PROGRAMME: B.E.
MECHANICAL ENGINEERING
CURRICULUM

SEMESTER 1										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	MARKS		Page No.
								CAE	ESE	
1	Theory	SMTA1101	Engineering Mathematics - I	3	*	0	3	50	50	1
2	Theory	SPHA1101	Physics for Engineers	3	1	0	4	50	50	2
3	Theory	SBTA1101	Environmental Science and Engineering	2	0	0	0	-	-	4
4	Theory	SCSA1103	Programming in C	3	*	0	3	50	50	5
5	Theory	SMEA1101	Engineering Graphics	1	0	4	3	50	50	6
6	Theory	SMEA1203	Fundamentals of Mechanical Engineering	3	0	0	3	50	50	7
7	Practical	SPHA2101	Physics Lab	0	0	2	1	25	25	8
8	Practical	SCSA2104	Programming in C Lab	0	0	4	2	50	50	9
9	Practical	SMEA2101	Computer Aided Design Lab	0	0	4	2	50	50	10
Total Credits for Semester 1 - 21										
Total Marks for Semester 1 - 750										

SEMESTER 2										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SHSA1101	Technical English	3	0	0	3	50	50	11
2	Theory	SMTA1201	Engineering Mathematics - II	3	*	0	3	50	50	14
3	Theory	SEEA1101	Basic Electrical and Electronics Engineering	3	0	0	3	50	50	15
4	Theory	SCYA1101	Engineering Chemistry	3	1	0	4	50	50	16
5	Theory	SMEA1201	Engineering Materials and Metallurgy	3	0	0	3	50	50	18
6	Theory	SMEA1202	Engineering Mechanics	3	*	0	3	50	50	20
7	Practical	SCYA2101	Engineering Chemistry Lab	0	0	2	1	25	25	21
8	Practical	SMEA2201	Workshop Practice	0	0	4	2	50	50	22
Total Credits for Semester 2 - 22										
Total Marks for Semester 2 - 750										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS,
CAE – CONTINUOUS ASSESSMENT EXAMINATION,
ESE – END SEMESTER EXAMINATION

SEMESTER 3										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1301	Engineering Mathematics - III	3	*	0	3	50	50	23
2	Theory	SMEA1301	Engineering Metrology	3	0	0	3	50	50	24
3	Theory	SMEA1302	Engineering Thermodynamics	3	*	0	3	50	50	26
4	Theory	SMEA1303	Fluid Mechanics and Machinery	3	*	0	3	50	50	27
5	Theory	SMEA1304	Machine Drawing	1	0	4	3	50	50	28
6	Theory	SMEA1305	Mechanics of Solids	3	*	0	3	50	50	30
7	Practical	SMEA2301	Fluid Mechanics and Machinery Lab	0	0	4	2	50	50	31
8	Practical	SMEA2302	Material Testing and Metallurgy Lab	0	0	4	2	50	50	32
Total Credits for Semester 3 – 22										
Total Marks for Semester 3 – 800										

SEMESTER 4										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1401	Engineering Mathematics - IV	3	*	0	3	50	50	33
2	Theory	SAIC4001	Industry 4.0	2	0	0	2	50	50	34
3	Theory	SMEA1401	Manufacturing Technology - I	3	0	0	3	50	50	35
4	Theory	SMEA1402	Mechanics of Machines	3	*	0	3	50	50	36
5	Theory	SMEA1403	Power Plant Engineering	3	0	0	3	50	50	37
6	Theory	SMEA1404	Thermal Engineering	3	*	0	3	50	50	38
7	Practical	SMEA2401	Engineering Metrology and Dynamics Lab	0	0	4	2	50	50	39
8	Practical	SMEA2402	Manufacturing Processes Lab	0	0	4	2	50	50	40
Total Credits for Semester 4 – 21										
Total Marks for Semester 4 - 800										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

SEMESTER 5										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMEA1501	CAD/CAM	3	0	0	3	50	50	41
2	Theory	SMEA1502	Design of Machine Elements	3	*	0	3	50	50	43
3	Theory	SMEA1503	Finite Element Analysis	3	*	0	3	50	50	44
4	Theory	SMEA1504	Heat and Mass Transfer	3	*	0	3	50	50	45
5	Theory	SMEA1505	Manufacturing Technology - II	3	0	0	3	50	50	46
6	Theory		Open Elective - I	3	0	0	3	50	50	-
7	Practical	S15APT1	Professional Training	0	0	4	2	50	50	-
8	Practical	SMEA2501	CAD / CAM Lab	0	0	4	2	50	50	47
9	Practical	SMEA2502	Thermal Engineering Lab - I (Engines)	0	0	4	2	50	50	48
Total Credits for Semester 5 - 24										
Total Marks for Semester 5 – 900										

SEMESTER 6										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMEA1601	Design of Transmission Systems	3	*	0	3	50	50	49
2	Theory	SMEA1602	Gas Dynamics and Jet propulsion	3	*	0	3	50	50	50
3	Theory		Elective - I	3	0	0	3	50	50	-
4	Theory		Elective - II	3	0	0	3	50	50	-
5	Theory		Open Elective - II	3	0	0	3	50	50	-
6	Practical	SMEA2601	Design and Analysis Lab	0	0	4	2	50	50	51
7	Practical	SMEA2602	Thermal Engineering Lab - II (Heat Transfer)	0	0	4	2	50	50	52
8	Project	S15APT2	Inter Disciplinary project	0	0	6	3	50	50	-
Total Credits for Semester 6 - 22										
Total Marks for Semester 6 - 800										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

SEMESTER 7										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMEA1701	Automobile Engineering	3	0	0	3	50	50	53
2	Theory	SMEA1702	Industrial Mechatronics	3	0	0	3	50	50	54
3	Theory		Elective - III	3	0	0	3	50	50	-
4	Theory		Elective – IV	3	0	0	3	50	50	-
5	Theory		Open Elective – III	3	0	0	3	50	50	-
6	Practical	SMEA2701	Robotics and Automation Lab	0	0	4	2	50	50	55
7	Project	S15APROJ1	Project Work (Phase – I)	0	0	6	3	50	50	-
Total Credits for Semester 7 - 20										
Total Marks for Semester 7 - 700										

SEMESTER 8										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory		Elective - V	3	0	0	3	50	50	-
2	Theory		Elective - VI	3	0	0	3	50	50	-
3	Project	S15APROJ2	Project Work (Phase – II)	0	0	14	7	50	50	-
Total Credits for Semester 8 – 13										
Total Marks for Semester 8 – 300										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

LIST OF ELECTIVES

PROFESSIONAL ELECTIVE COURSES									
Sl. No.	Course Code	Course Title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SMEA3001	Additive Manufacturing	3	0	0	3	50	50	56
2	SMEA3002	Advanced Internal Combustion Engines	3	0	0	3	50	50	57
3	SMEA3003	Computational Fluid Dynamics	3	*	0	3	50	50	58
4	SMEA3004	Fluid Power Systems	3	0	0	3	50	50	59
5	SMEA3005	Non Destructive Testing and Techniques	3	0	0	3	50	50	61
6	SMEA3006	Refrigeration and Air-conditioning	3	*	0	3	50	50	62
7	SMEA3007	Computer Integrated Manufacturing Systems	3	0	0	3	50	50	63
8	SMEA3008	Composite Materials	3	*	0	3	50	50	64
9	SMEA3009	Product Design and Development	3	0	0	3	50	50	66
10	SMEA3010	Automation in Manufacturing	3	0	0	3	50	50	67
11	SMEA3011	Design of Jig and Fixtures	3	0	0	3	50	50	68
12	SMEA3012	Industrial Robotics and Expert Systems	3	*	0	3	50	50	69
13	SMEA3013	Non-Conventional Energy Systems	3	0	0	3	50	50	70
14	SMEA3014	Concurrent Engineering	3	0	0	3	50	50	71
15	SMEA3015	Material handling and Storage systems	3	0	0	3	50	50	72
16	SMEA3016	Modern Manufacturing Systems	3	0	0	3	50	50	73
17	SMEA3017	Industrial Safety Engineering	3	0	0	3	50	50	75
18	SMEA3018	Fundamentals of Nano materials and Technology	3	0	0	3	50	50	76
19	SMEA3019	Vibration and Noise Control	3	*	0	3	50	50	77
20	SECA3007	MEMS and its Applications	3	0	0	3	50	50	78

OPEN ELECTIVE COURSES									
Sl. No.	Course Code	Course Title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SALA4001	Intellectual Property Law	3	0	0	3	50	50	A1
2	SAEA4001	Fundamentals of Aerospace Technology	3	0	0	3	50	50	A2
3	SBAA4001	Fundamentals of Management	3	0	0	3	50	50	A3
4	SBAA4002	Principles of Management and Professional Ethics	3	0	0	3	50	50	A4
5	SBTA4001	Biology for Engineers	3	0	0	3	50	50	A5
6	SBMA4001	Neurology	3	0	0	3	50	50	A6
7	SBMA4002	Modelling of Physiological Systems	3	0	0	3	50	50	A7
8	SBMA4003	Drug Delivery System	3	0	0	3	50	50	A8
9	SBMA4004	Fundamentals of Mechatronics	3	0	0	3	50	50	A9
10	SBMA4005	Virtuality and Augmented Reality	3	0	0	3	50	50	A10
11	SBMA4006	Medical Optics and Laser Applications	3	0	0	3	50	50	A11
12	SBMA4007	Forensic Science	3	0	0	3	50	50	A12
13	SBMA4008	Artificial Intelligence and Expert Systems	3	0	0	3	50	50	A13
14	SBMA4009	Human Factors in Engineering and Design	3	0	0	3	50	50	A14
15	SCHA4001	Corrosion Engineering	3	0	0	3	50	50	A15
16	SCHA4002	Energy Engineering	3	0	0	3	50	50	A16
17	SCHA4003	Environmental Impact Assessment	3	0	0	3	50	50	A17
18	SCHA4004	Environmental Pollution and Control	3	0	0	3	50	50	A18
19	SCIA4001	Disaster Management	3	0	0	3	50	50	A19
20	SCSA4001	R Programming	3	0	0	3	50	50	A20
21	SCSA4002	5 G Networks	3	0	0	3	50	50	A21
22	SECA4001	Software Tools for Engineering Applications	3	0	0	3	50	50	A22
23	SMEA4001	Resource Management Techniques	3	0	0	3	50	50	A23
24	SMEA4002	Wind and Solar Energy	3	0	0	3	50	50	A24

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

Semester	Theory courses (including elective courses)			Practical Courses (including PT and project)		
	Total no.	Total Credits	Total Marks	Total no.	Total Credits	Total Marks
1	6	16	500	3	5	250
2	6	19	600	2	3	150
3	6	18	600	2	4	200
4	6	17	600	2	4	200
5	6	18	600	3	6	300
6	5	15	500	3	7	300
7	5	15	500	2	5	200
8	2	6	200	1	7	100
Overall Total	42	124	4100	18	41	1700

Overall total credits for B.E Mechanical Engineering	165
Overall total marks for B.E Mechanical Engineering	5800

SMTA1101	ENGINEERING MATHEMATICS - I (COMMON TO AERO, AUTOMECH & MECHATRONICS)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- The Objective of this Course is to identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgments.
- The purpose of this course is for Modeling the Engineering problems and obtaining its solutions Mathematically.
- This helps in understanding Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 MATRICES **9 Hrs.**

Characteristic equation of a square matrix – Eigen values and Eigen vectors of a real matrix – Properties of eigen values and eigen Vectors – Cayley-Hamilton theorem (without proof) – verification, finding inverse and power of a matrix – Diagonalisation of a matrix using orthogonal transformation – Quadratic forms – Nature of quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT 2 GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS **9 Hrs.**

Curvature – centre, radius and circle of curvature in Cartesian co-ordinates – Evolutes – Envelope of family of curves with one and two parameters – Evolute as envelope of normal.

UNIT 3 FUNCTIONS OF SEVERAL VARIABLES **9 Hrs.**

Partial derivatives (Definition) – Total derivative – Jacobian – Taylor's expansion – Maxima and minima of functions of two variables – Constrained maxima and minima using Lagrange's multiplier method.

UNIT 4 INTEGRAL CALCULUS I **9 Hrs.**

Definite integrals – Properties of definite integrals and problems – Beta and Gamma integrals – Relation between them – Properties of Beta and Gamma integrals with proofs – Evaluation of definite integrals in terms of Beta and Gamma function.

UNIT 5 INTEGRAL CALCULUS II **9 Hrs.**

Double integrals in Cartesian and Polar co-ordinates – Change of order of integration – Change of variables from Cartesian to Polar coordinates – Area of plane curves using double integrals – Triple integrals – Volume using triple integrals in Cartesian co-ordinates (Simple Applications).

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define eigen values and eigen vectors, radius and circle of curvature. Recall properties of definite integrals.
CO2 - Understand the concept of partial derivatives to find Jacobian and Taylors series expansion. Explain change of order of integration.
CO3 - Uses of Cayley Hamilton theorem and its verification. Solve problems in Area and Volume using integration. CO4 - Point out the stationary points and categorize maxima and minima. Discuss the problems involving Beta and Gamma integrals.
CO5 - Produce diagonal matrix by transformation of symmetric matrices.
CO6 - Develop the canonical form of a quadratic form. Construct evolute and envelope of family of curves.

TEXT / REFERENCE BOOKS

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, Singapore, 2012.
2. Grewal B.S., Higher Engineering Mathematics, 41st Edition, Khanna Publications, Delhi, 2011.
3. Veerarajan T., Engineering Mathematics for First Year, 2nd Edition, Tata McGraw Hill Publishers, New Delhi, 2008.
4. Kandaswamy P & Co., Engineering Mathematics for First Year, 9th Revised Edition, S.Chand & Co Pub., 2010.
5. Venkataraman M.K., Engineering Mathematics – First Year, 2nd Edition, National Publishing Co., 2000.
6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill, New Delhi, 11th Reprint, 2010.
7. N.P. Bali and Manish Goyal, A Text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**
PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SPHA1101	PHYSICS FOR ENGINEERS	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES

- To introduce the basic concepts of quantum mechanics.
- To realize the electronic structure of various materials via the band theory.
- To appreciate the role of quantum physics in the design and development of novel sensor devices.
- To understand the heat transfer mechanism in solids and fluids.

UNIT 1 BASIS OF QUANTUM PHYSICS 12 Hrs.

Introduction –electromagnetic waves - Photoelectric effect, Compton scattering, photons, Franck-Hertz experiment, Bohr atom, electron diffraction, wave - particle duality of radiation, de Broglie waves, wave-particle duality of matter. Physical interpretation of wave function, conditions to be satisfied for an acceptable wave function, normalized wave function, wave packets, Heisenberg uncertainty principle - statement, applications to radius of Bohr's first orbit and to energy of particle in 1D box. Operators associated with different observables, Schrodinger Equation – stationary states - Eigen value, Eigen function. Physical applications of Schrödinger's equation to (i) square well potential in one dimension: transmission and reflection coefficient at a barrier. Application of barrier penetration-α decay, field-ionization and scanning tunnelling microscope.

UNIT 2 PHYSICS OF SOLIDS 12 Hrs.

Structure of solids - Bloch Theorem and Origin of energy bands, band structure of conductors, semiconductors (n-type and p-type), insulators, half metals, semi metals. Metals - Free Electron Theory of metals, Fermi level, Fermi surface, density of states. Wiede-mann Franz Law- Derivation. Semiconductors-Direct and indirect band gap, derivation of intrinsic carrier concentration in terms of energy band gap, experimental determination of energy band gap. Superconductors- Properties, BCS theory - energy gap, AC & DC Josephson effect, Superconducting Quantum Interference Device, Cryotron, Magnetic levitation.

UNIT 3 MAGNETISM, LASER FUNDAMENTALS AND OPTO ELECTRONICS 12 Hrs.

Magnetism- Bohr magneton, magnetic moments due to electron spin, Ferromagnetism- Weiss theory-Energies involved in domain formation, Hysteresis. Magnetic bubbles - formation and propagation. Nano magnets and magneto resistance, spin valve using GMR and TMR – hard disk drive storage technology. Lasers-Spontaneous and stimulated emission, condition for Laser action, Einstein Coefficients, relation between spontaneous and stimulated emission probability. Injection Laser Diode (ILD). Quantum Cascade Laser, Comparison between ILD and QCL.

UNIT 4 THERMAL PHYSICS 12 Hrs.

Laws of thermodynamics-basic concepts, closed and open systems-first law. Heat transfer-thermal expansion of solids and liquids – expansion joints-bimetallic strips, thermal conduction**,** convection and radiation. Conduction in solids – thermal conductivity- Forbe's method, Lees' disc method, conduction through compound media, formation of ice on ponds, thermal insulation, applications- heat exchangers, refrigerators, ovens and solar water heaters. Thermal Convection - properties of radiant heat, sea and land breeze. Prevost's theory of heat exchanges. Thermal Radiation – emission and absorption radiation, emissive power, black body radiation – Kirchoff's, Stefan's laws, wien's law, Newton's law of cooling.

UNIT 5 SENSORS AND DEVICES 12 Hrs.

Introduction- measurands and measurement, basic concepts, types, mechanism, examples, significance and drawbacks, applications of each of pressure sensors, temperature sensors, vibration sensors, acoustic sensors, LDR and photo diode, pressure gauge-bourdon tube, magnetic sensors – Hall sensors, strain gauge-strain sensitivity.

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Identify the basic concepts in quantum mechanics, magnetism, lasers, superconductors, semiconductors & in thermal physics.

CO2 - Analyze the band structure of various materials.

CO3 - Apply the wave mechanical concepts to determine the radius of Bohr atom, transmission and reflection coefficient.

CO4 - Generate equation of motion of matter waves and to solve for cases related with 1D square well potential, linear harmonic oscillator and barrier penetration.

CO5 - Compare the efficiency of various memory storage devices, heat exchanger devices, opto electronic devices and sensors.

CO6 - Determine the thermal conductivity of conducting and insulting materials, convective heat transfer coefficient, emissivity, rate of cooling, etc.

TEXT / REFERENCE BOOKS

1. Griffiths, David J. Introduction to Quantum Mechanics. Pearson Prentice Hall, 2004. ISBN: 9780131118928.
2. Shankar, Ramamurti**.** Principles of Quantum Mechanics. Plenum Press, 1994.
3. Mahesh C Jain, Quantum Mechanics: A Textbook for Undergraduates, 2017.
4. Kittel, Charles. Introduction to Solid State Physics. 8th Edition, New York, NY: John Wiley & Sons, 2004.
5. Ashcroft, Neil W. and N. David Mermin. Solid State Physics. New York, NY: Holt, Rinehart and Winston, 1976.
6. William D. Callister, & David G. Rethwisch, Materials Science & Engineering -An Introduction, 9th Edition, 2013.
7. R.Asokamani, Solid State Physics, 2nd Edition, Easwar Press, 2015 ISBN: 9781904798835.
8. R.K.Gaur & S.L.Gupta - Engineering Physics, Dhanpat Rai Publication, 2007, Edition.
9. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India, 1997.
10. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw Hill Inc.,1995.
11. G. Keiser, Optical Fiber Communications, McGraw Hill Inc., 3rd Edition, 2000.
12. Heat and Thermodynamics, D.S.Mathur, Sultan Chand, 1995.
13. Heat and Thermodynamics Brij Lal, N. Subrahmanyam, S. Chand, Limited, 2001.
14.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SBTA1101	ENVIRONMENTAL SCIENCE AND ENGINEERING (COMMON TO ALL BRANCHES OF B.E./B.TECH)	L	T	P	Credits	Total Marks
		2	0	0	0	100

COURSE OBJECTIVE

- To impart knowledge on the issues related to environment and to emphasize the importance of a clean environment.

UNIT 1 INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES 9 Hrs.

Definition, scope and importance, need for public awareness, forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams, floods, drought, conflicts over water, dams-benefits and problems, mineral resources: use effects on forests and tribal people. water resources: use and over-utilization of surface and ground water, exploitation, environmental effects of extracting and using mineral resources, case studies food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: growing energy needs, renewable and non renewable energy sources, use of alternate energy sources: Case studies. Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

UNIT 2 ECOSYSTEMS AND BIODIVERSITY 9 Hrs.

Concept of an ecosystem, structure and function of an ecosystem - producers, consumers and decomposers - energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Introduction to biodiversity, definition: genetic, species and ecosystem diversity - biogeographical classification of India - value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, biodiversity at global, national and local levels. India as a mega-diversity nation, hot- spots of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India, conservation of biodiversity, in-situ and exsitu conservation of biodiversity.

UNIT 3 ENVIRONMENTAL POLLUTION 9 Hrs.

Definition - causes, effects and control measures of: (a) air pollution (b) water pollution (c) soil pollution (d) marine pollution (e) noise pollution (f) thermal pollution (g) nuclear hazards. Solid waste management: causes, effects and control measures of urban and industrial wastes, role of an individual in prevention of pollution, pollution case studies, disaster management: floods, earthquake, cyclone and landslides.

UNIT 4 SOCIAL ISSUES AND THE ENVIRONMENT 9 Hrs.

From unsustainable to sustainable development, urban problems related to energy, water conservation, rain water harvesting, watershed management, resettlement and rehabilitation of people; its problems and concerns, case studies, environmental ethics: issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation, consumerism and waste products - environment protection act: air (prevention and control of pollution) act - water (prevention and control of pollution) act, wildlife protection act; forest conservation act. Issues involved in enforcement of environmental legislation, Key initiatives of Rio declaration, Vienna convention, Kyoto protocol, Johannesburg summit and public awareness.

UNIT 5 HUMAN POPULATION AND THE ENVIRONMENT 9 Hrs.

Population growth, variation among nations, population explosion, family welfare programme, environment and human health, human rights, value education, HIV / AIDS, women and child welfare, role of information technology in environment and human health, case studies. Visit to a local area to document environmental assets river/ forest / grassland / hill / mountain. Visit to a local polluted site-urban/rural/ industrial/agricultural-study of common plants, insects, birds-study of simple ecosystems, pond, river, hill slopes etc.

Max. 45 Hrs.

TEXT / REFERENCE BOOKS

1. Meenakshi. P, Elements of Environmental Science and Engineering, 1st Edition, Prentice Hall of India, New Delhi, 2009.
2. Ravikrishnan. A, Environmental Science & Engineering, 3rd Edition, Sri Krishna Publications, Chennai, 2008.
3. Wrigh. R.T. & Nebel B.J., Environmental science-towards a sustainable future by Richard 8th Edition, Prentice Hall of India, New Delhi, 2006.
4. Erach Bharucha, Text Book of Environmental Studies, 2nd Edition, University Press, Chennai, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SCSA1103	PROGRAMMING IN C	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- Learn the organization of a digital computer.
- Be exposed to the number systems.
- Learn to think logically and write pseudo code or draw flow charts for problems.
- Be exposed to the syntax of C.
- Be familiar with programming in C.
- Learn to use arrays, strings, functions, pointers, structures and unions in C.

UNIT 1 INTRODUCTION OF C 9 Hrs.

Introduction: Generation and Classification of Computers- Basic Organization of a Computer Algorithms & flowcharts - Overview of C - Features of C - Structure of C program - Compilation & execution of C program - Identifiers, variables, expression, keywords, data types, constants, scope and life of variables, and local and global variables – Operators: arithmetic, logical, relational, conditional and bitwise operators– Special operators: size of () & comma (,) operator – Precedence and associativity of operators & Type conversion in expressions – Input and output statements- solving simple scientific and statistical problems.

UNIT 2 CONTROLS STRUCTURES AND FUNCTIONS 9 Hrs.

Control structures: Conditional statements – Looping statements – Functions: Library Functions - User Defined– Function Prototype - Function Definition – Types of Functions – Functions with and without Arguments-Functions with no return and with Return Values - solving simple scientific and statistical problems- Nested Functions - Recursion.

UNIT 3 ARRAYS AND STRINGS 9 Hrs.

Arrays: Single and Multidimensional Arrays – Array Declaration and Initialization of Arrays Array as Function Arguments. Strings: Declaration – Initialization and String Handling Functions- Simple programs- sorting- searching – matrix operations. Structure and Union: Definition and Declaration – Nested Structures – Array of Structures – Structure as Function Argument – Function that Returns Structure – Union.

UNIT 4 STORAGE CLASS AND POINTERS 9 Hrs.

Storage Class Specifier: Auto, Extern, Static, & Register. Pointers: The '&' and' *' Operators – Pointers Expressions – Pointers arithmetic- Example Problems. Arrays Using Pointers – Structures Using Pointers– Functions Using Pointer – Function as Arguments – Command Line Arguments.

UNIT 5 MEMORY MANAGEMENT AND FILES 9 Hrs.

DMA functions: malloc (), calloc (), sizeof (), free () and realloc (). Pre-processor directives. File management: File operations - opening & closing a file, Read and write binary files ,input and output statements, Control statements.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able

to CO1 - Design C Programs for problems.

CO2 - Write and execute C programs for simple applications.

CO3 - Develop programs using the basic elements like control statements, Arrays and Strings.

CO4 - Solve the memory access problems by using pointers.

CO5 - Understand about the dynamic memory allocation using pointers which is essential for utilizing memory.

CO6 - Understand the uses of pre-processors and various header file directives.

TEXT / REFERENCE BOOKS

1. Byron S Gottfried, "Programming with C", Schaum's Outlines, 2nd Edition, Tata McGrawHill, 2006.
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.
4. Balaguruswami. E., "Programming in C", TMH Publications, 2003.
5. Yashavant P. Kanetkar, 'LET US C', 5th Edition.2005.
6. Stevens, 'Graphics programming in C', BPB Publication, 2006.
7. Subburaj. R , 'Programming in C', Vikas Publishing, 1st Edition, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1101	ENGINEERING GRAPHICS	L	T	P	Credits	Total Marks
		1	0	4	3	100

COURSE OBJECTIVES

- To know the basics of Engineering Graphics.
- To make the student to visualize and read the drawings.
- To make the students to understand the importance of sectioning and development of surfaces.
- To learn about the orthographic and pictorial projections.

UNIT 1 LETTERING, DIMENSIONING AND GEOMETRICAL CONSTRUCTION 9 Hrs.

BIS - Lettering - Two systems of dimensioning - Dividing a straight line into any number of equal parts - Bisecting an angle and right angled triangle - Drawing a regular pentagon and hexagon given one side - Conic sections - ellipse, parabola, hyperbola by eccentricity method.

UNIT 2 ORTHOGRAPHIC PROJECTION 9 Hrs.

Projection - Types of projection - Projection of points lying in four quadrants - Projection of lines (First angle projection only) - Projection of lines parallel and inclined to one or both the planes - Projection of simple solids like prisms, pyramids, cylinder, cone with its axis perpendicular to HP, axis perpendicular to VP, axis inclined to HP, axis inclined to VP.

UNIT 3 SECTION OF SOLIDS 9 Hrs.

Purpose of sectioning - Sectional views - Hatching - Section plane perpendicular to one plane and parallel to other plane - Section plane inclined to HP - Section plane inclined to VP - True shape of the section.

UNIT 4 DEVELOPMENT OF SURFACES 9 Hrs.

Need for development of surfaces - Types of development of surfaces - Development of pentagonal and hexagonal prisms - Development of cylinders - Development of pentagonal and hexagonal pyramids - Development of cones.

UNIT 5 ISOMETRIC PROJECTION 9 Hrs.

Isometric view and isometric projection - Isometric scale - Isometric view of circle, cube, square, pentagonal and hexagonal prisms, Isometric view of square, pentagonal and hexagonal pyramids - Combination of two solids - Drawing of orthographic views of objects from their isometric views.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Adapt the drawing standards, conventions and practices in engineering drawing.
CO2 - Draw the conic sections for the given real world example using the eccentricity method.
CO3 - Interpret the orthographic projections for the points, straight lines or solids using the change of position method.
CO4 - Interpret the sections of solids with cutting plane perpendicular to one plane and parallel or inclined to other plane.
CO5 - Interpret the development drawings required to make the sheet metal work.
CO6 - Draw the isometric projections for the given solids and combination of solids using box method.

TEXT / REFERENCE BOOKS

1. Engineering drawing practice for schools and colleges, SP 46 – 1988 (http://web.iitd.ac.in/~achawla/public_html/201/lectures/sp46.pdf).
2. Natarajan, K.V., A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 21st Edition, 2012.
3. Bhatt, N.D., Engineering Drawing Drawing, Charotar Publishing House, 53rd Edition, 2014.
4. Venugopal, K., Prabhu Raja, V., Engineering Graphics, New Age International Publishers, 15th Edition, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**
PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA1203	FUNDAMENTALS OF MECHANICAL ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the design concepts and various product development stages.
- To learn the fundamentals of the machining processes and machine tools.
- To study the working principles of power plant, IC engines and the related components.

UNIT 1 CONCEPTS OF DESIGN **9 Hrs.**

Introduction to engineering design, Need for design, Product life cycle, Product development process, Types of product development process, Idea generation methods, Design process.

UNIT 2 FOUNDRY, FORMING AND JOINING PROCSSES **9 Hrs.**

Concepts of manufacturing, Foundry: tools, patterns and allowances - green and dry sand moulding, furnaces. Casting principles. Metal forming: Concepts and principles, forging, rolling, extrusion and drawing, Metal joining processes: Arc welding and Gas welding, brazing and soldering. Sheet metal operations: Shearing, piercing, blanking, bending, forming and spinning.

UNIT 3 MACHINING PROCESSES **9 Hrs.**

Machining Concepts, Tool and work holding devices. Machine tools and operations: lathe, drilling machine, boring machine, milling machine, shaper, planer, broaching machine and grinder. Introduction to digital manufacturing: NC, DNC and CNC.

UNIT 4 I.C. ENGINES **9 Hrs.**

Engine classification -Working principle of S.I. and C.I.engines - four stroke and two stroke cycles - comparison of four stroke and two stroke engines, Components of I.C. engines - function of piston, piston rings, cylinder, connecting rod and crankshaft. Ignition systems - single jet carburettor - spark plug - cooling systems - lubrication systems - fuel pump and fuel injector.

UNIT 5 POWER GENERATION **9 Hrs.**

Energy demand, Non-renewable energy, Renewable energy. Power plants: Thermal, Gas turbine, diesel, hydro, wind, solar, nuclear, geothermal power plants. Boilers: Classification and types of Boilers, Modern high pressure boilers, Turbines: Classification, construction and working principle of impulse and reaction turbines.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recommend the appropriate method for product development and design process of a given product.
CO2 - Prepare the list and the sequence of manufacturing operations required to make a given product.
CO3 - Suggest the right machines, production resources and tools required for machining a given product.
CO4 - Choose the components required to achieve the particular IC engine specifications.
CO5 - Propose the type of power plant suitable for a specific case based on the location, power demand, sustainability, cost, availability, capacity and pollution.
CO6 - Suggest the suitable type of boilers/ turbines for the specified application.

TEXT / REFERENCE BOOKS

1. Karl T. Ulrich, Steven D. Eppinger, "Product Design & Development", Tata McGraw Hill, New Delhi, 2003.
2. Kevin Otto & Kristin Wood Product Design, “Techniques in Reverse Engineering and new Product Development”, 1st Edition, Pearson Education, New Delhi, 2004.
3. Hajra Choudhury S.K., Hajra Choudhury A.K., Nirjhar Roy, “Elements of Workshop Technology”, Vol.1, Media Promoters, 2009.
4. Serope Kalpakjian, Steven R. Schmid, "Manufacturing Engineering & Technology", 7th Edition, Pearson Publications, 2014.
5. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 4th Edition, Pearson Education, 2014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SPHA2101	PHYSICS LAB	L	T	P	Credits	Total Marks
		0	0	2	1	50

COURSE OBJECTIVE

- To introduce experiments in optics, semiconductors, magnetism, thermal physics and quantum mechanics in order to acquire the first hand information and to realize the basic physics concepts.

SUGGESTED LIST OF EXPERIMENTS (ANY EIGHT EXPERIMENTS)

A. SEMICONDUCTORS

1 Measurement of carrier concentration of semiconductors.-Four probe method.
2 Determination of Hall coefficient -Hall Effect experiment.
3 Determination of Energy gap of a semiconductor diodes.
4 Study of I–V characteristics and variation of photocurrent voltage and intensity- by Photo Diode Characteristics.
5 Measurement of Resistivity of a semiconductor by 2-probe and 4-probe module.
6 Measurement of high resistance measurement by 2-probe module.

B. OPTICS

7 Measurement of wavelength of laser source using diffraction grating.
8 Measurement of fibre loss- Optical fibre.
9 Diffraction Grating using spectrometer - Determination of Wavelength of Light.
10 Measurement of speed of light in water and glass medium – minimum deviation from a prism.

C. MAGNETISM

11 Hysteresis loop- Measurement of Hysteresis loss.
12 Magnetic susceptibility –Quincke's method.

D. THERMAL PHYSICS

13 Characterization of Thermocouple.
14 Determination of Thermal conductivity of bad conductor-Lee's Disc method.

E. QUANTUM MECHANICS

14. Experimental Study of Photoelectric Effect.
15. Recording hydrogen atom spectrum.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 - Measure the band gap, electrical resistivity and carrier concentration of the given semiconductor. CO2 - Find Hall coefficients of the given material.
CO3 - Analyse the I-V characteristics of the given photo diode.
CO4 - Determine the wavelength of the given laser light source.
CO5 - Measure the Numerical aperture and the optical power loss of the given optical fiber.
CO6 - Measure the magnetic susceptibility of the given liquid sample and to identify dia, para / ferro magnetic liquid sample.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50 **Exam Duration: 2 Hrs.**

CAE	Evaluation of Regular Lab class	**15 Marks**	**25 Marks**
	Model practical exam	**10 Marks**	
ESE	End Semester Practical exam		**25 Marks**

SCSA2104	PROGRAMMING IN C LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To develop programs in C using basic constructs.
- To develop applications in C using strings, pointers, functions, structures.
- To develop applications in C using file processing.
- To make the student learn a programming language.
- To learn problem solving techniques.
- To teach the student to write programs in C and to solve the problems.

SUGGESTED LIST OF EXPERIMENTS

1. Programs using I/O statements and expressions.
2. Program for Looping and decision statements.
3. Program on Functions.
4. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.
5. Program on Arrays.
6. Program on String Manipulations.
7. Generate salary slip of employees using Structures and Union.
8. Program on Pointers.
9. Program to demonstrate the Command Line Arguments.
10. Program using Dynamic memory allocation.
11. Insert, update, delete and append telephone details of an individual or a company into a telephone directory using random access file.
12. Count the number of account holders whose balance is less than the minimum balance using sequential access file.
13. Program to implement math function.
14. Program to Implement sorting algorithms.
15. Program to Implement searching algorithms.
16. Create a ―Railway reservation systemll with the following modules
    - Booking
    - Availability checking
    - Cancellation
    - Prepare chart

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Develop C programs for simple applications making use of basic constructs, arrays and strings.
CO2 - Develop C programs involving functions, recursion, pointers, and structures.
CO3 - Design applications using sequential and random access file processing.
CO4 - Read, understand and trace the execution of programs written in C language.
CO5 - Implement Programs with pointers and arrays, perform pointer arithmetic, and use the pre-Processor.
CO6 - Write programs that perform operations using derived data types.

SMEA2101	COMPUER AIDED DESIGN LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To gain practical knowledge in engineering modeling through computer aided systems.
- To understand the functioning of 2D drafting and 3D modeling softwares.

INTRODUCTION TO CAD

Basics, Fundamentals of feature-based modeling.

TWO DIMENSIONAL OBJECTS

Create basic drawing objects: Points, Lines, Circles, Arcs, Planes and their combinations. Layout and sketching.
Setup a drawing with correct scales. Draw with precision using Coordinate input and object Snaps, Isometric drawings, Orthographic projections, Auxiliary views.
Dimensioning, Dimension styles.
Various other AutoCAD commands and relevant keyboard shortcuts.

THREE DIMENSIONAL OBJECTS

Creating and editing 3D solid objects.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Use 2D and 3D modeling features of a CAD package to sketch the required engineering drawing
CO2 - Sketch the given 2D and 3D part models in the CAD package.
CO3 - Sketch the given 2D and 3D assembly models in the CAD package.
CO4 - Set up the drawing template with the drawing layout, title block and other drawing properties.
CO5 - Include the dimensions, annotations, symbols and tolerances in the drawing document.
CO6 - Include the multiple views in the drawing document like orthographic views, isometric views and auxiliary views.

SHSA1101	TECHNICAL ENGLISH	L	T	P	Credits	Total Marks
		3	1	0	3	100

COURSE OBJECTIVES

- To enable the students to read and respond to specialized (scientific) materials and to subject areas included for their study.
- To provide an opportunity for students to comprehend and react in oral and written forms to the specialized texts that they read in their respective courses so as to summarize and paraphrase the texts presented in the class.
- To provide opportunities for students to respond to listening and writing tasks by using digital tools.
- To enhance 21st century skills like communication, collaboration, critical thinking and creativity through blended learning contexts.

UNIT 1 LANGUAGE AT THE WORD LEVEL 9 Hrs.

Listening	:	Note Taking, Summarizing the information related to resume preparation and also in flow chart templates.
Speaking	:	Self Introduction, Talking about likes and dislikes.
Reading for global understanding	:	The content from subject related matter or *True Love by Isaac Asimov*.
Writing	:	Formal and informal emails and letters and letter to the editor with current problems and solutions suggested.
Vocabulary	:	Affixes, technical terms, collocations, ordering words, sequence words, contextual guessing of words.
Language Focus	:	Changing one form of speech into another; present tense, signaling words for time and order.
Language Lab work	:	Focus Digital literacy: students join Google classroom/ or class wiki: become familiar with these online tools, by introducing themselves by doing ice breaking activity

UNIT 2 LANGUAGE AT THE SENTENCE LEVEL 9 Hrs.

Listening and Predicting	:	Listen to the current trends about product sales; arrive at inference about technical and environmental issues
Speaking	:	Debate on current issues, JAM on current topics
Reading for global comprehension	:	Identifying topic sentences by reading Short story on *Men are Different* or content from the subject areas.
Writing	:	Writing compare/ contrast paragraphs, process descriptive paragraphs and paraphrasing passages to express meaning in own words.
Vocabulary	:	identifying and framing verbal phrases, prepositions and prepositional phrases form the reading materials suggested.
Language Focus	:	Recognizing Past and future tense, Conjunctions and sentence linkers with specific focus on signaling words for Comparison/similar ideas, Contrast/opposite ideas, adjectives/ adverbs for comparisons there by to use in senesces. Identify clauses, kinds of sentences based on their functions in the passage, Transformation of sentences from one type into the other (Simple, compound, complex), impersonal passive voice.
Language Lab	:	Digital literacy: Respond to quiz using Google spread sheet, Prepare a quiz on Language focused areas, sharing links in Google classroom, and collect answers/ respond to survey sheets of their classmates to write compare contrast paragraphs of responses in wikis.

UNIT 3 LANGUAGE AT THE DISCOURSE LEVEL –REPORTING 9 Hrs.

Listening	:	Listening for gist / to summarize and to find the attitude and tone of the speaker
Speaking	:	Making Group Presentations based on information gathered by eliciting responses- Preparing a questionnaire, with open ended questions to make a survey about electronic gadgets/ social media/ environmental issues using elements of reasoning to make a presentation in the class.
Reading	:	Skimming and Scanning to find specific information and preparing notes on Passage on 'Making Effective presentation'
Writing	:	Framing open ended questions using elements of reasoning. Survey Report: Preparation of and documenting to report the findings Arranging the sentences in the right order.
Vocabulary	:	Word classification, word associations, paired expressions.
Language Focus	:	Subject verb agreement, punctuation, Common errors in spelling, punctuation.
Language Lab Work	:	Digital literacy: Use interactive power point tools like Prezi, Slide share to make presentation on the survey report to share link in the Google classroom

UNIT 4 LANGUAGE AT THE DISCOURSE LEVEL - PRODUCT DESCRIPTION 9 Hrs.

Listening	:	Classifying information related products
Speaking	:	Group discussion on current topics to arrive at solutions to problems by using elements of reasoning
Reading	:	Reading to prepare notes, categorising under headings and subheadings by reading Short Extracts from User Manuals. Reading and contextual guessing by reading about products
Writing	:	Instructions and recommendations, Preparation of User Manual on the electronic products in current usage
Vocabulary	:	Classification of words, descriptive words about products, definitions, compound nouns
Language Focus	:	Reported Speech, causatives and double negatives, Tag questions
Language Lab work	:	Digital literacy: Use Padlet/ quia to develop and complete vocabulary tasks created by peers in group work

UNIT 5 LANGUAGE AT THE DISCOURSE LEVEL – CRITICAL THINKING AND CREATING 9 Hrs.

Listening and summarizing	:	Listening to famous speeches to identify the structure of speeches- Ted Talks/ peer presentations to fill the template
Speaking	:	Giving impromptu talks, Speech Writing
Reading for Global Understanding	:	Read technical passages and trends in social media or technological developments to summarise, Read speeches by MS Narayana Murthy ' My Life's Lessons , Dr APJ Kalam's Speech "Unity of Minds" to identify the structure of Speech
Writing	:	Essay writing related to the Speeches suggested for reading, besides topic areas covered in all the units, self and peer editing using rubrics
Vocabulary	:	Homophones/Homonyms, idioms and phrases related to technology
Language Focus	:	Same word acting as different parts of speech
Language Lab work	:	Digital literacy: to create their own Blogs thereby to share their creations, interactive exercises and quizzes make them visible online.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Classify technical words to use them in sentences framing, compose problem solving paragraphs in semi formal letters, use rubrics to self evaluate, listening to take linear notes, reading to infer, predict and to differentiate facts from opinions, guess contextual meaning of words, modify the verbs in present tense, use learnt language in role plays with 80% accuracy.

CO2 - Categorize information based on global understanding of reading materials to prepare notes in graphic format like tables, use cohesive words related to comparing and contrasting by writing short paragraphs based on visual inputs in the form of bar diagrams, pie chart etc; describe process by composing paragraphs, recognize topic sentences and identifying verbal phrases while reading, use prepositions and prepositional phrases, modify the verbs from one form to the other in past and future tenses with 80% accuracy.

CO3 - Generate specific information by using scanning and skimming reading materials, Construct questionnaire to conduct class survey by framing open ended questions to generate data on current issues to make oral presentations and report in written format by using template provided, arrange sentences in the right order by using sentence linkers as clues, revise the written materials by identifying elements of editing, edit errors related to subject verb agreement, punctuation and spelling besides coherence with 70 % accuracy, use reported speech in spoken and written form in class room in reporting contexts, list paired words, word associations by recalling and identifying by noticing them while reading CO 4: Paraphrase based on reading to discuss and design products thereby to create and design user manual, identify technical words related to compound nouns to expand and to paraphrase, enact role plays to present the product, discuss facts and opinions of the product in pair and team work, read current topics to summarise in note form , listen to current issues to deduct meaning from the context, choose the right option, define technical words related to the reading materials.

CO5 - Summarise reading materials, use the ideas while writing essays, take, and differentiate meaning of homonyms and homophones.

CO6 - Demonstrate the ability to work cooperatively in a small group environment, in activities developed for language learning in the classroom/ online for formative assessment purposes, use and develop rubrics for self reflection, apply elements of reasoning skills for critical reading, identify facts and opinions and make judgements independently, develop intellectual courage and perseverance in pair and group work.

TEXT / REFERENCE BOOKS

1. English for Science and Technology. Department of English, Sathyabama, 2013.
2. P Bhaskaran Nair, C Radha Krishna Pillai, Geetha Rajeevan, CLN Prakash, Nadhini Nayar Reflections - An Anthology of Prose, Poetry and Fiction, Foundation Books, Chennai . Foundation Books. ISBN 978-93-85386-008, 2015.
3. Leiki M., Academic Writing. CUP, 1998.
4. Seely John, Oxford Guide to Effective Writing and Speaking , OUP, 2013.
5. Sen S., Mahendra et al., Communication and Language Skills, Foundation Books, Chennai, 2015.
6. Sheelagh Deller, Teaching Other Languages Through English, CUP, 2012.

LINKS FOR REFERENCE

1. https://www.teachingenglish.org.uk/article/theories-reading-2.
2. http://www.uefap.com/writing/parag/par_sig.htm.
3. https://designteachengage.wisc.edu/course-activities-learner-interaction/sdc-activity-types-active-learning/
4. https://www.uen.org/rubric/previewRubric.html?id=1219.
5. https://www.diigo.com/profile/Teachonlineuw?query=%22Critical+Thinking%22+rubric.
6. .Unit I reading adapted version - https://www.lifehack.org/articles/productivity/10-steps-for-success-applying-the-power-your-subconscious-mind.html.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMTA1201	ENGINEERING MATHEMATICS - II (COMMON TO AERO, AUTO, MECH & MECHATRONICS)	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVE

- Analytical, logical thinking and conclusions based on quantitative information will be the main objective of learning this course.

UNIT 1 DIFFERENTIAL EQUATIONS 9 Hrs.

Higher order linear differential equations with constant coefficients – Particular Integral for e^{ax}, sinax or cosax, x^n, $x^n e^{ax}$, xsinax, xcosax, e^{ax}sinbx or e^{ax}cosbx – Method of Variation of Parameters – Homogeneous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT 2 VECTOR CALCULUS 9 Hrs.

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector Integration – Simple problems on line, surface and volume Integrals – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (without proofs)– Simple applications involving cubes and rectangular parallelopipeds.

UNIT 3 LAPLACE TRANSORMATION 9 Hrs.

Laplace transform – Transforms of standard functions – properties – Transforms of derivatives and integrals – Transforms of the type $e^{at}f(t)$, tf(t), f(t)/t – Transform of periodic functions – Transform of unit step function and impulse function – Inverse Laplace transforms – Convolution theorem – Initial and final value theorems.

UNIT 4 APPLICATIONS OF LAPLACE TRANSORMATION 9 Hrs.

Linear ordinary differential equation with constant coefficients – Integral equations – Integral equations of convolution type –simultaneous linear differential equations with constant coefficients.

UNIT 5 FOURIER TRANSFORMATION 9 Hrs.

The infinite Fourier transform – Sine and Cosine transform – Properties – Inversion theorem – Convolution theorem – Parseval's identity – Finite Fourier sine and cosine transform.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - List the properties of Laplace transform. Recall the solution of ordinary Differential equations.
CO2 - Understand the concept of Directional derivative, Irrotational and Solenoidal vector fields.
CO3 - Explain Laplace transform and Fourier transform of functions and solve them.
CO4 - Discuss different types of inverse Laplace and Fourier transform problems.
CO5 - Evaluate problems on Green's, Stoke's and Divergence theorems.
CO6 - Produce the solution of integral and differential equations using Laplace transforms.

TEXT / REFERENCE BOOKS

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, Singapore, 2012.
2. Grewal B.S., Higher Engineering Mathematics, 41st Edition, Khanna Publications, Delhi, 2011.
3. Bali N.P. and Manish Goyal, A Text book of Engineering Mathematics, 8th Edition, Laxmi Publications Pvt. Ltd., 2011.
4. Veerarajan T., Engineering Mathematics for First Year, 2nd Edition, Tata McGraw Hill Publishers, 2008.
5. W.E.Boyce and R.C.DiPrima, Elementary Differential Equations and Boundary Problems, 9th Edition, Wiley India, 2009.
6. Venkataraman M.K., Engineering Mathematics – First Year, 2nd Edition, National Publishing Co., 2000.
7. Ross, S.L., Differential Equations, 3rd Edition, Wiley India, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SEEA1101	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To impart knowledge on the analysis of DC and AC Circuits.
- To gain knowledge about the working of electrical machines.
- To impart Knowledge on the operation of the basic electronic devices.

UNIT 1 D.C. CIRCUITS 9 Hrs.

Electrical Quantities - Ohm's law - Kirchoff's laws -Resistance in series and parallel combinations - Current and Voltage division rules - Mesh analysis and Nodal analysis.

UNIT 2 A.C. CIRCUITS 9 Hrs.

Sinusoidal functions - R.M.S and Average values for Sinusoidal waveform - Phasor representation - Sinusoidal excitation applied to purely resistive, inductive and capacitive circuits - RL , RC and RLC series circuits - power and power factor - Introduction to three phase circuits with balanced load.

UNIT 3 INTRODUCTION TO MACHINES 9 Hrs.

Construction and Principle of Operation of DC Generators - DC Motors - Single Phase Transformer - Single Phase Induction Motors - Stepper Motor.

UNIT 4 SEMICONDUCTOR DEVICES 9 Hrs.

VI Characteristics of PN-junction diodes and Zener diodes, BJT and its configurations – input/output Characteristics, Junction Field Effect Transistor – Drain and Transfer Characteristics, MOSFET – Depletion type and Enhancement type, Uni Junction Transistors - Silicon Controlled Rectifiers.

UNIT 5 DIGITAL ELECTRONICS 9 Hrs.

Number systems – Binary arithmetic - Boolean algebra, laws & theorems – Boolean Functions - Simplification of Boolean functions - Logic gates - Implementation of Boolean expressions using logic gate - Standard forms of Boolean expression.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze electrical circuits using Kirchoff's Laws.

CO2 - Compare the behaviour of R, L and C and their combinations in AC circuits. CO3 - Describe the construction and working principle of DC and AC machines. CO4 - Demonstrate the characteristics of various semi-conductor devices.

CO5 - Understand the concept of digital electronics.

CO6 - Recognize the importance of electronic devices.

TEXT / REFERENCE BOOKS

1. Mittle B.N. & Aravind Mittle, Basic Electrical Engineering, 2nd Edition, Tata McGraw Hill, 2011.
2. Theraja B.L., Fundamentals of Electrical Engineering and Electronics, 1st Edition, S.Chand & Co., 2009.
3. Smarajit Ghosh, Fundamentals of Electrical and Electronics Engineering, 2nd Edition, PHI Learning Private Ltd, 2010.
4. Kothari D.P. and I.J Nagarath, Electrical Machines, 3rd Edition, Tata McGraw Hill Publishing Company Limited, 2006.
5. Sanjay Sharma, Electronic Devices and Circuits, 2nd Edition, S.K.Kataria & Sons, 2012.
6. John Bird, Electrical Circuit Theory and Technology, 4th Edition, Published by Taylor & Francis, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SCYA1101	ENGINEERING CHEMISTRY	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES

- To understand the basic concepts of quantum chemistry for bonds to bands.
- To learn the principles and applications of energy levels in molecules.
- To explore the importance of functional materials for electronic devices.
- To study the structure and properties of carbon materials.
- To identify the significance of chemistry in engineering and technology.

UNIT 1 BONDS TO BANDS 12 Hrs.

Introduction to quantum chemistry – Motion of a quantum mechanical particle in one dimension (time- independent) – Schrödinger wave equation for hydrogen atom (No derivation) – Physical meaning of wave function - Angular and radial wave functions and probability densities – Quantum numbers – Principal, azimuthal, spin and magnetic quantum numbers – Wave functions and orbital shapes - *s,p,d,f* - LCAO-MO of H_2 – Band theory of solids: Conductors, semi-conductors and superconductors – Role of As and Ga doping on band structures.

UNIT 2 MOLECULAR SPECTROSCOPY 12 Hrs.

Electromagnetic spectrum – Interaction of radiation with matter – Energy levels in molecules – Microwave spectroscopy – Principle – Classification of molecules based on moment of Inertia – Rotational energy expression (J levels) – Calculation of J for CO molecule – Vibrational spectroscopy – Normal modes of vibrations – Vibrations of polyatomic molecules (CO_2 and H_2O) – Determination of Force constant – Electronic transitions in organic molecules – Mathematical derivation of Beer-Lambert's law – Stimulated Emission – Lasers in action – Excimer laser, Diode laser and Gas laser.

UNIT 3 FUNCTIONAL MATERIALS 12 Hrs.

Introduction to conducting polymers – Charge transport carriers: Exciton formation in organic solar cells and organic light emitting diodes (principle and working) – Conduction mechanism in polymers: Soliton, polaron and bipolaron formation in polyacetylene and polyaniline – Liquid crystals: Characteristic features and phases of liquid crystals – Liquid crystal displays.

UNIT 4 CARBON MATERIALS FOR HEALTH, STEALTH AND ENERGY 12 Hrs.

Introduction to carbon materials – Fullerenes – Production, properties and applications – Vander Waal's solid – Structure of graphene, graphene oxide and reduced graphene oxide – Mechanical and electrical properties of graphene – Graphene based energy storage devices for space applications – Carbon nanotubes – Single-walled and multiwalled CNTs - Synthesis of CNTs by Thermal CVD and laser ablation method – Electrical and mechanical properties of CNTs - Applications of CNTs.

UNIT 5 ENGINEERING MATERIALS 12 Hrs.

Phase equilibria - Gibbs phase rule – Terms involved in Phase rule – Phase diagram of water system – Thermal method of analysis – Construction of simple eutectic system (Lead-Silver system).

Fuels - Classification of fuels – Determination of calorific values of solid fuels by bomb calorimeter – Manufacture of synthetic petrol by Fischer-Tropsch method – Knocking in IC engines – Chemical structure – Octane and cetane rating of fuels.

Nanomaterials - Size dependent properties of nanomaterials – Synthesis of gold and silver nanoparticles by Chemical reduction method – Applications of nanoparticles in medicine.

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand quantum chemistry and its application to band theory.
CO2 - Analyse the interaction of radiation with matter in spectroscopic techniques.
CO3 - Interpret charge transport mechanism for electronic devices.
CO4 - Illustrate the applications of carbon materials in health, stealth and energy.
CO5 - Learn basic concepts of phase diagram, nanoparticle synthesis and importance of fuels.
CO6 - Analyze and demonstrate the applications of materials in real world.

TEXT / REFERENCE BOOKS

1. Chandra A.K., Introductory Quantum Chemistry, Tata McGraw Hill, 4th Edition, 1994.
2. Ira N. Levine, Physical chemistry, 6th Edition, 2008.
3. Ira N. Levine, Quantum chemistry, 7th Edition, 2013.
4. David W. Ball and Thomas Baer, Physical Chemistry, Wadsworth Cengage Learning, 2nd Edition, 2014.
5. Donald W. Rogers, Concise Physical Chemistry, John Wiley and Sons, 2011.
6. Douglas A. Skoog and Donald M.West, Principles of Instrumental Analysis, Cengage, 6th Edition, 2014.
7. Jain P.C. and Monika Jain, Engineering Chemistry, Dhanpat Rai Publication, 2018.
8. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India Private Ltd., 3rd Edition, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1201	ENGINEERING MATERIALS AND METALLURGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- Understand the fundamental concepts of material science, crystallography, phase diagrams, failure theory and testing procedures.
- To learn the different types and grades of ferrous and non-ferrous alloys, their compositions and applications and various strengthening processes used in the making of ferrous and non-ferrous alloys.
- Understand the material characterization techniques and material selection guidelines for selecting the appropriate materials for the requirements in real time applications.

UNIT 1 FUNDAMENTALS OF MATERIALS 9 Hrs.

Crystallography: Basics, Atomic radius and Atomic packing factor of BCC, FCC & HCP, Miller's indices, Allotropy, Solid solutions and intermetallic compounds. Atomic Diffusion: Laws of diffusion, Factors affecting diffusion. Phase diagrams: Solidification of metals, Phase rules, Construction of phase diagram, Isomorphous diagram, Eutectic diagram showing partial solid solubility, Peritectic system.

UNIT 2 FERROUS AND NON-FERROUS ALLOYS 9 Hrs.

Ferrous alloys: Cooling curve of pure iron, Fe–Fe_3C equilibrium diagram, Critical points in Fe–Fe_3C equilibrium diagrams, Classification of ferrous alloys, Influence of alloying elements, Designation systems, Types of steels and cast iron, Typical compositions, properties and applications of ferrous alloys. Non-ferrous alloys: Typical compositions, properties and applications of Aluminium and its alloys, Copper & its alloys, Ti & its alloys, and Nickel & its alloys.

UNIT 3 STRENGTHENING PROCESSES 9 Hrs.

Heat treatment of steel: TTT diagram and CCT diagram. Heat treatment processes: Annealing, Normalizing, Tempering and Quenching, Jominy quency test for hardenability. Case hardening: Carburizing, Nitriding, Cyaniding, Carbonitriding, Flame hardening and Induction hardening. Others: Dispersion strengthening & Precipitation hardening

UNIT 4 FAILURE OF MATERIALS AND TESTING 9 Hrs.

Tensile testing: Significance, Universal testing machine, Stress–strain curve for ductile & brittle material, Results. Hardness Testing: Significance, Rockwell harness test, Brinell's hardness test and Vicker's hardness test, Results. Impact testing – Significance, Charpy impact test and Izod impact test, Results. Failure of materials: Defects in materials, Deformation mechanisms, Failure mechanisms and influencing factors of ductile and brittle failures, fatigue failure, creep failure and impact failure.

UNIT 5 MATERIAL CHARACTERIZATION AND SELECTION 9 Hrs.

X-ray diffraction (XRD): Bragg's law of diffraction, Powder, rotating crystal and Laue methods to determine the crystal structure. Optical microscopy: Image formation techniques, Construction, Sample preparation and Applications of optical microscopes. Scanning electron microscopy (SEM): Image formation techniques, Construction, Sample preparation and Applications of SEM. Transmission electron microscopy (TEM): Image formation techniques, Construction, Sample preparation and Applications of TEM. Materials selection: Engineering materials and their properties, Materials selection charts, Material selection strategy, Factors affecting materials selection, Case studies.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Interpret the given binary phase diagram to quantify the relative fraction of phases and micro-structural development at different temperatures and compositions.

CO2 - Select the suitable grade of ferrous and/ or non-ferrous materials for the given engineering application.

CO3 - Recommend the appropriate heat treatment/ strengthening mechanism to obtain the desired material properties.

CO4 - Provide suggestions to overcome the material failure after investigating the given material failure case study.

CO5 - Prepare a detailed testing plan for evaluating the desired mechanical properties according to the ISO/ ASTM testing standards.

CO6 - Suggest the suitable materials for the stated engineering application through the material selection procedure and criteria.

TEXT / REFERENCE BOOKS

1. Sidney H. Avner, "Introduction to Physical Metallurgy", 2nd Edition, Tata McGraw Hill Education Pvt. Ltd., 2009.
2. William D. Callister Jr. & David G. Rethwisch "Materials Science and Engineering: An Introduction", 9th Edition, John Wiley & Sons Inc., 2013.
3. James F. Shackelford & Madanapalli K. Muralidhara, "Introduction to Materials Science for Engineers", 6th Edition, Pearson Education, 2006.
4. Padmakar R. Khangaonkar, "An Introduction to Material Characterization", 1st Edition, Penram International Publishing Pvt. Ltd., 2013.
5. Michael F. Ashby, "Materials Selection in Mechanical Design", 5th Edition, Butterworth-Heinemann, 2017.
6. O.P. Khanna, "A Text Book of Material Science & Metallurgy", 2nd Edition, Dhanpat Rai Publications, 2014.
7. R. Balasubramaniam, "Callister's Materials Science and Engineering" 2nd Edition, Wiley India Pvt. Ltd., 2007.
8. Kenneth G. Budinski & Michael K. Budinski, "Engineering Materials: Properties and Selection", 9th Edition, Pearson, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1202	ENGINEERING MECHANICS (FOR MECH, MECHATRONICS, AERO AND AUTO)	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To understand the concept of Statics.
- To learn the concept of Equilibrium.
- To understand the properties of surfaces and solids.
- To learn the theory of Friction.
- To acquire the knowledge about concept of Dynamics.

UNIT 1 BASICS & STATICS OF PARTICLES 9 Hrs.

Introduction-Units and Dimensions-Laws of Mechanics-Vectors-Vectorial representation of forces and moments - Vector operations-resolution and composition of forces - equilibrium of a particle - Free body diagram - forces in space-equilibrium of a particle in space-equivalent systems of forces-principle of transmissibility–Resultant and Equilibrant.

UNIT 2 EQUILIBRIUM OF RIGID BODIES 9 Hrs.

Types of supports and their reactions - requirements of stable equilibrium – Moments and Couples- Varignon'st theorem-Equilibrium of Rigid bodies in two dimensions- Equilibrium of Rigid bodies in three dimensions.

UNIT 3 PROPERTIES OF SURFACES AND SOLIDS 9 Hrs.

Determination of Areas - First moment of Area and the centroid - simple problems involving composite figures. Second moment of plane area-Parallel axis theorem and perpendicular axis theorem-Polar moment of Inertia – Principal moments of Inertia of plane areas – Principle axes of inertia – relation to area moments of Inertia. Second moment of plane area of simple sections like C,I,T,Z etc. - Basic Concept of Mass moment of Inertia.

UNIT 4 FRICTION 9 Hrs.

Frictional Force - Laws of Coulomb friction - Cone of friction-Angle of repose-relation between cone of friction and angle of repose- limiting friction-Rolling resistance- Simple contact friction - Screw - Wedge– Ladder- Belt friction.

UNIT 5 KINETICS OF RIGID BODIES AND DYNAMICS OF PARTICLES 9 Hrs.

Dynamics- Classification- Kinematics- Kinetics- Types of energy-Displacement, Velocity and acceleration their relation-Relative motion - Curvilinear motion - Newton's Law - D'Alembert's Principle, Work Energy Equation- Impulse and Momentum-Impact of elastic bodies- General plane motion.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Determine the force and moment of a particle in space under the equilibrium condition using the laws of mechanics.
CO2 - Analyze the equilibrium of two/ three dimensional rigid bodies subjected to a system of forces.
CO3 - Determine the centroid and moment of inertia for surfaces and solids.
CO4 - Recommend the condition to the specified engineering system under friction to hold in static equilibrium.
CO5 - Choose the suitable motion behavior for the given kinetic application using the equations of motion.
CO6 - Choose the characteristics of the projectile motion for the given kinematic application using the equations of motion.

TEXT / REFERENCE BOOKS

1. Bhavikatti S.S., Engineering Mechanics,1st Edition, New Age International publishers, 2017.
2. Bansal R.K., A Textbook of Engineering Mechanics, 4th Edition, Laxmi Publications, 2002.
3. Bedi D.S., Engineering Mechanics,1st Edition, Khanna Publishing Co. (P) Ltdl, 2013.
4. Khurmi R.S. and Khurmi N, Engineering Mechanics, S.Chand Publishing, 2018.
5. Beer & Johnston, "Vector Mechanics for engineers - Vol I &II", 9th Edition, Tata McGraw Hill, 2010.
6. Sharma, D.P., Engineering Mechanics, Pearson, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**
PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SCYA2101	ENGINEERING CHEMISTRY LAB	L	T	P	Credits	Total Marks
		0	0	2	1	50

COURSE OBJECTIVES

- To understand the basic principle involved in adsorption, kinetics and viscosity measurements.
- To acquire practical knowledge in pH metry, Potentiometry and Conductometry.
- To develop the skill in water analysis.

LIST OF SUGGESTED EXPERIMENTS (ANY EIGHT EXPERIMENTS)

1. Separation and identification of organic compounds and determination of R_f values by thin layer chromatography.
2. Estimation of hardness of water by EDTA method.
3. Determination of freezing point depression of a compound.
4. Determination of pKa value of glycine by pHmetry.
5. Estimation of mixture of acids by conductometry.
6. Estimation of ferrous ion by potentiometry.
7. Determination of saponification value of oil.
8. Determination of the partition coefficient of a substance between two immiscible liquids.
9. Verification of freundlich adsorption isotherm using adsorption of acetic acid by charcoal.
10. Determination of high molecular weight polymer using Ostwald viscometer.
11. Estimation of copper in brass.
12. Determination of alkalinity of water.
13. Estimation of Iron by photocolorimetry.
14. Determination of dissolved oxygen content of water sample by Winkler's method.
15. Estimation of sodium in water by using Flame Photometry.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To acquire knowledge about adsorption in separation of mixtures.
CO2 - To estimate the total hardness in water sample by complexometry.
CO3 - To gain the knowledge of colligative properties by Rast Method.
CO4 - To learn the principle of potentiometric and conductometric titrations.
CO5 - To understand the significance of saponification value of oil.
CO6 - To apply the concept of viscosity in determining the molecular weight of polymer.

TEXT / REFERENCE BOOKS

1. G.H. Jeffery, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition. Persons Education 2004.
2. S.S. Dara, Experiments and Calculations in Engineering Chemistry, S. Chand and Co. 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA2201	WORKSHOP PRACTICE	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVE

- To provide the students with hands on experience on different trades of engineering like Plumbing Works, Fitting, Carpentry, Plumbing, Foundry, Welding and Sheet metal.

A. PLUMBING WORKS:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
(e) Demonstration of plumbing requirements of high-rise buildings.

B. CARPENTRY

a) Handling of carpentry tools, A practice in marking, sawing planning and chiseling to size. Making simple joints such as half-lap, dove-tail and mortise and tenon joints.
b) Use of modern materials such as plywood, chip board, novapan, laminated sheet (Demonstration only).

C. FITTING

Use of fitting tools-practice in marketing, fitting to size and drilling-making of simple mating and profiles such as V, Square, Dove-tail, Half-round joints.

D. WELDING

i. Electric Arc Welding .
   a) Study on Edge preparation techniques for Arc welding.
   b) List of Welding Exercises.
      1. Lap Joint 2. Butt Joint 3. Fillet Joint 4. Tee Joint 5. V Joint 6. Corner Joint
ii. Study on gas welding and gas cutting .
iii. Study on TIG & MIG welding.

E. FOUNDRY

i. Sand testing - Grain fineness - Permeability test.
ii. Study on Pattern Allowances.
iii. Preparation of green sand moulding
   1. Flanges 2. Glands 3. Bush 4. Dumbbell
iv. Metal casting technique (Demonstration only).

F. SHEET METAL

- Tools and equipments– practice.
- Making rectangular tray, hopper, scoop, etc.
- Fabrication of a small cabinet, dust bin, etc.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Suggest the suitable pipe connections for the stated real life plumbing requirement.
CO2 - Produce the specified wooden work using the carpentry tools with the acceptable dimensional accuracy.
CO3 - Produce the specified metal work using the fitting tools with the acceptable dimensional accuracy
CO4 - Join two metals using the welding process without the welding defects
CO5 - Prepare the green sand mold using the foundry tools for the given pattern.
CO6 - Produce the specified sheet metal work using the sheet metal tools with the acceptable dimensional accuracy.

SMTA1301	ENGINEERING MATHEMATICS - III (COMMON TO AERO, AUTO, MECH AND MECHATRONICS)	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVE

- The ability to identify, reflect upon, evaluate and apply different types of information and knowledge to form independent judgments. Analytical, logical thinking and conclusions based on quantitative information will be the main objective of learning this subject.

UNIT 1 COMPLEX VARIABLES 9 Hrs.

Analytic functions – Cauchy - Riemann equations in Cartesian and polar form – Harmonic functions – Properties of analytic functions – Construction of analytic functions using Milne – Thompson method – Some Standard Transformations – Translation, Magnification and Rotation, Inversion and Reflection and simple problems based on the above - Bilinear transformation.

UNIT 2 COMPLEX INTEGRATION 9 Hrs.

Cauchy's integral theorem – Cauchy's integral formula – problems – Taylor's and Laurent's series – Singularities – Poles and Residues – Cauchy's residue theorem and problems – Contour Integration (Integration around the Unit circle).

UNIT 3 Z TRANSFORMATION AND DIFFERENCE EQUATIONS 9 Hrs.

Z –Transform – Elementary properties – Inverse Z – Transform – Partial Fraction method, Convolution method, Residue method – Formation of difference equations – Solution of difference equations using Z-Transform.

UNIT 4 PARTIAL DIFFERENTIAL EQUATIONS 9 Hrs.

Formation of equations by elimination of arbitrary constants and arbitrary functions – Solutions of First order Linear PDE – Lagrange's linear equation – Solution of Linear Homogeneous PDE of higher order with constant coefficients.

UNIT 5 THEORY OF SAMPLING AND TESTING OF HYPOTHESIS 9 Hrs.

Test of Hypothesis – Large samples – Z test – Single proportion – Difference of proportions – Single mean – Difference of means – Small samples – Student's t test – Single mean – Difference of means –Test of variance – Fisher's test – Chi square test: Goodness of fit, Independence of attributes.

Max. 45 Hrs.

TEXT / REFERENCE BOOKS

1. Erwin Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley and Sons AsiaPvt. Ltd., Singapore, 2001.
2. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi,2011.
3. Kandasamy P., Thilagavathy K. & Gunavathy K., Engineering Mathematics, (4th Revised Edition),S.Chand & Co., New Delhi, 2001.
4. Veerarajan T., Engineering Mathematics Tata Mcgraw Hill Publishing Co., New Delhi, 1999.
5. J.W. Brown and R.V. Churchill, Complex Variables and Applications, 7th Edition, Mc.Graw Hill, 2004.
6 Gupta S.C., Kapoor V.K., Fundamentals of Mathematical Statistics, S. Chand & Company, 2012.
7 Bali N.P and Manish Goyal, A Text book of Engineering Mathematics, 8th Edition, Laxmi Publications Pvt Ltd., 2011.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define analytic functions, theorems on complex integration, Singularities. List Fourier transform of standard functions and Parseval's identity. Form partial differential equation.
CO2 - Explain the properties of analytic functions and Fourier transform. Understand the concept of Taylor's and Laurent's series Understanding the concepts of Z- transformation and its applications and solving it.
CO3 - Apply bilinear transformation, Taylor's and Laurent's series. Solve problems on Fourier transform.
CO4 - Classify partial differential equation and test of hypothesis.
CO5 - Evaluate problems on complex integration and Appraise sampling theory using different tests.
CO6 - Construct an analytic function, produce the solution of linear partial differential equations.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1301	ENGINEERING METROLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the basics of measurements and its applications.
- To acquire the knowledge on linear and angular measurements.
- To understand the measurements of power, pressure, temperature and flow.
- To learn the correct procedures adopted in various measurements.

UNIT 1 INTRODUCTION TO METROLOGY 9 Hrs.

Accuracy, precision, resolution and sensitivity of measuring instruments, classification of errors in measurements, alignment errors, evaluation and propagation of errors , Limits, fits and tolerances. Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation, geometric tolerance, position-tolerances. Classification of gauges, brief concept of design of gauges (Taylor's principles), Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials, Terminologies in Measurement - Care of Measuring Instruments-Reliability.

UNIT 2 LINEAR AND ANGULAR MEASUREMENTS 9 Hrs.

Linear Measuring Instruments – Evolution – Types – gauge design – Comparators: Functional requirements, classification, mechanical, sigma comparators, dial indicator, electrical principles, LVDT, Pneumatic- back pressure gauges, solex comparators and optical comparators- Zeiss ultra-optimeter, slip gauges – Types –Indian standards on slip gauge, method of selection of slip gauge, stack of slip gauge, adjustable slip gauge, wringing of slip gauge, care of slip gauge, slip gauge accessories, Angular measuring instruments – Sine bar, angle gauges, autocollimator, angle dekkor, tool maker's microscope, Bevel protractor, clinometers, spirit levels– Alignment telescope – Applications.

UNIT 3 MEASUREMENTS OF POWER, PRESSURE, TEMPERATURE AND FLOW 9 Hrs.

Power, Force and Torque – mechanical, hydraulic, pneumatic and electrical type – Pressure – low pressure measurement using Mc Leod gauge, thermal conductivity gauge and ionization gauges – high pressure measurement using diaphragm gauges and bulk modulus pressure gauge. Temperature – thermo couple, RTD, thermistor-electrical resistance thermometer-pyrometers. Flow – Turbine type flow meter, magnetic flow meter, ultra-sonic flow meter, thermal flow meter and hot wire anemometer, Venturimeter, Orifice meter, Rotameter, Pitot tube – Temperature: bimetallic strip.

UNIT 4 FORM MEASUREMENTS 9 Hrs.

Standard screw thread profiles, Terminology of screw threads, Measurement of major, minor and effective diameter by 2 wire, 3 wire method and best wire size, Screw thread gauges, Tool maker's microscope. Gear tooth profile measurement, Gear tooth terminology, tooth thickness measurement using constant chord method, addendum comparator method and base tangent method, measurement of pitch, concentricity, run out, and involute profile. Gear roll tester for composite error. Form measurement-Straightness - Flatness, Roundness, Surface finish measurement.

UNIT 5 ADVANCES IN METROLOGY 9 Hrs.

Basic concept of lasers - Advantages of lasers – Interferometry – laser interferometers – types – DC and AC Lasers interferometer- Applications – Straightness – Alignment. Computer Aided Inspection-Basic concept of Co-ordinate Measuring Machines(CMM) – Types of CMM – Constructional features – Probes –working principle, applications, alignment and errors; Machine Vision, elements of vision system, applications in manufacturing.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Write the specifications required for selecting a measuring instrument
CO2 - Design the gauges used in the go/no-go testing of the given part geometry.
CO3 - Suggest the appropriate measuring instruments for the linear and/ or angular measurements.
CO4 - Suggest the appropriate measuring instruments for the thermo physical measurement problem.
CO5 - Suggest the appropriate measuring instruments for the stated form measurement application.
CO6 - Justify how the advanced measuring techniques can be useful for the industrial quality control.

TEXT / REFERENCE BOOKS

1. Connie L Dotson, “Fundamentals of Dimensional Metrology”, Thomson Delmer Learning, 2006.
2. Beckwith T.G. and Marangoni, “Mechanical Measurements”, Addison Wesley, 2000.
3. Gupta I C, “Text Book of Engineering Metrology”, Dhanpat Rai Publishers, 2003.
4. Jain R.K., “Engineering Metrology”, Khanna Publishers, 1994.
5. Sirohi, “Mechanical Measurements”, New Age Publications, 2013.
6. Gaylor & Shotbolt, “Engineering Metrology”, Mc Donald & Co Publications, 2005.
7. Hume K.J., “Engineering Metrology”, ELBS, 1970.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1302	ENGINEERING THERMODYNAMICS	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To understand the basic concepts of thermodynamics.
- To comprehend laws of thermodynamics and apply it to the related processes.
- Perform thermal analysis on behavior and performance of systems.

UNIT 1 BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS 9 Hrs.

Basic concepts - concept of continuum, microscopic and macroscopic approach. Thermodynamic systems - closed, open and isolated. Thermodynamic Equilibrium, Property, state, path and process, quasi-static process and irreversible processes, heat and work, modes of work. Zeroth law of thermodynamics- concept of temperature and thermal equilibrium. 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 2 SECOND LAW OF THERMODYNAMICS AND ENTROPY 9 Hrs.

Second law of thermodynamics - Kelvin's and Clausius statements. Reversibility and irreversibility. Heat Engine, Refrigerator, Heat pump, Carnot theorem, Carnot cycle, reversed Carnot cycle, efficiency, COP. Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy. Available and Unavailable energy -Availability of non-flow and steady flow systems-Irreversibility and second law efficiency.

UNIT 3 PROPERTIES OF PURE SUBSTANCES 9 Hrs.

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, Dryness fraction and its determination by separating and throttling calorimeter, Calculations of work done and heat transfer in non-flow and flow processes.

UNIT 4 IDEAL AND REAL GASES, GAS MIXTURES AND THERMODYNAMIC RELATIONS 9 Hrs.

Properties of ideal and real gases - Equations of state for ideal and real gases - compressibility factor - compressibility chart. Properties of gas mixture. Exact differentials - Maxwell's relations-T-ds relations – Difference and ratio of heat capacities-Clausius Clapeyron equations - Joule Thomson effect.

UNIT 5 PSYCHROMETRY 9 Hrs.

Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Calculations & Applications**.**

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the first law of thermodynamics for the open and closed systems.
CO2 - Evaluate the performance of Heat engine, Refrigerator and heat pump with Kelvin Planck and Claudius statements.
CO3 - Calculate the thermodynamic properties of gases and steam, and apply it to related system analysis.
CO4 - Derive thermodynamic relations for the ideal and real gases.
CO5 - Estimate the combustion equations required for the complete and incomplete combustion.
CO6 - Determine the calorific value of the fuel, and perform the proximate and ultimate analysis for the fuels.

TEXT / REFERENCE BOOKS

1. Nag.P.K, Engineering Thermodynamics, 6th Edition, Tata McGraw-Hill, 2017.
2. R.K.Rajput, A Textbook of Engineering Thermodynamics, 5th Edition, Laxmi Publications, 2016.
3. Onkar Singh, Applied Thermodynamics, 4th Edition, New Age International Private Limited, 2018.
4. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2016.
5. Yunus A Cengel and Michael A Boles, Thermodynamics: An Engineering Approach, 8th Edition, McGraw Hill, 2017.
6. Claus Borgnakke, Richard E. Sonntag, Fundamentals of Thermodynamics, 8th Edition, Wiley, 2016.
7. Lynn D. Russell, George A. Adebiyi, Engineering Thermodynamics, 6th Edition, Oxford University Press, New Delhi, 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1303	FLUID MECHANICS AND MACHINERY	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To understand the fluid properties, flow characteristics and hydrostatic force on surfaces.
- To study the equation of motions such as mass, momentum and energy equation and their practical applications.
- To understand the functioning and characteristic curves of hydraulic machines.

UNIT 1 FLUID PROPERTIES 9 Hrs.

Fluid Properties: Density-Specific Weight-Specific Gravity-viscosity-surface tension-capillarity-Vapour pressure-compressibility. Fluid Static: Hydrostatic Law-Pressure Variation in static fluid-Hydrostatic force on a submerged plane surfaces-Location of hydrostatic force. Manometers-Simple, U tube and differential Manometers. Buoyancy-Meta centric height-determination of stability of floating bodies and submerged bodies.

UNIT 2 EQUATIONS OF MOTION 9 Hrs.

Types of fluid flow-Concept of Control Volume- Control Volume Analysis of mass, momentum and energy. Differential equation of continuity and momentum - Euler's and Bernoulli's Equation and its applications. Flow Measurement: Orifice meter, Venturi meter, Piezometer, Pitot tube.

UNIT 3 FLOW THROUGH ORIFICE, NOTCHES, WEIRS AND PIPES 9 Hrs.

Hydraulic co-efficient-Flow through orifice, Notches and weirs. Laminar and Turbulent flow-Reynolds experiment-laminar flow through circular pipe (Hagen poiseulle's)-Major and minor losses in pipes-Darcy weisbach's equation, chezy's formula- friction factor- moody diagram-pipes in series and pipes in parallel-total energy line-hydraulic gradient line-Equivalent pipe. Concept of Boundary Layer-Types of boundary layer thickness-drag on flat plate.

UNIT 4 PUMPS 9 Hrs.

Centrifugal Pumps: Introduction-Definitions of heads and efficiencies-Operations-work done by the Impeller with Velocity triangles-Performance curves-Cavitations-Multi-staging: Pumps in Series and Parallel. Reciprocating Pumps: Operation–power required driving the pump-Slip-indicator Diagram–Separation-Air vessels.

UNIT 5 TURBINES AND DIMENSIONAL ANALYSIS 9 Hrs.

Hydraulic Turbines: Classification of hydraulic turbines-Working principle of Pelton wheel, Francis and Kaplan turbines-velocity triangles-draft tube-hydraulic turbine characteristics. Governing of turbines. Dimensional Analysis: Needs and methods-Buckingham's π Theorem, Non-Dimensional Numbers, Similarities of flow. Model studies .

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Evaluate the hydrostatic stability of floating and submersible bodies.
CO2 - Apply the Bernoulli's equation of fluid motion to flow measuring devices.
CO3 - Evaluate the hydraulic coefficients and the energy losses in pipes.
CO4 - Analyze the performance characteristics of centrifugal and reciprocating pumps.
CO5 - Interpret the performance characteristics of hydraulic turbines.
CO6 - Predict the performance of prototype with dimensional analysis.

TEXT / REFERENCE BOOKS

1. Bansal.R.K, Fluid Mechanics & Hydraulics Machines, 9th Edition, Laxmi Publications, 2015.
2. Modi P.N., Seth S.M., Hydraulics and Fluid Mechanics Including Hydraulic Machines, 21st Edition, Standard Book House, 2017.
3. Goyal, Manish Kumar, Fluid Mechanics and Hydraulic Machines, PHI Learning Pvt. Ltd., 2015.
4. Kumar K.L., Engineering Fluid Mechanics, 8thEdition, Eurasia Publication House (P) Ltd, 2014.
5. R. K. Rajput, Fluid Mechanics & Hydraulics Machines, 4th Edition, S. Chand Limited, 2008.
6. Yunus.A.Cengel, John.M.Cimbala, Fluid Mechanics Fundamentals and Application, 3rd Edition, Tata McGraw Hill, 2013.
7. Robert W. Fox, Alan T. McDonald, Philip J.Pritchard, John W.Mitchell, Fluid Mechanics, 9th Edition, Wiley India Edition, 2016.
8. Franck M.White, Fluid Mechanics, 8th Edition, Tata McGraw Hill Publication, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**

PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA1304	MACHINE DRAWING	L	T	P	Credits	Total Marks
		1	0	4	3	100

COURSE OBJECTIVES

- To understand and apply national standards while drawing machine components based on BIS.
- To understand the conventions, abbreviations and symbols to be followed by Engineers for making assembly drawings.
- To make the students to understand sectioning, concept of limits, fits and tolerances used for component design.
- To understand surface texture, riveted joints, welded joints and keys.
- To know various thread forms and its engineering applications.
- To make the students learn to draw the assembly, orthographic and sectional views of various machine components and to interpret the assembly drawing.

1. CONVENTIONS, ABBREVIATIONS AND SYMBOLS

Conventional representation of shaft, hollow shaft, bar - Conventional representation of common machine elements such as threads, slotted head, bearings, straight and diamond knurling, holes on a linear and circular pitch, helical spring, leaf spring – Conventional representation of metals, glass, packing and insulating materials, liquids, concrete and wood – Conventional representation of screw, rivet and pin in section. Abbreviations for iron, carbon steel, alloy steel – Abbreviations for across corners, across flats, assembly, bearing, center of gravity, counterbore, countersunk, insulation, left hand, right hand, nominal, pitch circle diameter, tolerance, undercut.

2. SECTIONAL VIEWS

Full section, half section, partial or local section, revolved or superimposed section, removed section, successive section, parts that are not sectioned.

3. LIMITS, FITS AND TOLERANCES

Definitions: Limits, Fits and Tolerances – Upper limit, lower limit, tolerance, deviation, upper deviation, lower deviation, tolerance zone – Standard tolerance grades – Computation of IT tolerance using formulae and tables – Fundamental deviation – Computation of fundamental deviation – System of fits - Clearance fit – Interference fit – Transition fit – Problems on clearance and interference fit on shaft and hole basis system.

4. SURFACE TEXTURE

Nominal surface – Roughness – Waviness – Lay – Sampling length – Indication of surface roughness by roughness values, roughness grade number, roughness symbols – Indication of surface roughness by surface texture symbol with all the characteristics.

5. THREADED FASTENERS AND ITS APPLICATIONS

Screw thread terminology – Basic forms of screw threads - Standard forms of V threads – Basic form of square threads – Modified forms of square threads – Basic knuckle thread – Standard form of knuckle thread - Conventional representation of internal V thread and external V thread – Square thread – Designation of threads – Empirical proportions of hexagon and square head bolt and nut.

6. RIVETED JOINTS, WELDED JOINTS AND KEYS

Application of riveted joints – Difference between a bolt and a rivet – Disadvantages of riveted joints – Types of riveted joints – Empirical proportions of riveted joints – Types of welded joints – Symbolic representation of weld – Elementary weld symbols – Keys – Application of keys.

7. ASSEMBLY DRAWING (USING MINI-DRAFTER) FOR THE FOLLOWING WITH PART DRAWINGS GIVEN

Preparation of assembled views from exploded views for the following components: Cotter joint with sleeve, screw jack, snug type pedestal bearing, swivel bearing, tail stock.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Adapt the drawing standards, practices and conventions in the preparation of the machine drawing.
CO2 - Interpret the sectional part drawings for the given machine component.
CO3 - Use the fits and tolerance tables appropriately to set the correct fits and tolerance values to the specified machine components.
CO4 - Interpret the assembly drawings from the given individual component drawings according to the BIS standards, conventions and practices.
CO5 - Interpret the assembly drawings from the given exploded views according to the BIS standards, conventions and practices.
CO6 - Investigate the given machine assembly case study to interpret the machine drawing according to the BIS standards, conventions and practices after interpreting the dimensions and finding the features for sectioning

TEXT / REFERENCE BOOKS

1. Engineering drawing practice for schools and colleges, SP 46 – 1988. (http://web.iitd.ac.in/~achawla/public_html/201/lectures/sp46.pdf).
2. Gopalakrishnan, K.R., Machine Drawing, Subhas Publications, 16th Edition, 2008.
3. Bhatt, N.D., Machine Drawing, Charotar Publishing House, 48th Edition, 2013.
4. Brian Griffiths, "Engineering Drawing for Manufacture", Kogan Page Science, 2003.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1305	MECHANICS OF SOLIDS (COMMON TO MECH AND AUTO)	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To study the aspects of Strength, Stiffness and Stability.
- To gain knowledge of different types of stresses, strain and deformation induced in the components due to external loads.
- To study the distribution of various stresses in the elements such as beams, shafts etc.
- To study the effect of component dimensions and shapes on the stresses and deformations.

UNIT 1 STRESS STRAIN DEFORMATION OF SOLIDS 9 Hrs.

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stresses and strains. Elastic constants – Relation between Elastic constants- Strain energy and unit strain energy – Strain energy in uniaxial loads.

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UNIT 2 ANALYSIS OF STRESSES IN TWO DIMENSIONS 9 Hrs.

Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress - simple problems- Stresses on inclined plane.Biaxial state of stresses – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells – Efficiency of joint- Effect of Internal Pressure.

UNIT 3 BEAMS - LOADS AND STRESSES 9 Hrs.

Types of beams - Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams – SFD and BMD for inclined loads and couples. Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced.

UNIT 4 TORSION 9 Hrs.

Analysis of torsion of circular bars – Shear stress distribution – Bars of Solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Composite shafts Springs - Laminated springs, axial load and twisting moment acting simultaneously both for open and closed coiled springs– Deflection of helical coil springs under axial loads – stresses in helical coil springs under torsion.

UNIT 5 BEAM DEFLECTION 9 Hrs.

Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine Gordon formula for columns.Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method, Macaulay Method, and Moment-area Method.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Determine the stress-strain values for the uniform and varying composite sections using analytic methods.
CO2 - Calculate the principal stresses for the given thin shell application.
CO3 - Suggest the beam section by constructing the shear force and bending moment diagrams for the given transverse load application.
CO4 - Suggest the suitable shaft dimensions to withstand the desired twisting moment using the maximum shear stress and maximum angle of twist approaches.
CO5 - Recommend the suitable dimensions for the given long column specifications by evaluating the crippling loads.
CO6 - Suggest the suitable slope and deflection for the safe transverse loading on beams by evaluating the deflection parameters.

TEXT / REFERENCE BOOKS

1. Bansal R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 5th Edition, 2012.
2. Punmia B.C. & Jain A.K., Mechanics of Materials, Laxmi Publications, 2001.
3. Ryder G.H, "Strength of Materials, Macmillan India Ltd"., 3rd Edition, 2002.
4. Ray Hulse, Keith Sherwin & Jack Cain, "Solid Mechanics", Palgrave ANE Books, 2004.
5. Allan F. Bower, Applied Mechanics of Solids, CRC Press, 2009, 820 pages.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA2301	FLUID MECHANICS AND MACHINERY LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To practically perform various principles of Fluid Mechanics.
- To understand the principle of flow measurements by various types of flow measuring devices.
- To evaluate the performance of hydraulic machines.

FLUID MECHANICS LAB

1. Measurement of friction factor in pipe flow.
2. Determination of discharge coefficient for venturimeter.
3. Determination of discharge coefficient for orifice meter.
4. Determination of discharge coefficients for notches.
5. Determination of Meta centric height of ship model.
6. Determination of Co-efficient of discharge of Orifice and Mouth Piece.
7. Determination of Co-efficient of velocity in Pitot tube.

FLUID MACHINERY LAB

1. Study and Performance characteristics of Centrifugal Pump.
2. Study and Performance characteristics of Reciprocating Pump.
3. Study and Performance characteristics of Multistage Centrifugal Pump.
4. Study and Performance characteristics of Gear Pump.
5. Study and Performance characteristics of Jet Pump.
6. Study and Performance characteristics of Deep well Turbine Pump.
7. Study and Performance characteristics of Pelton Wheel Turbine.
8. Study and Performance Characteristics of Francis Turbine.
9. Study and Performance characteristics of Kaplan Turbine.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Estimate the friction factor in a pipe flow.
CO2 - Compute the flow coefficients for flow measuring devices.
CO3 - Analyze the stability of ship model by measuring the meta centric height.
CO4 - Estimate performance parameters of Centrifugal and Reciprocating pump.
CO5 - Evaluate the performance parameters of gear pump, jet pump and Deep well pump.
CO6 - Analyze the performance characteristics of turbines.

SMEA2302	MATERIAL TESTING AND METALLURGY LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To understand the fundamental practices of material testing, such as specimen preparation, micro structural analysis and hardenability.
- To test and evaluate the mechanical properties, such as hardness, stiffness, impact strength, shear strength, torsion strength, tensile strength.

METALLURGY LAB

1. Studying the preparation of a specimen for metallographic examination.
2. To study the microstructure of plain carbon steel (Low carbon steel, medium carbon steel and high speed steel).
3. To study the effect of heat treatment on plain carbon steel (Annealing, Normalizing and Hardening).
4. To study the microstructure of alloy steels (Stainless steels, Tool steels).
5. To study the microstructure of cast iron (Grey cast iron, white cast iron, malleable cast iron and spheroidal graphite cast iron).
6. To study the microstructure of light alloys (Aluminium alloy and Magnesium alloy).
7. To study the microstructure of heavy alloys (Copper alloy, Nickel alloy).
8. Determine the Hardenability of steel by Jominy end quench testing.

MATERIAL TESTING LAB

1. Hardness test on metals- Brinell, Vicker and Rockwell Hardness tests.
2. Impact test on metals-Charpy, Izod impact tests.
3. Shear test on metals-direct shear strength, single shear, double shear.
4. Deflection test on beams-load deformation characteristics, Young's modulus, Maxwell's reciprocal law verification.
5. Torsion test on beams-torque and angle of twist characteristics, shear stress, modulus of rigidity, energy.
6. Tests on helical springs-compression, tension springs-load deformation characteristics, stiffness, shear stress, modulus of rigidity, energy.
7. Tension test on metals-stress strain characteristics, ductility, resilience, toughness.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Prepare the specimens suitable for the metallographic examination as per the standard procedures.
CO2 - Identify the material and the constituting elements/compounds from the microstructure.
CO3 - Determine the stress-strain properties of the given specimen using the standard testing procedure.
CO4 - Determine the hardness of the given specimen using the standard testing procedure.
CO5 - Determine the impact properties for the given specimen using the standard testing procedure.
CO6 - Determine the spring characteristics using the standard testing procedure.

SMTA1401	ENGINEERING MATHEMATICS - IV (COMMON TO AERO, AUTO, MECH AND MECHATRONICS)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- The ability to identify, reflect upon, evaluate and apply different types of information and knowledge to form independent judgments. Analytical, logical thinking and conclusions based on quantitative information will be the main objective of learning this subject.

UNIT 1 FOURIER SERIES **9 Hrs.**

Fourier series – Euler's formula – Dirichlet's conditions – Fourier series for a periodic function – Parseval's identity (without proof) – Half range cosine series and sine series – simple problems – Harmonic Analysis.

UNIT 2 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION **9 Hrs.**

One dimensional wave equation – Transverse vibrating of finite elastic string with fixed ends – Boundary and initial value problems – One dimensional heat equation – Steady state problems with zero boundary conditions – Two dimensional heat equation – Steady state heat flow in two dimensions- Laplace equation in Cartesian form(No derivations required).

UNIT 3 NUMERICAL METHODS FOR SOLVING EQUATIONS **9 Hrs.**

Solution of algebraic equation and transcendental equation: Regula Falsi Method, Newton Raphson Method (including solving algebraic equations in two variables $f(x,y)=0$ and $g(x,y)=0$) – Solution of simultaneous linear algebraic equations: Gauss Elimination Method, Gauss Jacobi & Gauss Seidel Method.

UNIT 4 INTERPOLATION, NUMERICAL DIFFERENTATION AND INTEGRATION **9 Hrs.**

Interpolation: Newton forward and backward interpolation formula, Lagrange's formula for unequal intervals – Numerical differentiation: Newton's forward and backward differences to compute first and second derivatives – Numerical integration: Trapezoidal rule, Simpson's 1/3rd rule and Simpson's 3/8th rule.

UNIT 5 NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS AND PARTIAL DIFFERENTIAL EQUATIONS **9 Hrs.**

Ordinary differential equations: Taylor series method, Runge Kutta method for fourth order – Partial differential equations – Finite differences – Laplace equation and its solutions by Liebmann's process – Solution of Poisson equation – Solutions of parabolic equations by Bender Schmidt Method – Solution of hyperbolic equations.

Max. 45 Hrs.

TEXT / REFERENCE BOOKS

1. Kreyszig E., Advanced Engineering Mathematics, (8th Edition), John Wiley and Sons (Asia) Pte Ltd., Singapore, 2001.
2. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi,2011.
3. Kandasamy P., Thilagavathy K. & Gunavathy K., Engineering Mathematics, (4th Revised Edition), S.Chand & Co., New Delhi, 2001.
4. Veerarajan,T., Engineering Mathematics, Tata Mcgraw Hill Publishing Co., NewDelhi, 2005.
5. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, Tata Mcgraw Hill Publishing Co., New Delhi, 2003.
6. Kandasamy P., Thilagavathy K. and Gunavathy, K., Applied Numerical Methods, S.Chand & Co., New Delhi, 2003.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - List the formulae in Fourier series, algebraic and transcendental equations. Recall the condition for convergence of simultaneous linear algebraic equations.
CO2 - Understand various numerical methods for Interpolation, differentiation and integration.
CO3 - Apply the concepts of ordinary and partial differential equations by choosing the most suitable numerical method.
CO4 - Categorize and implement the numerical solutions of algebraic, transcendental, simultaneous linear equations.
CO5 - Appraise the solution of one dimensional wave, one dimensional heat and two dimensional heat equations.
CO6 - Develop Fourier series for different types of functions. Evaluate solution for Interpolation, numerical differentiation and integration.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SAIC4001	INDUSTRY 4.0	L	T	P	Credits	Total Marks
		2	-	2	2	100

UNIT 1 ADVANCED TECHNOLOGY AND ADVANCED MATERIALS 7 Hrs.

Advanced electro-optical sensing technology-active, passive multi-spectral and hyper spectral imaging; electronic beam steering; vacuum technology, surface and coating technology, health care technology, Nanotechnology- Nanomechanics, Nano optoelectronics; energy storage technology-next generation Li-based Batteries, Hydrogen storage, solar photovoltaic's, Flexible electronics. Intellectual Property Rights - case studies governing/pertaining to Materials/Technology.

UNIT 2 TRANSFORMING TECHNOLOGIES IN BIOENGINEERING 7 Hrs.

Establishment of smart biotechnology factory, Artificial intelligence in Bioprocess technology, Omics – Big data analysis through automation, 3D bio printing for tissue engineering. Simulation tools, RSM and Box model. Cyber physical system based telemedicine, diagnosis and therapeutics through real time biosensors. Bionanotechnology. Intellectual Property rights (IPR): Case Studies.

UNIT 3 ADVANCEMENTS IN SUSTAINABLE BUILT ENVIRONMENT 7 Hrs.

Introduction – Technological developments in Architectural, Engineering and Construction (AEC) - Building Information Modelling (BIM) using Cloud computing technology and Internet of things (IoT) – Unmanned Aerial Vehicles, sensors – Additive manufacturing in construction – Concrete 3D printing - Materials used - Lightweight and functionally graded structures - Net Zero Energy buildings, Bioswales, Biofiltration pond, Ecosan systems- Recent developments in Waste water Management, Air pollution control, waste disposal - Integration of energy, water and environmental systems for a sustainable development- Emerging Technologies: Robot Highway- Vertical farming - Intellectual Property rights: Case studies.

UNIT 4 SMART MANUFACTURING 8 Hrs.

Smart factories and interconnection, Smart Manufacturing – automation systems, Additive Manufacturing, Smart grids, Micro Electro Mechanical Systems (MEMS), Stealth technology, Metal Finishing, Self propelled vehicles, e mobility, Green fuels, drones – unmanned aerial vehicles(UAVs), aerodynamics. Robotic Automation and Collaborative Robots – Augmented reality and haptics, engineering cybernetics and artificial intelligence (AI), Disruptive Technologies – Frugal Innovations – Emerging Technologies - Autonomous Robots, Swam Robot, Modular Robotics, Space craft, Intellectual Property Rights (IPR): Case Studies.

UNIT 5 SMART WORLD 8 Hrs.

Smart Sensors and IIOT, Smart grid, Hybrid renewable energy systems, Electronics in Smart city, Integration of Sensors in Robots and Artificial Intelligence, 5G Technology, Communication protocols, Human-Machine Interaction, Virtual Reality, Quantum Computing: Changing trends in transistor technology: Processor, Emerging Trends: Deep Space, Swarm Robots, Cyborg, Geofencing, Pervasive Computing, Intellectual Property Rights- Case Studies.

UNIT 6 CYBER PHYSICAL SYSTEMS 8 Hrs.

Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, healthcare and human computer interactions, Industrial Artificial Intelligence, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Transportation, Intellectual Property Rights (IPR) : Case Studies.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the basic concepts for electro optical sensing technology and selection of materials.
CO2 - Analyze the technology on AI and Big Data for biomedical applications.
CO3 - Elaborate the various technologies for sustainable built environment.
CO4 - Evaluate different smart manufacturing technologies for industrial robotics based automation.
CO5 - Compare various advanced technologies for development of smart city.
CO6 - Build Cyber physical systems using AI for Industry, Agriculture and disaster management applications.

Max. 45 Hrs.

TEXT / REFERENCE BOOKS

1. William D. Callister,"Materials Science and Engineering, An Introduction, John Willey and Sons Inc. Singapore, 2001.
2. V. Raghavan, "Physical Metallurgy: Principle and Practice,. Prentice Hall India Pvt Ltd, 2006.
3. Flavio Craveiro, Jose Pinto Duarte, Helena Bartolo and Paulo Jorge Bartolo, "Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0", Automation in Construction, Vol. 103,pp. 251- 267, 2019.
3. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
4. Oliver Grunow, "SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Studylab Publications, 2016.
5. Alasdair Gilchrist, "INDUSTRY 4.0: Industrial Internet of Things", Apress, 2016.
6. Sang C. Suh, U. John Tanik, John N Carbone, Abdullah Eroglu, "Applied Cyber-Physical Systems", Springer Publications, New York, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**
PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA1401	MANUFACTURING TECHNOLOGY – I	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of basic manufacturing processes.
- To understand various manufacturing techniques, such as metal casting, metal joining, metal forming and manufacture of plastic components.

UNIT 1 METAL CASTING PROCESSES 9 Hrs.

Sand casting – Sand moulds - Type of patterns – Pattern materials – Pattern allowances – Types of Moulding sand – Properties – Core making – Methods of Sand testing – Moulding machines – Types of moulding machines - Melting furnaces – Working principle of Special casting processes – Shell, investment casting – Ceramic mould – Lost Wax process – Pressure die casting – Centrifugal casting – 2CpOrocess – Sand Casting defects – Inspection methods.

UNIT 2 JOINING PROCESSES 9 Hrs.

Fusion welding processes – Types of Gas welding – Equipments used – Flame characteristics – Filler and Flux materials - Arc welding equipments - Electrodes – Coating and specifications – Principles of Resistance welding – Spot welding – seam welding – Percusion welding - Gas metal arc welding – Flux cored – Submerged arc welding – Electro slag welding – TIG welding – Principle and application of special welding processes - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding – Diffusion welding – Weld defects – Brazing and soldering process – Methods and process capabilities – Filler materials and fluxes – Types of Adhesive bonding.

UNIT 3 BULK DEFORMATION PROCESSES 9 hrs.

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – Characteristics of the process – 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 – Equipments used.

UNIT 4 SHEET METAL PROCESSES 9 Hrs.

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 forming – Rubber pad forming – Metal spinning – Introduction to Explosive forming, Magnetic pulse forming, Peen forming, Super plastic forming.

UNIT 5 MANUFACTURING OF PLASTIC COMPONENTS 9 Hrs.

Types of plastics - Characteristics of the forming and shaping processes – Moulding of Thermoplastics – Working principles and typical applications of - Injection moulding – Plunger and screw machines – Compression moulding, Transfer moulding - Typical industrial applications – Introduction to Blow moulding – Rotational moulding – Film blowing – Extrusion - Thermoforming - Bonding of Thermoplastics.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Suggest a suitable metal casting process by evaluating the factors affecting the selection for the given application.
CO2 - Suggest the appropriate type of joining operations in the real life engineering applications.
CO3 - Develop the process-maps for the metal forming processes for the given application.
CO4 - Propose the sheet metal operations for making the specific sheet metal works.
CO5 - Choose the specific forming and shaping processes required to make the products made of thermo- and thermoset plastics.
CO6 - Choose the appropriate non-traditional manufacturing processes for the special industrial applications.

TEXT / REFERENCE BOOKS

1. Hajra Choudhury S.K. and Hajra Choudhury A.K., “Element of Manufacturing Technology Vol. I”, Media Publications, 2009.
2. Kalpakjian S., “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2006.
3. Rao P.N., Manufcturing Technology Foundry, Forming and Welding, TMH, 2009.
4. Roy A. and Lindberg, “Process and Material Manufacture”. PHI 1995.
5. Sharma P.C., “A Text book of Production Technology”, S. Chand and Co. Ltd., 5th Edition, 2004.
6. Rao P.N., Manufacturing Technology Vol. II Metal cutting and Machine Tools, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**

PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA1402	MECHANICS OF MACHINES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- Provide the insights of the fundamentals of Mechanisms and Cams.
- Understand the basics of Flywheels, Balancing of Rotating and Reciprocating unbalance systems.
- Enhance knowledge of Single degree - Free and Damped Vibrations.
- Provide the detailed overview of Forced Vibrations.
- Discuss the fundamentals of Gears, Gyroscopes and Governors.

UNIT 1 MECHANISMS AND CAMS 9 Hrs.

Mechanisms – Terminology and definitions – Kinematics inversions of 4 bars and slider crank chain – Kinematic analysis in simple mechanisms. Types of cams and followers - Terminology and definitions – Displacement diagrams – SHM, uniform velocity, uniform acceleration and retardation. Graphical constructions of cam profiles – Disc cam with knife edge follower, roller follower and flat-faced follower.

UNIT 2 FLY WHEELS AND BALANCING 9 Hrs.

Turning moment diagrams – Fluctuation of Energy and speed – Energy stored in Flywheel – Mass of Flywheel – Dimensions of Flywheel. Balancing – Static and Dynamic Balancing of Rotating Masses - Balancing of several masses rotating in same plane and in different planes- Partial Balancing of locomotives – Variation of tractive force, Hammer blow and swaying couple.

UNIT 3 FUNDAMENTALS OF VIBRATION 9 Hrs.

Basic features of vibratory systems - Lumped mass systems - Degrees of freedom - Free vibration of Longitudinal, Transverse and Torsional systems of Single degree of freedom - Equations of motion - Natural frequency – Whirling of shafts and critical speed - Dunkerley's Method – Torsional vibration of Two and Three rotor system. Damped free vibration - Types of Damping –Critical damping coefficient - Damping Factor – Logarithmic Decrement.

UNIT 4 FORCED VIBRATION 9 Hrs.

Forced vibration of single degree freedom system with damping - Response to periodic forcing- Harmonic Forcing - Force transmissibility and amplitude transmissibility - Reciprocating and rotating unbalance - vibration isolation and transmissibility - Support motion - self excited vibration with examples.

UNIT 5 GEARS, GOVERNORS AND GYROSCOPES 9 Hrs

Spur gear terminology – law of toothed gearing – Involutes gearing – Path of contact, arc of contact and contact ratio. Interchangeable gears – Gear tooth action – interference and undercutting – Gear trains – Epicyclic gear train – tabular method of finding velocity ratio.Governors - Types - Centrifugal governors – Porter– Characteristics –Sensitivity – Stability – Hunting – Isochronisms – equilibrium speed - Controlling Force- Gyroscopes - Gyroscopic couple - Gyroscopic stabilization - Gyroscopic effects in Aeroplanes.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recommend the cam and follower arrangement for the specific case study.
CO2 - Examine the balancing of rotating and reciprocating unbalanced mass systems using analytical and graphical methods.
CO3 - Design the flywheels for the specific mechanical system using analytical techniques.
CO4 - Establish the free and/or forced vibration characteristics of the given mechanical system using analytical methods.
CO5 - Predict the gyroscopic effects on the stability of the given moving vehicle analytically.
CO6 - Compare the characteristics of governors for the specific automotive system.

TEXT/REFERENCE BOOKS

1. Khurmi R.S. & Gupta J.S, "Theory of Machines", 16th Edition, S.Chand & Company, 2005, Reprint 2016.
2. Singh V.P, "Mechanical Vibrations", 3rd Edition, Dhanpatrai & Co., 2006.
3. Ghosh A. and Malik A.M, "Theory of Mechanism and Machines", 4th Edition, Affiliated East West Press (P) Ltd., 2009.
4. Ashok G. Ambekar, "Mechanism and Machine Theory", 1st Edition, PHI Learning Private limited, 2009.
5. Rattan S. S, Theory of Machines, 3rd Edition, Tata Mcgraw Hill, 2009.
6. Gordon R Pennock, Joseph E Shigley, "Theory of Machine and Mechanisms" SI Edition, 4th Edition, Oxford University Press, 2014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1403	POWER PLANT ENGINEERING	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To provide essential knowledge of construction and working of various types of power plants.
- To detail the role of Mechanical Engineers in their operation and maintenance.

UNIT 1 STEAM POWER PLANT **9 Hrs.**

Layout of Thermal Power Plant, Fuel And Ash Handling, Dust collection, Super Critical & FBC Boilers, Super heaters, Air pre heaters, Economizer, Condensers, Feed water heaters and evaporators – Draught System, Cooling pond and cooling towers, Feed Water Treatment.

UNIT 2 DIESEL, GAS, HYDRO ELECTRIC POWER PLANT **9 Hrs.**

Layout and Components of Diesel - Gas Turbine and Hydro Electric Power Plants- site selection, operations, Advantages - Disadvantages - Applications.

UNIT 3 NUCLEAR & COMBINED POWER PLANT **9 Hrs.**

Nuclear Engineering, Layout and components of Nuclear Power Plants, Working of Nuclear Reactors: BWR, PWR, CANDU, Fast Breeder, Gas Cooled and Liquid Metal Cooled Reactors, Combined and Binary Cycle Power Plants. Integrated Gasifier Combined Cycle power plants.

UNIT 4 ECONOMIC AND ENVIRONMENTAL ISSUES **9 Hrs.**

Load Distribution Parameters, Load Curve, Capital and Operating Cost of Different Power Plants - Power Tariff Types - Pollution Control Technologies Including Waste Disposal Options for Thermal and Nuclear Power Plants.

UNIT 5 NON-CONVENTIONAL POWER GENERATION **9 Hrs.**

Principle, Construction and Working of Wind, Tidal, Solar Thermal, Solar Electrical, Geothermal, Biogas and Fuel Cell Power Systems, Different Direct Energy conversion systems.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Comprehend knowledge of various components and systems of steam power plant.
CO2 - Evaluate the performance parameters of Boiler, condenser, feed water heater and cooling tower.
CO3 - Examine the functions of various instruments used in power plant.
CO4 - Analyze the various cycles of gas turbine and nuclear power plants.
CO5 - Comprehend knowledge of various non-conventional energy based power plants.
CO6 - Estimate the economic parameters and environmental aspects of power plant.

TEXT / REFERENCE BOOKS

1. Nag. P.K., "Power Plant Engineering", 4th Edition, Tata McGraw – Hill Publishing Company Ltd., 2012
2. Domkundwar, Power Plant Engineering - Dhanpat Rai & Sons, Delhi, 2016.
3. Vopal and Stortzki," Power Plant Engineering", PHI, 2007.
4. Rajput.R.K, "Power Plant Engineering", 5th Edition, Laxmi Publications, 2016.
5. Nagpal.G.R, Sharma.S.C, "Power Plant Engineering, 16th Edition, Khanna Publishers, 2012.
6. Joel Weisomon and Roy Eckart, "Modern Power Plant Engineering", PHI, 1985.
7. Rai G.D, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1404	THERMAL ENGINEERING	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To incorporate the laws, processes and cycles from the basics of thermodynamics to the different gas power cycles.
- To evaluate the Internal combustion engine performance with the application of thermodynamic concepts.
- To examine the significance of Steam nozzles, Turbines, Compressors, Refrigeration and Air conditioning systems in the field of Thermal Engineering.

UNIT 1 GAS AND VAPOUR POWER CYCLES 9 Hrs.

Air Standard Cycle analysis - Otto, Diesel, Dual, Brayton cycle, Simple Rankine, Reheat and Regeneration cycles performance.

UNIT 2 INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS 9 Hrs.

Working of S.I. and C.I engines, two stroke and four stroke engines – Valve timing, port timing and PV diagrams of S.I and C.I engines - Estimation of brake power indicated power, thermal efficiency, Heat balance sheet. Electronic and Common Rail Direct injection systems. Magneto and Battery coil ignition systems, Lubrication and Cooling systems. Supercharging and turbocharging systems.

UNIT 3 AIR COMPRESSORS 9 Hrs.

Classification and working of air compressors - Classification of compressors and their comparison - Reciprocating air compressor-principle of operation, work requirement, isothermal efficiency, volumetric efficiency and effect of clearance, Multi stage compression with inter cooling, saving work, Working of Rotary Compressors and comparison with reciprocating air compressors.

UNIT 4 STEAM NOZZLES AND STEAM TURBINES 9 Hrs.

Flow of steam through nozzles, Isentropic flow, ideal and actual expansion in nozzle, condition for maximum discharge, critical pressure ratio, Meta stable flow. Steam turbines, impulse and Reaction principles, Compounding, Velocity diagrams for impulse and reaction blades, Work done on turbine blades, optimization and efficiency.

UNIT 5 REFRIGERATION AND AIR CONDITIONING SYSTEMS 9 Hrs.

Bell Coleman and vapour compression refrigeration systems, Performance calculations, vapour absorption refrigeration system, Air conditioning systems and types, working principle-Estimation of cooling load.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Apply the thermodynamic principles to air standard cycles.
CO2 - Analyze heat balance sheet for IC engines
CO3 - Recommend a suitable type of compressors for a particular application.
CO4 - Design steam nozzle and construct velocity diagrams for turbines
CO5 - Estimate the coefficient of performance of refrigeration system.
CO6 - Evaluate cooling and heating loads in an air conditioning system.

TEXT / REFERENCE BOOKS

1. Rajput, R.K, Thermal Engineering, 10th Edition, Laxmi Publications, 2017.
2. Ajoy kumar, G.N. Sah, Thermal Engineering, 2nd Edition, Narosa Publications, 2010.
3. Ballaney, P.L., Thermal Engineering, 24th Edition, khanna Publishers, 2003.
4. Kothandaraman C.P., Khajuria P.R and Domkundwar.S., 4th Edition, A Course in Thermal Engineering. Dhanpat Raj & Sons, 2004.
5. Sarkar B.K, Thermal Engineering, McGraw Hill, 2004.
6. Sarao. A.S, Thermal Engineering, Satya Prakashan, New Delhi. 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA2401	ENGINEERING METROLOGY AND DYNAMICS LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To understand metrology and working of various measuring instruments.
- To acquire the knowledge on linear and angular measurements, coordinate measuring machines, comparators, screw thread and gear measurements.
- To supplement the principles learnt in Mechanics of Machines.

SUGGESTED LIST OF EXPERIMENTS

1. Angle measurement using Bevel Protractor and Sine bar .
2. Measurement of linear and angular dimensions by using Tool Maker's Microscope (TMM).
3. Testing Squareness of a Tri-square using Slip Gauges.
4. Bore diameter Measurement by two balls and four balls method.
5. Internal taper angle measurement by using spheres.
6. Measurement of linear and angular dimensions by using profile projector.
7. Measurement of gear tooth thickness by using gear tooth vernier.
8. Measurement of circularity, cylidricity, dimensional tolerance and run out using Mechanical, Electronic comparator.
9. Composite error in gears using Parkinson Gear Tester .
10. Measurement of surface finish by using surface roughness tester.
11. Straightness measurement using Autocollimator.

SUGGESTED LIST OF EXPERIMENTS

1. Longitudinal vibration of spring mass system.
2. Undamped free vibration of equivalent spring mass system.
3. Undamped torsional vibration of single rotor system.
4. Critical speed of whirling shafts.
5. Amplitude and frequency of forced vibration using vibration exciter and vibration meter.
6. Characteristics of Governors – Watt Porter and Proell.
7. Gyroscopic torque measurement.
8. Drawing profile of the cam.
9. Velocity ratio of epicyclic gear train.
10. Balancing of rotating and reciprocating masses.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Perform the angular measurement using Sine Bar and Bevel Protractor.
CO2 - Compare the dimension of the given geometry using various measurement methods.
CO3 - Calculate the surface finish and quality of the given component.
CO4 - Predict the longitudinal, un-damped free and torsional vibrations.
CO5 - Measure the cutting force using dynamometer.
CO6 - Analyse the amplitude and frequency of forced vibration.

SMEA2402	MANUFACTURING PROCESSES LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVE

- To study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

SUGGESTED LIST OF EXPERIMENTS.

1. Lathe Operations: Turning, Taper Turning, Boring, Thread cutting – Internal and External.
2. Shaping Machines: Machine of plane and inclined surfaces, grooving – V grooving, dovetail cutting.
2. Planing: Exercise involving plane and inclined surfaces.
3. Grinding: Exercise involving cylindrical grinding – Surface grinding – single point tool grinding in tool and cutter grinder.
4. Milling: Cutting of spur, helical, bevel gear, milling of polygon surface.
5. Boring: Simple exercise in boring machine.
6. Hobbing: Making of spur and helical gear.
7. Slotting: Key way cutting (internal & external).
8. Measurement of cutting forces in turning, milling and drilling (tool dynamometer).
9. Practices in Capstan and Turret lathes (at least one exercise).
10. CNC Lathe – Simple Turing, Step Turning, Thread Turing.
11. Machining Center – A typical job production-Milling, Drilling, Reaming.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Make the specified cylindrical objects by performing the external machining operations to using lathe machine tool.

CO2 - Make the specified cylindrical objects by performing the external machining operations to make the specified prismatic objects using shaper/ planer/ miller.

CO3 - Make the specified cylindrical objects by performing the internal machining operations using slotter/ driller/ boring machine.

CO4 - Perform the machining operations in semi-automatic/ CNC machines.

CO5 - Analyze the cutting forces during the machining operations in order to set the suitable value depending on the work piece.

CO6 - Produce the specified engineering component within the allowable tolerance limits, which needs to be machined in different machines.

SMEA1501	CAD / CAM	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide the fundamental information about computer graphics, elements of CAD/CAM and basic understanding about transformations, clipping, windowing and hidden line removal.
- To provide understanding of various wireframe, surface and solid modelling techniques used for generating computer models.
- To provide the details on how computer applications are used directly and indirectly for the manufacturing applications.

UNIT 1 FUNDAMENTALS OF CAD/CAM 9 Hrs.

Introduction: Elements of CAD, Elements of CAM, CAD/CAM integration, Advantages and applications. Computer graphics: Input and output devices, CAD/CAM databases, Requirements of Computer graphics packages. Transformations: Geometric transformation versus viewing transformation, Basic transformation matrices, such as translation, rotation and scaling.

UNIT 2 GEOMETRIC MODELLING - I 9 Hrs.

Wireframe modelling of analytical curves, such as line, circle and conics, and synthetic curves, such as Hermite cubic spline, Bezier curve and B-Spline curve. Surface modelling of analytical surfaces, such as plane surface, ruled surface, surface of revolution and tabulated cylinder, and synthetic surfaces, such as Hermite cubic surface, Bezier surface and B-Spline surface.

UNIT 3 GEOMETRIC MODELING - II 9 Hrs.

Solid modelling techniques: Constructive solid geometry (CSG) representation and Boundary representation. Assembly modelling: Assembly of part drawing, Approaches, Interferences of positions and orientation. Graphics standards: Product data exchange, File format of DXF, IGES and STEP files. Capabilities of modelling & analysis packages.

UNIT 4 COMPUTER AIDED MANUFACTURING - I 9 Hrs.

NC, DNC and CNC machine tools. NC Programming: point to point and continuous path machining approaches, G Codes, M Codes, Canned cycles, Manual NC programming for turning and milling operations. Use of computer applications in inspection, rapid prototyping, material handling and other manufacturing related tasks.

UNIT 5 COMPUTER AIDED MANUFACTURING - II 9 Hrs.

Computer Aided Process Planning (CAPP): Traditional process planning, Benefits of CAPP, Variant and Generative approaches. Computer integrated production system (CIPS): Traditional production planning, Benefits of CIPS, Master production Schedule, Material Requirement Planning, Inventory Management, Capacity planning, Shop floor control.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Interpret how the basic transformation operations are applied for the geometric and viewing transformations in a CAD environment.

CO2 - Interpret how the analytic and synthetic curves are generated using the parametric representations in a CAD environment.

CO3 - Interpret how the analytic and synthetic surfaces are generated using the parametric representations in a CAD environment.

CO4 - Sketch the 3D model of a given part drawing step by step using a 3D modeling representation technique.

CO5 - Write the manual NC programming using the FANUC standard NC code library for the given part drawing.

CO6 - Suggest the appropriate computer aids for the phases of manufacturing and control activities for the stated industrial application.

TEXT / REFERENCE BOOKS

1. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM : Theory and Practice: Special Indian Edition", 2nd Edition, McGraw Hill Education, 2009.
2. M. Groover and E. Zimmers, "CAD/CAM Computer-Aided Design and Manufacturing", 1st Edition, Pearson Education, 2003.
3. Donald D. Hearn and M. Pauline Baker, "Computer Graphics, C Version", 2nd Edition, Pearson Education, 2014.
4. John F. Hughes, Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner and Kurt Akeley, "Computer Graphics: Principles and Practice", 3rd Edition, Pearson Education India, 2013.
5. Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", 4th Edition, Pearson Education, 2014.

6. Mike Mattson, "CNC Programming: Principles and Applications", 1st Edition, Delmar, 2013.
7. M. Adithan and B.S. Pable, "CNC Machines", 3rd Edition, New Age International Publishers, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1502	DESIGN OF MACHINE ELEMENTS (FOR MECH AND MECHATRONICS)	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To understand the various procedures involved in the design process based on strength requirements.
- To understand the design steps involved in evaluating the dimensions of a component to satisfy functional operation.
- To learn standard practices and standard data by using design data book and catalogues.
- To familiarize the use of data books and various codes for practice.

UNIT 1 STATIC STRESSES AND VARIABLE STRESSES IN MACHINE COMPONENTS 9 Hrs.

Introduction to the design process-factors influencing machine design, selection of materials based on mechanical properties - Principal stresses for various load -Factor of safety-Theories of failure- design based on strength and stiffness- stress concentration-Design for Variable loading –Gerber line, Goodman's line, and Soderberg's Line.

UNIT 2 DESIGN OF SHAFTS AND COUPLINGS 9 Hrs.

Design of solid and hollow shafts based on strength and rigidity, Keys- different types of keys- Design Keys, keyways, failures of keys-Couplings - Rigid coupling- flexible coupling

UNIT 3 TEMPORARY AND PERMANENT JOINTS 9 Hrs.

Threaded fasteners- stress in screwed threads, Bolted joints including eccentric loading- Design of knuckle and cotter joints- Welded joints- merits and demerits of welded joints, Types of welded joints, weld symbols, Strength of parallel and fillet weld, strength of a welded joint, eccentrically loaded welded joints.

UNIT 4 DESIGN OF SPRINGS AND CONNECTING ROD 9 Hrs.

Functions of springs-applications- spring materials-Design of helical, Belleville springs (disc) and torsion spring–Design of Leaf Spring – Design of connecting rod.

UNIT 5 DESIGN OF BEARINGS FLYWHEELS 9 Hrs.

Introduction -Design of bearings - Sliding contact bearing – Design of journal bearings- Mckees equation- Lubrication in journal bearings -Rolling contact bearing (antifriction bearing). Types of fly wheels- Design of flywheels involving stresses in rim and arm.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Adapt the design principles, material selection guidelines, safety considerations and the use of design handbook for the design of machine elements.
CO2 - Recommend the design parameters of the shafts, keys and couplings for the required strength and rigidity.
CO3 - Design the temporary and permanent joints for the specified application.
CO4 - Propose the type of design parameters of the springs required to meet the given load conditions of a case study.
CO5 - Design bearings for the given dynamic load conditions using Mckees equation.
CO6 - Suggest the flywheel parameters to develop the energy required for maintaining the uniform speed for the given case study.

TEXT / REFERENCE BOOKS

1. Juvinall R.C. and Marshek K.M., "Fundamentals of Machine Component Design", John Wiley & Sons, 2002.
2. Bhandari V.B, "Design of Machine Elements", Tata McGraw-Hill Book Co, 2003.
3. Norton R.L, "Design of Machinery", Tata McGraw-Hill Book Co., 2004.
4. Spotts M.F, Shoup T.E., "Design and Machine Elements", Pearson Education, 2004.
5. Kannaiah, P., Machine Design, 2nd Edition, Scitech Publication Pvt. Ltd.,2009.
6. Shigley, J.E and Mischke, C. R. Mechanical Engineering Design,6th Edition, Tata McGraw Hill, 2005.
7. Sundararajamoorthy, T.V. and Shanmugam, N., Machine Design, Anuradha Agencies, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**

PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA1503	FINITE ELEMENT ANALYSIS	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To understand the concepts of Mathematical Modeling of Engineering Problems.
- To apply the use of FEM in various engineering problems.
- To learn the efficient implementation of finite element method in solving of simple problems.
- To solve simple and complicated 2D structural problems for stress analysis under impact loads from general engineering aspects.

UNIT 1 INTRODUCTION **9 Hrs.**

Historical Background– Basic Concepts of FEM – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems–Residual Methods- Variational Formulation of Boundary Value Problems – Ritz Method .

UNIT 2 ONE-DIMENSIONAL PROBLEMS **9 Hrs.**

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices- Solution of problems from solid mechanics and heat transfer-Bar, Beam Elements – Applications to Heat Transfer.

UNIT 3 TWO DIMENSIONAL PROBLEMS **9 Hrs.**

Basic Boundary Value Problems in Two Dimensions – Triangular, quadrilateral, higher order elements – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT 4 SOLUTION TO PLANE ELASTICITY PROBLEMS **9 Hrs.**

Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT 5 ISO PARAMETRIC FORMULATION **9 Hrs.**

Natural Co-ordinate System – Lagrangian Interpolation Polynomials – Iso-parametric Elements – Formulation –Numerical Intergration – 1D -2D Triangular elements – rectangular elements – Introduction to Analysis Software-– h & p elements- Errors and Types

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Compare the variational methods to solve the boundary value problems.
CO2 - Formulate the governing equations for the matrix manipulations required for finite element analysis.
CO3 - Solve the one dimensional problems using finite element method.
CO4 - Solve the two dimensional problems using finite element method.
CO5 - Solve the plane elastic problems using finite element method.
CO6 - Solve the structural problems using finite element method with isoparametric element types.

TEXT / REFERENCE BOOKS

1. Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2010.
2. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
3. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 4th Edition, Prentice Hall College Div, 1997.
4. Rao, S.S., “The Finite Element Method in Engineering”,4th Edition, Butterworth Heinemann, 2005.
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1504	HEAT AND MASS TRANSFER	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To learn the various modes of heat transfer and understand the basic concepts of mass transfer.
- To understand the applications of various experimental heat transfer correlations in engineering applications.
- To discuss the thermal analysis and sizing of heat exchangers.

UNIT 1 CONDUCTION **9 Hrs.**

General Heat Conduction Equation- Cartesian, Polar and Spherical Co-ordinate Systems – One dimensional steady state heat conduction in simple geometries – Plane wall – Cylinder and sphere – Composite walls – Composite cylinders and spheres – Critical thickness of insulation – heat generation in plane wall, cylinder and sphere – extended surfaces - unsteady state heat conduction-Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts.

UNIT 2 CONVECTION **9 Hrs.**

Free and Forced Convection – Hydrodynamic and Thermal Boundary Layer – Free and Forced Convection during external flow over Plates and Cylinders – Internal flow through tubes.

UNIT 3 RADIATION **9 Hrs.**

Laws of radiation - Wien's, Rayleigh-Jeans' and Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws – Concept of Gray, White, Opaque, Transparent and Black body radiation – shape factor - radiation exchange between surfaces -Radiations resistance network - Radiation shields.

UNIT 4 PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER **9 Hrs.**

Boiling and condensation – pool boiling regimes and correlations – crictical heat flux - flow boiling correlations - Nusselt's theory – filmwise and dropwise condensation - Condensation over surfaces. Heat Exchanger Types – Overall Heat Transfer Coefficient – Fouling Factors – Analysis – LMTD method – NTU method.

UNIT 5 MASS TRANSFER **9 Hrs.**

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..

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyse the conduction heat transfer characteristics for both simple and composite geometries.
CO2 - Evaluate the physical problems related to free and forced convection situation.
CO3 - Design the heat exchangers with LMTD and NTU procedures.
CO4 - Evaluate the radiation properties and shape factor for the stated different shapes.
CO5 - Analyze the similarity in governing equations of mass transfer.
CO6 - Evaluate the convective mass transfer correlations

TEXT / REFERENCE BOOKS

1. Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 7th Edition, John Wiley, 2011.
2. Holman, J.P., Heat Transfer, 10th Edition, Tata McGraw-Hill, 2010.
3. Ozisik, M.N., Heat Transfer - A Basic Approach, McGraw-Hill, 1985.
4. Cengel, Y.A., Heat Transfer - A Practical Approach, 2nd Edition, McGraw-Hill, 2002.
5. Sachedva, R.C., Fundamentals of Heat and Mass Transfer, 4th Edition, New Age International, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA1505	MANUFACTURING TECHNOLOGY – II	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.
- To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming.

UNIT 1 THEORIES OF METAL CUTTING **9 Hrs.**

Introduction: material removal processes, types of machine tools – theory of metal cutting: chip formation, orthogonal cutting, cutting tool materials, tool wear, tool life, surface finish, cutting fluids.

UNIT 2 CENTRE LATHE AND SPECIAL PURPOSE LATHES **9 Hrs.**

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 3 SHAPER, MILLING, DRILLING, BORING, PLANER AND BROACHING **9 Hrs.**

Reciprocating machine tools: shaper, planer, slotter - Milling: types, milling cutters, operations - Hole making : drilling - Quill mechanism , Reaming, Boring, Tapping - Sawing machine: hack saw, band saw, circular saw; broaching machines: broach construction – push, pull, surface and continuous broaching machines.

UNIT 4 ABRASIVE PROCESSES AND GEAR CUTTING **9 Hrs.**

Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centerless grinding – honing, lapping, super finishing, polishing and buffing, abrasive jet machining - Gear cutting, forming, generation, shaping, hobbing.

UNIT 5 CNC MACHINE TOOLS AND PART PROGRAMMING **9 Hrs.**

Numerical control (NC) machine tools – CNC: types, constructional details, special features – design considerations of CNC machines for improving machining accuracy – structural members – slide ways – linear bearings – ball screws – spindle drives and feed drives. Part programming fundamentals – manual programming – computer assisted part programming.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Relate the theory of metal cutting for the material removal during the machining operations.
CO2 - Compare the working principle and various features of conventional and special purpose lathes.
CO3 - Demonstrate the constructional and operational features of shapers, planners, millers and boring machines.
CO4 - Apply the principles of surface integrity on the finishing processes.
CO5 - Demonstrate the constructional and operational features of CNC machines.
CO6 - Write the manual NC part-programming for different part drawing.

TEXT / REFERENCE BOOKS

1. Hajra Choudhary. S.K. and Hajra Choudhary A.K, "Elements of Manufacturing Technology, Vol. 1st Edition, Media Publishers 2013.
2. RAO.P.N, "Manufacturing Technology, Metal cutting and Machine tools", 2nd Edition, TMH, 2010.
3. Chapman. W.A.J, "Workshop Technology Vol II", 5th Edition, Arnold Publishers, 2003.
4. Roy A. Lindberg, "Process and Material Manufacturers", 4th Edition, PHI, 1995.
5. Pabla B.S. and Adithan M., "CNC Machines", 1st Edition, New Age International, 2012.
6. H.M.T Production Technology Tata McGraw Hill, 2009.
7. Hastle Hurst M, Manufacturing Technology, 3rd Edition ELBS, 1998.
8. Sharma P.C., "A Text book of Production Technology", S.Chand and Co. Ltd., V edition, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA2501	CAD / CAM LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To draw complex geometries of machine components in sketcher mode.
- To create complex engineering assemblies using appropriate assembly constraints.
- To write programs to generate analytical and synthetic curves used in engineering practice.
- To generate freeform shapes in part mode to visualize components.
- To develop 'G' and 'M' codes for turning and milling components and to generate automated tool paths for a given engineering component.
- To generate automated tool paths for a given engineering component.

COURSE SYLLABUS

A. CAD LAB

1 Drafting: Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances.
2 Part Modeling: Generation of various 3D Models through Protrusion, revolve, sweep. Creation of various features. Study of parent child relation.
3 Feature based and Boolean based modeling and Assembly Modeling. Study of various standard Translators. Design of simple components.

B. CAM LAB

1 Study of CNC Machines.
2 Study of G-codes and M-codes.

1. CNC Milling

3 Part Programming for Linear Milling Cycle.
4 Part Programming for Drilling Cycle.
5 Part Programming for Contouring Cycle.
6 Part Programming for Circular Pocketing Cycle.
7 Part Programming for Rectangular Pocketing.
8 Part Programming for Mirroring Cycle.

2. CNC Lathe

9 Part Programming for Facing and Turning Cycle.
10 Part Programming for Step Turning Cycle.
11 Part Programming for Profile Turning.
12 Part Programming for Taper Turning Cycle.
13 Part Programming for Grooving Cycle.
14 Part Programming for Thread Cutting Cycle.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Sketch the three dimensional part models using a CAD package.
CO2 - Sketch the assembly models from the part models using the CAD package.
CO3 - Sketch the drawing document with the layouts, title blocks, bill of materials, annotations, and multiple views.
CO4 - Execute the part program to the required part using the CNC milling operations using a CAM package.
CO5 - Execute the part program to the required part using the CNC turning operations using CAM package.
CO6 - Produce the machined product for the given part drawing using CNC turning/ milling center.

SMEA2502	THERMAL ENGINEERING LAB - I (Engines)	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To expose the students to the basic knowledge on testing the properties of fuels and lubricants.
- To conduct experiments and report result on I.C. Engine performance.
- To understand the importance of heat balance sheet in I.C. Engines.

SUGGESTED LIST OF EXPERIMENTS

1. Performance characteristics of a two stroke petrol engine.
2. Performance characteristics of a four stroke multi -cylinder petrol engine.
3. Performance test on a four stroke diesel engine.
4. Performance test on a multi cylinder diesel engine.
5. Determination of Mechanical efficiency using retardation test.
6. Heat balance test on a multi-cylinder diesel engine.
7. Determination of Optimum speed for engine fuel consumption.
8. Determination of indicated power of multi cylinder petrol engine - Morse test.
9. Determination of Mechanical efficiency using negative horse power method.
10. Valve timing diagram of a four stroke engine, Port timing diagram of a two stroke engine.
11. Determination of viscosity of liquid using say bolt viscometer and redwood viscometer.
12. Determination of Calorific value of liquid and gaseous fuel.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Conduct testing to determine the performance characteristics of petrol engines.
CO2 - Conduct testing to determine the performance characteristics of diesel engines.
CO3 - Prepare the heat balance sheet for the given IC engines.
CO4 - Examine the fuel properties for the given fuel samples
CO5 - Estimate the valve timing and port timing diagram of IC engines.
CO6 - Estimate the frictional HP in multi-cylinder engines.

SMEA1601	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	Credits	Total Marks
		3	*	0	3	100

(Use of approved design data book is permitted)

COURSE OBJECTIVES

- To gain knowledge on the principles and procedure for the design of Mechanical power transmission components.
- To understand the standard procedures available for Design of Transmission Elements.
- To identify critical static and dynamic stresses in a mechanical component.
- To learn to use standard data from the design data book and catalogues.

UNIT 1 DESIGN OF FLEXIBLE DRIVES 9 Hrs.

Design of Flat belts and pulleys – Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys- Design of Transmission chains and Sprockets.

UNIT 2 SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9 Hrs.

Speed ratios and number of teeth-Force analysis- Tooth stresses –Dynamic effects-Fatigue strength-Factor of Safety-Gear materials-Design of Straight tooth spur and helical gears based on strength and wear considerations- Pressure angle in the normal and transverse plane –Equivalent number of teeth – Forces for helical gears.

UNIT 3 BEVEL AND WORM GEARS 9 Hrs.

Straight bevel gear: Tooth terminology- Design of pair of straight bevel gears - Tooth forces and stresses Worm Gear: Merits and demerits- Terminology. Design of the worm and gear - Forces and stresses, efficiency.

UNIT 4 GEAR BOXES 9 Hrs.

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of slidingmesh gear box -Constant mesh gear box. - Design of multi speed gear box.

UNIT 5 CLUTCHES AND BRAKES 9 Hrs.

Design of plate clutches –Cone clutches – Centrifugal clutches- Electromagnetic clutches. Band and Block brakes- External shoe brakes – Internal expanding shoe brake.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Adapt the standards, safety aspects, the use of design handbook and procedures involved during the design of transmission systems.
CO2 - Propose the appropriate type of flexible drive and its key specifications for the stated power transmission application.
CO3 - Suggest the suitable gear with nomenclature for the stated power transmission application by considering strength and wear.
CO4 - Recommend a suitable kinematic layout required to meet the specified multi-speed gear box system
CO5 - Design a suitable clutch considering the specifications, design considerations and the safety conditions
CO6 - Design a suitable brake considering the specifications, design considerations and the safety conditions

TEXT / REFERENCE BOOKS

1. Bhandari V, "Design of machine elements", 4th Edition, Tata Mcgraw Hill Book Company, 2017.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett —Mechanical.
3. Engineering Design, 8th Edition, Tata McGraw-Hill, 2008.
4. Prabhu. T.J., —Design of Transmission Elements, Mani Offset, Chennai, 2000.
5. Sundararajamoorthy T. V, Shanmugam .N, —Machine Design, Anuradha Publications, Chennai, 2003.
6. GitinMaitra, L. Prasad —Hand book of Mechanical Design, 2nd Edition, Tata McGraw-Hill, 2001.
7. C.S.Sharma, Kamlesh Purohit, —Design of Machine Elements, Prentice Hall of India, Pvt. Ltd., 2003.
8. Bernard Hamrock, Steven Schmid, Bo Jacobson, —Fundamentals of Machine Elements, 2nd Edition, Tata McGraw-Hill Book Co., 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**

PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA1602	GAS DYNAMICS AND JET PROPULSION (Use of approved gas tables is permitted)	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To discuss the concepts of compressible and incompressible fluids.
- To understand Mach number variation on area ratio.
- To impart in depth knowledge on the flow characteristics through constant area duct.

UNIT 1 FUNDAMENTALS OF COMPRESSIBLE FLUID FLOW 9 Hrs.

Concept of compressible flow, Energy and momentum equations, various regions of flow, fluid velocity, stagnation state, velocity of sound, critical states, Mach number, critical mach number, Crocco number, types of waves, mach cone, mach angle, effect of mach number on compressibility.

UNIT 2 FLOW THROUGH VARIABLE AREA DUCTS 9 Hrs.

Isentropic flow through variable area duct, T-S and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, Mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

UNIT 3 FANNO FLOW AND RAYLEIGH FLOW 9 Hrs.

. Flow in constant area duct with friction - Fanno curves, and Fanno Flow equations, variation of flow properties, variation of Mach number with duct length. Flow in constant area duct with heat transfer, Rayleigh line and Rayleigh flow equations, variation of flow properties, maximum heat transfer.

UNIT 4 NORMAL SHOCK AND OBLIQUE SHOCKS 9 Hrs.

Governing equations, variation of flow parameters, static pressure, static temperature, density, stagnation pressure, entropy across normal shock and oblique shocks. Normal shocks - stationary and moving, applications. Prandtl Meyer equation, impossibility of shock in sub-sonic flows, flow in convergent and divergent nozzles with shock, Flows with oblique shock.

UNIT 5 JET AND SPACE PROPULSION 9 Hrs.

Aircraft propulsion, types and working of jet engines - energy transfer in jet engines, thrust, thrust power, propulsive and overall efficiencies, thrust augmentations in turbo jet engines, ram jet and pulse jet engines. Rocket propulsion, types of rocket engines, Liquid and solid fuel rocket engines, Introduction to Electrical and Nuclear rockets-Space Flights, Orbital and escape velocity.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the concepts of compressible flows in variable area ducts.
CO2 - Evaluate the isentropic properties of compressible flows in variable area ducts
CO3 - Evaluate the isentropic properties of the compressible flows with friction and heat transfer.
CO4 - Analyze the flow properties across the shock waves in various flow regions.
CO5 - Estimate the thrust and efficiency in jet propulsion using gas dynamics principles.
CO6 - Calculate the efficiency in rocket propulsion.

TEXT / REFERENCE BOOKS

1. Yahya S.M.,"Fundamental of Compressible flow", New Age International (P) Ltd., New Delhi, 2003.
2. Cohen H., Rogers R.E.C. and Sravanamutoo, "Gas Turbine Theory", Addison Wesley Ltd., 2001.
3. Hill D. and Peterson C., "Mechanics & Thermodynamics of Propulsion ", Addision Wesley, 1992.
4. Ganesan V., "Gas Turbines", Tata McGraw Hill Publishing Company, New Delhi. 1999.
5. Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 1975.
6. J.D. Anderson, Modern compressible flow, McGraw-Hill Education; 3rd Edition, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA2601	DESIGN AND ANALYSIS LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To provide working knowledge on Computer Aided Design methods and procedures.
- To impart training on solid modeling software.
- To impart training on finite element analysis software.

1. **Introduction to solid modeling and Finite Element Analysis software**
   Basics, Fundamentals of modeling and analysis. Need and importance of Analysis.
2. **Exercises on modeling and assembly.**
   Creation of higher end 3D solid models like Knuckle Joint, Cotter joint.
   Creation of assembled views of joints and couplings.
3. **Exercises on Structural Analysis**
   Practice on Ansys Software for the following exercises:
   1. Cantilever beam with Point load at the end.
   2. Simply supported beam with inclined load.
   3. Overhanging beam with Uniformly distributed load (UDL).
   4. Determination of deflection for a Truss system.
   5. Determination of deflection in a Pressure vessel.
4. **Finite Volume Method *(Optional)***
   1. Determination of temperature distribution in a stepped bar.
   2. Thermal - mixed boundary example.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Sketch the three dimensional part models using a CAD package.

CO2 - Sketch the assembly models from the part models using the CAD package.

CO3 - Use various features and the procedure to be followed in an FEA package to solve the structural/ thermal problems.

CO4 - Interpret the numerical results obtained from the simulation of one dimensional structural/ thermal problems using FEA package.

CO5 - Interpret the numerical results obtained from the simulation of two dimensional structural/ thermal problems using FEA package.

CO6 - Interpret the numerical results obtained from the simulation of three dimensional structural/ thermal problems using FEA package.

SMEA2602	THERMAL ENGINEERING LAB - II	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To study the heat transfer phenomena and predict the relevant coefficient using implementation.
- To study the performance of refrigeration cycle / components and air compressor.

SUGGESTED LIST OF EXPERIMENTS

HEAT TRANSFER LAB

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2. Thermal conductivity measurement using guarded plate apparatus.
3. Heat transfer through composite walls.
4. Heat transfer by free and forced convection.
5. Heat exchanger test – parallel flow and counter flow.
6. Emissivity measurement.
7. Heat transfer from fins – natural and forced convection.
8. Determination of Stefan Boltzmann constant.

TURBO MACHINES LAB

1. Performance test on an air blower.
2. Performance test on a reciprocating air compressor.
3. Drag and Lift Experiments in wind tunnel.

REFRIGERATION AND AIR-CONDITIONING LAB

Performance test on an air conditioning testing.

1. Performance test on a refrigeration system.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Determine the thermal conductivity and emissivity of the given engineering materials.
CO2 - Analyze the heat transfer coefficient in free convection and forced convection.
CO3 - Interpret the effectiveness of parallel flow and counter heat exchanger.
CO4 - Evaluate the performance of air compressor and air blower.
CO5 - Estimate the COP of refrigeration and air conditioning system.
CO6 - Determine the lift and drag forces acting on test specimen in Wind tunnel.

SMEA1701	AUTOMOBILE ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of various components of an automobile.
- To learn about the working principle of various automotive components.
- To learn about advancements in electrical and hybrid vehicles.

UNIT 1 INTRODUCTION **9 Hrs.**

Automobile history and development, classifications, vehicle layout-engine location and drive arrangement, Safety regulations, specifications of vehicles, chassis types, constructional details, frames, sub frames, frameless vehicles, vehicle dimensions, details of chassis material, Engine Components: Cylinder – piston – connecting rod - functions and materials, emissions from automobiles, pollution standards – National and International-pollution control techniques.

UNIT 2 CLUTCHES AND TRANSMISSION **9 Hrs.**

Clutches: Classification of clutches, single plate, multi plate, cone diaphragm spring, centrifugal, clutch materials, Electromagnetic, vacuum operated, Necessity of gear box, manual gear box – constant mesh, Synchromesh, Transmission System: Geared automatic transmission, epicycle, continuous variable transmission, Electronic transmission control, overdrive, propeller shaft, constant velocity joint, differential and final drive, non-slip differential, Cruise system.

UNIT 3 FRONT AXLE, STEERING SYSTEM, REAR AXLE, WHEEL AND TYRES **9 Hrs.**

Purpose and requirement front axle, Steering System: steering geometry- castor, camber, king pin inclination, toe-in, toe out, center point steering; types of steering mechanism, steering linkages, power steering, Axle: Universal joint - Live and dead axles, live axle arrangement, wheel construction, alloy wheel, wheel alignment and balancing, types of tyres, tyre construction, thread design.

UNIT 4 SUSPENSION SYSYTEM AND BRAKES **9 Hrs.**

Suspension system: Objects and principles of suspension system, types, rigid axle and independent suspension for front and rear ends, leaf spring, torsion bar, shock absorber Brakes: Types of brake systems-drum, disc, operation-mechanical, hydraulic, air brakes, servo and power braking, ABS.

UNIT 5 ELECTRICAL SYSTEM **9 Hrs.**

Battery: Classification of batteries, battery construction, maintenance, testing and charging, cutout, lighting circuit, horn, indicators, sprays, wipers, starting system, instruments, sensors and actuators, electric control unit, electric stability program, traction control devices, electrical car layout, Electric and Hybrid Vehicles.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Compare the vehicle layout designs and the specifications offered by different manufacturers.
CO2 - Relate the safety regulations, pollution standards and other vehicle related guidelines to the current vehicles in market.
CO3 - Compare different mechanisms used in the power transmission in automobiles.
CO4 - Compare different mechanisms used in the suspension systems in automobiles.
CO5 - Compare different mechanisms used in the brake systems in automobiles.
CO6 - Demonstrate the use of electrical systems in automobiles.

TEXT / REFERENCE BOOKS

1. Kirpal Singh, "Automobile Engineering Vol 1 and 2 " 12th Edition Standard Publishers 2015.
2. Banga T.R. & Nathu Singh, "Automobile Engineering" 3rd Edition Khanna Publications. 2012.
3. Rajput R.K. "A Text–Book of Automobile Engineering", Laxmi Publications Private Limited, 2015.
4. Heldt.P.M. Automotive Chassis, 3rd Edition Chilton Co. Publications, New York, 2012.
5. Heinz heisler "Advanced vehicle technology" 2nd Edition Edward Arnold publication 2002.
6. Heitner, J. Automotive Mechanics Principle and Practice, 2nd Edition, Affiliated East-West Press Ltd., 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**

PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA1702	INDUSTRIAL MECHATRONICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To enable the student to understand the modern mechatronics components.
- To present the underlying principles and alternatives for mechatronics systems design.
- To provide the student with the opportunity for hands-on experience with the related components of the technology for diverse domains of application.

UNIT 1 MECHATRONICS, SENSORS AND TRANSDUCERS 10 Hrs.

Introduction to Mechatronics Systems – Key elements, Information systems, Real time interfacing, Elements of data acquisition system - sequential controllers-Block diagram of Washing Machine-Sensors and Transducers – Performance Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Range sensors, Light Sensors, Humidity, Vibration. Special transducers - Piezoelectric transducer - Magnetostrictive transducer - Shape memory alloy (SMA) transducer. – Selection of Sensors.

UNIT 2 SIGNAL CONDITIONING&8085 MICROPROCESSOR 8 Hrs.

Signal Conditioning – Analogue to Digital Convertor – Digital to Analogue Convertor- Multiplexer – De multiplexer – Interfacing Concepts – Temperature Control - Architecture of 8085 micro processor – pin configuration – addressing modes – instruction sets – timing diagram - block diagrams.

UNIT 3 SYSTEM MODELS AND CONTROLLERS 10 Hrs.

Building blocks of Mechanical, Electrical, Fluid and Thermal Systems. Rotational – Translational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems. Continuous and discrete process Controllers – Control Mode – Two Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers – Velocity Control – Adaptive Control.

UNIT 4 PROGRAMMING LOGIC CONTROLLERS 9 Hrs.

PLC: Introduction to the design and mode of operation of programmable logic control (PLC) – Basic Structure – Input / Output Processing – Programming –Ladder programming-Cylinder sequencing problems- sequence charts- Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Analog Input / Output – Selection of a PLC.

UNIT 5 DESIGN OF MECHATRONICS SYSTEM 8 Hrs.

Introduction to MEMS, Micro sensors in mechatronics, Sensors for condition monitoring, Artificial intelligence in mechatronics, Stages in designing Mechatronics Systems – Traditional and Mechatronic Design Possible Design Solutions. Case studies of Mechatronics systems- Pick and place Robot- piece counting system, Autonomous mobile robot-Wireless surveillance balloon-Engine Management system- Automatic car park barrier.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Propose the appropriate sensors for the specified mechatronics application.
CO2 - Suggest the appropriate microprocessor/ microcontroller for the specified mechatronics system.
CO3 - Formulate the system models for the given mechanical/ electrical/ thermal/ fluid systems.
CO4 - Develop the PLC ladder diagram for the stated mechatronics application.
CO5 - Recommend the recent technology, such as MEMS, AI, IOT, etc., on to the mechatronics application.
CO6 - Design a mechatronic system systematically after investing the given mechatronics case study.

TEXT / REFERENCE BOOKS

1. Bolton, “Mechatronics”, Pearson education, 2nd Edition, fifth Indian Reprint, 2003.
2. Smaili.A and Mrad.F, "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008
3. Rajput. R.K, A textbook of mechatronics, S. Chand & Co, 2007.
4. Michael B. Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, McGraw-Hill International Editions, 2000.
5. Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
6. Dan Necsulesu, “Mechatronics”, Pearson Education Asia, 2002 (Indian Reprint).
7. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**
PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA2701	ROBOTICS AND AUTOMATION LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To understand basics about the mechatronics systems and its interfacing.
- To understand basic Concepts of Lab view software and its applications.
- To recall fundamentals about Image processing techniques.

SUGGESTED LIST OF EXPERIMENTS

1. Basic cylinder sequencing operations using Pneumatic trainer Kit.
2. Simulation of basic Hydraulic and Pneumatic circuits using software.
3. Experiment on cylinder sequencing for A+ B+ A- B- using pneumatic trainer kit.
4. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.
5. Design and testing of fluid power circuits to control (i) Velocity (ii) direction and (iii) force of single and double acting actuators.
6. Proportional Integral Derivative (PID) controller interfacing.
7. Study of Boolean operations in Lab view and interfacing of Sensors in Lab view.
8. Speed control of stepper and servo motor using micro processor kit.
9. A/D and D/A Conversion.
10. Study of Image Processing Technique.
11. Basic operations on pick and place robot using (i) linear mode (ii) Re-orient mode.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recommend the pneumatic/ hydraulic circuit and the component specifications required for the stated fluid power application using a fluid power simulation package.

CO2 - Use the pneumatic/ hydraulic trainer kit to make the required pneumatic/ hydraulic cylinder sequencing.

CO3 - Predict the system behavior using a simulation package by constructing the system models for the specified mechatronic systems.

CO4 - Examine the signal conditioning systems and interfacing systems used in the mechatronics systems.

CO5 - Program the mechatronic circuit using the microprocessor/ microcontroller kit for the required mechatronic application.

CO6 - Use the pick and place robot for the specified material handling application.

SMEA3001	ADDITIVE MANUFACTURING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To explore the technology used in additive manufacturing.
- To understand the importance of additive manufacturing in advance manufacturing process.
- To acquire knowledge, techniques and skills to select relevant additive manufacturing process.
- To explore the potential of additive manufacturing in different industrial sectors.
- To apply 3D printing technology for additive manufacturing.

UNIT 1 INTRODUCTION 9 Hrs.

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.

UNIT 2 ADDITIVE MANUFACTURING PROCESSES 9 Hrs.

Z-Corporation 3D-printing, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM).

UNIT 3 ADDITIVE MANUFACTURING MACHINES AND SYSTEMS 9 Hrs.

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing.

UNIT 4 PRE-PROCESSING IN ADDITIVE MANUFACTURING 9 Hrs.

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials.

UNIT 5 POST-PROCESSING IN ADDITIVE MANUFACTURING 9 Hrs.

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the various process used in Additive Manufacturing.
CO2 - Analyze and select suitable process and materials used in Additive Manufacturing. CO3 - Identify, analyze and solve problems related to Additive Manufacturing.
CO4 - Apply knowledge of additive manufacturing for various real-life applications.
CO5 - Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing.
CO6 - Understand the basic concept of additive manufacturing application.

TEXT / REFERENCE BOOKS

1. Gibson, I, Rosen, D W., and Stucker,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles andapplications", 3rd Edition, World Scientific Publishers, 2010.
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: 4th Edition of Rapid Prototyping, World Scientific Publishers, 2014.
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.Kenneth G. Budinski& Michael K. Budinski, "Engineering Materials: Properties and Selection", 9th Edition, Pearson, 2009, 792 pages.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**
PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA3002	ADVANCED INTERNAL COMBUSTION ENGINES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the underlying principles of operation of different IC engines and components.
- To provide knowledge on emission formation, control, alternate fuel etc.

UNIT 1 INTRODUCTION TO I.C ENGINES 9 Hrs.

Classification of IC engines - based on fuel, working cycle, method of fuel supply - Ignition and Governing - Scavenging of two stroke engines. Fuel – air cycles and actual air cycles and their analysis. Combustion of fuels-Rating of fuels – composition of petrol and diesel fuels - importance Of valve and port timing diagrams.

UNIT 2 SPARK IGNITION ENGINES 9 Hrs.

Carburetion-mixture strength requirements. Simple carburetor -limitations, compensating arrangements. Gasoline injection systems. Flame speed-effect of turbulence and other parameters. Combustion in SI Engines-Combustion Chambers, Factors controlling combustion chamber design, stages of combustion, Fuel requirements, knock ratings - Auto ignition and Pre ignition.

UNIT 3 COMPRESSION IGNITION ENGINES 9 Hrs.

Diesel Fuel injection system, MPFI&CRDI, Function of components, jerk type pump, Distributor pump. Mechanical and pneumatic Governor, Fuel injector, Types of nozzle, importance of swirl, squish, Turbulence air motion, Combustion in CI Engines-Stages of combustion, Combustion Chambers, Factors controlling combustion chamber design, Factors affecting ignition delay, knock in CI Engines, variables affecting knocking.

UNIT4 ENGINE EMISSIONS 9 Hrs.

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – EURO and BHARAT emission norms.

UNIT 5 MODERN DEVELOPMENTS AND ALTERNATE FUELS 9 Hrs.

Modern developments - Wankel engine. Stratified charge engine. Dual-fuel engines. HCCI concept. Alternate Fuels For IC Engines - Need for use of alternate fuels - Use of alcohol fuels – Biodiesel - Biogas and Hydrogen in engines.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Gain the knowledge of working and performance of IC Engines through thermodynamic cycles.
CO2 - Describe the combustion phenomena in SI engines.
CO3 - Understand combustion phenomena CI engines and factors influencing combustion chamber design.
CO4 - Outline emission formation mechanism of IC engines, its effects and the legislation standards.
CO5 - Recall the working principles of instrumentation used for engine performance and emission parameters.
CO6 - Analyze the latest developments in IC Engines and alternate fuels.

TEXT / REFERENCE BOOKS

1. Ganesan,V., Internal Combustion Engines, McGraw Hill, 4th Edition, 2012.
2. Mathur, M.L., and Sharma, R.P., A Course in Internal Combustion Engines, Dhanpat Rai and Sons, 2014.
3. John Heywood, Internal Combustion Engine Fundamentals, McGraw Hill, 2011.
4. Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications, 2011.
5. R.K. Rajput, A textbook of Internal Combustion Engines, Laxmi Publications, 3rd Edition, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3003	COMPUTATIONAL FLUID DYNAMICS	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To understand the various discretization techniques and solving solution methodologies.
- To understand the Navier stroke equation for different flow field.
- To learn the different grid generation methods.
- To understand the fluid flow and heat transfer problems and its applications.

UNIT 1 INTRODUCTION **9 Hrs.**

Historical Background-One dimensional Computations -Finite Difference Methods-Finite Element Methods - Finite Volume Methods, Neumann Boundary Conditions, Dirichlet Boundary Conditions -Governing Equations-Classification of Partial Differential Equations- Introduction to Navier-Stokes System of Equations, Comparison of numerical, analytical and experimental.

UNIT 2 FINITE DIFFERENCE METHODS AND SOLUTIONS **9 Hrs.**

Simple Methods -General Methods -Higher Order Derivatives- Multidimensional Finite Difference Formulas - Mixed Derivatives –Non uniform Mesh- Higher Order Accuracy Schemes- Accuracy of Finite Difference Solutions-Elliptic Equations- Parabolic Equations- Hyperbolic Equations- Burgers' Equation- Coordinate Transformation for Arbitrary Geometries.

UNIT 3 INCOMPRESSIBLE VISCOUS FLOWS AND COMPRESSIBLE FLOWS **9 Hrs.**

Artificial Compressibility Method - Pressure Correction Methods -Semi-Implicit Method for Pressure-Linked Equations - Pressure Implicit with Splitting of Operators -Marker-and-Cell Method -Vortex Methods -Potential Equation-Euler Equations-Central Schemes with Combined Space and Independent Space-Explicit Schemes-Implicit Schemes-PISO Scheme for Compressible Flows-Finite Difference Volume Equations.

UNIT 4 STRUCTURED AND UNSTRUCTURED GRID GENERATION **9 Hrs.**

Algebraic Methods- PDE Mapping Methods- Unidirectional Interpolation- Multidirectional Interpolation-Domain Vertex Method-Transfinite Interpolation Methods - PDE Mapping Methods- Control Functions-Hyperbolic Grid Generator- Multiblock Structured Grid Generation- Delaunay-Voronoi Methods- Advancing Front Methods- Three-Dimensional Applications- DVM in 3D- AFM in 3-D.

UNIT 5 COMPUTING TECHNIQUES AND APPLICATION **9 Hrs.**

Domain Decomposition Methods- Multigrid Methods- Parallel Processing- Turbulence Models- Zero-Equation Models- One-Equation Models -Two-Equation Models -Second Order Closure Models (Reynolds Stress Models) - Algebraic Reynolds Stress Models -Compressibility Effects- Direct Numerical Simulation- RANS- LES.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the different methods used for heat transfer problems and the numerical errors associated with the first order and second order.

CO2 - Derive discretization equation using finite difference methods for heat transfer application.

CO3 - Derive compressible and incompressible equation for fluid flow problems.

CO4 - Generate the grid required in the computational domain for solving the Navier-stroke equation. CO5 - Describe the various computing models and application.

CO6 - Apply the knowledge gained in various heat transfer and fluid flow problems.

TEXT / REFERENCE BOOKS

1. Chung T.J, "Computational fluid dynamics", Cambridge University press, 2nd Edition, 2010.
2. Suhas V Patankar,"Numerical Heat Transfer and Fluid Flow", Taylor and Francis, 2nd Edition, 2017.
3. M. Ramakrishna, "Elements of Computational Fluid Dynamics", Golden Jubilee Publication, 2011.
4. Anderson.J.D. "Computational Fluid Dynamics: An Introduction", 3rd Edition, 2009.
5. Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Longman, 2nd Edition, 2007.
6. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2nd Edition 2014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3004	FLUID POWER SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide the insights of the fundamental knowledge about the fluid power, types of fluid power systems and the general understanding of the system components.
- To detail the construction and working principle of various hydraulic and pneumatic system components and their applications in the hydraulic circuits for a variety of applications.
- To make aware of maintenance and trouble shooting of hydraulic or pneumatic system components.

UNIT 1 FUNDAMENTAL PRINCIPLES 9 Hrs.

Fluid power: Advantages and applications of fluid power, Components of fluid power system, Types of fluid power systems, Fluid power symbols. Basic Hydraulics: Physical properties of hydraulic fluids, General types of fluids, Review of mechanics, Pascal's law, Applications of Pascal's Law, Energy, power and flow rate hydraulics. Frictional Losses: Reynolds's number, Darcy's equation, Losses in laminar flow, Losses in turbulent flow, Losses in valves and fittings, Hydraulic circuit analysis. Illustrative problems.

UNIT 2 HYDRAULIC SYSTEM COMPONENTS 9 Hrs.

Hydraulic Pumps: Gear pumps, vane pumps and piston pumps, pump performance. Hydraulic Cylinders: Single acting, double acting and special cylinders, Cylinder mountings and mechanical linkages, Cylinder cushions. Hydraulic motors: Gear, vane and piston motors, Hydraulic motor performance. Hydraulic Valves: Director control valves, Pressure control valves, Flow control valves, Servo valves, Proportional control valves, Catridge valves, Hydraulic fuses. Ancillary Devices: Reservoirs, Accumulators, Pressure intensifiers, Sealing devices.

UNIT 3 DESIGN OF HYDRAULIC CIRCUITS 9 Hrs.

Control of a single-acting hydraulic cylinder, Control of a double-acting hydraulic cylinder, Regenerative cylinder circuit, Pump-unloading circuit, Counterbalance valve application, Hydraulic cylinder sequencing circuits, Automatic cylinder reciprocating circuit, Cylinder synchronizing circuit, Fail-safe circuits, Speed control of hydraulic cylinder, Speed control of hydraulic motor, Hydraulic motor braking system, Air-over-oil circuit. Case studies.

UNIT 4 PNEUMATIC SYSTEM COMPONENTS AND CIRCUITS 9 Hrs.

Pneumatic Sytem Components: Properties of air, Compressors, Fluid Conditioners, Air control valves, Pneumatic actuators. Circuits: Control of single-acting cylinder, Control of double-acting cylinder, Air pilot control of double-acting cylinder, Cylinder cycle timing system, Two-step speed control system, Two-handed safety control circuit, Control of air motor, Sequential circuit design for simple applications using cascade method. Case studies.

UNIT 5 ADVANCED CONTROLS AND MAINTENANCE 9 Hrs.

Electrical controls: Electrical components, Limit switches and pressure switches, Counting, timing and reciprocation, Fluid logic control systems, Electrohydraulic servo system, Programmable logic controls, Ladder diagrams, Illustrative examples. Case studies. Maintenance: Maintaining and disposing of fluids, Filters and strainers, Fluid cleanliness levels, Preventive maintenance procedures, Troubleshooting of fluid power systems, Safety considerations, Environmental issues.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of fluid power systems, basic components, need and the requirements.
CO2 - Explain the construction and working of various system components used in hydraulic systems and simple hydraulic circuits.
CO3 - Design hydraulic circuits for a variety of applications.
CO4 - Explain the construction and working of various system components used in pneumatic systems. CO5 - Design pneumatic circuits for a variety of applications.
CO6 - Explain the general maintenance guidelines, trouble shooting of various system components and safety aspects.

TEXT / REFERENCE BOOKS

1. Anthony Esposito, "Fluid Power with Applications", 7th Edition, Pearson Education Limited, 2013.
2. Andrew Parr, "Hydraulics and Pneumatics: A Technician's and Engineer's Guide", 3rd Edition, Elsevier, 2011..
3. James R. Daines and Martha J. Daines, "Fluid Power: Hydraulics and Pneumatics", 3rd Edition, Good heart - Willcox Publisher, 2018.
4. James Johnson, "Introduction to Fluid Power", Cengage Learning, 2002.
5. S. Ilango and V. Soundararajan, "Introduction to Hydraulics and Pneumatics", 2nd Edition, PHI Learning Pvt. Ltd., 2011.

6. Majumdar, "Oil Hydraulic Systems: Principles and Maintenance", 1st Edition, Tata McGraw-Hill Education, 2002.
7. Majumdar, "Pnuematic Systems: Principles and Maintenance", 1st Edition, Tata McGraw-Hill Education, 2017.
8. R. Keith Mobley, "Fluid Power Dynamics Plant engineering maintenance series", Elsevier, 1999.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3005	NON DESTRUCTIVE TESTING AND TECHNIQUES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To enable the student to understand the modern NDT techniques.
- To present the underlying principles and alternatives for destructive testing procedures.
- To provide the student with the opportunity for hands-on experience for diverse domains of application.

UNIT 1 INTRODUCTION AND VISUAL INSPECTION METHODS 9 Hrs.

Scope and advantages of NDT. Comparison of NDT with DT. Some common NDT methods used since ages, Terminology. Flaws and Defects, Visual inspection-Unaided, Equipment used for visual inspection. Ringing test chalk test (oil whitening test). Attractive uses of above tests in detecting surface cracks, bond strength and surface defects.

UNIT 2 LIQUID PENETRANT TESTING AND MAGNETIC PARTICLE TESTING 9 Hrs.

Die penetrate test (liquid penetrate inspection), Principle, scope. Equipment & techniques, Tests stations, Advantages, types of penetrant and developers. Illustrative examples – Heavy castings of large size, frame of jet engine, porosity testing of nickel alloys, leak testing. Magnetic particle Inspection – Scope, principle, Ferro Magnetic and Non-ferro magnetic materials, equipment & testing. Advantages, limitations Interpretation of results. DC and AC magnetization, Skin Effect, use of dye and wet powders for magna glow testing, different methods to generate magnetic fields, Applications and demonstration.

UNIT 3 RADIOGRAPHIC METHODS 9 Hrs.

X-ray radiography principle, equipment and methodology. Applicability, types of radiations limitations. Interpretation of Radiographs, limitations of gamma-ray radiography –principle, equipment. Attenuation of electromagnetic radiations, source of radioactive materials and technique. Photo electric effect, Rayleigh's scattering (coherent scattering), Compton's scattering (Incoherent scattering). Pair production, Beam geometry, scattering factor. Precautions against radiation hazards. Xero-Radiography, Digital Radiography, Gamma ray Radiography, Safety in X- ray and Gamma ray radiography. Advantages of gammaray radiography over X-ray radiography.

UNIT 4 ULTRASONIC TESTING AND ACOUSTIC EMISSION TESTING 9 Hrs.

Introduction, Principle of operation, Piezoelectricity. Ultrasonic probes, CRO techniques, advantages, Limitation & typical applications. Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages& Limitations, Applications and demonstration.

UNIT 5 EDDY CURRENT TESTING AND THERMOGRAPHY 9 Hrs.

Eddy current Testing – Principle, properties of eddy currents, Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages and Limitations and applications. Thermography – Introduction, Principle, Contact and Non-Contact inspection methods, Active and Passive methods, Liquid Crystal – Concept, example, advantages and limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Applications and demonstration.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able

to CO1 - Recall the basic concepts of NDT.
CO2 - Interpret the quality of the components.
CO3 - Design the precautions against the radiation hazards.
CO4 - Apply the knowledge on Interpretation of results.
CO5 - Analyze products as production team member.
CO6 - Apply the knowledge on Electromagnetic spectrum.

TEXT / REFERENCE BOOKS

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Research Techniques in NDT Vol.3, R.S. Shah, Academic 2002.
3. Paul E Mix, "Introduction to non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005.
4. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, 1st Revised Edition, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3006	REFRIGERATION AND AIR-CONDITIONING	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To understand and discuss fundamentals of refrigeration principles, vapour compression cycles and its performance, refrigerants, compressors, condensers, evaporators.
- To understand Non-conventional Refrigeration Systems and Psychrometry.
- To understand air conditioning systems and their design, load calculation, control and accessories.
- To have a thorough knowledge of the applications of refrigeration and air conditioning.

UNIT 1 BASICS OF REFRIGERATION 9 Hrs.

Definition and methods, Unit of refrigeration, COP, EER, Carnot Principle, Heat pump and Refrigerator, Air Refrigeration System, Reversed Brayton cycle– Quantitative treatment, Aircraft refrigeration system, Refrigerants properties, Types, Selection criteria, Designation,Oil Compatibility, Eco Friendly Refrigerants, Environmental Impact,Ozone depletion potential and Global warming potential, Montreal / Kyoto protocols.

UNIT 2 VAPOUR COMPRESSION REFRIGERATION 9 Hrs.

Simple and actual VCR cycle, T-s and p-h representation, Effect of Sub cooling and superheating – Quantitative treatment, Two stage compression, flash chamber, Intercooler. Compressors: single and multistage, Hermetic, Screw, Vane and Centrifugal compressors, Condensers and evaporators; Expansion devices, Cooling towers, types –Qualitative treatment only.

UNIT 3 NON-CONVENTIONAL REFRIGERATION 9 Hrs.

Vapour absorption refrigeration, importance, Principle of Operation of Ammonia-Water, Lithium Bromide-Water VAR systems, Comparison of VCR and VAR systems, merits over VCR system, Electrolux System, Steam ejector system. Introduction to adsorption system, Thermoelectric, Vortex tube and pulse tube refrigeration, Descriptive study of Low temperature refrigeration, Joule Thomson effect, Applications of cryogenics – Qualitative treatment only.

UNIT 4 PSYCHROMETRICS AND AIR CONDITIONING 9 Hrs.

Psychrometry properties, charts, processes and relations, Gibbs-Dalton's law,Adiabatic mixing of two streams, Human comfort , factors affecting comfort, Comfort chart, Ventilation requirement, Comfort air conditioning, Air conditioning loads, load estimation, Solar radiation, infiltration and ventilation, Air washer; BPF, ADP temperature, RSHF, GSHF, ERSHF – Quantitative treatment.

UNIT 5 AIR CONDITIONING SYSTEMS 9 Hrs.

Summer, winter and central air conditioning systems. room air conditioners, packaged air conditioning plant, central air conditioning systems, split air conditioning systems Ducts, types, various types of losses of fluid flow in ducts, Methods of duct design, arrangement system. Air distribution system, Fans and blowers, filters; sources of noise in AC equipments and methods to control noise; Refrigeration and air conditioning controls: pressure, humidity, temperature sensors; safety controls; actuators.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the various types of refrigeration systems and learn the classification and properties of refrigerants.
CO2 - Analyze the performance of refrigeration cycles and various components used in the cycles.
CO3 - Describe the various refrigeration concepts other than the vapour compression cycle.
CO4 - Understand the Psychrometric chart and processes in design the air conditioning and cooling load calculations.
CO5 - Analyze the Air Conditioning equipments, air distribution equipments and their applications.
CO6 - Apply the knowledge gained in various refrigeration and air conditioning systems.

TEXT / REFERENCE BOOKS

1. Refrigeration and Air conditioning, Manohar Prasad- New Age International, 3rd Edition, 2011.
2. Refrigeration and Air Conditioning , C. P. Arora, Tata McGraw-Hill Education, 3rd Revised Edition, 2010.
3. Principles of Refrigeration, Roy J. Dossat, Pearson Education, 5th Edition, 2012.
4. Basic Refrigeration and Air Conditioning, P. N. Ananthanarayanan, TMH, 4th Edition, 2013.
5. Refrigeration and Air conditioning, W.F.Stoeker, Tata McGraw-Hill, 2nd Edition, 2010.
6. ASHRAE Handbook (Fundamentals) 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3007	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To familiarize the student with current trend in production management activities.
- To prepare them to use modern technologies in future management systems.

UNIT 1 INTRODUCTION **9 Hrs.**

Introduction to CAD,CAM, CIM, Types of production, Concurrent engineering, Elements of CIM systems, , CIM wheel, CIM components, Needs and Benefits of CIM, NC,CNC, DNC-applications, advantages and disadvantages , Functions of NC, CNC, DNC.

UNIT 2 GROUP TECHNOLOGY AND CELLULAR MANUFACTURING **9 Hrs.**

Group technology - Role of G.T in CAD/CAM integration - Part families - Classification and Coding - DCLASS, MICLASS, OPTIZ coding systems - Benefits of GT. Cellular manufacturing-Machine cell design and layout-Quantitative analysis in cellular Manufacturing - Rank order Clustering method.

UNIT 3 COMPUTER AIDED PROCESS PLANNING **9 Hrs.**

Approaches to computer aided process planning- Varient approach and generative approach - CAPP . Material Requirement Planning (MRP), Manufacturing Requirement Planning (MRP-II), Inventory control, hop floor control (SFC), Enterprise Resources Planning (ERP).

UNIT 4 FLEXIBLE MANUFACTURING SYSTEM AND AUTOMATED GUIDED VEHICLE SYSTEMS **9 Hrs.**

Types of Flexibility-FMS-Components- application and Benefit, FMS Planning and Control, Quantative analysis in FMS. Automated Guided Vehicle (AGV) system -Applications, Vehicle Guidance technology-Vehicle management and safety.

UNIT 5 MONITORING AND QUALITY CONTROL **9 Hrs.**

Types of production monitoring system, process control and strategies, direct digital control - Supervisory computer control - computer aided quality control - objectives of CAQC, QC and CIM, contact, non-contact inspection methods, CMM and Flexible Inspection systems. Integration of CAQC with CIM.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques.

CO2 - Formulate competitive priorities and manufacturing strategy for a given production system to derive strategic advantage.

CO3 - Apply ROP, MRP and JIT systems for inventory control in production systems.

CO4 - Obtain an overview of computer technologies including computers, database and data collection, networks, machine control, etc., as they apply to factory management and factory floor operations.

CO5 - Design push and pull systems using the principles of factory dynamics.

CO6 - Design factory systems for shop floor control, production scheduling, aggregate planning and capacity planning.

TEXT / REFERENCE BOOKS

1. Kant Vajpayee. S., 'Principles of Computer Integrated Manufacturing', Prentice Hall of India, 1999.
2. Radhakrishnan.P, Subramanyan. S, 'CAD/CAM/CIM', New Age International publishers, 2009.
3. Scheer.A.W., 'CIM- Towards the factory of the future' Springer - Verlag, 1994.
4. Daniel Hunt.V., 'Computer Integrated Manufacturing Hand Book', Chapman & Hall, 1989.
5. Groover M.P, 'Computer Aided Design and Manufacturing', Prentice Hall of India, 1987.
6. YoremKoren, 'Computer Control of Manufacturing System', McGraw Hill, 1986.
7. Ranky Paul. G., 'Computer Integrated Manufacturing', Prentice Hall International, 1986.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3008	COMPOSITE MATERIALS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide the fundamental knowledge about the composite materials, the classification, advantage and limitations.
- To provide the technical information about the properties, applications and manufacturing methods of metallic, ceramic and polymeric composites.
- To provide the material selection details of composite materials for a variety of applications.

UNIT 1 FUNDAMENTALS OF COMPOSITES 9 Hrs.

Need for composites, Role of matrix and fiber reinforcement, Rule of mixtures, Benefits of composites, Classification of composities. Fiber types, Forms of reinforcements, Fiber-matrix compatibility, Effect of reinforcements, Commercial fibers, Fiber extraction of commercial synthetic and natural fibers.

UNIT 2 METALLIC COMPOSITES 9 Hrs.

Engineering metallic materials, Popular MMCs, Composition, Properties, Advantages, Limitations and Applications. Fabrication Methods, such as Powder metallurgy, Slurry casting, Spray deposition and infiltration.

UNIT 3 CERAMIC COMPOSITES 9 Hrs.

Engineering ceramic materials, Popular CMCs, Composition, Properties, Advantages, Limitations and Applications. Fabrication Methods, such as Sintering, Hot pressing, Cold isostatic pressing, and Hot isostatic pressing.

UNIT 4 POLYMERIC COMPOSITES 9 Hrs.

Engineering polymeric materials, Popular PMCs, Composition, Properties, Advantages, Limitations and Applications. Fabrication Methods, such as Layup processes Filament winding, Liquid molding, Resin film infusion, Pultrusion, Therfoforming, Injection moulding.

UNIT 5 MODERN COMPOSITES AND SELECTION 9 Hrs.

Recent trends of composite materials, such as nanocomposites, green composites, biocompatible composites, etc. Selection of composites: Factors affecting the selection of composites, measurement of properties, mechanical, electrical and thermal properties of composites, selection of composites for tailor-made applications. Case studies related to selection of composite materials for a variety of applications, such as aerospace, automobile, packaging, structures, etc.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamental knowledge about the composite materials, the classification, advantage and limitations.

CO2 - Compare the technical information about the properties, applications and manufacturing methods of metallic composites.

CO3 - Compare the technical information about the properties, applications and manufacturing methods of ceramic composites.

CO4 - Compare the technical information about the properties, applications and manufacturing methods of polymeric composites.

CO5 - Examine the technical information about the recent trends in the field of composites.

CO6 - Choose the suitable composite materials for a variety of applications.

TEXT / REFERENCE BOOKS

1. F.C. Campbell, "Structural Composite Materials", ASM International, 2010, 612 pages.
2. Ever J. Barbero, "Introduction to Composite Materials Design", 3rd Edition, CRC Press, 2017, 534 pages.
3. Frank L. Matthews, R D Rawlings, "Composite Materials: Engineering and Science", CRC Press, 1999, 480 pages.
4. P.K. Mallick, "Fiber-Reinforced Composites: Materials, Manufacturing, and Design", 3rd Edition, CRC Press, 2007, 638 pages.
5. Navinchandra Gopal Shimpi, "Biodegradable and Biocompatible Polymer Composites: Processing, Properties and Applications", Woodhead Publishing, 2017, 438 pages.

6. Giuseppe Cirilloand Marek A. Kozlowski, Umile Gianfranco Spizzirri, "Composites Materials for Food Packaging", John Wiley & Sons, 2018.
7. Georgios Koronisand Arlindo Silva, "Green Composites for Automotive Applications", Woodhead Publishing, 2018.
8. Sarabjeet Singh Sidhu, Preetkanwal Singh Bains, Redouane Zitoune, Morteza Yazdani, "Futuristic Composites", 1st Edition, Springer, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3009	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the integration of customer requirements in product.
- To learn about the principles of design for manufacture and environment.
- To understand the various aspects of design such as industrial design and design for manufacture.
- To apply structural approach to concept generation, selection and testing.

UNIT 1 INTRODUCTION **9 Hrs.**

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. Development Processes and Organizations, Product Planning, Identifying Customer Needs - organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Product Specifications: establishing target specifications, setting the final specifications.

UNIT 2 BASIC CONCEPTS **9 Hrs.**

Concept Generation: The activity of concept generation clarify the problem, search externally, search internally, explore systematically, and reflect on the results and the process. Concept Selection: Overview of methodology, concept screening, and concept scoring. Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

UNIT 3 PRODUCT ARCHITECTURE **9 Hrs.**

Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT 4 DESIGN FOR MANUFACTURING AND ECONOMICS **9 Hrs.**

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes. Product Development Economics: Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.

UNIT 5 INDUSTRIAL DESIGN **9 Hrs.**

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Describe the new product based on mechanical design engineering.
CO2 - Define the mechanical aspects of product design by incorporating concept, creativity, structural, manufacturing, aesthetics and ergonomics etc.
CO3 - Understand contemporary issues and their impact on provided solution.
CO4 - Solve open ended problem belongs to design engineering that meet the requirements.
CO5 - Apply the various tools used for design development analysis and optimization.
C06 - Drafting various Industrial Design and management processes.

TEXT / REFERENCE BOOKS

1. Karl T Ulrich, Steven D Eppinger , " Product Design & Development." Tata McGrawhill New Delhi 2003.
2. Kevin Otto & Kristin Wood Product Design: "Techniques in Reverse Engineering and new Product Development." 1st Edition, Pearson Education New Delhi, 2004.
3. David G Ullman, "The Mechanical Design Process." McGrawhill Inc Singapore 1992
4. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003.
5. New Product Development - Timjones. Butterworth Heinmann -Oxford. UCI -1997.
6. Product Design for Manufacture and Assembly - Geoffery Boothroyd, Peter Dewhurst and Winston Knight – 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3010	AUTOMATION IN MANUFACTURING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide the fundamentals, components and industrial applications of automation.
- To provide the automation facilities offered by automation in machine tools, manufacturing and materials handling.
- To provide basic knowledge of the modern automation systems.

UNIT 1 INTRODUCTION TO AUTOMATION 9 Hrs.

Developments in manufacturing technology, Need of automation, Levels of automation, Strategies, advantages, limitations and applications of automation. Analog-to-digital conversion, Digital-to-analog conversion, Input and output, Numbering systems, Mechanisms and machine elements. Components of a control system, Mathematical characterization and transfer functions, Laplace transforms and system response.

UNIT 2 CONTROLLERS, SENSORS AND ACTUATORS 9 Hrs.

Controllers: Microprocessors, microcontrollers, PLCs and computers. Actuators: Electrical linear and rotary actuators, Hydraulic linear and rotary actuators, Pneumatic linear and rotary actuators, Control elements. Sensors: Position, displacement and velocity sensors, Relays, Timers and Switches.

UNIT 3 AUTOMATION FOR MACHINE TOOLS 9 Hrs.

NC, DNC and CNC machine tools, Indexing mechanisms, Part identification, Automatic tool changers, Automatic assembly transfer systems. NC Programming. Line balancing, Automated assembly, CMM, Machine vision.

UNIT 4 AUTOMATION FOR MATERIALS HANDLING 9 Hrs.

Part identification techniques, Material handling equipments: Conveyors, Industrial vehicles, AGVs, AS/RS, Robot Technology: Robot classification, Parts of robot system and industrial applications.

UNIT 5 MODERN AUTOMATION AND APPLICATIONS 9 Hrs.

Rapid prototyping techniques and applications. Applications of artificial intelligence and expert systems in automation, Industry 4.0: Generations of industrial revolution, Smart manufacturing and Applications. Case studies and automation circuit design for a variety of industrial applications.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall the fundamentals and control theory of automation systems.

CO2 - Understand the basics components, such as controllers, sensors and actuators used in the automation systems. CO3 - Examine various automations systems and techniques used for machine tools and quality testing.

CO4 - Know various automations systems and techniques used for materials handling and storage.

CO5 - Describe various modern automations systems, such as rapid prototyping, artificial intelligence and industry 4.0.

CO6 - Apply automation principles for a variety of industrial applications.

TEXT / REFERENCE BOOKS

1. Mikell P. Groover, "Automation, Production Systems, and Computer-integrated Manufacturing", Prentice Hall, 2008.
2. StamatiosManesis, George Nikolakopoulos, "Introduction to Industrial Automation", CRC Press, 2018.
3. Frank Lamb, "Industrial Automation: Hands On", McGraw Hill Professional, 2013.
4. A.K.Gupta and S.K.Arora, "Industrial Automation and Robotics", Firewall Media, 2007.
5. Shimon Y. Nof, "Springer Handbook of Automation", Springer Science & Business Media, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3011	DESIGN OF JIGS AND FIXTURES	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES

- To understand the concepts of locating devices, Jigs and Fixtures.
- To provide the concepts of various press tools and dies for real time applications.

UNIT 1 LOCATING AND CLAMPING DEVICES **9 Hrs.**

Introduction, Locating Principle, Locating Methods and Devices, Standard Parts, Types of clamping, Types of pneumatics and hydraulic actuation clamping, Analysis of clamping forces, Problems.

UNIT 2 JIGS **9 Hrs.**

Drill bushes, Elements of a Jig, Construction and Jigs, Types, group Jig & fixtures, chip control, Economic justification, clearance, selection, Construction, Materials, types, group jig and Fixtures, chip control, economic justification, clearances, and problems.

UNIT 3 FIXTURES **9 Hrs.**

Design principle, types of boring fixtures, Broaching Fixtures, Milling Fixtures, Welding fixtures, Indexing Fixtures, problems

UNIT 4 PRESS TOOLS **9 Hrs.**

Press working, Elements of Mechanical Presses, types, Press working operations, Press accessories, problems.

UNIT 5 BENDING **9 Hrs.**

Bending, V-die, U-die, Wipe bending, surface flatness, Forming die, solid pressure, coining forming dies, Drawing dies, metal flow in rectangular cells, spring pressure pad and stripper, Deep drawing dies, compound and progressive dies, problems.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the locating and clamping devices for various machining components.
CO2 - Understand the selection of materials for design and construction of Jigs.
CO3 - Design Concepts of fixtures for various machining operations.
CO4 - Explain the various types of press operations and its accessories.
CO5 - Recall the fundamental concepts of various bending dies.
CO6 - Design the jigs and Fixtures.

TEXT / REFERENCE BOOKS

1. Joshi, P.H. "Jigs and Fixtures", 2nd Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2. Donaldson, Lecain and Goold "Tool Design", 3rd Edition Tata McGraw Hill, 2012.
3. K. Venkataraman, "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2015.
4. Joshi, P.H. "Press Tools" – Design and Construction", Wheels publishing, 2010.
5. Hoffman "Jigs and Fixture Design" – Thomson Delmar Learning, Singapore, 2004.
6. ASTME handbook of Fixture Design
7. Design data book, PSG College of Technology, Coimbatore.
8. ASTME Fundamentals of Tool Design Prentice Hall of India, 1962.
9. C.Elamchezhian, T.Sunder Selvin, B.Vijaya Ramnath"Design of Jigs, Fixtures and Press tools", 2nd Edition, Eswar Press 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3012	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- Understand the basics of robotics and Automation Systems.
- Learn the robot cell design, Robot Configuration and robot programming.
- Understand the application of artificial intelligence and expert systems in robotics.

UNIT 1 INTRODUCTION AND ROBOTIC KINEMATICS 9 Hrs.

Definition need and scope of industrial robots- Coordinate Systems Classification of Robot- Robot anatomy - work volume - Precision movement – End effectors - sensors. Robot kinematics – Basics about plane rotation – rotation matrix - Direct and inverse kinematics - Robot trajectories-Control of robot manipulators - Robot dynamics - Methods for orientation and location of objects. Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load.

UNIT 2 ROBOT DRIVES AND CONTROL 9 Hrs.

Controlling the robot motion - Position and velocity sensing devices - Design of drive systems - Hydraulic and Pneumatic drives - D.C. Servo Motors, Stepper Motors, A.C. Servo Motors Linear and rotary actuators and control valves –Electro hydraulic servo valves, electric drives - Motors –Selection of Drives- designing of end effectors - Vacuum, magnetic and air operated grippers.

UNIT 3 ROBOT PATH PLANNING AND IMAGE PROCESSING 9 Hrs.

Introduction-Path planning overview- Road map path planning- Cell decomposition path planning-Potential field path planning-Obstacle avoidance- Robotic vision system - Image Gripping - Image processing and analysis - Image segmentation – Pattern recognition - Training of vision system.

UNIT 4 ROBOT CELL DESIGN AND FIELD ROBOTS 9 Hrs.

Robot work cell design and control - Safety in Robotics - Robot cell layouts - Multiple robots and machine interference - Robot cycle time analysis - Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.

UNIT 5 ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 9 Hrs.

Methods of robot programming - characteristics of task level languages lead through programming methods-Motion interpolation. Artificial intelligence - Basics - Goals of artificial Intelligence - AI techniques – problems representation in AI-Problem reduction and solution techniques - Application of AI. Elements of Knowledge Representation -Logic, Production Systems, Semantic Networks, Expert Systems Knowledge Building Environment Systems (KBES)-Humanoids.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall fundamental Concepts of Robots and Kinematics.
CO2 - Implement Drives concepts in End effectors.
CO3 - Analyze and design Path planning and Image processing.
CO4 - Design robot work cell for automation industries.
CO5 - Apply the knowledge about robot programming methods.
CO6 - Apply the concepts of AI and expert systems.

TEXT / REFERENCE BOOKS

1. K.S.Fu, R.CGonzalez and C.S.G. Lee, Robotics control, Sensing, Vision and intelligence", McGraw Hill,1994.
2. Kozyrey, Yu, "Industrial Robotics", MIR Publishers Moscow, 1998.
3. Richard.D.,Klafter, Thomas.A, Chmielewski, Machine Negin "Robotics Engineering-An Integrated Approach", Prentice Hall of India, 1984.
4. Deb, S.R. "Robotics Technology and Flexible Automation", Tata McGraw Hill, 1994.
5. Mikell,P.Groover, Mitchell Weis, Roger N.Nagel, Nicholas Odrey "Industrial Robotics Technology, Programming and Applications", McGraw Hill, Int., 1986.
6. Timothy Jordonidesetal,"Expert Systems and Robotics", Springer-Verlag, New York, May 1991.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3013	NON CONVENTIONAL ENERGY SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To give essential knowledge of construction and working of various types of Non-Conventional Energy Systems.
- To detail the role of Mechanical Engineers in their operation and maintenance.

UNIT 1 INTRODUCTION **9 Hrs.**

Various non-conventional energy resources - availability, classification, relative merits and demerits, World Energy Use – Reserves of Energy Resources – Renewable Energy Scenario in Tamil Nadu, India and around the World - Potentials - Achievements / Applications.

UNIT 2 SOLAR ENERGY **9 Hrs.**

Solar energy: Solar Radiation and its measurement, solar constant, estimation of average solar radiation, solar radiation on tilted surfaces, solar-thermal conversion, flat plate collectors, concentrating type collectors, solar energy storage systems, applications, Principles of Solar Radiation, solar constant, extra-terrestrial and terrestrial solar radiation, instruments for measuring solar radiation, solar radiation data. Flat plate and concentrating collectors, Solar Energy Storage and Applications: Sensible, latent heat and stratified storage, solar ponds, solar heating/cooling technique, solar distillation and drying, photovoltaic energy Conversion and Components.

UNIT 3 WIND ENERGY **9 Hrs.**

Wind Energy: Sources and potentials, – Types of Wind Energy Systems – Performance - Site Selection – Details of Wind Turbine Generator – Betz criteria, Safety and Environmental Aspects.

UNIT 4 BIO-ENERGY **9 Hrs.**

Principles of Bio-Conversion, Biomass direct combustion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, Ethanol production – Bio diesel –Cogeneration - Biomass Applications, utilization for cooking and power generation.

UNIT 5 OTHER RENEWABLE ENERGY SOURCES **9 Hrs.**

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage – Fuel Cell Systems – Hybrid Systems, Direct Energy Conversion: Need for DEC, limitations, principles of DEC, Magneto Hydro dynamometer.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basic concepts of Non-Conventional Power Generation & its importance. CO2 - Apply the basic thermodynamic principles to different renewable energy systems.

CO3 - Analyze and understand solar energy systems, working and its significance.

CO4 - Analyze thermodynamic cycles of Wind, bio & other renewable energy sources.

CO5 - Understand the importance ad necessity of renewable energy sources.

CO6 - Recognize renewable energy production, Distribution & cost estimation.

TEXT / REFERENCE BOOKS

1. Rai G.D, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 2011.
2. Sukhatme S.P, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
3. Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 2006.
4. Chetan Singh Solanki, Solar Photovoltaic's, Fundamentals, Technologies and Applications, PHI Learning Private Limited, New Delhi 2009.
5. Johnson Gary, L. Wind Energy Systems, Prentice Hall, New York, 1985.
6. Rao. S and Parulekar.B.B, "Energy Technology" Khanna Publishers, 2nd Edition 1997.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3014	CONCURRENT ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide essential knowledge of construction and working of various types of Non Conventional Energy Systems
- To detail the role of Mechanical Engineers in their operation and maintenance.

UNIT 1 INTRODUCTION TO CONCURRENT ENGINEERING 9 Hrs.

Extensive definition of CE - CE design methodologies - Organizing for CE - CE tool box collaborative product development.

UNIT 2 USE OF INFORMATION TECHNOLOGY 9 Hrs.

IT support - Solid modeling - Product data management - Collaborative product commerce - Artificial Intelligence - Expert systems - Software hardware co-design.

UNIT 3 DESIGN STAGE 9 Hrs.

Life-cycle design of products - opportunity for manufacturing enterprises - modality of Concurrent Engineering Design - Automated analysis idealization control - Concurrent engineering in optimal structural design - Real time constraints.

UNIT 4 MANUFACTURING CONCEPTS AND ANALYSIS 9 Hrs.

Manufacturing competitiveness - Checking the design process - conceptual design mechanism - Qualitative physical approach - An intelligent design for manufacturing system - JIT system - low inventory - modular - Modeling and reasoning for computer based assembly planning - Design of Automated manufacturing.

UNIT 5 PROJECT MANAGEMENT 9 Hrs.

Life Cycle semi realization - design for economics - evaluation of design for manufacturing cost - concurrent mechanical design - decomposition in concurrent design - negotiation in concurrent engineering design studies - product realization taxonomy - plan for Project Management on new product development - bottleneck technology development.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Design and implement a product development program.

CO2 - Analyze and demonstrate knowledge of computer-aided tolerance

analysis. CO3 - Evaluate appropriate rapid manufacturing modelling techniques.

CO4 - Implement Analyze a framework for robust system and process design.

CO5 - Recall the management and engineering philosophy for improving quality and reducing costs and lead time.

CO6 - Recognize the importance of current industry sequential practices.

TEXT / REFERENCE BOOKS

1. Anderson MM and Hein, L. Berlin, "Integrated Product Development", Springer Verlog, 1987.
2. Cleetus, J, "Design for Concurrent Engineering", Concurrent Engg. Research Centre, Morgantown, WV, 1992.
3. Andrew Kusaik, "Concurrent Engineering: Automation Tools and Technology", John Wiley and Sons Inc., 1992.
4. Prasad, "Concurrent Engineering Fundamentals: Integrated Product Development", Prentice Hall, 1996.
5. Sammy G Sinha, "Successful Implementation of Concurrent Product and Process", John Wiley and Sons Inc., 1999.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3015	MATERIAL HANDLING AND STORAGE SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To gain in depth knowledge of fundamental principles of material handling systems.
- To discuss understanding of special concepts in material handling.

UNIT 1 INTRODUCTION TO MATERIAL HANDLLING 9 Hrs.

Introduction-principles of material handling, primary groups of material handling equipments -conveyers, power trucks, cranes and hoists, robots, automated guided vehicles (AGVs), automated storage/retrieval systems. Principles of material handling based on College-Industry Council on Material Handling Education (CICMHE).

UNIT 2 MATERIAL HANDLING TECHNIQUE 9 Hrs.

Selection of equipments-present value calculation, estimation of fixed and variable costs, calculation of the upper and lower bounds for equipment selection. Ergonomics in material handling-Modern trends in material handling.

UNIT 3 MATERIAL TRANSPORTATION 9 Hrs.

Behaviors of dynamic shortest paths with known events. Transportation and transshipment models. Vehicle-routing problems: traveling distance, customer demand, limited/unlimited capacity.

UNIT 4 MATERIAL STORAGE 9 Hrs.

General requirements for storage of materials-storing materials in open yard-indoor storage of materials-requirements for handling flammable and combustible materials.

UNIT 5 SAFETY REGULATIONS 9 Hrs.

Employee hazard & safety training-general regulations for storage-safeguards followed on stacking materials- precautions to avoid storage hazard-Types of legal liability and contributory negligence.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Design and implement of a basic understanding of material handling facilities and the fundamental principles of material handling.
CO2 - Analyze and design quantitative techniques for warehouse and material handling systems and an understanding of their limitations.
CO3 - Select appropriate equipment for material handling and understand the basic roles of the different equipment.
CO4 - Implement an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
CO5 - Describe the appropriate techniques for improving existing material handling systems.
CO6 - Recognize the importance of safety and applications of optimization techniques to warehousing and material handling.

TEXT / REFERENCE BOOKS

1. Matthew P. Stephens, Fred E. Meyers, Manufacturing Facilities Design and Material Handling, Prentice Hall, 2013.
2. Smith JD, Chapter 57: Storage and Warehousing, Handbook of Industrial Engineering: Technology and Operations Management, 3rd Edition, New York: John Wiley & Sons.
3. "The Definitive Guide to Warehousing: Managing the Storage and Handling of Materials and Products in the Supply Chain" by CSCMP and Scott B Keller.
4. "Design and Selection of Bulk Material Handling Equipment and Systems: Volume I: Mining, Mineral Processing, Port, Plant and Excavation Engineering" by Peter Hilgraf.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3016	MODERN MANUFACTURING SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the principles of working, Constructional details, design features and performance characteristics of advanced casting and forming processes.
- To understand the necessity, role in modern industries, working principles, constructional details and performance characteristics of various non-traditional machining processes.

UNIT 1 ADVANCED CASTING PROCESSES AND FORMING PEOCESSES 9 Hrs.

Metal Mould Casting- Low and High Pressure, Vacuum Mould Casting, Evaporative Shell casting, Ceramic Shell Casting. Basics of High energy rate forming processes, Electromagnetic forming, explosive forming, Contour roll forming, Stretch forming, and Electro hydraulic forming.

UNIT 2 NON CONVENTIONAL MACHINING PROCESSES AND MECHANICAL PROCESS 9 Hrs.

Need of Non-Traditional Machining Processes – Classification Based on Energy, Mechanism, source of energy, transfer media and process – Process selection Based on Physical Parameters, shapes to be machined, process capability and economics – Overview of all processes. Abrasive Jet Machining: Principle – Mechanics of cutting – Process Variables – Material Removal Rate – Advantages and Limitations – Applications. Water Jet Machining: Principle – Process Variables – Advantages and Limitations – Practical Applications – Abrasive water jet machining process.

UNIT 3 ELECTRICAL DISCHARGE MACHINING 9 Hrs.

Electrical Discharge Machining: Mechanism of metal removal – Dielectric Fluid – Flushing methods – Electrode Materials – Spark Erosion Generators – Electrode Feed System – Material Removal Rate – Process Parameters – Tool Electrode Design – Tool wear Characteristics of Spark Eroded Surfaces- Advantages and Limitations – Practical Applications. Electrical Discharge Wire Cut and Grinding: Principle – Wire Feed System – Advantages and Limitations – Practical applications

UNIT 4 CHEMICAL AND ELECTRO CHEMICAL MACHINING 9 Hrs.

Chemical Machining: fundamentals, Principle –classification and selection of Etchant -chemical milling, Engraving, Blanking – Advantages and limitations – Applications. Electro Chemical Machining: Electro-chemistry of the process-Electrolytes – Electrolyte and their Properties – Material Removal Rate – Tool Material – Tool Feed System – Design For Electrolyte Flow – Process Variables – Advantages and Limitations – Applications – Electro Chemical Grinding: Honing, cutting off, Deburring and turning.

UNIT 5 HIGH ENERGY MACHINING PROCESS 9 Hrs.

Ultrasonic Machining: Principle- Mechanics of cutting- Transducer types – Concentrators – Abrasive Slurry – Process Parameters – Tool Feed Mechanism – Advantages and Limitations Applications. Electron Beam Machining: Principle – Generation and control of electron beam-Advantages and Limitations – Applications. Laser Beam Machining: Principle – Solid and Gas Laser Application – Thermal Features of LBM – Advantages and Limitations – Applications. Ion Beam Machining: Equipment – process characteristics – Advantages and Limitations – Applications. Plasma Arc Machining: Principle –Gas mixture– Types of Torches – Process Parameters – Advantages and Limitations – Applications. Ion Beam Machining – Principle – MRR – advantages, limitation, applications.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basic principles of advanced casting and forming processes.
CO2 - Select various nontraditional manufacturing processes used in industries, also to understand the concept of green manufacturing and ecofriendly system.
CO3 - Understand the selection of electrical discharge machining processes for different applications.
CO4 - Calculate the MRR in Chemical and Electro chemical Processes and can select the cost effective process for different applications.
CO5 - Understand the manufacturing process involving high energy transfer.
CO6 - Select and analyze the different chip less manufacturing processes.

TEXT / REFERENCE BOOKS

1. Pandey P.C., Shan H.S., Modern Machining Processes – Tata McGraw Hill, 1980.
2. Ghosh and Malik, Machining Science Affiliated East-West Press, 2002.
3. Jain V.K., Unconventional Machining, 2004.
4. Benedict G.F. & Marcel Dekker Non Traditional Manufacturing Processes, 1995.

5. McGeongh Chapman J.A. and Hall - Advanced Methods of Machining, Kulwer Academic Publishers Group, 1988.
6. Gunsekaran A., Agile Manufacturing, Elsevier, 2001.
7. Hartely J.R., Cambridge M.A., Concurrent Engineering by Productivity by Press, 1992.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3017	INDUSTRIAL SAFETY ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the safety functions and safety audit.
- To understand the types of operational safety like hot metal operation and gold metal operation.
- To understand the safety consideration with health, Welfare Act.
- To learn the safety performance monitoring and management techniques

UNIT 1 INTRODUCTION **9 Hrs**.

Evaluation of modern safety concepts - Safety management functions - safety organization, safety department - safety committee, safety audit - performance measurements and motivation - employee participation in safety - safety and productivity.

UNIT 2 OPERATIONAL SAFETY **9 Hrs.**

Hot metal operation – safety in Cutting – safety in welding – safety in Boilers- Pressure vessels – Furnace (all types) - Heat treatment processes shops – electroplating – grinding – forming processes- rolling – forging - surface hardening – casting – Moulding – coiling. Operational safety (cold metal operation), Safety in Machine shop - Cold bending and chamfering of pipes - metal cutting - shot blasting, grinding, painting - power press and other machines.

UNIT 3 SAFETY, HEALTH, WELFARE AND LAW **9 Hrs**.

Features of Factory Act – explosive Act – boiler Act – ESI Act – workman's compensation Act – industrial hygiene – occupational safety – diseases prevention – ergonomics - Occupational diseases, stress, fatigue - Health, safety and the physical environment - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.

UNIT 4 SAFETY PERFORMANCE MONITORING **9 Hrs.**

Permanent total disabilities, permanent partial disabilities, temporary total disabilities -Calculation of accident indices, frequency rate, severity rate, frequency severity-incidence, incident rate, accident rate, safety "t" score, safety activity rate – problems.

UNIT 5 SAFETY MANAGEMENT **9 Hrs.**

Methods of promoting safe practice – Safety organization- OSHA – Safety controls. visible and latent hazards - human factors and safety - safety audit - Case study roll of management and roll of Govt. in industrial safety - safety analysis Industrial fatigue- role of industrial psychology- risk analysis - safety training - accident and near miss investigations- promotional measures to avoid accidents - human reliability - safety management characteristics-industrial safety policies and implementation

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the safety audit committee and management functions.
CO2 - Evaluate the modern safety concepts, measurements and motivations.
CO3 - Obtain knowledge on different types of operational safety in hot metal and cold metal working process,
CO4 - Evaluate the performance of safety health and Welfare Act, also implementation Workman Compensation Act.
CO5 - Examine the safety performance monitoring and evaluations of accident rate.
CO6 - Analyze and implementing management techniques.

TEXT / REFERENCE BOOKS

1. Deshmukh, Industrial Safety Management, Tata McGraw Hill, 2008.
2. Krishnan N.V., "Safety in Industry", Jaico Publisher House, 1996.
3. Nair P M C, Industrial safety and the law" Attam Publisher's, 1994.
4. Roland P.Blake, Industrial Safety, Prentice Hall, 1963.
5. Rollin.H.Simonds, John V, Grimaldi, Technology and Engineering, 1989.
6. Roy Asfatil C, David W Rieske, Industrial safety and Health Management, Prentice Hall, 2009.
7. Joseph F. Gustin, Safety Management: A Guide for facility Management, The Fairmont Press, Inc., 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice **20 Marks**

PART B: 4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks **80 Marks**

SMEA3018	FUNDAMENTALS OF NANOMATERIALS AND TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide the fundamentals of nanotechnology and different classes nanomaterials.
- To impart the basic knowledge on fabrication methods of nanomaterials, characterization techniques and applications.

UNIT 1 BASICS AND SCALE OF NANOTECHNOLOGY 9 Hrs.

Introduction – Scientific revolutions –Time and length scale in structures – Definition of a nanosystem –Dimensionality and size dependent phenomena – Surface to volume ratio -Fraction of surface atoms – Surface energy and surface stress- surface defects-Properties at nanoscale (optical, mechanical, electronic,and magnetic).

UNIT 2 DIFFERENT CLASSES OF NANOMATERIALS 9 Hrs.

Classification based on dimensionality-Quantum Dots,Wells and Wires- Carbon- based nano materials (buckyballs, nanotubes, graphene)– Metalbased nano materials (nanogold, nanosilver and metal oxides) -Nanocomposites- Nanopolymers – Nanoglasses –Nano ceramics -Biological nanomaterials.

UNIT 3 SYNTHESIS OF NANOMATERIALS 9 Hrs.

Chemical Methods: Metal Nanocrystals by Reduction - Solvothermal Synthesis- Photochemical Synthesis - Sonochemical Routes- Chemical Vapor Deposition (CVD) – Metal Oxide - Chemical Vapor Deposition (MOCVD).Physical Methods:Ball Milling – Electrodeposition - Spray Pyrolysis - Flame Pyrolysis - DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE).

UNIT 4 FABRICATION AND CHARACTERIZATION OF NANOSTRUCTURES 9 Hrs.

Nanofabrication: Photolithography and its limitation-Electron-beam lithography (EBL)- Nanoimprint – Softlithography patterning. Characterization:Field Emission Scanning Electron Microscopy (FESEM) – Environmental Scanning Electron Microscopy (ESEM) High Resolution Transmission Electron Microscope (HRTEM) –Scanning Tunneling Microscope (STM)- Surface enhanced Raman spectroscopy (SERS)- X-ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy (AES) – Rutherford backscattering spectroscopy (RBS).

UNIT 5 APPLICATIONS 9 Hrs.

Solar energy conversion and catalysis - Molecular electronics and printed electronics -Nanoelectronics -Polymers with aspecial architecture - Liquid crystalline systems - Linear and nonlinear optical and electro-optical properties, Applications in displays and other devices -Nanomaterials for data storage - Photonics, Plasmonics- Chemical and biosensors - Nanomedicine and Nanobiotechnology – Nanotoxicology challenges.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the basics and scale of nanotechnology.
CO2 - Relate the unique properties of nanomaterials to the reduce dimensionality of the material.
CO3 - Describe tools for synthesis of nanomaterials, working and significance of its various components.
CO4 - Understand the fabrication of nanostructures.
CO5 - Discuss applications of nanomaterials and implication of health and safety related to nanomaterials.
CO6 - Explain about the characterization of nanostructures.

TEXT/REFERENCE BOOKS

1. Massimiliano Ventra, Stephane Evoy and James R. Heflin, Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology), 2004.
2. Guozhong Cao and Ying Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications (World Scientific Series in Nanoscience and Nanotechnology), 2011.
3. Malkiat S. Johal, Understanding Nanomaterials, 2011.
4. Pradeep T., “A Textbook of Nanoscience and Nanotechnology”, Tata McGraw Hill Education Pvt. Ltd., 2012.
5. Hari Singh Nalwa, “Nanostructured Materials and Nanotechnology”, Academic Press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SMEA3019	VIBRATION AND NOISE CONTROL	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide the insights of the fundamentals of vibrations, of two degree freedom systems and multi degree freedom system.
- To provide the detailed overview of the analysis and measurement of sound and the fundamentals of noise control.

UNIT 1 INTRODUCTION **9 Hrs.**

Fundamentals of vibrations: Simple harmonic motion, combination of two simple harmonic motions, beats, Fourier analysis, Single degree of freedom system: Free un-damped vibrations-Equivalent systems linear and torsional, natural frequency estimation, energy methods, Damped vibrations, Damping models, structural, coulomb, and viscous damping, critically, under and over-damped, system, Damping factor, Logarithmic decrement, Forced vibrations, Harmonic excitation, support motion, vibration isolation, critical speeds of shafts in bending.

UNIT 2 TOW DEGREE FREEDOM SYSTEM **9 Hrs.**

Free vibrations of spring coupled system, general solution, torsional vibrations, two degree of freedom mass coupled system, bending vibrations in two degree of freedom system, forced vibrations of an un damped two degree of freedom system, dynamic vibration absorber, forced damped vibrations.

UNIT 3 MULTI-DEGREE FREEDOM SYSTEM **9 Hrs.**

Free un-damped analysis- Numerical methods- Dunkerley's, Rayleigh, Holzer methods- Experimental methods in vibration analysis: Vibration measurement devices and analysers, balancing of rigid rotors.

UNIT 4 ANALYSIS AND MEASUREMENT OF SOUND **9 Hrs.**

One dimensional waves in a gas, sound perception and the decibel scale, the ear, combining sound levels in decibels, octave bands, loudness, weightings, directionality of acoustic sources and receivers, directivity index.

UNIT 5 NOISE CONTROL **9 Hrs.**

Noise criteria, sound absorption and insulation, noise barriers, acoustic enclosures, silencers.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall the fundamentals of Single degree Free, Damped free and forced Vibrations.
CO2 - Understand the basic of two degree freedom systems.
CO3 - Understand the fundamentals of Multi degree freedom systems.
CO4 - Apply the fundamentals of Analysis and measurement of sound.
CO5 - Learn the fundamentals of Noise types and control.
CO6 - Learn the fundamentals acoustic enclosures and silencers.

TEXT / REFERENCE BOOKS

1. SingiresuS.Rao - "Mechanical Vibrations" - Pearson Education, 6th Edition- 2017.
2. KewalPujara "Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 1992.
3. Julian Happian-Smith - "An Introduction to Modern Vehicle Design"- Butterworth-Heinemann, 2004.
4. Ramamurti V., "Mechanical Vibration Practice and Noise Control", Narosa Publishing House, 2012.
5. Sujatha C., "Vibration and Acoustics – Measurement and Signal Analysis", Tata McGraw Hill Education Private Ltd, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**

SECA3007	MEMS AND ITS APPLICATIONS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To have adequate knowledge in MEMS and Microsystems.
- To understand the fabrication procedures and have knowledge on MEMS sensors and actuators and their applications.
- To be made aware of the MEMS design procedures and RFMEMS.
- To investigate various applications of MEMS.

UNIT 1 OVERVIEW OF MEMS AND MICROSYSTEMS **9 Hrs.**

Definition - historical development - Fundamentals - Properties, Introduction to Design of MEMS and NEMS, MEMS ,Microsystems microelectronics, miniaturization, Working principle of micro system - Micro sensors, Micro actuators, Micro accelerometers and Micro fluidics, MEMS materials: Silicon, silicon compounds, polymers, metals.

UNIT 2 MEMS FABRICATION **9 Hrs.**

Micro-system fabrication processes: Photolithography, Ion Implantation, Diffusion, and Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology.

UNIT 3 MICROSENSORS AND ACTUATORS **9 Hrs.**

Micro-sensing for MEMS: Piezo-resistive Pressure Sensor, Capacitive sensor, Piezoelectric sensing, Resonant sensing, Surface Acoustic Wave sensors Vibratory gyroscope, Electromechanical transducers: Piezoelectric transducers, Electrostrictive transducers, Magnetostrictive transducers, Electrostatic actuators, Electromagnetic transducers, Electro-dynamic transducers, Case study-Piezo-resistive pressure sensor, Comb drive actuators.

UNIT 4 MEMS DESIGN AND INTRODUCTION TO OPTICAL RF MEMS **9 Hrs.**

Micro system Design - Design consideration, process design, Mechanical design, Mechanical design using MEMS. Optical MEMS,- System design basics - Gaussian optics, Matrix operations, Resolution. MEMS scanners and retinal scanning display, Digital Micro mirror devices. RF Memes - Design basics, case study - Capacitive RF MEMS switch, Performance issues.

UNIT 5 MEMS PACKAGING AND APPLICATIONS **9 Hrs.**

MEMS packaging: Role of MEMS packaging, Types of MEMS packaging, selection of packaging materials, flip-chip and multichip Unit packaging, RF MEMS packaging issues. Micro-machined transmission line and components, micro-machined RF Filters, Micromachined Phase shifters, and Micro-machined antenna, Gyros and Bio-MEMS. Recent trends in MEMS.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basics of MEMS technology and microsystems.

CO2 - Acquire knowledge in the types and procedures involved in MEMS fabrication. CO3 - Apply the acquired knowledge in understanding MEMS sensors and actuators. CO4 - Analyse various MEMS design and familiarise with optical RF MEMS.

CO5 - Investigate various applications of MEMS.

CO6 - Develop real time MEMS based devices.

TEXT / REFERENCE BOOKS

1. Vijay K. Varadan, K. J. Vinoy and K. A. Jose , “RF MEMS & Their Applications”, John Wiley & Sons, 2003.
2. Tai - Rai Hsu, “MEMS and Microsystems Design and Manufacturing”, Tata MC Graw Hill, New Delhi, Edition 2002.
3. Gabriel M Rebeiz, “RF MEMS - Theory Design and Technology”, John Wiley and Sons, 2003.
4. Nadim Maluf, “An introduction to Micro electro mechanical system design”, Artech House ,2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4,1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4,1 question from CO5 and CO6 with internal choice , each carrying 16 marks	**80 Marks**