled gasoline injection system for SI engines (Multi point fuel injection system), Electronically controlled diesel injection system for CI engines (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system, Starter motor, Lighting system, Windscreen wiper, Automobile air conditioning, Vehicle tracking system

Total Periods: 45

Text Books

1. Kirpal Singh, "Automobile Engineering Vol 1 & 2", Standard Publishers, New Delhi, (2013)
2. Rajput R.K., " Internal Combustion Engines", Lakshmi Publication, (2005)

References

1. Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers, (2009)
2. Joseph Heitner, "Automotive Mechanics", East-West Press, (1999)
3. Heinz Heisler, "Advanced Engine Technology", SAE International Publications, USA, (1998)
4. Jain K.K., and Asthana R.B., "Automobile Engineering", Tata McGraw Hill Publishers, New Delhi, (2010)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		2	2		3							3			
CO2			3			2										2
CO3						2							2			
CO4									2		1					1
CO5	2		3										3			
CO6			2						2			2	3			

191ME64	HEAT AND MASS TRANSFER			L-T-P	C
				3-0-2	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**VI**	**Category:**	**PC**
Prerequisites:					
Aim:	To understand the basic concepts of Heat and Mass Transfer and its application				

Course Outcomes:

The students will be able to

CO1. Identify the modes of heat transfer and solve the conduction and extended surface problems
CO2. Know about the basic concept of convection, flow over plate, cylinders and spheres
CO3. Familiarize the concept of pool boiling
CO4. Identify the types of heat exchanger and solve the heat exchanger problems
CO5. Well known about radiation and solve the radiation problems
CO6. Solve the mass transfer problem and know about the diffusion mass transfer

UNIT 1 CONDUCTION **12**

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – Fourier Law of Conduction – General Differential equation of Heat Conduction – Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Use of Heislers Chart

**Practical: Thermal conductivity measurement by guarded plate method, Thermal conductivity of pipe insulation using lagged pipe apparatus

UNIT 1I CONVECTION **12**

Basic Concepts – Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent – Flow over Bank of tubes – Free Convection – Dimensional Analysis – Flow over vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres

**Practical: Natural convection heat transfer from a vertical cylinder, Forced convection inside tube

UNIT 1II PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS **12**

Nusselts theory of condensation – pool boiling, flow boiling, correlations in boiling and condensation – Types of Heat Exchangers – Heat Exchanger Analysis – LMTD Method and NTU – Effectiveness – Overall Heat Transfer Coefficient – Fouling Factors

**Practical: Effectiveness of Parallel/counter flow heat exchanger, Heat transfer from pin-fin (natural & forced convection modes

UNIT 1V RADIATION **12**

Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchoffs Law – Black Body Radiation – Grey body radiation – Shape Factor Algebra – Electrical Analogy – Radiation Shields – Introduction to Gas Radiation

**Practical: Determination of emissivity of a grey surface

UNIT V MASS TRANSFER **12**

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations

**Practical: Determination of Stefan-Boltzmann constant

Lecture: 45 Practice: 15 Total Periods: 60

Text Books:

1. Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", New Age International publication, (2017)
2. Kothandaraman C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, (2012)

References:

1. Yadav R., "Heat and Mass Transfer", Central Publishing House, (2004)
2. Ozisik M.N., "Heat Transfer", McGraw-Hill Book Co., (2001)
3. Nag P.K., "Heat Transfer", Tata McGraw-Hill, New Delhi, (2014)
4. Holman J.P., "Heat and Mass Transfer", Tata McGraw-Hill, (2013)

LIST OF EQUIPMENTS		
1.	Guarded plate apparatus	1 No.
2.	Lagged pipe apparatus	1 No.
3.	Natural convection-vertical cylinder apparatus	1 No.
4.	Forced convection inside tube apparatus	1 No.
5.	Pin fin apparatus	1 No.
6.	Stefan-Boltzmann apparatus	1 No.
7.	Emissivity measurement apparatus	1 No.
8.	Parallel/counter flow heat exchanger apparatus	1 No.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	3		2	2					1	2	2		2
CO2	3	2	3	3		2	2					1	2	2		1
CO3	3	2	2	2		1	2					1	2	1		2
CO4	3	3	2	2		2	2					1	2	2		2
CO5	3	2	1	3		1	2					1	2	2		2
CO6	3	2	1	3		1	1					1	2	1		1

191ME67	CAD/CAM LABORATORY				L-T-P	C
					0-0-3	2
Programme:	B.E. Mechanical Engineering	**Sem:**	**VI**	**Category:**	**PC**	
Prerequisites:	Computer Aided Drafting Laboratory					
Aim:	To communicate knowledge in Solid Modeling & CNC by using relevant CAD/CAM software					

Course Outcomes:

The students will be able to

CO1. Interpret the fundamentals of the Computer Aided Design which will equip them to pursue higher studies

CO2. Identify the different modeling, transformation and assembling tools in computer aided modeling of structural problems

CO3. Illustrate any solid part modeling and assembling the parts by using modeling software package

CO4. Recognize the need of G & M codes in CNC part programming

CO5. Write part programme for Milling and Lathe

CO6. Realize the need of simulation and hands on training in CNC machine

Computer Aided Design (CAD)

3D PART MODELING – Protrusion, revolve protrusion, swept protrusion, lofted protrusion, helical protrusion, rib, dimensioning, Move, Pattern, Mirror, Round, Chamfer, Hole, Thread etc.,

ASSEMBLY – 3D Modeling of

- Knuckle joint
- Universal coupling
- Plummer Block
- Screw Jack
- Stuffing Box
- Tail Stock
- Bushed Pin Type Flange coupling
- Crane Hook
- C-Clamp

Computer Aided Manufacturing (CAM)

a) MANUAL PART PROGRAMMING (Using G and M Codes) in CNC lathe

Part programming for

1. Turning,
2. Facing,
3. Drilling
4. Internal Thread cutting
5. External Thread cutting

b) MANUAL PART PROGRAMMING (using G and M codes) in CNC milling

Part programming for

1. Linear & Circular interpolation
2. Rectangular and circular
3. Canned cycles

NOTE: Practical examination duration is Three hours. Students will carry out one exercise in modeling and one exercise in CNC part programming & simulation.

SYSTEM REQUIREMENTS
(For a batch of 30 Students)

Hardware:

1. Intel i3 core due processor with 4GB ram with 500GB hard disk – 30 Nos.
2. Laser Printer – 1 No.
3. Trainer CNC Lathe – 1 No.
4. Trainer CNC Milling – 1 No.

Software:

1. CAD/CAM software – Solid Edge V20/CREO V2.0 – 50 licenses
2. CAM Software – CNC Programming & Simulation software – 30 licenses

Total Periods: 45

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	3		2			3	2	2	2	3	3	2
CO2	2	2	2	3	3		2			3	2	2	2	3	3	2
CO3	2	2	2	3	3		2			3	2	2	2	3	3	2
CO4	2	2	2	3	3		2			3	2	2	2	3	3	2
CO5	2	2	2	3	3		2			3	2	2	2	3	3	2
CO6	2	2	2	3	3		2			3	2	2	2	3	3	2

191ME71	TOTAL QUALITY MANAGEMENT			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:** VII	**Category:**	PC	
Prerequisites:	Nil				
Aim:	To understand the various principles, practices of TQM to achieve quality and to learn the various statistical approaches for Quality control				

Course Outcomes:

The students will be able to
CO1. Know the basics of TQM
CO2. Understand the principles of TQM
CO3. Improve their workplace with the help of 5S
CO4. Learn the six sigma and bench marking techniques
CO5. Familiarize Quality circles and QFD
CO6. Study the various quality systems

UNIT 1	EVALUATION OF TQM	9

Introduction – Need for quality – Evolution of quality – Definition of quality – Dimensions of manufacturing and service quality – Basic concepts of TQM – Definition of TQM – TQM Framework – Contributions of Deming, Juran and Crosby – Barriers to TQM

UNIT 1I	TQM PRINCIPLES	9

Leadership – Strategic quality planning, Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal – Continuous process improvement – PDSA cycle, 5S, Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating

UNIT 1II	TQM TOOLS & TECHNIQUES I	9

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking– Reason to bench mark, Bench marking process – FMEA – Stages, Types

UNIT 1V	TQM TOOLS & TECHNIQUES II	9

Quality circles – Quality Function Deployment – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures

UNIT V	QUALITY SYSTEMS	9

Need for ISO 9000 – ISO 9000:2000 Quality System – Elements, Documentation, Quality auditing – QS 9000 – ISO 14000 – TS1600 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT

	Total Periods:	**45**

Text Books

1. Dale H. Besterfiled et al., **"Total Quality Management",** Pearson Education Asia, (2014)
2. Shridhara Bhat K., **"Total Quality Management",** Himalaya Publishing House, (2013)

References

1. James R. Evans and William M. Lindsay, **"The Management and Control of Quality",** Thomson South-Western, (2010)
2. Oakland J.S., **"TQM – Text with Cases",** Butterworth – Heinemann Ltd., Oxford, (2003)
3. Suganthi L., Anand Samuel, **"Total Quality Management",** PHI Pvt. Ltd., (2011)
4. Janakiraman B. and Gopal R.K., **"Total Quality Management – Text and Cases",** PHI Pvt. Ltd., (2012)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		2							3	2	3	1		2		3
CO2								2	3			2				2
CO3								2	3			2		2		3
CO4	2			3					2		2	2		2	2	3
CO5	1			3						2	2	1		1		2
CO6								1		2	3	1				3

191ME72	GAS DYNAMICS AND JET PROPULSION			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**VII**	**Category:**	**PC**
Prerequisites:					
Aim:	To understand the compressible flow, shock waves, jet propulsion and Rocket Propulsion				

Course Outcomes:

The students will be able to

CO1. Explain the classification of compressible fluid flow
CO2. Describe the isentropic flow through ducts, nozzle, and diffusers
CO3. Analyze the flow through heat transfer for Rayleigh flow and fanno flow
CO4. Describe the governing equation using normal and oblique shocks to analyze the Mayer relation and its applications
CO5. List the jet engines and to determine the propulsive efficiency
CO6. Elaborate the performance of turbo jet, turbo fan and turbo prop engines

UNIT 1	**BASIC CONCEPTS AND ISENTROPIC FLOWS**	**9**

Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers – Use of Gas tables

UNIT 1I	**FLOW THROUGH DUCTS**	**9**

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties – Use of tables and charts – Generalised gas dynamics

UNIT 1II	**NORMAL AND OBLIQUE SHOCK**	**9**

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Use of table and charts – Applications

UNIT 1V	**JET PROPULSION**	**9**

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operation principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines

UNIT V	**SPACE PROPULSION**	**9**

Types of rocket engines – Propellants – feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – space flights

	Total Periods:	**45**

Text Books:

1. Anderson J.D., "Modern Compressible Flow", McGraw Hill, (2011)
2. Yahya S.M., "Fundamentals of Compressible Flow", New Age International (P) Limited, New Delhi, (2010)

References:

1. Hill P., Peterson C., "Mechanics and Thermodynamics of Propulsion", Addison – Wesley Publishing company, (2012)
2. Zucrow N.J., "Principles of Jet Propulsion and Gas Turbines", John Wiley, New York, (2010)
3. Sutton G.P., "Rocket Propulsion Elements", John Wiley, (2012)
4. Ganesan V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, (2011)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1			2	2					3		2		
CO2	2	2	1	3	2		1					3	1			
CO3	1	3	3	3										2		
CO4	3		1	2								3		2		
CO5	3	2	1	3	1							3			3	
CO6	1	2	2	3	1							3		2		

191ME73	FINITE ELEMENT ANALYSIS				L-T-P	C
					3-1-0	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**VII**	**Category:**	**PC**	
Prerequisites:	Fluid Mechanics and Machinery & Heat and Mass Transfer					
Aim:	To introduce the concepts of Mathematical Modeling of Engineering Problems and to appreciate the use of FEM to a range of Engineering Problems					

Course Outcomes:

The students will be able to

CO1: Express the various approximation and elimination methods to find the solution
CO2: Solve various numerical engineering problems in 1D bar & Truss element
CO3: Compile the elements in CST & axisymmetric element
CO4: Expose the difference between iso, super and sub parametric elements
CO5: Elucidate the numerical engineering problems in dynamic analysis & fluid mechanics problems
CO6: Realize the various applications involved in 1D, 2D heat transfer

UNIT 1	**INTEGRAL FORMULATION & VARIATION METHODS**	**12**

Methods of engineering analysis –weighted residual methods– general weighted residual statement– weak formulation of the weighted residual statement– principle of stationary total potential (PSTP) – Rayleigh Ritz method– piecewise continuous trial functions– simultaneous linear algebraic equations– Numerical integration – Gaussian quadrature

UNIT 1I	**1D BAR & TRUSS ELEMENT**	**12**

Introduction to matrix algebra – general steps in FEA – co-ordinates – linear bar element– shape functions– stiffness matrix– application to bar element – quadratic bar element– spring element – truss element – development of element equations– assembly– element connectivity– global equations

UNIT 1II	**PLANE STRESS & PLANE STRAIN ANALYSIS**	**12**

Introduction– constant strain triangular element (CST)– strain displacement matrix – stress strain relations– four noded rectangular element – iso-parametric elements– jacobian matrix –natural co-ordinate system and co-ordinate transformation – axisymmetric element

UNIT 1V	**DYNAMIC & FLUID FLOW ANALYSIS**	**12**

Fundamentals of vibration – equations of motion based on weak form – longitudinal vibration of bars – transverse vibration of beams – consistent & lumped mass matrices – Eigen values & Eigen vectors –Fluid mechanics in 2-D– shape function, stiffness matrix, load vector, assembly – Application

UNIT V	**HEAT TRANSFER ANALYSIS**	**12**

Temperature distribution using weighted residual approach – application to one-dimensional heat transfer problems in bar element – heat transfer analysis in CST element – axisymmetric element – scalar variable problems in 2-D

	Total Periods:	**60**

Text Books

1. Seshu P., **"Text Book of Finite Element Analysis",** Prentice-Hall of India Pvt. Ltd. New Delhi, (2013)
2. Chennakesava R. Alavala, **"Finite Elements Methods-Basic Concepts and Applications",** Prentice- Hall of India, Eastern Economy Editions, (2009)

References

1. Bhavikatti S.S., **"Finite Element Analysis",** New Age International Publishers, (2015)
2. Reddy J.N., **"An Introduction to the Finite Element Method",** McGraw-Hill Edition, (2010)
3. David V. Hutton, **"Fundamentals of Finite Element Analysis",** Tata McGraw-Hill Edition, (2005)
4. Senthil S. and Panneerdhass R., **"Finite Element Analysis",** Lakshmi Publications, Chennai, (2014)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	1						1	2	3	2		
CO2	3	3	3	3	3						2	2	3	2	1	
CO3	3	2	3	2	3						2	2	3	2	1	
CO4	3	2	1	1	2						1	2	3	3	1	
CO5	3	3	3	3	3						1	2	3	3	1	
CO6	3	3	3	3	3						1	2	3	3	1	

191ME74	MECHATRONICS			L-T-P	C
				3-0-2	4
Programme:	B.E. Mechanical Engineering	**Sem:**	**VII**	**Category:**	**PC**
Prerequisites:					
Aim:	To understand multidisciplinary applications of Electronics in Mechanical systems				

Course Outcomes:

The students will be able to

CO1. Explain the basics of Mechatronics systems

CO2. Classify various sensors and transducers with their properties

CO3. Operate Hydraulic, Pneumatic, Electrical and Mechanical Systems

CO4. Develop solution for various types of system models and controllers

CO5. Illustrate the basic concept and structure of PLC

CO6. Realize various Mechatronics Systems design

UNIT 1 MECHATRONICS, SENSORS AND TRANSDUCERS **9**

Introduction to Mechatronics Systems – Systems – Measurement Systems – Control Systems —Sensors for Displacement, Position, Proximity, Velocity, Motion, **Force**, Fluid Pressure, **Liquid Flow**, Liquid Level, Temperature, Light Sensors.

UNIT 1I ACTUATION SYSTEMS **9**

Sensors and Transducers – Performance Terminology - Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – Construction and working principle of DC and AC Motors – speed control of AC and DC drives, Stepper Motors – AC & DC Servo motors.

UNIT 1II SYSTEM MODELS AND CONTROLLERS **9**

Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational – Transnational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems – Control Mode – Two Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers – Velocity Control – Adaptive Control – Digital Logic Control – Micro Processors Control.

UNIT 1V PROGRAMMING LOGIC CONTROLLERS **9**

Programmable Logic Controllers – Basic PLC Structure – Input / Output Processing – Ladder Programming – Mnemonics – Timers, Latching, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC

UNIT V DESIGN OF MECHATRONICS SYSTEM **9**

Stages in designing Mechatronics Systems – Possible Design Solutions – designing of various Mechatronics systems -- **compare Traditional and Mechatronics – Selection of Sensors** – automatic washing machine – digital camera – Pick and place Robot – Autonomous mobile robot – Wireless surveillance balloon– Engine Management system – Automatic car park barrier

Total Periods: **45**

Text Books:

1. William Bolton., "Mechatronics – A multidisciplinary approach", Pearson education, (2016)
2. Rajput R.K., "A textbook of Mechatronics", S. Chand & Co., (2012)

References:

1. Smaili, A. and Mrad, F., "Mechatronics integrated technologies for intelligent machines", Oxford university press, **(2014).**
2. Michael B. Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, (2014).
3. Dan Necsulesu, "Mechatronics", Pearson Education Asia, (2002).
4. Nitaigour Premchand Mahadik, "Mechatronics", Tata McGraw-Hill publishing Company Ltd, (2010)

LIST OF EXPERIMENTS

1. Design and testing of fluid power circuits to control
   (i) velocity (ii) direction and (iii) force of single and double acting actuators
2. Design of circuits with logic sequence using Electro pneumatic trainer kits
3. Simulation of basic Hydraulic, Pneumatic and Electric circuits using software
4. Circuits with multiple cylinder sequences in Electro pneumatic using PLC
5. Speed Control of DC drives
6. Servo controller interfacing for DC motor
7. PID controller interfacing
8. Stepper motor interfacing with 8051 Micro controller
   (i) full step resolution (ii) half step resolution
9. Modeling and analysis of basic electrical, hydraulic and pneumatic systems using LABVIEW

Total Periods: 45

LIST OF EQUIPMENTS
(For a batch of 30 students)

1.	Basic Pneumatic Trainer Kit	2 Nos.
2.	Electrical controls/PLC control kit	1 No.
3.	Hydraulics and Pneumatics Systems Simulation Software – Fluidsim	10 Nos.
4.	8051 - Microcontroller kit with stepper motor and drive circuit sets	2 Nos.
5.	LAB VIEW software with Sensors to measure Pressure, Flow rate, direction, speed, velocity and force	2 Nos.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		1								1	2	1			
CO2	3		1		1						2	2	1	2		1
CO3	2		1		1						2	2	1	2		2
CO4	2	2	1	2	1						2	2	1	2		1
CO5	2		1		1						2	2	1	2		2
CO6	2	2	1		2						2	2	1	3		3

191ME79	PROJECT – I				L-T-P	C
					0-0-4	2
Programme:	B.E. Mechanical Engineering	**Sem:**	**VII**	**Category:**	**PROJ**	
Prerequisites:	Knowledge gained in all semesters					
Aim:	To understand the real time applications in engineering fields through project work					

Course Outcomes:

The students will be able to

CO1. Apply the basic principles of mechanical engineering courses

CO2. Ensure the working principle of mechanisms involved in the fabrication

CO3. Analyze the real time problems

CO4. Realize the industrial project work concepts

CO5. Simulate and design the mechanical systems

CO6. Use the software's in mechanical applications

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	1		2	2	1	1	3	3	2		
CO2	3	3	3	3	2		2	2	2	1	2	3	3		3	
CO3	3	3	3	3	2				2	1	2	3	2	3		
CO4	3	3	3	3		3	2		2	1	2	3	2		2	
CO5	3	3	3						2	2	2	3	2	3		2
CO6	3	3	3		3				2	2	2	3	3	2		2

191ME77	SIMULATION AND ANALYSIS LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E. Mechanical Engineering	**Sem:**	**VII**	**Category:**	**PC**
Prerequisites:					
Aim:	To gain knowledge in analyzing various structures by using relevant software				

Course Outcomes:

The students will be able to

CO1. Demonstrate the features of ANSYS software
CO2. Validate the stress analysis in beam problems with empirical formulas
CO3. Explicit the stress analysis of a plate with a circular hole and axi-symmetric component
CO4. Identify the need of mode frequency analysis in 2D component
CO5. Realize the Thermal analysis of a 2D component
CO6. Import any solid model to ANSYS for contact analysis

List of Exercises

1. Static Analysis of 2-D beam problems
2. Static Analysis of Plane stress problems
3. Static Analysis of Axisymmetric problems
4. Structural Analysis of Trusses
5. Stress analysis of rectangular L bracket
6. Stress analysis of a plate with a circular hole
7. Stress analysis of a bicycle frame
8. Mode frequency analysis of a 2D plate
9. Mode frequency analysis of beams
10. Harmonic analysis of a 2D component
11. Transient Heat Transfer Analysis of 2D problems
12. Heat Transfer Analysis of Axisymmetric Problems
13. Contact Analysis of a simple solid model
14. Buckling Analysis of a column

NOTE: Practical examination duration is Three hours. Students will carry out two exercises by using ANSYS software.

SYSTEM REQUIREMENTS
(For a batch of 30 Students)

Hardware:

1. Intel i3 core due processor with 4GB ram with 500GB hard disk – 30 Nos.
2. Laser Printer – 1 No.

Software:

1. ANSYS V14.5/equivalent – 50 licenses

Total Periods: 45

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3						2	3		2	2			2
CO2	2	1	1		2				2	2		3	3	3	1	2
CO3	2	3	3		2					2		2	3	3	2	2
CO4	2	3	3		2					2		2	3	3	2	2
CO5	2	3	3		2				2	2		2	3	3	2	2
CO6	2	3	3		2				2	1		3	2	3	3	3

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

191ME89	PROJECT – II				L-T-P	C
					0-0-12	6
Programme:	B.E. Mechanical Engineering	**Sem:**	**VIII**	**Category:**	**PROJ**	
Prerequisites:	Knowledge gained in all semesters					
Aim:	To understand the real time applications in engineering fields through project work					

Course Outcomes:

The students will be able to

CO1. Apply the basic principles of mechanical engineering courses

CO2. Ensure the working principle of mechanisms involved in the fabrication

CO3. Analyze the real time problems

CO4. Realize the industrial project work concepts

CO5. Simulate and design the mechanical systems

CO6. Use the software's in mechanical applications

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	1		2	2	1	1	3	3	2		
CO2	3	3	3	3	2		2	2	2	1	2	3	3		3	
CO3	3	3	3	3	2				2	1	2	3	2	3		
CO4	3	3	3	3		3	2		2	1	2	3	2		2	
CO5	3	3	3						2	2	2	3	2	3		2
CO6	3	3	3		3				2	2	2	3	3	2		2

Regulation 2019

PROGRAMME ELECTIVES

191HSEA	PROFESSIONAL ETHICS IN ENGINEERING			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	-	**Category:**	**HSMC**
Prerequisites:					
Aim:	To create an awareness on Engineering Ethics and human values. To instill moral and social values and loyalty and to appreciate the rights of others				

Course Outcomes:

The students will be able to

CO1. Summarize the various concepts and theories of Ethics
CO2. Illustrate the role of Engineers in experimentation
CO3. Estimate risk factors and analyze the various ways of reducing the risk
CO4. Outline the rights and responsibility of engineers in bargaining and conflict Management
CO5. Know how to get patent rights
CO6. Analyze the ethical issues in global level

UNIT I	ENGINEERING ETHICS	9

Senses of Engineering Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.

UNIT II	ENGINEERING AS SOCIAL EXPERIMENTATION	9

Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics – Codes of Ethics – Industrial Standards – A Balanced Outlook on Law – ~~The Challenger Case Study.~~

UNIT III	ENGINEER'S RESPONSIBILITY FOR SAFETY	9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk – Chernobyl Case Studies and Bhopal.

UNIT IV	RESPONSIBILITIES AND RIGHTS	9

Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality– Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V	GLOBAL ISSUES	9

Multinational Corporations – Business Ethics – Environmental Ethics – Computer Ethics – Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct.

Total Periods:	**45**

Text Books:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York (2015)
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics Concepts and Cases", Thompson Learning, (2016)

References:

1. Charles D. Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, (2010).
2. John R. Boatright, "Ethics and the Conduct of Business", Pearson Education, (2017)
3. Edmund G. Seebauer and Robert L. Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, (2015)
4. David Ermann and Michele S. Shauf, "Computers, Ethics and Society", Oxford University Press, (2016)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1						1		3	1		1	2				2
CO2						2		3	2		2	2				2
CO3						2		3			2	2				2
CO4						1		3	2		2	1				2
CO5						1		3			1	2				2
CO6						1		3			2	2				2

191MEEA	ADDITIVE MANUFACTURING			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**
Aim:	To know the principle, methods, possibilities and limitations as well as environmental effects of Additive Manufacturing technologies.				

UNIT I	**INTRODUCTION**	**9**
Overview – Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Benefits –Case studies.		
UNIT II	**DESIGN FOR ADDITIVE MANUFACTURING**	**9**
Design tools: Data processing - CAD model preparation – Part orientation and support structure generation – Model slicing –Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – DFAM for part quality improvement- Customised design and fabrication for medical applications.		
UNIT III	**PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES**	**9**
Photo polymerization: SLA-Photo curable materials – Process - Advantages and Applications. Powder Bed Fusion: SLS-Process description – powder fusion mechanism – Process Parameters – Typical Materials and Application. Electron Beam Melting.		
UNIT IV	**EXTRUSION BASED AND SHEET LAMINATION PROCESSES**	**9**
Extrusion Based System: FDM-Introduction – Basic Principle – Materials – Applications and Limitations – Bioextrusion. Sheet Lamination Process:LOM- Gluing or Adhesive bonding – Thermal bonding.		
UNIT V	**PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES**	**9**
Droplet formation technologies – Continuous mode – Drop on Demand mode – Three Dimensional Printing – Advantages – Bioplotter - Beam Deposition Process:LENS- Process description – Material delivery – Process parameters – Materials – Benefits – Applications		
	Total Periods:	**45**

Text Books:

1. Chua C.K., Leong K.F., and Lim C.S., **"**Rapid prototyping: Principles and applications**"**, Third edition, World Scientific Publishers, 2010.
2. 2 Ian Gibson, David W.Rosen, Brent Stucker **"**Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing**"** Springer , 2010.

References:

1. Andreas Gebhardt **"**Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing**"** Hanser Gardner Publication 2011.
2. Kamrani A.K. and Nasr E.A., **"**Rapid Prototyping: Theory and practice**"**, Springer, 2006.
3. Liou L.W. and Liou F.W., **"**Rapid Prototyping and Engineering applications: A tool box for prototype development**"**, CRC Press, 2007.
4. Tom Page **"**Design for Additive Manufacturing**"** LAP Lambert Academic Publishing, 2012.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1	2	3	2	1					1	1	2	2	3
CO2	2	2	1	3	3	2	2					3	1	3	2	3
CO3	2	2	1	3	3	2	1					3		2	2	2
CO4	2	2	1	3	3	2	1					1		2	2	2
CO5	1	2	1	3	3	2	1					1		2	2	2
CO6	1	2	1	3	3	2	1					1		2	2	2

191MEEB	COMPOSITE MATERIALS AND ENGINEERING			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**
Prerequisites:					
Aim:	To understand the fundamentals of composite material and its mechanical behavior				

Course Outcomes:

The students will be able to

CO1. Understand the concept of fiber preparation and its applications
CO2. Identify the different composite manufacturing methods
CO3. Learn the flat plate laminate constitute equations
CO4. Understand the lamina strength analysis
CO5. Know the anisotropic analysis of composites
CO6. Analyze the thermal properties of composites

UNIT I	BASICS TO FIBERS AND REINFORCEMENT MATERIALS	9

Definition – Matrix materials – Polymers – Metals – Ceramics – Reinforcements – Particles, Whiskers, Inorganic Fibers, Metal Filaments – Ceramic Fibers – Fiber Fabrication – Natural Composite Wood, Jute – Advantages and Drawbacks of Composites Materials – Mechanical Properties and Applications of Composites – Particulate – Reinforced Composite Materials – Dispersion Strengthened Composite – Fiber –Reinforced Composites Rule of Mixtures – Characteristics of Fiber Reinforced Composites – Manufacturing

UNIT II	MANUFACTURING OF COMPOSITES	9

Manufacturing of Polymer Matrix Composites (PMCs) – Handlay-up, Spray Technique, Filament Winding, Pultrusion, Resin Transfer Moulding (RTM) – Bag Moulding, Injection Moulding, Sandwich Mould Composites (SMC) – Manufacturing of Metal Matrix Composites (MMCs) – Solid state, Liquid State, Vapour State Processing, Manufacturing of Ceramic Matrix Composites (CMCs) – Hot Pressing – Reaction Bonding Process – Infiltration Technique, Direct Oxidation – Interfaces

UNIT III	LAMINA CONSTITUTIVE EQUATIONS	9

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint – Basic Assumptions of Laminated anisotropic plates – Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates – Laminate Structural Moduli – Evaluation of Lamina Properties from Laminate Tests – Quasi-Isotropic Laminates – Determination of Lamina stresses within Laminates

UNIT IV	STRENGTH ANALYSIS OF COMPOSITES	9

Introduction – Maximum Stress and Strain Criteria – Von-Misses – Yield criterion for Isotropic Materials – Generalized Hill's Criterion for Anisotropic materials – Tsai-Hill's Failure Criterion for Composites – Prediction of laminate Failure Equilibrium Equations of Motion – Energy Formulations – Static Bending Analysis – Buckling Analysis – Free Vibrations – Natural Frequencies

UNIT V	THERMAL ANALYSIS	9

Assumption of Constant C.T.E's – Modification of Hooke's Law – Modification of Laminate Constitutive Equations – Orthotropic Lamina C.T.E's – C.T.E's for special Laminate Configurations – Unidirectional, off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

	Total Periods:	**45**

Text Books:

1. Gibson, R.F., "Principles of Composite Material Mechanics", McGraw-Hill, CRC press in progress (1994)
2. Mallick P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, (1993)

References:

1. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press Edition (2007)
2. Robert M. Jones, "Mechanics of Composite Materials", McGraw Hill, (1998)
3. Halpin J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., (1984)
4. Agarwal B.D. and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, (1990)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2						1				1	2	1		3	
CO2	2		1				1				1	2	1			1
CO3	2	1		2			1					1	1	1		2
CO4	2	1	1	2			1					1	1	1		2
CO5	2	1	1	2								1	1	1		2
CO6	2	1	1	2								1	1	1		2

191MEEC	COMPUTATIONAL FLUID DYNAMICS			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**
Prerequisites:	Fluid Mechanics and Machinery				
Aim:	To impart the knowledge of numerical techniques to the solution of fluid dynamics and heat transfer problems				

Course Outcomes:

The students will be able to

CO1. Understand the governing equations of fluid flow
CO2. Apply explicit, implicit and semi-implicit methods of finite differencing
CO3. Possess the knowledge of CFD techniques
CO4. Know the basic aspects of grid generation
CO5. Model fluid flow problems and heat transfer
CO6. Solve fluid flow field using some popular CFD techniques

UNIT I	**INTRODUCTION AND GOVERNING EQUATIONS**	**9**
Introduction – Impact and applications of CFD in diverse fields – Governing equations of fluid dynamics – Continuity – Momentum and energy – Generic integral form for governing equations – Initial and Boundary conditions – Governing equations for boundary layers – Classification of partial differential equations – Hyperbolic – Parabolic – Elliptic and Mixed types – Applications and relevance		
UNIT II	**FINITE DIFFERENCE METHOD**	**9**
Introduction to Finite differences – Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit – Crank-Nicolson – ADI scheme – Stability criterion – Example problems on elliptic and parabolic equations – Grid independence test – Optimum step size		
UNIT III	**GRID GENERATION**	**9**
Grid generation – General transformation of the equations – Form of the governing equations suitable for CFD – Boundary fitted Co-ordinate systems – Elliptic grid generation – Adaptive grids – Modern developments in grid generation		
UNIT IV	**FINITE VOLUME METHOD FOR CONVECTION DIFFUSION**	**9**
Steady one-dimensional convection and diffusion – Central, upwind differencing schemes – properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, quick Schemes		
UNIT V	**CALCULATION OF FLOW FIELD**	**9**
Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, simple algorithm and its variants – Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models		
	Total Periods:	**45**

Text Books

1. Versteeg H.K. and Malalasekera W., **"An Introduction to Computational Fluid Dynamics: The finite volume Method",** Pearson Publication, (2008)
2. Hoffman K.A., **"Computational Fluid Dynamics for Engineering",** Engineering Education System, Austin, Texas, (2000)

References

1. Muralidhar K., and Sundarajan T., **"Computational Fluid Flow and Heat Transfer",** Narosa Publishing House, New Delhi, (2011)
2. Anderson J.D., **"Computational Fluid Dynamics – The basics with applications",** McGraw-Hill, (2000)
3. Patankar S.V., **" Numerical Heat Transfer and Fluid Flow",** Hemisphere Publishing Corporation, (2004)
4. Prodip Niyogi, Chakrabarty S.K., Laha M.K., **"Introduction to Computational Fluid Dynamics",** Pearson Education, (2005)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		3	2								2	2	3		
CO2	2	2		2	3							2	3			
CO3	3		2	2								1	2		3	
CO4	2	3		3	2							2	2		3	
CO5	2		3		3							2	2	3		
CO6	2	2	3		3							2	2		3	

191MEED	COMPUTER INTEGRATED MANUFACTURING			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	PE
Prerequisites:					
Aim:	To gain the knowledge about the Advanced and computerized Manufacturing Techniques followed in the Shop floor of the Industries				

Course Outcomes:

The students will be able to

CO1. Understand the concept of CIM
CO2. Explain the components of CIM
CO3. Recognize the Group Technology and CAPP
CO4. List out the various techniques in shop floor control
CO5. Know the concept of FMS
CO6. Familiarize the computer aided planning and control

BASICS OF CIM	**9**

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control – Introduction to CAD/CAM – Concurrent Engineering – CIM concepts – Computerized elements of CIM system – Types of production – Typical CAD command structure, wire frame modeling, surface modeling and solid modeling (concepts only) in relation to popular CAD packages

COMPONENTS OF CIM	**9**

CIM as a concept and a technology, CASA/SME model of CIM, CIM II, benefits of CIM, communication matrix in CIM, fundamentals of computer communication in CIM – CIM data transmission methods – serial, parallel, asynchronous, synchronous, modulation, demodulation, simplex and duplex – Types of communication in CIM – point to point (PTP), star and multiplexing. Computer networking in CIM – the seven layer OSI model, LAN model, MAP model, network topologies – star, ring and bus, advantages of networks in CIM

GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING	**9**

History Of Group Technology – role of G.T. in CAD/CAM Integration – part families – classification and coding – DCLASS and MICLASS and OPTIZ coding systems – facility design using G.T. – benefits of G.T. – cellular manufacturing – Process planning – role of process planning in CAD/CAM Integration – approaches to computer aided process planning – variant approach and generative approaches

SHOP FLOOR CONTROL AND FMS	**9**

Shop floor control – phases – factory data collection system – automatic identification methods – Bar code technology – automated data collection system – FMS – components of FMS – types – FMS workstation – material handling and storage system – FMS layout – computer control systems – applications and benefits

COMPUTER AIDED PLANNING, CONTROL AND MONITORING	**9**

Production planning and control – cost planning and control – inventory management – material requirements planning (MRP) – Lean and Agile Manufacturing – Types of production monitoring systems – structure model of manufacturing – process control and strategies – Direct Digital Control

Total Periods:	**45**

Text Books:

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education (2013)
2. Mikell P. Groover, Emory Zimmers Jr., "CAD/CAM", Prentice Hall of India Pvt. Ltd., (2006)

References:

1. James A. Regh and Henry W.Kreabber, "Computer Integrated Manufacturing", Pearson Education, (2005)
2. Chris McMahon and Jimmie Browne, "CAD CAM Principles, Practice and Manufacturing Management", Pearson Education, (2005)
3. Ranky Paul G., "Computer Integrated Manufacturing", Prentice Hall of India Pvt. Ltd., (2005)
4. Yorem Koren, " Computer Integrated Manufacturing", McGraw Hill, (2005)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1		1	2							1	1	1		2
CO2	2			2	2							2	1			2
CO3	1		2	1	1					1		1	1		1	1
CO4	2		1	1						1		1	1		1	1
CO5																
CO6	2			1	1					1		1	1			1

191MEEE	FIREWORKS SAFETY				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**	
Prerequisites:	Nil					
Aim:	To learn the properties, preparation of fireworks chemicals and safety in fireworks industry					

Course Outcomes:

The students will be able to

CO1. Describe the properties of various chemicals used in fireworks industry
CO2. Test the sensitivity of fireworks chemicals
CO3. Recall the concepts of earthing and legal requirements
CO4. Improve the process safety in fireworks industry
CO5. Use the proper material handling techniques / equipment
CO6. Control the wastes and ensure the human safety in fireworks

UNIT I	**PROPERTIES OF FIREWORKS CHEMICALS**	**9**

Fire properties – Ingredients of fireworks chemicals – Fuel – Oxidizer – Colouring Agent - Binder - properties of chemicals used in fireworks: Aluminum powder, Ammonia, Antimony, Barium Carbonate, Barium Chlorate, Barium Nitrate , Boric Acid, Calcium sulfate, Carbon, Charcoal, Magnesium , Phosphorous, Potassium benzoate , Potassium Chlorate, Potassium Nitrate, Potassium per chloride, Sodium Nitrate, Strontium Nitrate, Sulphur – reactions – impact and friction sensitivity

UNIT II	**STATIC CHARGE AND DUST EXPLOSION**	9

Concept of static charge – reasons – prevention – earthing – types of earthing – lightning – causes and effects – concept, installation and maintenance of lightning arrestor – Dust explosion - size of dust – sources - prevention - non-respirable – biological barriers – personal protective equipments – pollution prevention

UNIT III	**PROCESS SAFETY**	9

Process – quantity, mixing – filling – fuse cutting – fuse fixing – finishing – drying at various stages – packing storage – hand tools – materials, layout: building – distances – personal protective equipments – pollution prevention - factories act – explosive act and rules

UNIT IV	**MATERIAL HANDLING**	9

Material handling – factors – types – fuse handling – paper caps handling – nitric acid handling in snake eggs manufacture – handling the mix inside factory –material movement –-waste pit – transport restrictions – overhead power lines – fire extinguishers – loose chemicals handling and transport

UNIT V	**WASTE CONTROL AND USER SAFETY**	9

Concepts of wastes – wastes in fireworks – disposal – spillages – storage of residues - waste pit - dimensions – User safety - hazards in display –electronic ignition – restrictions in sales outlets – fire prevention and control - fire extinguishers – burns and scalds – role of fire service - factories act – classes of explosive act and rules 2008

	Total Periods:	**45**

Text Books

1. Pitchipoo P., Marichamy P. and Johnson Raja S., "Fireworks – Production and Safety", 1st Edition, Shanlax Publications, Madurai, (2019)
2. Ronald Lancaster, Roy E.A. Butler, J. Mark Lancaster and Takeo Shimizu, **"Fireworks Principles and Practice",** Chemical Publishing Company, New York, (2006)

References

1. John Barton, **"Dust Explosion Prevention and Protection",** Institution of Chemical Engineers, UK, (2002)
2. Michael S. Russell, **"The Chemistry of Fireworks",** Royal Society of Chemistry, UK, (2009)
3. Proceedings of National conference on **"Pyro Tech 2013",** by Petroleum and Explosives Safety Organization (PESO), Ministry of Explosives, Government of India, (2013)
4. Bill Ofca, **"Fireworks Safety Manual: A Collection of Essays",** Hyde Park, New York, (1990)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1		1					1	2	2			
CO2	2	2	1	1		1	2	1	1		1	1	1	2		2
CO3	2	1	3	1		3	2			2			2			
CO4	2	1	3	2		3	2		1		2	1	2			2
CO5	2	1	1	2		1	1				2		2	2		2
CO6	2	2	3	2		3	3	2	1	1	2	1	2			1

191MEEF	FUNDAMENTALS OF NANO TECHNOLOGY			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**
Prerequisites:	Physics of Materials				
Aim:	To learn about basis of nanomaterial science, preparation method, types and application				

Course Outcomes:

The students will be able to

CO1. Familiarize about the science of nano materials
CO2. Prepare nano materials using various methods
CO3. Know the various nano materials and oxides
CO4. Identify the various characterization technique
CO5. Understand the applications of MEMS
CO6. Realize the nano information storage system

UNIT I	BASICS OF NANOSCIENCE	9

Nano scale Science and Technology – Implications for Physics, Chemistry, Biology and Engineering – Classifications of nano structured materials – nano particles – quantum dots, nanowires – ultra thinfilms multilayered materials – Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties

UNIT II	GENERAL METHODS OF PREPARATION	9

Bottom-up Synthesis – Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III	NANOMATERIALS	9

Nanoforms of Carbon – Buckminster fullerene – graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT) – methods of synthesis (arc-growth, laser ablation, CVD routes, Plasma CVD), structure – property relationships applications – Nanometal oxides – ZnO, TiO_2, MgO, ZrO_2, NiO, nanoalumina, CaO, $AgTiO_2$, Ferrites, Nano clays functionalization and applications

UNIT IV	CHARACTERIZATION TECHNIQUES	9

X-ray diffraction technique, Scanning Electron Microscopy – environmental techniques, Transmission Electron Microscopy including high resolution imaging, Surface Analysis techniques – AFM, SPM, STM, SNOM, ESCA, SIMS – Nano indentation

UNIT V	APPLICATIONS	9

Nano InfoTech: Information storage – nanocomputer, molecular switch, super chip, nano crystal, Nano biotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging – Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS) – Nano sensors, nano crystalline silver for bacterial inhibition, Nano particles for sun barrier products - In Photostat, printing, solar cell, battery

Total Periods: 45

Text Books

1. Guozhong Cao, Ying Wang, **"Nanostructures and Nanomaterials: Synthesis, Properties, and Applications",** World Scientific Publications, Singapore, (2011)
2. Charles P. Poole and Frank J. Ownes, **"Introduction to Nanotechnology",** Wiley India, New Delhi, (2006)

References

1. Vollath D., **"Nanomaterials: An Introduction to Synthesis, Properties and Applications",** Wiley India, New Delhi, (2013)
2. Jeremy Ramsden, **"Nanotechnology: An Introduction",** Elsevier, UK, (2008)
3. Edelstein A.S., Cammearata R.C., **"Nanomaterials: Synthesis, Properties and Applications",** Institute of Physics Publishing, Bristol and Philadelphia, (1996)
4. Manasi Karkere, **"Nanotechnology: Fundamentals and Applications",** I.K. International, New Delhi, (2009)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3										3	3			
CO2	3	3		3	3							3				2
CO3		3		2								3		3		
CO4			2		3			1	2			3			3	
CO5	3			3	3	2	2					3		3		
CO6			3	2	3							3				2

191MEEG	HYBRID AND E-VEHICLES			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**
Prerequisites:	Thermal Engineering				
Aim:	To understand the basic concepts of Hybrid Electric Vehicles and its application				

Course Outcomes:

The students will be able to
CO1. Explain the Hybrid Electric Drive-trains and Electric Drive-trains
CO2. Develop Configuration and control of DC Motor drives
CO3. Explain the Energy Storage Requirements in Hybrid and Electric Vehicles
CO4. Matching the electric machine and the internal combustion engine
CO5. Identify the selecting the energy storage technology
CO6. Recognize the energy management strategies used in hybrid and electric vehicles

UNIT I	INTRODUCTION TO HYBRID ELECTRIC VEHICLES	9

Introduction to Hybrid Electric Vehicles, Conventional Vehicles. Hybrid Electric Drive-trains and Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT II	ELECTRIC PROPULSION	9

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT III	ENERGY STORAGE	9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles. Battery, Fuel Cell, Super Capacitor and Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT IV	SIZING THE DRIVE SYSTEM	9

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

UNIT V	ENERGY MANAGEMENT STRATEGIES	9

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

	Total Periods:	**45**

Text Books

1. Kirpal Singh, **"Automobile Engineering Vol.2",** Standard Publishers, New Delhi, (2014)
2. Ganesan V., **"Internal Combustion Engines",** Tata McGraw Hill, (2012)

References

1. Heinz Heisler, **"Advanced Engine Technology",** SAE International Publications, USA, (2005)
2. John B. Heywood, **"Internal Combustion Engine Fundamentals",** Tata McGraw-Hill, (1988)
3. Gupta H.N., **"Fundamentals of Internal Combustion Engines",** Prentice Hall of India, (2006)
4. Ultrich Adler, **"Automotive Electric/Electronic Systems",** Published by Robert Bosh GmbH, (1995)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1		1	2							1	1	1		2
CO2	2			2	2							2	1			2
CO3	1		2	1	1					1		1	1		1	1
CO4	2		1	1						1		1	1		1	1
CO5																
CO6	2			1	1					1		1	1			1

191MEEH	INDUSTRIAL ENGINEERING & MANAGEMENT			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**
Prerequisites:	Engineering Economics and Management				
Aim:	To provide students an insight into the concepts of industrial engineering and organization				

Course Outcomes:

The students will be able to

CO1. Forecast the demand using various forecasting techniques
CO2. Know the costing methods
CO3. Understand the concepts of industrial organization.
CO4. Familiarize with principles of work-study and ergonomics
CO5. Study the various aspects of plant design
CO6. Understand the various manufacturing systems

UNIT I	**DEMAND FORECASTING AND ELEMENTS OF COST**	**9**

Macro and micro economics – Demand and supply – Factors influencing demand – Elasticity of demand – Demand forecasting – Time series – Exponential smoothing casual forecast – Delphi method – Correlation and Regression – Elements of cost – Determination of Material cost – Labour cost – Expenses – Types of cost – Cost of production – Overhead expenses

UNIT II	**INDUSTRIAL ORGANISATION**	**9**

Introduction to Industrial Engineering – Concepts – History and Development of Industrial engineering – Roles of Industrial Engineer – Applications – Productivity – Factors affecting productivity – Increasing productivity of resources – Kinds of productivity measures

UNIT III	**WORK DESIGN**	**9**

Introduction to work study – Method study – Time study – stopwatch time study – Standard data – Method Time Measurement (M-T-M) – Work sampling – Ergonomics

UNIT IV	**PLANT LAYOUT**	**9**

Plant location – Factors – Plant layout – Types – Layout design process – Computerized Layout Planning – Construction and Improvement algorithms – ALDEP – CORELAP and CRAFT – Scheduling

UNIT V	**GROUP TECHNOLOGY**	**9**

Group technology – Problem definition – Production flow analysis – Heuristic methods of grouping by machine matrices – Flexible Manufacturing System – FMS work stations – Material handling and Storage system – Cellular Manufacturing System

Total Periods: 45

Text Books

1. Khanna O.P., **"Industrial Engineering and Management",** Dhanpat Rai Publications, New Delhi, (2006)
2. Panneerselvam. R. **"Production/Operations Management",** Prentice Hall of India, New Delhi, (2012)

References

1. Patil S.B., Karad A.A. and Kushare P.B., **"Industrial Engineering and Management",** Technical Publications, Pune, (2009)
2. Buffa E.S. and Sarin R.K., **"Modern Production/Operational Management",** Wiley India, New Delhi, (2009)
3. Dan Reid R., Nada R. Sanders, **"Operations Management: An Integrated Approach",** Wiley India, New Delhi, (2016)
4. Nigel Slack, Stuart Chambers, Robert Johnston., **"Operation Management",** Pearson Education, New Delhi, (2010)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2						2		2	3			2
CO2		2		3	1		1	3				3	2			2
CO3	1			3	1			2	2	2		3		3		3
CO4	2	1			2			3		1		3	1	2		2
CO5	3	2	1	2	3		1	1				3		1		3
CO6	3	2		1	1			2				3			2	2

191MEEI	PRODUCT DESIGN AND DEVELOPMENT				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**OE**	
Prerequisites:	Nil					
Aim:	Understand the application of product design methods to develop a product					

Course Outcomes:

The students will be able to
CO1: Know the customer needs for the product development
CO2: Design the product architecture
CO3: Determine the cost reduction for the design
CO4: Know the procedure for prototyping
CO5: Analyze the project development t
CO6: Develop the new product

UNIT I PRODUCT DEVELOPMENT AND CONCEPT SELECTION	**9**
Product development process Product development organizations- Identifying the customer needs Establishing the product specifications concept generation Concept selection.	
UNIT II PRODUCT ARCHITECTURE	**9**
Product architecture Implication of the architecture Establishing the architecture Related system level design issues.	
UNIT III INDUSTRIAL AND MANUFACTURING DESIGN	**9**
Need for industrial design Impact of industrial design Industrial design process. Assessing the quality of industrial design- Human Engineering consideration - Estimate the manufacturing cost Reduce the component cost Reduce the assembly cost Reduce the support cost Impact of DFM decisions on other factors	
UNIT IV PROTOTYPING AND ECONOMIC ANALYSIS	**9**
Principles of prototyping Planning for prototypes - Elements of economic analysis Base case financial model Sensitivity analysis Influence of the quantitative factors	
UNIT V MANAGING PRODUCT DEVELOPMENT PROJECTS	**9**
Sequential, parallel and coupled tasks - Baseline project planning Project Budget Project execution Project evaluation- patents- patent search-patent laws International code for patents.	
Total Periods:	**45**

References

1. Charles Gevirtz, Developing New products with TQM, McGraw Hill International editions, 1994
2. Karal .T. Ulrich, Steven D.Eppinger, Product Design and Development, McGRAW- HILL International Editions.2003.
3. S.Rosenthal, Effective product design and development, Irwin 1992.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		3	2	2						2		2	3	1		1
CO2		2		3	1		1	3				3	2			2
CO3				3	1			2	2	2		3		3	2	
CO4		1			2			3		1		3	1	2		
CO5		2	1	2	3		1	1				3		1		2
CO6		2		1	1			2				3			2	

191MEEJ	INTERNET OF THINGS FOR MANUFACTURING				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**		**Category:**	**PC**	
Prerequisites:	Manufacturing Technology					
Aim:	To discover key IoT concepts including identification, sensors, localization, wireless protocols To explore IoT technologies, architectures, standards, and regulation to realize the value created by collecting, communicating, coordinating, and leveraging data To examine developments that will likely shape the industrial landscape in the future					

Course Outcomes:

The students will be able to
CO1: Know the security issues in the IoT
CO2: Design procedure the implementing the IoT
CO3: Determine the requirement for the IoT in manufacturing environment
CO4: Analysis the prerequisites for IoT
CO5: Understand the applications of IoT in manufacturing
CO6: Know the places where the IoT can be implemented

UNIT I	INTRODUCTION	9

Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things.

UNIT II	DESIGN OF IoT	9

Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

UNIT III	PROTOTYPING OF IoT	9

Design principles for connected devices -Embedded devices, physical design, online components, embedded coding system. Informed Manufacturing plant Elements, IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Management of critical assets, Energy management and resource optimization, proactive maintenance.

UNIT IV	PREREQUISITES FOR IoT	9

IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems.

UNIT V	APPLICATION IN MANUFACTURING	9

Applications HCI and IoT world -Multilingual Interactions Robotics and Autonomous Vehicles Sensing and data Processing-Simultaneous mapping and Localization-Levels of autonomy, Smart factories,

Future research challenges

	Total Periods:	**45**

References

1. Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business, by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley & Sons.
2. Internet of Things: A Hands-On Approach by Vijay Madisetti, Arshdeep Bahga, VPT; 1st edition 2014.
3. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David -to-Machine to the Internet of Things -Introduction to a New Age of intelligence, Elsevier.
4. Meta Products -Building the Internet of Things by Wimer Hazenberg, Menno Huisman, BIS Publishers 2014

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3			1				1	1		3	1	1		3	
CO2	2	2	2	1		2	1	1	1		2	2	2		3	2
CO3	2	1	1	1		1	2	1	1		2	2	1		3	2
CO4	2	1	1	1		1	2	1	1		2	2	2		3	
CO5	2	1	1	1		1	2	1	1		2	2	2		3	2
CO6	2	1	1	1		1	3	1	1		2	2	2		3	

191MEEK	MODERN MACHINING PROCESSES				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	-	**Category:**	PC	
Prerequisites:	Manufacturing Technology					
Aim:	To understand the various unconventional machining processes, advantages and applications					

Course Outcomes:

The students will be able to

CO1. Classify unconventional machining process and identify various process selection parameters
CO2. Learn various mechanical energy based process
CO3. Understand the various unconventional machining process based on electrical energy
CO4. Study the various chemical energy machining process, parameters affecting it and applications
CO5. Know the machining process that fall under electro chemical energy, its parameters and applications
CO6. Explain the various thermal energy based machining processes in detail along with their applications

UNIT I	**MECHANICAL ENERGY BASED PROCESSES**	**9**

Unconventional machining Process – Need – classification – Brief overview – Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining – Ultrasonic Machining (AJM, WJM, AWJM and USM) – Working Principles – equipment used – Process parameters – MRR – Variation in techniques used – Applications

UNIT II	**ELECTRICAL ENERGY BASED PROCESSES**	**9**

Electric Discharge Machining (EDM) – working Principle – equipment's – Process Parameters – Surface Finish and MRR – electrode / Tool – Power and control Circuits – Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications

UNIT III	**CHEMICAL ENERGY BASED PROCESSES**	**9**

Chemical machining and Electro-Chemical machining (CHM and ECM) – Etchants – maskants –techniques of applying maskants – Process Parameters – Surface finish and MRR – Applications

UNIT IV	**ELECTRO-CHEMICAL ENERGY BASED PROCESSES**	**9**

Principles of ECM – equipment's – Surface Roughness and MRR – Electrical circuit – Process Parameters – ECG and ECH – Applications

UNIT V	**THERMAL ENERGY BASED PROCESSES**	**9**

Laser Beam machining and drilling (LBM), plasma Arc machining (PAM) and Electron Beam Machining (EBM) – Principles – Equipment –Types – Beam control techniques – Applications

Total Periods: 45

Text Books

1. Vijay K. Jain, **"Advanced Machining Processes",** Allied Publishers Pvt. Ltd., New Delhi, (2014)
2. Mishra P.K., **"Non-Conventional Machining",** The Institution of Engineers, India, (2015)

References

1. Benedict G.F., **"Nontraditional Manufacturing Processes",** Marcel Dekker Inc., New York, (2014)
2. Pandey P.C. and Shan H.S., **"Modern Machining Processes",** Tata McGraw-Hill, New Delhi (2015)
3. Mc Geough, **"Advanced Methods of Machining",** Chapman and Hall, London, (2010)
4. Paul De Garmo, Black J.T. and Ronald A. Kohser., **"Material and Processes in Manufacturing"**, Prentice Hall of India Pvt. Ltd., New Delhi, (2012)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3			1				1	1		3	1	1		3
CO2	3	2	2	2	1		2	1	1	1		2	2	2		3
CO3	3	2	1	1	1		1	2	1	1		2	2	1		3
CO4	3	2	1	1	1		1	2	1	1		2	2	2		3
CO5	3	2	1	1	1		1	2	1	1		2	2	2		3
CO6	3	2	1	1	1		1	3	1	1		2	2	2		3

191MEEL	RAPID PROTOTYPING			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**
Prerequisites:	161ME31-Manufacturing Technology				
Aim:	To provide knowledge on different types of Rapid Prototyping systems and its applications in various fields				

Course Outcomes:

The students will be able to

CO1. Gain depth knowledge in different types of Rapid Prototyping systems and its applications in various fields
CO2. Understand the various geometric modeling and meshing techniques
CO3. Recognize the data formats and interface
CO4. Expose in liquid and solid based engineering and digitization techniques
CO5. Know the powder sintering processes and its application
CO6. Design and generate supporting structures for any component

UNIT I	BASICS OF RAPID PROTOTYPING	9

Need – Development of RP systems – RP process chain – Impact of Rapid Prototyping on Product Development – Digital prototyping – Virtual prototyping – Rapid Tooling – Benefits – Applications

UNIT II	REVERSE ENGINEERING	9

Model Reconstruction – Data Processing for Rapid Prototyping: geometric modeling techniques: Wire frame, surface and solid modeling – data formats – Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation

UNIT III	LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS	9

Stereolithography: Apparatus: Principle, per-build process, part-building, post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Working principle, process, strengths, weaknesses and applications of Fused deposition Modeling, Solid Ground Curing, Laminated object manufacturing – Case studies

UNIT IV	POWDER BASED RAPID PROTOTYPING SYSTEMS	9

Selective Laser Sintering(SLS): Principle, process, Indirect and direct SLS – powder structures, modeling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications – Laser Engineered Net Shaping: Processes, materials, products, advantages, limitations and applications – Case Studies

UNIT V	OTHER RAPID PROTOTYPING TECHNOLOGIES	9

Three dimensional Printing: Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing: Introduction, basic process, shape decomposition, mold SDM and applications. Selective Laser Melting, Electron Beam Melting – Rapid manufacturing

	Total Periods:	**45**

Text Books

1. Chua C.K., Leong K.F., and Lim C.S., **"Rapid prototyping: Principles and applications",** World Scientific Publishers, (2010)
2. Andreas Gebhardt, **"Rapid prototyping",** Hanser Gardener Publications, (2003)

References

1. Liou W. Liou, Frank W. Liou, **"Rapid Prototyping and Engineering applications: A tool box for prototype development",** CRC Press, (2007)
2. Ali K. Kamrani, Emad Abouel Nasr, **"Rapid Prototyping: Theory and practice",** Springer, (2006)
3. Peter D.Hilton Hilton/Jacobs, Paul F.Jacobs, **"Rapid Tooling: Technologies and Industrial Applications",** CRC press, (2000)
4. Chee Kai Chua, Kah Fai Leong, **"3D-Printing and Additive Manufacturing: Principles and Applications",** World Scientific, (2014)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1	2	3	2	1					1	1	2	2	3
CO2	2	2	1	3	3	2	2					1	1	3	2	3
CO3	1	2	1	3	3	2	3					1		2	3	2
CO4	2	2	1	3	3	2	1					1		2	2	2
CO5	1	2	1	3	3	2	1					1		2	2	2
CO6	1	3	2	3	3	3	1					1		2	2	2

191MEEM	POWER PLANT ENGINEERING			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	**7**	**Category:**	**PC**
Prerequisites:					
Aim:	To understand the various components, operations and applications of different types of power plants				

Course Outcomes:

The students will be able to

CO1. Express the various power plants and boilers
CO2. Identify the handling equipments and different types of condenser
CO3. Discuss the various types of reactor
CO4. Select the different types of turbines for reactor
CO5. List the application of gas turbine power plants and inter cooling of combined cycle
CO6. Compute the operating cost and tariffs using the various power plants

INTRODUCTION TO POWER PLANTS AND BOILERS — **9**

Layout of Steam, Hydel, Diesel, MHD, Nuclear and Gas turbine Power Plants Combined Power cycles – comparison and selection, Load duration Curves Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidized Bed Boilers

STEAM POWERPLANT AND GAS TURBINE POWER PLANTS — **9**

Fuel and ash handling, Combustion Equipment for burning coal, Mechanical Stokers – Pulveriser, Electrostatic Precipitator, Draught – Different Types, Surface condenser types, cooling towers – Gas turbine power plant – Fuels – Gas turbine material – open and closed cycles – reheating – Regeneration and intercooling – combined cycle

NUCLEAR AND HYDEL POWER PLANTS — **9**

Nuclear Energy – Fission, Fusion Reaction, Types of Reactors, Pressurized water reactor, Boiling water reactor, Waste disposal and safety hydel Power plant – Essential elements, Selection of turbines, governing of Turbines – Micro hydel developments

DIESEL AND OTHER POWER PLANTS — **9**

Types of diesel plants, components, Selection of Engine type, applications – Geo thermal – OTEC – Tidel – Pumped storage – Solar central receiver system, Principle of working, Wind energy – types – HAWT, VAWT – Tidal Energy, Solar energy

POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATIONS — **9**

Fixed and operating costs – Energy rates – Types tariffs – Economics of load sharing, Effluents from power plants and impact on Environment – pollutants and pollution standards – Method of pollution control

Total Periods: 45

Text Books:

1. Rajput R.K., "A Text Book of Power Plant Engineering", Laxmi Publication, (2016)
2. Nag P.K., "Power Plant Engineering", Tata McGraw- Hill, (2014)

References:

1. EI-Wakil M.M., "Power Plant Technology", Tata McGraw-Hill, (2003)
2. Ramalingam K.K., "Power Plant Engineering", Scitech Publications,(2002)
3. Nagpal G.R., "Power Plant Engineering", Khanna Publishers, (2010)
4. Rai G.D., "Introduction to Power Plant Technology", Khanna Publishers, (2009)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	1	1	2	1				2	2	3		3
CO2	3	3	2	2		1	1	2				2	2	3		2
CO3	2	2	2	3	2	2	2	2	2	1		2		3		2
CO4	3	2	2	2	2	3	2	2			2	2		3		2
CO5	2	3	2	2	2	2	2	2	2	1	2	2	2	3		2
CO6	3	2			2	2	2	3	2	2		2	1	1	2	3

191MEEN	PROCESS PLANNING AND COST ESTIMATION			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**
Prerequisites:	Manufacturing Technology				
Aim:	To impart clear knowledge about process planning, costing and estimation of machining time				

Course Outcomes:

The students will be able to

CO1. Demonstrate the importance of Work study and Ergonomics
CO2. Describe the different approaches of Process Planning
CO3. Illustrate manufacturing logic and knowledge
CO4. Know the different cost and its components
CO5. Estimate the cost in fabrication shops
CO6. Find machining time calculation for different process

UNIT I	WORK STUDY AND ERGONOMICS	9

Method study – definition – objectives – motion economy – principles – Tools and Techniques – applications – work measurements – tools and techniques – standard time – ergonomics – principles – applications

UNIT II	PROCESS PLANNING	9

Definition – objective – scope – approaches to process planning – Process planning activities – Finished part requirements – operating sequences – machine selection – material selection parameters – documents for process planning – developing manufacturing logic and knowledge – production time calculation

UNIT III	COSTING AND ESTIMATION	9

Aims of costing and estimation – introduction to costs – cost accounting – classification of cost – elements of cost – types of estimates – methods of estimates – data requirements and sources – collection of cost – allowances in estimation – depreciation – analysis of depreciation

UNIT IV	ESTIMATION IN FABRICATION SHOPS	9

Estimation in foundry shop – Pattern cost – Casting cost – Estimation in Forging shop – Losses in forging – Forging cost – Estimation in welding shop – Gas cutting – Electric welding

UNIT V	ESTIMATION OF MACHINING TIME AND COST	9

Estimation of machining time for lathe operations – Estimation of machining time for drilling, boring, shaping, planning, milling and grinding operations

Total Periods: 45

Text Books

1. Banga T.R and Sharma S.C, **"Estimating and Costing",** Khanna publishers, New Delhi, (2012)
2. Khanna O.P., **"Industrial Engineering and Management",** Dhanpat Rai & Sons, (2010)

References

1. Russell R.S and Tailor, B.W, **"Operations Management",** PHI, (2008)
2. Chitale A.V. and Gupta R.C., **"Product Design and Manufacturing",** PHI, (2003)
3. Tailor B., Willip F. Ostwalal and Jairo Munez, **"Manufacturing Processes and Systems",** John wiley, (1998)
4. Nadha Muni Reddy C., **"Industrial Engineering and Management",** New Age International (P) Limited, New Delhi, (2011)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1					1					2	2		1	1		2
CO2					1						2	1		1		2
CO3							1	1		1	2		2	1		2
CO4	1				1						2				1	2
CO5	1										2	1		1		2
CO6	1										2			1		2

191MEEO	PRODUCTION PLANNING AND CONTROL			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**
Prerequisites:	Manufacturing Technology				
Aim:	To realize the various components and functions of product planning, process planning, production scheduling and inventory Control				

Course Outcomes:

The students will be able to

CO1. Familiarize in production control and its development
CO2. Understand the concepts of work study and work measurement
CO3. Familiarize the product planning and process planning
CO4. Acquire knowledge in production scheduling
CO5. Realize the need of inventory control
CO6. Know the recent trends in PPC

UNIT I	PRODUCTION CONTROL AND DEVELOPMENT	9

Objectives and benefits of planning and control – Functions of production control – Types of production – Product development and design – Marketing, Functional, Operational, aesthetic, Durability and dependability aspect – Profit consideration – Standardization, Simplification & specialization – Break even analysis

UNIT II	WORK STUDY AND WORK MEASUREMENT	9

Method study, basic procedure – Selection – Recording of process – Critical analysis, Development – Implementation – Micro motion and memo motion study – work measurement – Techniques of work measurement – Time study – Production study – Work sampling – Predetermined motion time standards

UNIT III	PRODUCT PLANNING AND PROCESS PLANNING	9

Product planning – Extending the original product information – Value analysis – Problems in lack of product planning – Process planning and routing – Pre requisite information needed for process planning – Steps in process planning – Quantity determination in batch production – Machine capacity, balancing – Analysis of process capabilities in a multi-product system

UNIT IV	PRODUCTION SCHEDULING	9

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

UNIT V	INVENTORY CONTROL AND RECENT TRENDS IN PPC	9

Inventory control – Purpose of holding stock – Effect of demand on inventories – Ordering procedures – Two bin system – Ordering cycle system – Determination of Economic order quantity and economic lot size – ABC analysis – Recorder procedure – Introduction to computer integrated production planning systems

	Total Periods:	**45**

Text Books

1. Martand Telsang, **"Industrial Engineering and Production Management",** S. Chand and Company, (2006)
2. James B. Dilworth, **"Operations Management: Providing Value in Goods and Services",** Dryden Press, (2000)

References

1. Mukhopadhyay S.K., **"Production Planning Control, Text and Cases",** PHI Publishers, (2015)
2. Mahajan M., **"Industrial Engineering and Production Management"**, Dhanpat Rai Publisher, (2010)
3. Elwood S. Buffa, and Rakesh K. Sarin, **"Modern Production/Operations Management",** Wiley India edition, (2009)
4. Kanishka Bedi, **"Production and Operations management",** Oxford university press, Edition (2016)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1					1					2	2		1	1		2
CO2					1						2	1		1		2
CO3							1	1		1	2		2	1		2
CO4	1				1						2				1	2
CO5	1										2	1		1		2
CO6	1										2			1		2

191MEEP	REFRIGERATION AND AIR CONDITIONING				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**PE**	
Prerequisites:	Engineering Thermodynamics					
Aim:	To provide knowledge on various refrigeration cycles, components, refrigerants and Refrigeration and Air conditioning systems					

The students will be able to

CO1. Construct the fundamentals of air conditioning & refrigeration cycle and C.O.P.
CO2. Distinguish the types of compressor and classifications of refrigerants
CO3. Relate the psychrometric processes using psychrometric charts
CO4. Analyze the performance of summer and window air conditioning
CO5. Calculate the cooling load of air conditioning system
CO6. Determine the duct design using friction method, air quality concept and application about the storage plants

UNIT I	**REFRIGERATION CYCLE**	**9**
Review of thermodynamic principles of refrigeration – Air Refrigeration cycles – Carnot refrigeration cycle – Vapour compression refrigeration cycle – use of P.H. charts – multistage compression and multiple evaporator systems – cascade system – COP comparison		
UNIT II	**REFRIGERANTS AND SYSTEM COMPONENTS**	**9**
Refrigerants – properties – selection of refrigerants, Alternate Refrigerants, Cycling controls – Compressors – reciprocating and rotary (elementary treatment), Types of condensers, evaporators, cooling towers – Functional aspects		
UNIT III	**PSYCHROMETRY**	**9**
Psychrometric processes use of psychrometric charts – Grand and Room Sensible Heat Factors – bypass factor – air washers, Cooling load calculation of air conditioning system		
UNIT IV	**AIR CONDITIONING SYSTEMS**	**9**
Comfort air conditioning – summer and Winter Air conditioning – working principles of centralized air conditioning systems, Split, Ductable split, Packaged Air conditioning, VAV & VRV Systems – Duct Design by equal friction method, Indoor Air quality concepts – Environmental effects		
UNIT V	**UNCONVENTIONAL REFRIGERATION CYCLES**	**9**
Vapour Absorption system – Ejector jet, Steam jet refrigeration and thermo electric refrigeration – Applications – ice plant – food storage plants – milk – chilling plants – petroleum refineries		
	Total Periods:	**45**

Text Books

1. Khurmi R.S. & Gupta J.K., **"Refrigeration and Air Conditioning",** S.Chand Publication, (2009)
2. Arora C.P., **"Refrigeration and Air Conditioning",** Tata McGraw Hill, New Delhi, (2008)

References

1. Roy J. Dossat, **"Principles of Refrigeration",** Pearson Education, (2007)
2. Jordon and Priester, **"Refrigeration and Air Conditioning",** Prentice Hall of India Pvt. Ltd., New Delhi, (2015)
3. Stoecker N.F. and Jones, **"Refrigeration and Air Conditioning",** TMH, New Delhi, (2011)
4. Jones, **"Air Conditioning Engineering",** Edward Amold Publication (2010)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1		2	2					2	2	2		2
CO2	3	1	2	1		2	2					2	2	2		2
CO3	3	2	1	3		2	2					1	2	2		2
CO4	3	2	3	2		2	2					2	2	2		2
CO5	3	2	3	2		2	2					2	2	2		2
CO6	3	1	3	1		2	2					2	2	2		2

191MEEQ	WELDING TECHNOLOGY				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**		**Category:**	**PE**	
Prerequisites:	Manufacturing Processes					
Aim:	To learn the concepts of metal joining and inspection					

Course Outcomes:

The students will be able to

CO1. Understand the basic concepts, working principles of welding
CO2. Know the special welding processes
CO3. Learn different welding methods and its applications
CO4. Acquire knowledge about welding automation
CO5. Examine the welding defects
CO6. Learn destructive, non-destructive testing and inspection of welded joints

UNIT I	BASICS AND PRINCIPLES OF WELDING PROCESS	9
Welding – weldability – classification of welding – types of weld joints – weld position – edge preparation – fluxes – filler – safety aspects in welding – gas welding – arc welding – electrode: types, selection – coding – welding symbols		
UNIT II	**SPECIAL WELDING PROCESSES**	**9**
Shielded metal arc welding, GTAW, GMAW, SAW, Resistance welding (spot, seam, projection, percussion, flash types) – atomic hydrogen arc welding – Thermit welding		
UNIT III	**ADVANCED WELDING PROCESSES**	**9**
Electron beam and Laser beam welding – plasma arc welding – stud welding – friction welding – explosive welding – ultrasonic welding – welding of plastics – brazing and soldering - welding of Aluminum, Copper		
UNIT IV	**AUTOMATED WELDING**	**9**
Automation – welding automation – welding operation, structure analysis – classification of welding automation – Introduction to welding robots – robotic welding system – types of welding robots – Robot selection mechanics – Design of welding robots – Joint tracking system – welding fixtures		
UNIT V	**WELD DEFECTS AND INSPECTION AND TESTING OF WELDING**	**9**
Weld defect – Surface defects, subsurface defect – Sources of weld defect – Introduction to inspection and testing of welds – Types of testing & inspection: Visual inspection and measurement, Destructive Testing – Tensile Tests, Impact Tests, Bend Tests, Break Tests, Etch Tests – Non-Destructive Testing – Liquid Penetrant Testing, Magnetic Particle Testing, Eddy Current Testing, Radio Graphic Testing, Magneto Graphic Testing, Ultrosonic Testing – Acceptance levels of arc welding defects		
	Total Periods:	**45**

Text Books

1. Little, **"Welding technology",** Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, (2004)
2. Khanna O.P., **"A text book of Welding Technology",** Dhanpat rai publications, New Delhi, (2002)

References

1. Parmer R.S., **"Welding Engineering & Technology",** Khanna Publishers, New Delhi, (2008)
2. Baldev Raj, V. Shankar, A. K. Bhaduri, **"Welding Technology for Engineers",** Alpha Science International, USA, (2006)
3. Rizvi S.A., **"Advanced Welding Technology",** S. K. Kataria & Sons, New Delhi, (2010)
4. William A. Bowditch, Kevin E. Bowditch, Mark A. Bowditch, **"Welding Technology Fundamentals",** Goodheart Willcox Publisher, USA, (2009)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		2			2	1		2			3				3
CO2	3		2			2	1		2			3				3
CO3	3		1			2	1		2			2				3
CO4	3		1			2	1		2			2				3
CO5	3		1			2	1		2			2				3
CO6	3		1			2	1		2			2				3

OPEN ELECTIVES

191OE6A	MAINTENANCE ENGINEERING			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**OE**
Prerequisites:	Nil				
Aim:	To understand the principles, functions and practices adapted in industry for the successful management of maintenance activities				

Course Outcomes:

The students will be able to

CO1. Know the principles of maintenance planning
CO2. Gain knowledge in maintenance organization and economics
CO3. Understand the maintenance policies – preventive maintenance
CO4. Familiarize the condition monitoring
CO5. Identify the repair methods for basic machine elements
CO6. Understand the repair methods for material handling equipment

UNIT I	**PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING**	**9**
Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics		
UNIT II	**MAINTENANCE POLICIES–PREVENTIVE MAINTENANCE**	**9**
Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle – Principles and methods of lubrication – TPM		
UNIT III	**CONDITION MONITORING**	**9**
Condition Monitoring – Cost comparison with and without CM – On-load testing and off- load testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis		
UNIT IV	**REPAIR METHODS FOR BASIC MACHINE ELEMENTS**	**9**
Repair methods for beds, slideways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location		
UNIT V	**REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT**	**9**
Repair methods for Material handling equipment – Equipment records – Job order systems – Use of computers in maintenance		
	Total Periods:	**45**

Text Books

1. Srivastava S.K., **"Industrial Maintenance Management",** - S. Chand and Co., (2018)
2. Bhattacharya S.N., **"Installation, Servicing and Maintenance",** S. Chand and Co., (2017)

References

1. White E.N., **"Maintenance Planning",** Gower Press, (1979)
2. Garg M.R., **"Industrial Maintenance",** S. Chand & Co., (1986)
3. Higgins L.R., **"Maintenance Engineering Hand book",** McGraw Hill, (1988)
4. Davies, **"Handbook of Condition Monitoring",** Chapman & Hall, (1996)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	2	2	2	2	1	3		2		2		2
CO2		2	2	3	1	1	2	1	1	2	2	2		2		2
CO3	1	2	2	2	2	2	2	2	2		2	2	1	2		2
CO4	1	3	2	2	2		1	2	2	1		2	1	2		2
CO5	1	3	2	2	2	2	2		2			2	1	2		2
CO6	2	3	2	3	3				3	2		2		2	2	2

191OE6B	NON-DESTRUCTIVE TESTING AND MATERIALS			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**OE**
Prerequisites:	Nil				
Aim:	To study and understand the various Non-Destructive Evaluation and Testing methods, theory and their industrial applications				

Course Outcomes:

The students will be able to

CO1. Differentiate various defect types and select the appropriate NDT methods for better evaluation
CO2. Explain basic knowledge of surface NDE techniques
CO3. Handle various inspection instrument with established procedures
CO4. Demonstrate their understanding of non-destructive testing principles
CO5. have a basic knowledge of ultrasonic testing which enables them to perform inspection of samples
CO6. Know the radiographic testing, interpretation and evaluation

UNIT I	**OVERVIEW OF NDT**	**9**

Overview of the Non-Destructive Testing NDT Versus Mechanical testing, Methods for the detection of manufacturing defects as well as material characterization, Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection

UNIT II	**SURFACE NDE METHODS**	**9**

Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results – Magnetic Particle Testing – Theory of magnetism, inspection materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism

UNIT III	**THERMOGRAPHY AND EDDY CURRENT TESTING**	**9**

Thermography – Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications – Eddy Current Testing – Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation

UNIT IV	**ULTRASONIC TESTING AND ACOUSTIC EMISSION**	**9**

Ultrasonic Testing – Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan – Phased Array Ultrasound, Time of Flight Diffraction – Acoustic Emission Technique-Principle, AE parameters, Applications

UNIT V	**RADIOGRAPHY**	**9**

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films – graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy-Xero-Radiography, Computed Radiography, Computed Tomography

	Total Periods:	**45**

Text Books

1. Baldev Raj, Jayakumar T., Thavasimuthu M., **"Practical Non Destructive Testing",** Narosa Publishing House, (2009)
2. Ravi Prakash, **"Non Destructive Testing Techniques",** New Age International Publishers, (2010)

References

1. Gnanaguru R. and Hari Balaji V., **"Non Destructive Testing and Materials",** Sams Publishers, Chennai, (2016)
2. Paul E. Mix, **"Introduction to Non Destructive testing: a training guide",** Wiley, (2005)
3. Charles J. Hellier, **"Handbook of Non Destructive evaluation",** McGraw Hill, New York, (2001)
4. ASM Metals Handbook, **"Non Destructive Evaluation and Quality Control",** American Society of Metals, Metals Park, Ohio, USA, (2001)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3		2	2	2	2	1		2	2	1			2	2	3
CO2	2	1	2		2	2	2		2	1			2	1		3
CO3	2			1	2	1	2		2						2	3
CO4	2	3	2	1	2				1		2	3	2			3
CO5	3	2	1	1			2	1	1		3		3	2		3
CO6		3	2	1	1		2	2		3	2	1		2	2	3

191OE6C	OPERATIONS RESEARCH AND MANAGEMENT				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**		**OE**
Prerequisites:	Nil					
Aim:	To understand the various techniques of optimization in utilization of resources, operations research techniques for industrial real-world problems					

Course Outcomes:

The students will be able to

CO1. Gain knowledge on Operations Research for industrial solutions
CO2. Apply L.P.P. in industrial optimization problems
CO3. Solve transportation problems using various OR methods
CO4. Solve assignment problems using various algorithms
CO5. Analyze the shortest route and critical path in a network
CO6. Apply OR methods in replacement strategy

UNIT I	**LINEAR MODELS**	**9**
Origin of Operations Research – The phases of O.R – Applications – Linear Programming: Formulation – Graphical method – Simplex method – Artificial Variable techniques: Big M Method		
UNIT II	**TRANSPORTATION MODELS**	**9**
Transportation Problems: Optimal solution by North West corner method – Vogel's Approximation method – Least cost method – MODI method		
UNIT III	**ASSIGNMENT MODELS**	**9**
Assignment Problems: Formulation – Unbalanced Assignment Problem – Hungarian algorithm – Traveling Salesman Problem		
UNIT IV	**NETWORK MODELS**	**9**
Network models – Shortest route – Minimal spanning tree – Maximum flow models – Project network – CPM and PERT networks – Critical path scheduling		
UNIT V	**REPLACEMENT MODELS**	**9**
Replacement Models: Replacement of items that deteriorate with time – Value of money changing with time & not changing with time – Optimum replacement policy: Individual & Group replacement		
	Total Periods:	**45**

Text Books

1. Hamdy A. Taha, **"Operations Research - An Introduction"**, Pearson Publications., New Delhi, 10th Edition (2017)
2. Natarajan A.M., Balasubramani P., Tamilarasi A., **"Operations Research"**, Pearson Publications., New Delhi, 2nd Edition (2014)

References

1. Ravindran A., Phillips Don T., Solberg James J., **"Operations Research: Principles and Practice",** John Wiley & Sons, New Delhi, 2nd Edition (2011)
2. Panneerselvam R., **"Operations Research"**, Prentice Hall of India., New Delhi, 2nd Edition (2010)
3. Prem Kumar Gupta and Hira D.S., **"Introduction to Operations Research"**, S. Chand and Co., New Delhi, 1st Edition (2012)
4. Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag, Preetam Basu**, "Operations Research–Concepts and Cases",** Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 7th Edition (2017)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3		3	1						3	2	3	2	2	3
CO2	2	3		3	1						3	2	3	2	2	3
CO3	2	3		3	1						3	2	3	2	2	3
CO4	2	3		3	1						3	2	3	2	2	3
CO5	2	3		3	1						3	2	3	2	2	3
CO6	2	3		3	1						3	2	3	2	2	3

191OE6D	RENEWABLE SOURCES OF ENERGY				L-T-P	C
					3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**		**OE**
Prerequisites:	Nil					
Aim:	To study the renewable energy resources and its economics of the utilization and environmental merits					

Course Outcomes:

The students will be able to

CO1. Clarify the different renewable energy sources and its applications
CO2. Explain the wind energy systems with hybrid systems
CO3. Group the bio energy sources and its environmental merits
CO4. Illustrate the various power plants and their environmental issues
CO5. Propose the new power generation systems
CO6. Do research in fuel cells

UNIT I	**SOLAR ENERGY**	**9**
Solar Radiation – Measurements of solar Radiation and sunshine – Solar Thermal Collectors – Flat Plate and Concentrating Collectors – Solar Applications – fundamentals of photo Voltaic Conversion – solar Cells – PV Systems – PV Applications		
UNIT II	**WIND ENERGY**	**9**
Wind Data and Energy Estimation – wind Energy Conversion Systems – Wind Energy generators and its performance – Wind Energy Storage – Applications – Hybrid systems		
UNIT III	**BIO – ENERGY**	**9**
Biomass, Biogas, Source, Composition, Technology for utilization – Biomass direct combustion – Biomass gasifier – Biogas plant – Digesters – Ethanol production – Bio diesel production and economics		
UNIT IV	**OTEC, TODAL, GEOTHERMAL AND HYDEL ENERGY**	**9**
Tidal energy – Wave energy – Data, Technology options – Open and closed OTEC Cycles – Smallhydro, turbines – Geothermal energy sources, power plant and environmental issues		
UNIT V	**NEW ENERGY SOURCES**	**9**
Hydrogen, generation, storage, transport and utilization, Applications: power generation, transport – Fuel cells – technologies, types – economics and the power generation		
	Total Periods:	**45**

Text Books

1. Gupta A., **"Non-Conventional Energy Resources",** Umesh Publication, (2012)
2. Rai G.D., **"Non-Conventional Sources of Energy",** Khanna Publisher, New Delhi, (2009)

References

1. Godfrey Boyle, **"Renewable Energy, Power for a Sustainable Future",** Oxford University Press, U.K., (2000)
2. Twidell J.W. & Weir A., **"Renewable Energy Sources",** EFN Spon Ltd., UK, (1986)
3. Tiwari G.N., **"Solar Energy – Fundamentals Design, Modelling and applications",** Narosa Publishing House, New Delhi, (2002)
4. Freris L.L., **"Wind Energy Conversion systems",** Prentice Hall, UK, (2002)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		2			3	2	3	2		2	3	3	2	2	2	
CO2	2	2	2	2	3	3	3	2		2	3	3	2	3	3	2
CO3			1				3	3		3	3	3		3		
CO4	3		2			3	3	3		2	2	3	1	2		3
CO5	2		2	3	2	2	3	3	2	2	3	3	2	2		1
CO6	1	2	2	3		2		2	3	3	2	2	2	2		3

191OE6E	ROBOTICS			L-T-P	C
				3-0-0	3
Programme:	B.E. Mechanical Engineering	**Sem:**	--	**Category:**	**OE**
Prerequisites:	Nil				
Aim:	To understand the basic concepts associated with the design and functioning and applications of Robots and robot programming				

Course Outcomes:

The students will be able to

CO1. Explain the robot anatomy, robot parts and functions
CO2. Define robot drive systems and end effectors
CO3. Identify the concept of sensors and actuators
CO4. Know the image processing and analysis for inspection and identification
CO5. Demonstrate the robot kinematics and programming principles for robot control
CO6. Illustrate the implementation and robot economics

UNIT I FUNDAMENTALS OF ROBOT **9**

Robot – Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Functions – Need for Robots – Different Applications

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS **9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of Drives End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers – Two Fingered and Three Fingered Grippers– Internal Grippers and External Grippers– Selection and Design Considerations

UNIT III SENSORS AND MACHINE VISION **9**

Requirements of a sensor – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), Touch Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors – Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques – Image Processing and Analysis – Algorithms – Inspection

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING **9**

Forward Kinematics, Inverse Kinematics and Differences – DH parameters – Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom, Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems – Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effector commands, and Simple programs

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS **9**

RGV, AGV – Implementation of Robots in Industries – Various Steps – Safety Considerations for Robot Operations – Economic Analysis of Robots – Pay back Method, EUAC Method, Rate of Return Method

Total Periods: 45

Text Books

1. Groover M.P., **"Industrial Robotics–Technology, Programming and Applications",** McGraw-Hill, (2001)
2. Fu K.S., Gonzalz R.C., and Lee C.S.G., **"Robotics Control, Sensing, Vision and Intelligence",** McGraw-Hill Book Co., (1987)

References

1. Deb S.R., **"Robotics Technology and Flexible Automation",** Tata McGraw-Hill Publication, (2008)
2. Yoram Koren, **"Robotics for Engineers",** McGraw-Hill Book Co., (1992)
3. Janakiraman P.A., **"Robotics and Image Processing",** Tata McGraw-Hill, (1995)
4. Saha S., "**Introduction to Robotics",** Tata McGraw-Hill Publication, (2008)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1		2	2					2	2	2		2
CO2	3	1	2	1		2	2					2	2	2		2
CO3	3	2	1	3		2	2					1	2	2		2
CO4	3	2	3	2		2	2					2	2	2		2
CO5	3	2	3	2		2	2					2	2	2		2
CO6	3	1	3	1		2	2					2	2	2		2

Mandatory Courses

191MC01	DESIGN THINKING	L	T	P	C
		2	0	0	0

Programme:	B.E., / B. Tech			Category:	MC

Aim:	To impart knowledge on design thinking process for understanding complex designs and to provide design skills to analyze design thinking issues and apply the tools and techniques of design.

Course Outcomes: Students will be able to

CO1.	Demonstrate knowledge of design thinking process
CO2.	Recall design thinking techniques to design relevant products/services
CO3.	Apply human centered design (HCD) methodology for product or service design.
CO4.	Use ideation techniques for developing innovative products or services
CO5.	Analyse the causes for the problems in the design of products or services
CO6.	Perform the steps to gain practical knowledge of prototyping, testing and validation.

UNIT-I OVERVIEW OF DESIGN THINKING PROCESS	6

Introduction to design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs Design thinking, Problem solving, Understanding design thinking and its process model, Design thinking tools. Human-Centered Design (HCD) process - Empathize, Define, Ideate, Prototype and Test and Iterate or Empathize, Analyze, Solve and Test.

UNIT-II EMPATHIZE	6

Design thinking phases, How to emphatize, Role of empathy in design thinking, purpose of empathy maps, Things to be done prior to empathy mapping, creation of user personas, customer journey mapping, How might we questions

UNIT-III SOLVE / IDEATE	6

Silent brainstorming, metaphors for ideation, CREATE and What-If tool for ideation, introduction to TRIZ, Inventive principles and their applications

UNIT-IV ANALYZE / DEFINE	6

Root cause analysis, conflict of interest, perspective analysis, big picture thinking through system operator, big picture thinking through function modeling.

UNIT-V TEST (PROTOTYPING AND VALIDATION)	6

Prototyping, Assumptions during the design thinking process, Validation in the market, best practices of presentation.

Total Periods	30

References

1. Dr. Bala Ramadurai, "Karmic Design Thinking", First Edition TRIZ Innovation India, 2020.
2. Karl T. Ulrich, “Design Creation of Artifacts in Society”, Trustees of the University of Pennsylvania Publisher, USA, 2011
3. Alma R. Hoffmann, “Sketching as Design Thinking”, Taylor & Francis, UK, 2019
4. Michael Lewrick, Patrick Link and Larry Leifer, “The Design Thinking Playbook”, Wiley, USA, 2018.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2		2		1	2	1	1	2	1		2		
CO2		1	2		1		2	1	1	1	1	1		1		
CO3			1				1		2					1		
CO4		2	2		2				2		2			1		
CO5	1		2			1		1		1		1		2		
CO6	1		2		1		2			1	1			1		

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

191MC02	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	L	T	P	C

				2	0	0	0
Programme:	B.E., / B. Tech			**Category:**		**MC**
Aim:	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.					
Course Outcomes: Students will be able to						
CO1.	Identify the concept of Traditional knowledge and its importance					
CO2.	Explain the need and importance of protecting traditional knowledge.					
CO3.	Illustrate the various enactments related to the protection of traditional knowledge.					
CO4.	Interpret the concepts of Intellectual property to protect the traditional knowledge.					
CO5.	Identify the importance of conservation and sustainable development of environment					
CO6.	Explain the importance of Traditional knowledge in Agriculture and Medicine.					

UNIT-I INTRODUCTION TO TRADITIONAL KNOWLEDGE	**6**
Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge	
UNIT-II PROTECTION OF TRADITIONAL KNOWLEDGE	**6**
The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.	
UNIT-III LEGAL FRAME WORK AND TRADITIONAL KNOWLEDGE	**6**
The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.	
UNIT-IV TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY	**6**
Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.	
UNIT-V TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS	**6**
Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.	
Total Periods	**30**

References

1. Amit Jha, “Traditional Knowledge System in India”, 2009.
2. Basanta Kumar Mohanta, Vipin Kumar Singh, “Traditional Knowledge System and Technology in India”, Pratibha Prakashan 2012.
3. Amit Jha, “Traditional Knowledge System in India”, Atlantic publishers, 2002
4. Kapil Kapoor, Michel Danino, "Knowledge Traditions anSd Practices of India"

E-Resources:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/

Course Outcomes	**Programme Outcomes (POs)**												**Programme Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1				1												

CO2				2												
CO3				1												
CO4				1												
CO5				1												
CO6				1												

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

191MC03	**INDIAN CONSTITUTION**			**L**	**T**	**P**	**C**
				2	**0**	**0**	**0**
Programme:	B.E., / B. Tech			**Category:**			**MC**
Aim:	To understand the importance of Indian constitution, Administration, Concept and Development of Human Rights, election commission.						
Course Outcomes: Students will be able to							

CO1.	Know the sources, features and principles of Indian Constitution.
CO2.	Learn about Union Government and its administration.
CO3.	Learn about State government and its administration.
CO4.	Get acquainted with Local administration and Panchayat Raj
CO5.	Be aware of basic concepts and developments of Human Rights.
CO6.	Gain knowledge on roles and functioning of Election Commission.

UNIT-I INTRODUCTION TO INDIAN CONSTITUTION	**6**
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 UNION GOVERNMENT AND STATE GOVERNMENT	**6**
Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions; **State Government and its Administration** Governor: Role and Position, CM and Council of ministers, State Secretariat: Organization, Structure and Functions	
UNIT-III LOCAL ADMINISTRATION AND PACHAYAT RAJ	**6**
Local Administration District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, **Panchayat raj:** Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.	
UNIT-IV CONCEPT AND DEVELOPMENT OF HUMAN RIGHTS	**6**
Meaning Scope and Development of Human Rights, United Nations and Human Rights – UNHCR, UDHR 1948, ICCPR 1996 and ICESCR 1966, Human Rights in India: Protection of Human Rights Act, 1993 - (NHRC and SHRC), First, Second and Third Generation Human Rights, Judicial Activism and Human Rights.	
UNIT-V ELECTION COMMISSION	**6**
Election Commission- Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women	
Total Periods	**30**

References

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd. New Delhi
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4E, 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government and Politics Hans
7. J. Raj Indian Government and Politics
8. M.V. Pylee, Indian Constitution
9. Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd. New Delhi
10. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-Resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																
CO5																
CO6																

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

191MC04	UNIVERSAL HUMAN VALUES			L	T	P	C
				2	0	0	0
Programme:	B.E., / B. Tech			Category:			MC

Aim:	To facilitate the competence to understand the harmony in nature/existence and participation of human being in the nature/existence.
Course Outcomes: Students will be able to	
CO1.	Ensure the clarity about human aspirations, goal, activities and purpose of life.
CO2.	Develop the understanding of human tradition and its various components.
CO3.	Critically evaluate their preconditioning and present beliefs.
CO4.	Begin with, and then to continue within the student leading to continuous self- evolution.
CO5.	Verify the truth or reality in their own right, based on their Natural Acceptance and subsequent Experiential Validation.
CO6.	Set do's and don'ts related to values.

UNIT-I INTRODUCTION	**6**
The basic human aspirations and their fulfillment through Right understanding and Resolution; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.	
UNIT-II UNDERSTANDING HUMAN BEING AND ITS EXPANSION	**6**
The domain of right understanding starts from understanding the human being (the knower, the experience and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	
UNIT-III ACTIVITIES OF THE SELF	**6**
Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Reasons for harmony/contradiction in the self.	
UNIT-IV UNDERSTANDING CO-EXISTENCE WITH OTHER ORDERS	**6**
The need and the process of inner evolution (through self-exploration, self-awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).	
UNIT-V EXPANSION OF HARMONY FROM SELF TO ENTIRE EXISTENCE	**6**
Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence.	
Total Periods	**30**

References

1. A Foundation Course in Human Values and Profession Ethics (Text Book and Teachers' Manual), R. R. Gaur, R. Sangal, G. P. Bagaria (2010), Excel Books, New Delhi [ISBN 978-8- 174-46781-2]
2. Avartansheel Arthshastra, A. Nagraj, Divya Path Sansthan, Amarkantak, India
3. Economy of Permanence – (a quest for social order based on non-violence), J. C. Kumarappa (2010), Sarva-Seva-Sangh-Prakashan, Varansi, India

4. Energy and Equity, Ivan Illich (1974), The Trinity Press, Worcester & Harper Collins, USA
5. Ishandi Nau Upnishad, Shankaracharya, Geeta press, Gorakhpur,
6. Manav Vyavahar Darshan, A. Nagraj, Divya Path Sansthan, Amarkantak, India
7. Manaviya Sanvidhan, A. Nagraj, Divya Path Sansthan, Amarkantak, India

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1								1						1		
CO2								1						1		
CO3								1						1		
CO4								1						1		
CO5								1						1		
CO6								1						1		

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

191MC05	**YOGA**			**L**	**T**	**P**	**C**
				2	**0**	**0**	**0**
Programme:	B.E., / B. Tech			**Category:**			**MC**

Aim:	To promote positive health, prevention of stress related health problems and rehabilitation through Yoga.

Course Outcomes: Students will be able to

CO1:	Know about the history and evolution of Yoga**.**
CO2:	Practice skills in Yoga for health.
CO3:	Find out the habits to ensure mental and emotional balance.
CO4:	Demonstrate basic skills associated with yoga activities including strength and flexibility, balance and coordination.
CO5:	Demonstrate the ability to perform yoga movements in various combination and forms.
CO6:	Demonstrate the ability to create and present various yoga sequences.

UNIT-I FOUNDATIONS OF YOGA	**5**

Origin of Yoga, History and Development of Yoga; Etymology and Definitions, Misconceptions, Aim and Objectives of Yoga, True Nature and Principles of Yoga.

UNIT-II YOUTH AND YOGA	**5**

Youth and yoga- yoga as a tool for healthy lifestyle, Yoga as a preventive, promotive and curative method. Pranayama and Different Yoga traditions and their impacts.

UNIT-III ROLE OF YOGA IN PREVENTIVE HEALTH CARE	**5**

Role of Yoga in preventive health care – Yoga as a way of life, Heyam dukham anagatam; Potential causes of Ill-health: Tapatrayas and Kleshas, Physical and Physiological manifestation of Disease: Vyadhi, Alasya, Angamejayatva and Ssvasa-prashvasa.

UNIT-IV METHODS OF TEACHING YOGA	**5**

Teaching and Learning: Concepts and Relationship between the two; Principles of Teaching: Levels and Phases of Teaching, Quality of perfect Yoga Guru; Yogic levels of learning, Vidyarthi, Shishya, Mumukshu; Meaning and scope of Teaching methods, and factors influencing them; Sources of Teaching methods;

UNIT-V ASAN AND PRANAYAM	**10**

Asan and Pranayam:

- Various yog poses and their benefits for mind & body
- Regularization of breathing techniques and its effects
- Different Phases in Pranayama Pracice:
  - Puraka (Inhalation), Kumbhaka (Retension) and Recaka (Exhalation)
  - Breathing Ratio in Pranayama Practice
  - Application of Bandhas in Pranayama

Total Periods	**30**

References

1. Yogic Asanas for Group Tarining-Part-I", Janardan Swami Yogabhyasi Mandal, Nagpur.
2. Swami Vivekananda, "Rajayoga or conquering the Internal Nature" Advaita Ashrama Publication, Kolkata.
3. Silva Mehta, Mira Mehta and Shyam Mehta, "Yoga: The Iyengar Way", Knopp publication, 1990.
4. Vishnu-Devananda, "The Complete Illustrated Book of Yoga", 1995.

5. Timothy McCall, “Yoga as Medicine: The Yogic Prescription for Health and Healing”, Harmony, 2007.
6. Hathayoga Pradipika of Swatmarama - Kaivalyadhama, Lonavala
7. The Science of Yoga - Taimini - Theosophical Publishing House, Adyar, Madras

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1								1						1		
CO2														1		
CO3														1		
CO4														1		
CO5														1		
CO6														1		

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