Detailed Course Structure and Syllabus

For

B. Tech. Mechanical Engineering

I Sem to VIII Sem

Effective for

Students admitted in the Academic Session 2019-20

onwards

Department of Mechanical Engineering

School of Engineering

Harcourt Butler Technical University,

Kanpur Kanpur-208002

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1. About the Department

The Department of Mechanical Engineering was established in 1964. It runs a regular B.Tech programme in Mechanical Engineering with a student intake of 60. The Department runs a regular M.Tech programme in Computer Aided Design with an intake of 18 students. Department also runs two part time programmes M.Tech (Mechanical Engineering Design) and M.Tech (Industrial System Design) with 10 seats each. Department is a QIP center and has two Ph.D seats under this scheme of MHRD, Govt. of India. Five Ph.D seats are also available in full time / part time. Department has committed and highly qualified faculty members and most of them have obtained their Ph.D from reputed institutions / universities of the country. They take care of all the academic and other requirements of the students and expose them to the latest developments, knowhow and skill enhancement.

2. Vision

To produce quality mechanical engineer with knowledge, skill and creativity to cater to the needs of the industry and the society.

3. Mission

M-1: To offer academic programme in tune with the requirements of the industry.

M-2: To undertake research and development activities for solving real life problems.

M-3: To provide conducive environment for promoting creativity and innovation.

4. Program Educational Objectives (PEOs)

PEO 1: To impart knowledge and skill in the students to understand basic mechanical engineering concepts.

PEO 2: To inculcate creativity and analytical power to solve real life engineering problems.

PEO 3: To provide ample opportunities, training and exposure to the students to work as a team and to develop leadership qualities.

PEO 4: To develop entrepreneurial capabilities in the students.

PEO 5: To encourage and motivate the students to imbibe the art of self-learning.

PEO 6: To prepare the students for the service in the industry and society by continuously updating the curriculum.

5. Program Outcomes (POs)

Engineering graduates will be able to:

PO 1 **Engineering knowledge:** An ability to apply basic knowledge of science, mathematics and engineering fundamentals in the field of mechanical engineering.

PO 2 **Problem analysis:** An ability to identify, formulate, review research literature and analyze mechanical engineering problems using basics principles of science, mathematics and engineering.

PO 3 **Design / development of solutions:** An ability to design for complex mechanical engineering problems using basic design concepts, analyze and process to meet the desired needs with in realistic constraints such as manufacturability, durability, sustainability and economy with appropriate consideration for the public health, safety, cultural, societal, and environmental considerations.

PO 4 **Conduct investigations of complex problems:** An ability to design and conduct experiments using research-based knowledge and methods including design of experiments, analyze, interpret the data and results with valid conclusion.

PO 5 **Modern tool usage:** An ability to apply the modern tools and apply appropriate techniques to synthesize, model, design, analyze, verify and optimize to solve complex mechanical engineering problems within defined specification by using suitable modern tools to satisfy the needs of the society within realistic constraints such as social, economical, political, ethical, health, safety and manufacturing.

PO 6 **The Engineer and Society:** An ability to understand the impact of mechanical engineering solutions globally, in terms economic, societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7 **Environment and sustainability:** An ability to understand the principles, commitment and practice to improve product sustainable development globally in mechanical engineering with minimal environmental effect.

PO 8 **Ethics:** An ability to understand and apply ethical principles and commitment to address professional ethical responsibilities of an engineer.

PO 9 **Individual and team work:** An ability to function efficiently as an individual and as a group member in a team in multidisciplinary activities

PO 10 **Communication:** An ability to communicate, comprehend and present effectively with engineering community and the society at large on complex engineering activities by receiving clear instructions for preparing effective reports and design documentation.

PO 11 **Project management and finance:** An ability to acquire and demonstrate the knowledge of contemporary issues related to finance and managerial skills to bring up entrepreneurs and entrepreneurship.

PO 12 **Life-long learning:** An ability to recognize and adapt to emerging field of application in engineering and technology by developing self-confidence for continuing education and lifelong learning process.

6. Program Specific Outcomes (PSOs)

By the completion of B. Tech. Mechanical Engineering program, the students will achieve the following program specific outcomes:

PSO 1 Identify, formulate and analyze complex engineering problems in thermal engineering, design engineering, manufacturing engineering and allied domains.

PSO 2 An ability to find out, articulate the local industrial problems and solve with the use of mechanical engineering knowledge and skills for realistic outcomes.

PSO 3 An ability of collaborative learning to find out effective and optimal solution for sustainable growth of mechanical systems.

7. Consistency/Mapping of PEOs with Mission of the Department

PEO Statements	**M1**	**M2**	**M3**
PEO1: To develop knowledge and skill in the student to understand basic mechanical engineering concepts.	2	1	1
PEO2: To inculcate creativity and analytical power to solve real life engineering problems.	2	3	3
PEO3: To provide ample opportunities, training and exposure to work as a team and to develop leadership qualities in the students.	2	3	3
PEO4: To develop entrepreneurship capabilities in the students.	1	3	3
PEO5: To encourage and motivate learner's in the art of self-learning.	1	3	2
PEO6: : To prepare students for successful career in the industry by identifying and upgrading the gaps between the curriculum and industries requirement.	2	3	3

Note:-M1, M2,…Mn are distinct elements of mission statement. Enter correlation levels 1, 2 or 3 as defined below:

1:Slight (low) 2: Moderate (medium) 3: Substantial (high) *If there is no correlation, put "-".*

Note: Wherever the word "process" is used in this document, its meaning is process formulation, notification to all the concerned and implementation.

8. Components of the curriculum

Program curriculum grouping based on course components

Different Types of Courses	Minimum Credits (As per Ordinance)	Credits as per Course Structure (Effective for the Session 2019-20 for new entrants) of Mechanical Engineering Semester								
		I	II	III	IV	V	VI	VII	VIII	Total
BSC- Basic Science Course	24	8	8	4	4					24
ESC-Engineering Science Course	29	7	12	5	5					29
HSMC-Humanities, Social Science & Management Course	11	5		3	3					11
PCC-Programme Core Course	63			10	10	19	19	5		63
PEC-Programme Elective Course	14							6	8	14
OEC-Open Elective Course	13					3	3	3	4	13
Seminar	2							2		2
Industrial Training	2							2		2
Project	14							4	10	14
MC-Mandatory Course	No Credit		2	2	2					
Total	172	20	20	22	22	22	22	22	22	172

DEPARTMENT OF MECHANICAL ENGINEERING, HBTU KANPUR-208002
SEMESTER WISE COURSE STRUCTURE & EVALUATION SCHEME
B.TECH (MECHANICAL ENGINEERING)
effective from Session 2019-20 (for New Entrants)

SEMESTER I

Sr. No.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESM	Total Mark
					MSE	TA	Lab	Total		
1.	BSC	BPH 151	Physics	4(3-0-2)	15	20	15	50	50	100
2.	BSC	BMA 151	Maths -I	4(3-1-0)	30	20	-	50	50	100
3.	ESC	EEE 151	Electrical Engg.	4(3-0-2)	15	20	15	50	50	100
4.	ESC	EME 151	Engg. Mechanics	3(3-0-0)	30	20	-	50	50	100
5.	HSMC	HHS 153	Professional Communication	3(2-0-2)	15	20	15	50	50	100
6.	HSMC	HHS 151	English Language & Composition	2(2-0-0)	30	20	-	50	50	100
Total Credits				**20**						

SEMESTER II

Sr. No.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESM	Total Mark
					MSE	TA	Lab	Total		
1.	BSC	BCY 152	Engineering. Chemistry	4(3-0-2)	15	20	15	50	50	100
2.	BSC	BMA 152	Maths-II	4(3-1-0)	30	20	-	50	50	100
3.	ESC	EET 152	Electronics & Instrumentation Engg.	3(3-0-0)	30	20	-	50	50	100
4.	ESC	ECE 152	Engineering. Graphics	3(0-0-6)	30	20	-	50	50	100
5.	ESC	ECS 152	Computer Concept & Programming	4(3-0-2)	15	20	15	50	50	100
6.	ESC	EWS 152	Workshop Practice	2(0-0-4)	-	20	30	50	50	100
7.	MC (Non- credit)	ECE 154	Environment and Ecology	0(2-0-0)	30	20	-	50	50	100
Total Credits				**20**						

BSC- Basic Science Course; ESC-Engineering Science Course; PCC-Programme Core course; PEC-Programme Elective Course; OEC-Open Elective Course; MC-Mandatory Course; HSMC-Humanities, Social Science & Management Course.

	ESC	EME 152	Engg. Mechanics	3(3-0-0)	30	20	-	50	50	100

SEMESTER III

Sr. No.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESM	Total Mark
					MSE	TA	Lab	Total		
1.	BSC	BMA 251	Maths-III	4(3-1-0)	30		-	50	50	100
2.	ESC	EME 251	Strength of Material	5(3-1-2)	15	20	15	50	50	100
3.	PCC	EME 253	Material Science	4(3-0-2)	15	20	15	50	50	100
4.	PCC	EME 255	Engineering Thermodynamics	4(3-1-0)	30	20	-	50	50	100
5.	PCC	EME 257	Machine Drawing	2(0-0-4)	-	20	30	50	50	100
6.	HSMC	HHS 251	Engg. Economics & Management	3(3-0-0)	30	20	-	50	50	100
7.	MC (Non- credit)	HHS 255	Indian Constitution	0(2-0-0)	30	20	-	50	50	100
Total Credits				**22**						

SEMESTER IV

Sr. No.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESM	Total
					MSE	TA	Lab	Total		
1.	BSC	BMA 256	CONM	4(3-1-0)	30	20	-	50	50	100
2.	ESC	ECE 252	Engineering Fluid Mechanics	5(3-1-2)	15	20	15	50	50	100
3.	PCC	EME 256	Applied Thermodynamics	3(3-0-0)	30	20	-	50	50	100
4.	PCC	EME 254	Manufacturing Science-I	4(3-0-2)	15	20	15	50	50	100
5.	PCC	EME 258	Kinematics of Machine	3(3-0-0)	30	20	-	50	50	100
6.	HSMC	HHS 254	Organizational Behavior	3(3-0-0)	30	20	-	50	50	100
7.	MC (Non-credit)	ECS 260	Cyber Security	0(2-0-0)	30	20	-	50	50	100
Total Credits				**22**						

SEMESTER V

Sr. No.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESM	Total Marks
					MSE	TA	Lab	Total		
1.	PCC	EME 351	Manufacturing Science-II	4(3-0-2)	15	20	15	50	50	100
2.	PCC	EME 353	Heat & Mass Transfer	4(3-0-2)	15	20	15	50	50	100
3.	PCC	EME 355	Dynamics of Machine	4(3-0-2)	15	20	15	50	50	100
4.	PCC	EME 357	Machine Design-I	4(3-0-2)	15	20	15	50	50	100
5.	**PCC**	**EME 359**	**IC Engines**	3(3-0-0)	30	20	-	50	50	100
6.	OEC (Maths)	BMA 351	Operation Research	3(3-0-0)	30	20	-	50	50	100
Total Credits				**22**						

SEMESTER VI

Sr. No.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESM	Total Marks
					MSE	TA	Lab	Total		
1.	PCC	EME 352	Fluid Machinery	4(3-0-2)	15	20	15	50	50	100
2.	PCC	EME 354	Machine Design II	4(3-0-2)	15	20	15	50	50	100
3.	PCC	EME 356	Computer Aided Design	3(3-0-0)	30	20	-	50	50	100
4.	PCC	**EME 358**	**Measurements**	3(2-0-2)	15	20	15	50	50	100
5.	PCC	EME 360	Energy Conversion	3(2-0-2)	15	20	15	50	50	100
6.	PCC	**EME 362**	**Power Plant Engineering**	2(2-0-0)	30	20	-	50	50	100
7.	OEC (Humanities)	HHS 352	Entrepreneurship Development	3(3-0-0)	30	20	-	50	50	100
Total Credits				**22**						

SEMESTER VII

Sr. No.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESM	Total Mark
					MSE	TA	Lab	Total		
1.	PCC	EME 451	Refrigeration & Air Conditioning	4(3-0-2)	15	20	15	50	50	100
2.	PCC	**EME 453**	**Computer Aided Manufacturing**	3(3-0-0)	15	20	15	50	50	100
3.	PEC	PEC-I	List is attached	3(3-0-0)	30	20	-	50	50	100
4.	PEC	PEC-II	List is attached	3(3-0-0)	30	20	-	50	50	100
5.	OEC	OEC-I	List is attached	3(3-0-0)	30	20	-	50	50	100
6.	Industrial Training	EME-461	Industrial Training	1(0-0-2)	-	50	-	50	50	100
7.	Seminar	EME-471	Seminar	1(0-0-2)	-	50	-	50	50	100
8.	Project	EME-497	Project	4(0-0-8)	-	50	-	50	50	100
Total Credits				**22**						

SEMESTER VIII

Sr. No.	Course Type	Subject Code	Course Title	Credits (L-T-P)	Sessional Marks				ESM	Total Mark
					MSE	TA	Lab	Total		
1.	PEC	PEC-III	List is attached	4(3-1-0)	30	20	-	50	50	100
2.	PEC	PEC-IV	List is attached	4(3-1-0)	30	20	-	50	50	100
3.	OEC	OEC-II	List is attached	4(3-1-0)	30	20	-	50	50	100
4.	Project	EME-498	Project	10(0-0-20)	-	50	-	50	50	100
Total Credits				**22**						

Total Programme Credits : 172

Department of Mechanical Engineering
Elective courses to be offered in VII & VIII Semester

Programme Elective-I			**3(3-0-0)**
1.	EME-455	Mechanical Vibrations	3(3-0-0)
2.	EME-457	Industrial Engineering	3(3-0-0)
3.	EME-459	Additive manufacturing	3(3-0-0)
4.	EME-463	Robotics	3(3-0-0)
Programme Elective-II			**3(3-0-0)**
1.	EME-465	Welding Processes	3(3-0-0)
2.	EME-467	Mechatronics	3(3-0-0)
3.	EME-469	Non-conventional Energy Resources & Utilization	3(3-0-0)
4.	EME-473	Engineering Materials	3(3-0-0)
Programme Elective-III			**4(3-1-0)**
1.	EME-452	Unconventional Manufacturing Processes	4(3-1-0)
2.	EME-454	Finite Element Method	4(3-1-0)
3.	EME-456	Thermal Turbo Machines	4(3-1-0)
4.	EME-458	Advanced Strength of Material	4(3-1-0)
5.	EME-460	Production Planning & Control	4(3-1-0)
Programme Elective-IV			**4(3-1-0)**
1.	EME-462	Automobile Engineering	4(3-0-2)
2.	EME-464	Optimization Methods in Engineering	4(3-1-0)
3.	EME-466	Experimental Stress Analysis	4(3-1-0)
4.	EME-468	Product Design & Development	4(3-1-0)
5.	EME-470	Non-Destructive Testing	4(3-1-0)
Open Elective-I			**3(3-0-0)**
1.	OME-481	Solar Energy	3(3-0-0)
2.	OME-483	Industrial Engineering and Automation	3(3-0-0)
3.	OME-485	Artificial Intelligence in Manufacturing	3(3-0-0)
Open Elective-II			**4(3-1-0)**
1.	OME-482	Alternative Energy Sources	4(3-1-0)
2.	OME-484	Composite Materials	4(3-1-0)
3.	OME-486	Optimization Methods in Engineering	4(3-1-0)

Detailed syllabus
1st Year

PHYSICS (BPH-151)

Type	L	T	P	Credits
BSC	3	0	2	4

Prerequisite: Basic knowledge of Maths (12^{th} level) and preliminary idea of Vector calculus

Course Objective:

To understand and to apply the fundamental basics of Physics.

Course Content:

Unit-1: Introductory Mechanics & Theory of Relativity:(Lectures: 08)

Potential energy function $F = -\text{grad}\ (V)$, equipotential surfaces, meaning of gradient, divergence, curl and their physical significance, Conservative and Non-Conservative forces, Curl of a force, Central forces, Examples of Central forces, Conservation of Angular Momentum, Inertial and Non-Inertial Frames of reference, Galilean transformation, Michelson Morley Experiment, Lorentz Transformation, Length contraction, Time dilation and Evidences for time dilation, Relativistic velocity addition formula, Relativistic variation of mass with velocity, Evidence of mass variation with velocity, Einstein's Mass energy equivalence, Examples from nuclear physics, Relativistic energy momentum relation.

Unit-2: Quantum Mechanics-Schrodinger Equation and its Applications: (Lectures: 08)

Dual Nature of matter & Radiation, Heisenberg's uncertainty Principle and their applications, wave group concept, Davisson Germer experiment, Postulates of quantum mechanics, Significance of wave function, Derivation of Schrodinger equation for time independent and time dependent cases, Application of Schrodinger wave equation for a free particle, Particle in a box (one dimensional and three dimensional), Simple harmonic oscillator (one dimensional).

Unit-3: Electromagnetic Theory: (Lectures: 08)

Ampere's law and Faraday's law of electromagnetic induction, Maxwell's equations, Correction of Ampere's law by Maxwell (concept of displacement current), transformation from integral to differential form, Physical significance of each equation, Poynting theorem, Maxwell's equations in free space, velocity of electromagnetic wave, Transverse character of the wave and orthogonality of **E**, **H** and **V** vectors, Maxwell's equation in dielectric medium and velocity of e.m. wave, Comparison with free space, Maxwell's equations in conducting media, Solution of differential equation in this case, penetration depth, its significance.

Unit-4: Materials of Technological Importance: (Lectures: 09)

Dielectric Materials: Electric field in presence of dielectric medium, concept of electric polarization, different types of polarizations, dielectric in A. C. field, concept of dielectric loss and loss energy.

Semiconducting Materials: Concept of energy bands in solids, carrier concentration and conductivity in intrinsic semiconductors and their temperature dependence, carrier concentration and conductivity in extrinsic semiconductors and their temperature dependence, Hall effect in semiconductors, compound semiconductors.

Nano Materials: Basic principles of nano science and technology, preparation, structure and properties of fullerene and carbon nanotubes, applications of nanotechnology.

Unit-5: Statistical Mechanics & Lasers: (Lectures: 09)

Phase space, the probability of distribution, most probable distribution, Maxwell-Boltzmann Statistics, Applications of Maxwell-Boltzmann Statistics, derivation of average velocity, RMS velocity and most probable velocity in the above case, Bose-Einstein Statistics, application to black body radiation, distribution law of energy, Planck's radiation formula and Stefan's law, Fermi – Dirac statics,

application in case of free electrons in metals, energy distribution, Fermi energy.

Lasers: Spontaneous and stimulated emission of radiations, Einstein's theory of matter-radiation interaction, Einstein's coefficients and relation between them, Population inversion, components of a laser, different kinds of lasers, Ruby laser, He-Ne laser, properties of laser beams, mono-chromaticity, coherence, directionality, and brightness, applications of lasers.

Text and Reference Books:

1. Physics, Marcelo Alonso, J. Finn Edwards, Addison Wesley
2. Perspectives of Modern Physics, Arthur Beiser, McGraw Hill
3. Engineering Physics, R. K. Shukla, Pearson Education
4. Electrical Engineering Materials, R.K. Shukla, McGraw Hill
5. Introduction to Electrodynamics, David Griffiths, Cambridge University Press
6. Principles of Engineering Physics, R.K. Shukla, Ira Books
7. Introduction to Solid State Physics, Charles Kittel, Wiley

Lab Work:

Any ten (10) experiments from the following

1. To determine the energy of band gap of a N-type Ge-semiconductor using four probe method
2. Verification of Stefan's fourth power law for black body radiation, determination of the exponent of the temperature
3. Study of thermoelectricity: Determination of thermo-power of Copper-constantan thermo-couple
4. To study the variation of magnetic field with distance along the axis of current carrying coil and then to estimate the radius of the coil
5. Study of Carrey Foster's bridge: determination of resistance per unit length of the bridge wire and of a given unknown resistance
6. Determination of specific charge (charge to mass ratio; e/m) for electron
7. Study of tangent galvanometer: determination of reduction factor and horizontal component of earth's magnetic field
8. Determination of the wavelength of sodium light using Newton Rings' method
9. To determine the concentration of sugar solution using half shade polarimeter
10. Determination of wavelength of spectral lines of mercury (for violet, green, yellow-1 and yellow-2) using plane transmission grating
11. Determination of charge sensitivity and ballistic constant of a ballistic galvanometer
12. To determine the wavelength of spectral lines of hydrogen & hence to determine the value of Rydberg Constant
13. Draw the V-I characteristic of Light Emitting Diode (LED) and determine the value of Planck's constant

Course Outcomes

1. To understand and to apply principle of conservation of momentum e.g. in rocket propulsion and in many other space applications. To understand the theory of relativity and to analyse how the physical quantities undergo drastic changes in their original value at very high velocities and also to see how its principles are applicable in particle accelerators, nuclear devices as an alternative sources of energy and for defense purpose.
2. To understand the basics of quantum mechanics, and to apply its principles to learn the phenomena that occur at subatomic dimensions.

3. To understand and to apply Maxwell's equations, which form the basis of electromagnetic theory. This has a wide application in communication systems. All the information propagating in the universe utilizes the principle of electromagnetic theory.
4. To study the fundamentals of material science especially dielectric materials, semiconducting materials and nanomaterial and to apply the knowledge to use how dielectrics are used for the storage of charge. infrared detectors, crystal oscillators, manufacture of microphones, headsets loudspeakers, transducers, ultrasound applications, gas ignitors, accelerometers etc.
   Semiconductor material technology which has completely changed the scenario by replacing the older vacuum tube technology, are another technologically important materials which are widely used in LEDs, miniaturisation of electronic devices and to develop materials with improved efficiency and economy.
   Nanotechnology is the most emerging field at present and is extremely important. It has got various applications in many areas including information technology, biomedical, energy-storage, automotive industry, electronics industry, textiles and chemical industries.
5. To understand the statistical behaviour of the constituent particles which give rise to form a material, and to apply the principles of statistical mechanics and to understand the basics of Laser.

MATHEMATICS-I (BMA-151)

Type	L	T	P	Credits
BSC	3	1	0	4

Course Objective: The objective of this course is to educate the students about

- The convergence of infinite series, improper integrals and differential calculus.
- partial differentiation, multiple integrals and Beta, Gamma functions.

Course Outcomes:

On the successful completion of the course, students will be able to

CO1	find nth derivative, determine the expansion of functions and find convergence of series and improper integrals.	Understand, Apply
CO2	find partial differentiation and evaluate area and volume using multiple integrals.	Apply, Evaluate
CO3	convert line integrals to surface integrals and volume integrals, determine potential functions for irrotational force fields.	Apply, Evaluate
CO4	solve linear system of equations and determine the eigen vectors of the matrix.	Apply, Analyse Evaluate,
CO5	learn concept of optimization and optimization techniques.	Apply, Analyse, Evaluate,

Course Content:

Unit-1: Functions of One Real Variable

Successive differentiation, Leibnitz theorem, Mean value theorems, sequences and series, Expansion of functions, Improper integrals and their convergence.

Unit-2: Functions of Several Real Variables

Limit, Continuity, Partial differentiation, Total differential and approximations, Jacobian, Euler's theorem Expansion of functions, Beta and Gamma Functions, Multiple integral, Change of order, Change of variables, Applications to area, volume, mass, surface area etc. Dirichlet's Integral & applications.

Unit-3: Vector Calculus

Point functions, differentiation, Gradient, Directional derivative, Divergence and Curl of a vector and their physical interpretations, Solenoidal & irrotational fields, Integration, Line, Surface and Volume integrals Green's. Stoke's and Gauss Divergence theorems (without proof) and applications.

Unit-4: Matrices and Linear Algebra

Vector space and subspace, linear dependence, dimensions and basis, Linear transformation and its matrix representation, Elementary transformations, Echelon form, rank & nullity, Consistency of linear system of equations and their solutions, characteristic equation, Cayley Hamilton theorem, Real and complex eigenvalues and eigenvectors, diagonalisation, quadratic forms, complex, orthogonal,

and unitary matrices, Application to Cryptography, discrete, Compartmental models and system stability.

Unit-5: Optimization

Engineering applications of optimization, statement and classification of optimization problems, Optimization techniques, single variable optimization, multi variable optimization with no constraint, with equality and inequality constraints, Linear Programming Problems, Graphical method and Simplex method.

Text and Reference Books:

1. R. K. Jain & S. R. K. lyengar; Advanced Engineering Mathematics, Narosa Publishing House 2002.
2. Erwin Kreyszig: Advanced Engineering Mathematics. John Wiley & Sons 8th Edition.
6. Dennis G. Zill & Michael R Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers, 2nd Edition.
3. S. S. Rao; Optimization: Theory & application Wiley Eastern Limited.
4. T. M. Apostol, calculus, Vol. I, 2nd ed., Wiley 1967.
5. T. M. Apostol, Calculus, Vol. II, 2nd ed**.,** Wiley 1969.
6. Gilbert Strang, Linear Algebra & its applications, Nelson Engineering 2007.
7. Calculus & Analytic Geometry, Thomas and Finny.

ELECTRICAL ENGINEERING (EEE-151)

Type	L	T	P	Credits
BSC	3	0	2	4

Prerequisite:

Course Content:

Unit-1: DC Circuit Analysis and Network Theorems: Circuit Concepts: Concepts of Network, Active and Passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements. R L and C as linear elements. Source Transformation. Kirchhoff's Law; loop and nodal methods of analysis; star – delta transformation; Network Theorems: Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem. (Simple Numerical Problems)

Unit-2: Steady State Analysis of Single Phase AC Circuits: AC Fundamentals: Sinusoidal, Square and Triangular waveforms – average and effective values, form and peak factors, concept of phasors, phasor representation of sinusoidally varying voltage and current. Analysis of series, parallel, and series – parallel RLC Circuits: Apparent, Active & Reactive Powers, Power factor, causes and problems of low power factor, power factor improvement. Resonance in Series and Parallel Circuits, Bandwidth and Quality Factor. (Simple Numerical Problems)

Unit-3: Three Phase AC Circuits: Three Phase System – its necessity and advantages, meaning of phase sequence and star and delta connections, balanced supply and balanced load, line and phase voltage / current relations, three phase power and its measurement. (Simple Numerical Problems)

Measuring Instruments: Types of instruments: Construction and Working Principles of PMMC and Moving Iron type Voltmeter & Ammeters, Single Phase Dynamometer Wattmeter and Induction Type Energy Meter, use of Shunts and Multipliers. (Simple Numerical Problems on Energy Meter, Shunts and Multipliers)

Unit-4: Introduction To Power System: General layout of Electrical Power system and functions of its elements, standard transmission and distribution voltages, concept of grid. Magnetic Circuit: Magnetic circuit concepts, analogy between Electric & Magnetic circuits, Magnetic circuits with DC and AC excitations, Magnetic leakage. B-H curve, Hysteresis and Eddy Current looses, Magnetic circuit calculations mutual Coupling. Single Phase Transformer: Principle of Operation, Construction, e.m.f. equation, equivalent circuit, Power losses, efficiency, introduction to auto transformer. (Simple Numerical Problems)

Unit-5: Electrical Machines: Principles of electro mechanical energy conversion.

DC Machines: Types of DC machines, e.m.f. equation of generator and torque equation of motor, characteristics and applications of dc motors. (Simple Numerical Problems). Three Phase Induction Motor: Types, Principle of Operation, Slip – torque Characteristics, applications. (Simple Numerical Problems). Single Phase Induction Motor: Principle of Operation and introduction to methods of starting, applications. Three Phase Synchronous Machines: Principle of Operation of alternator and synchronous motor and their applications.

Lab Work:

A minimum ten experiments out of the following list.

1. Verification of Kirchhoff's laws.
2. Verification of (1) Superposition Theorem (2) Thevenin's Theorem (3) Maximum Power Transfer Theorem.
3. Measurement of power and power factor in a 1 – Ø ac series inductive circuit and study improvement of power factor using capacitor.
4. Study of phenomenon of resonance in RLC series circuit and obtain the resonant frequency.
5. Measurement of power in 3 – Ø circuit by Two Wattmeter method and determination of its power factor.
6. Determination of parameter of ac 1 – Ø series RLC Circuit.
7. Determination of (1) Voltage Ratio (2) Polarity and (3) Efficiency by load test of a 1 – Ø Transformer.
8. To Study speed control of dc shunt motor using (1) Armature Voltage Control (2) Field Flux Control.
9. Determination of Efficiency of a dc shunt motor by load test.
10. To study running and speed reversal of a 3 – Ø induction motor and record its speed in both direction.
11. To measure energy by a 1 – Ø energy meter and determine error.
12. Department may add any three experiments in the above list.

Text and Reference Books:

1. V. Del Toro, "Principles of Electrical Engineering" Prentice Hall International
2. I. J. Nagarath, "Basic Electrical Engineering" Tata Mc - Graw Hill
3. D. E. Fitzgerald & A. Grabel Higginbotham, "Basic Electrical Engineering" Mc - Graw Hill
4. Edward Hughes, "Electrical Technology" Longman
5. T. K. Nagsarkar & M. S. Sukhija, "Basic Electrical Engineering" Oxford University Press
6. H. Cotton, "Advanced Electrical Technology" Wheeler Publishing
7. W. H. Hayt & J. E. Kennely, "Engineering Circuit Analysis" Mc - Graw Hill

Course Outcomes:

1. Understand the common electrical elements and their behaviour with insight applications.
2. Analyze the ac circuit and calculate the various parameters.
3. Understand the 3-phase connections of source and load, various electrical measuring instruments and measurement of 3-phase power.
4. Understand the structure of Power system and Grid, magnetic circuit with working & applications and 1-phase transformer. Calculate the various parameters of magnetic circuits and transformer efficiency.
5. Understand the electromechanical energy conversion, 1-phase & 3-phase Induction motor and Synchronous machines with characteristics & applications.

ENGINEERING MECHANICS (EME-151)

Type	L	T	P	Credits
ESC	3	0	0	3

Prerequisite: Class XII Mathematics & Physics

Course Objective: To provide the basic fundamentals of forces, moments, stresses and strains.

Course Outcomes:

1. Apply basic principal of mechanics and its application in engineering problems.
2. Determine resultants and apply conditions of static equilibrium to plane force systems
3. Identify and quantify all forces associated with a static framework
4. Generate and sketch shear force and bending moment diagrams
5. Derive and apply stress and strain relationships in single and compound members subject to axial force, bending moment and torsion.

Course Content:

Unit-1:

Two Dimensional Force Systems: Basic concepts, Laws of motion, Principle of Transmissibility of forces, Transfer of a force to parallel position, Resultant of a force system, Simplest Resultant of Two dimensional concurrent and Non-concurrent Force systems, Distributed force system, Free body diagrams, Equilibrium and Equations of Equilibrium, Applications.

Friction: Introduction, Laws of Coulomb Friction, Equilibrium of Bodies involving Dry-friction, Belt friction, Applications.

Unit-2:

Beam: Introduction, Shear force and Bending Moment, Differential Equations for Equilibrium, Shear force and Bending Moment Diagrams for Statically Determinate Beams.
Trusses: Introduction, Simple Truss and Solution of Simple truss, Method of Joints and Method of Sections.

Unit-3:

Centroid and Moment of Inertia: Centroid of plane, curve, area, volume and composite bodies, Moment of inertia of plane area, Parallel Axes Theorem, Perpendicular axes theorems, Principal Moment Inertia, Mass Moment of Inertia of Circular Ring, Disc, Cylinder, Sphere and Cone about their Axis of Symmetry.

Unit-4:

Simple Stress and Strain: Introduction, Normal and Shear stresses, Stress- Strain Diagrams for ductile and brittle material, Elastic Constants, One Dimensional Loading of members of varying cross- sections, Strain energy.
Compound stress and strains: Introduction, state of plane stress, Principal stress and strain, Mohr's stress circle, Theories of Failure.

Unit-5:

Pure Bending of Beams: Introduction, Simple Bending Theory, Stress in beams of different cross sections.
Torsion: Introduction to Torsion of circular shaft, combined bending & torsion of solid & hollow shafts.

Text and Reference Books:

1. Engineering Mechanics by Chanda and Nag, Wiley india Pvt. Ltd
2. Engineering Mechanics by R.K.Bansal
3. Strength of Materials by R.K. Rajput

Reference books

1. Engineering Mechanics by Irving H. Shames, Prentice-Hall
2. Mechanics of Materials by E. P. Popov, PHI
3. Strength of Materials by Ryder
4. Mechanics of Material by Gere & Timoshenko
5. Engineering Mechanics by A. Nelson
6. Engineering Mechanics by U.C. Jindal
7. Engineering Mechanics Statics by J. L. Meriam & L.G.Kraige

PROFESSIONAL COMMUNICATION (HHS-153)

Type	L	T	P	Credits
HSMC	2	0	2	3

Prerequisite: NIL

Course Objectives:

The Objective of this course is to educate the students about Convey their messages through constructive writing and Draft potent E-Mails, letters, proposals and reports

Course Content:

Unit-1: Fundamentals of Technical Communication:
Process of communication, language as a tool of communication, levels of communication, flow of communication, barriers to communication, communication across cultures; Technical Communication: meaning, significance, characteristics, difference between technical and general communication.

Unit-2: Elements of Written Communication:
Words and phrases, word formation, synonyms and antonyms, homophones, one word substitution, sentence construction, paragraph construction,

Unit-3: Forms of Technical Communication:
(A) Business letters, job application letter and resume, business letters: sales & credit letters, letters of enquiry, letters of quotation, order, claim and adjustment letters, official letters: D.O. letters, government letters, letters to authorities, etc.
(B) Technical Reports: general format of a report, formal and informal reports, memo report, progress report, status report, survey report, trip report, complaint report, , Joining Report ,laboratory report, research papers, dissertations and theses. E-mail writing, Technical Proposals: purpose, characteristics, types, structure.

Unit-4: Presentation Strategies:
Defining the subject, Scope and purpose, analysing audience & locale, collecting materials, preparing outlines, organising the contents, visual aids, nuances of delivery, extemporaneous, manuscripts, impromptu, non- verbal strategies.

Unit-5: Value-based Text Reading:
(A) Study of the following essays from the text book with emphasis on writing skills:

1. Man and Nature by J. Bronowski
2. The Language of Literature and Science by Aldous Huxley
3. The Aims of Science & the Humanities by Moody E Prior
4. Gods in this Godless Universe by Bertrand Russell
5. Science and Survival by Barry Commoner

(B) Readings of selected short stories:

1. The Renunciation by Rabindranath Tagore
2. The Lament by Anton P. Chekhov
3. The Barber's Trade Union by Mulk Raj Anand
4. The Eyes Are Not Here by Ruskin Bond

Lab Work:

Interactive practical sessions with emphasis on oral presentations/ spoken communication:

1. Group Discussions: selected topical issues to be discussed in groups.
2. Mock interviews
3. Communication skills for seminars/conferences/workshops with emphasis on non-verbal skills.
4. Presentation skills for technical papers/project reports/professional reports.
5. Theme presentation/ key note presentation based on correct argumentation methodologies.
6. Argumentative skills
7. Role play
8. Comprehension skills based on reading and listening practice, asking questions.
9. Introduction to International Phonetics Alphabets
10. Audio Visual demonstration of effective communicative strategies & TED Talks

Text and Reference Books:

1. 'Improve Your Writing', V N Arora and Laxmi Chandra, Oxford University Press, New Delhi
2. 'An Anthology of English Short Stories', edited by R P Singh, Oxford University Press.
3. 'Technical Communication- Principles and Practices',Meenakshi Raman & Sangeeta Sharma, Oxford University Press, New Delhi.
4. Effective Technical Communication, by Barun K Mitra, Oxford University Press.
5. Business Correspondence & Report Writing by R.C. Sharma & Krishna Mohan, Tata McGraw Hill, N.D.
6. Developing Communication Skills by Krishna Mohan & Meera Banerjee, Macmillan India.

7. 'Technical Communication- Principles and Practices' by M R S Sharma, Oxford University Press, New Delhi.
8. Sethi and Dhamija, 'A Course in Phonetics and Spoken English', Prentice Hall of India, New Delhi.
9. Joans Daniel, 'English Pronouncing Dictionary', Cambridge University Press.
10. R. K. Bansal & J.B. Harrison, Spoken English for India, Orient Longman.
11. Excellence in Business Communication, Boeuve & Thill and Courtland.

Course Outcomes:

At the end of this course students should be able to:

1. Effectively communicate their ideas in the contemporary global competitive environment.
2. Convey their messages through constructive writing.
3. Draft potent E-Mails, letters, proposals and reports.
4. Present their presentations along with using all nuances of delivery with clarity and thoroughness.
5. Solve problems based on real time situations and articulate them eventually.

ENGLISH LANGUAGE AND COMPOSITION (HHS-151)

Type	L	T	P	Credits
HSMC	2	0	0	2

Prerequisite:

Course Objectives:

The objective of this course is to educate the students about

1. Write professional statements & organizational communications.
2. Develop writing skills by applying different strategies on organization system.
3. Develop the project reports, their relevance and significance

Course Content:

Unit-1: Basic Applied Grammar and Usage (Sentence Structure-1)

Constituent of a sentence- noun, verb, adjective, preposition, etc.; use of articles, adjectival forms, prepositions, adverbs; verb forms; finite and non-finite verbs, gerund and participles, auxiliary verbs. Tense and mood, Subject- verb concord, pronoun concord

Unit-2: Sentence Structure-2

(i) adverb clause, adjective clause, noun-clause; (ii) negation and interrogation; (iii) passive; (iv) exclamatory; (v) transformations; (vi) tense forms; (vii) varieties of sentences; (viii) placement of modifiers

Unit-3: Paragraph Writing

Structure of Paragraph, Topic Sentence, Construction of Paragraph, Technique of Paragraph writing, Unity, Coherence, Emphasis

Unit-4: Comprehension and Précis Writing

Reading and listening comprehension, improving comprehension skills, précis writing

Unit-5: Short Essay Writing

Dimension of essay writing- literary, Scientific, Comparison and Contrast, Narrative, Descriptive, Reflective, Expository, Argumentative and Imaginative

Text and References Books:

1. Das, B K and A David, 'A Remedial Course in English for Colleges', (Book -1, 2, 3) Oxford University Press, New Delhi.
2. Sinha, R P, 'Current English Grammar and Usage with Composition', Oxford University Press, New Delhi.
3. Wren, P C & Martin, 'English Grammar and Composition', S Chand & Co Ltd. New Delhi.
4. A. S. Horne, Guide to Pattern and usage in English, Oxford University Press, N.D.
5. M. L. Tickoo & A. E. Subramanian, Intermediate Grammar, usage & composition, Orient Longman

Course Outcomes:

1. Write professional statements & organizational communications.
2. Develop writing skills by applying different strategies on organisation system.
3. Develop the project reports, their relevance and significance.

ENGINEERING CHEMISTRY (BCY-152)

Type	L	T	P	Credits
BSC	3	0	2	4

Prerequisite: Basic knowledge of Maths (12^{th} Level)

Course Objectives:

The objective of this course is to make students learn the laboratory skills needed to design safe conduction of reactions and experiments in Chemistry. The student will acquire a foundation of Chemistry to enable them to understand and critically interpret the primary research in Chemistry.

Course Content:

Unit-1:

***Bonding*:** CFT, Electronic Spectra and Ligands (strong and weak field), Phosphorescence and Fluorescence, Jablonski diagram, hydrogen bonding and their effect on physical properties, Metallic bonds, Classification and Applications of Liquid crystals, Band Theory of Solids and superconductors. (Lectures: 7-8)

Spectroscopy: Basic Principles, Instrumentation and Applications of UV-VIS and IR Spectroscopy. (Lectures: 5-6)

Unit-2:

Chemical Kinetics: Second order reactions. Determination of order, Fast and slow reaction, steady state approximation, Temperature effect, Concept of Activated Complex/Transition State: Energy of activation, Potential energy surface, Theories of reaction rate: Collision and Transition State theories in terms of enzyme catalysis. (Lectures: 4-5)

Unit-3:

Electrochemistry: Dry and fuel cells, electrochemical cell, Solar cells, Disensitized cell, Photovoltaic cell. (Lectures: 3-4)

***Environmental Chemistry*:** Air and Water Pollution, analysis of gaseous effluents oxides of Nitrogen, oxides of Sulphur and H_2S, chemical analysis of effluents liquid streams, BOD, COD, control of pollution, Depletion of ozone layer. (Lectures: 5-6)

Unit-4:

Stereochemistry: Stereoisomerism of organic compounds containing one & two chiral centers. Enantiomers & Diastereomers, E-Z nomenclature, R-S configuration, Atropisomerism, and Optical isomerism in Allenes, biphenyl and Spiranes, Circular Dichroism. (Lectures: 5-6)

Reaction Mechanism: Inductive, Electromeric and Mesomeric effects. Study of reaction intermediates (Carbanion, carbocation, carbene, nitrene and benzyne). Mechanism of nucleophilic and electrophilic substitution reactions. Mechanism and application of following reactions:

a) Suzuki-Miyaura Cross coupling reaction
b) Fries and Photo-Fries Rearrangement
c) Wagner- Meerweir Rearrangement
d) Umpolung Reactions
e) Reaction of vision **(**Lectures: 4-5)

Unit-5:

Polymers: Introduction and their classifications, types of polymerization, Free radical, anionic and cationic polymerization, Preparation, Rheological properties and uses of some common polymers. Synthetic Polymers (carbon framework, silicon framework, fluorinated polymer), Conducting and Biodegradable polymers. (Lectures: 4-5)

Water Analysis: Introduction; Hardness of Water- cause, types, units, Disadvantages of using hard water for domestic and industrial purposes, Softening of hard water, Chemical analysis of Water- estimation of free chlorine, total alkalinity, hardness, Numerical based on determination of hardness. (Lectures: 4-5)

Lab Work:

1. Determination of alkalinity in given water sample.
   a. Sodium Carbonate & Sodium Bicarbonate
   b. Sodium Carbonate & Sodium Hydroxide
2. Determination of temporary and permanent hardness in water sample using EDTA as standard solution.
3. Determination of Chloride content of water by Mohr's Method.
4. Determination of Chlorine content in Bleaching powder.
5. Determination of strength of supplied Ferrous Ammonium Sulphate (FAS) solution in using external, internal indicators.
6. Determination of viscosity of a given liquid by Ostwald's viscometer.
7. Determination of surface tension of a given liquid by Stalagmometer.
8. pH determination of given sample.
9. Determination of iron content of water by Mohr's Method.
10. Determination of Dissociation constant of weak acids by conductometric Titration.

Text and Reference Books:

1. Advance Organic Chemistry by Jerry March, Third Edition Wiley Eastern Limited, New Delhi.
2. Organic Chemistry by Morrision & Boyd, Allyn and Bacon, Inc. Boston.
3. Physical Chemistry by Puri, Sharma & Pathania, Peter Atkins & Julio de Paula, Arun Bahl, B.S. Bahl & G.D.Tuli.
4. Textbook of Physical Chemistry by S. Glasstone, Macmillan and Co. Ltd., London.
5. Chemical Kinetics and Reaction Dynamics by Puri, Sharma & Pathania.
6. Principles of Polymerization by George Odian.
7. Polymer Science by V. R. Gowarikar, N. V. Vishwanathan and J. Shridhar, Wiley Eastern Ltd., New Delhi.
8. Principles of Instrumental Analysis by Douglas and Skoog, Saunder College Publishing Co., New York.

9. Engineering Chemistry by Jain & Jain, Dhanpat Rai Publication Co., New Delhi.
10. Application of Absorption Spectroscopy of Organic Compounds by John R. Dyer, Prentice Hall of India Pvt. Ltd., New Delhi.
11. Spectroscopy of Organic Compounds by P.S. Kalsi, Y.R. Sharma.

Course Outcome:

1. Interpret UV-Visible and IR–Spectra. (Apply)
2. Describe a reaction rate having various reaction orders. (Understand)
3. Understand different aspects of corrosion (Chemical and electrochemical corrosion, mechanism, factors affecting, protection and practical problems, prevention methods). Thermodynamic overview of electrochemical processes. Reversible and irreversible cells. (Understand)
4. Gain hands-on experience in making different polymers, distinguish between different polymeric structures, classify polymers and analyze the polymerization mechanism. The uses of polymers in different walks of life. (Apply)
5. Knowledge of conductivity polymers, bio-degradable polymers and fiber reinforced plastics. (Understand)
6. Acquire knowledge about water and treatment of municipal water. (Understand)

Experimental Outcome:

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to:

1. Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments
2. Communicate the results of scientific work.
3. Measure molecular/system properties such as surface tension, viscosity, conductance of solution.
4. Chemical analysis of water-hardness, alkalinity, pH and chloride content.

Expected Experimental Learning Outcomes

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will be able to:

1. Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments. (Apply, Analyse)
2. Be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems. (Apply, Analyse)
3. Clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large. (Apply)
4. Explore new areas of research in both chemistry and allied fields of science and technology. (Analyse)
5. Appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine. (Understand)
6. Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments. (Apply)
7. Communicate the results of scientific work. (Understand)
8. Measure molecular/system properties such as surface tension, viscosity, conductance of solution. (Apply)
9. Perform Chemical analysis of water-hardness, alkalinity, pH and chloride content.

MATHEMATICS-II (BMA-152)

Type	L	T	P	Credits
BSC	3	1	0	4

Prerequisite: NIL

Course Objectives:

The objective of this course is to educate the students about:

- ordinary differential equations and their applications as mathematical models.
- series solutions of ordinary differential equations and special functions.
- Laplace transform, Fourier series, differential equations and boundary value problems.

Course Outcomes:

On the successful completion of the course, students will be able to

CO1	solve first and higher order ordinary differential equations.	Apply, Analyse Evaluate,
CO2	find series solutions of ordinary differential equations and learn Bessel's and Legendre's function and its applications.	Apply, Analyse Evaluate,
CO3	solve IVP_S and BVP_S using Laplace Transform.	Apply, Analyse Evaluate,
CO4	find Fourier series expansion of given function and solve partial differential equations.	Apply, Analyse Evaluate,
CO5	solve boundary value problems using variable separable method etc.	Apply, Analyse Evaluate,

Course Content:

Unit-1: Ordinary Differential Equations

First order ordinary differential equations, Existence and uniqueness of solutions of initial value problems, Solution of higher order linear differential equation with constant coefficients, Solution of second order differential equations by changing dependent and independent variables, Cauchy- Euler equations, Methods of diagonalization, undetermined coefficients and variation of parameters: Nonlinear equations, Linear and nonlinear models, Initial value and boundary value problems, Systems of equations. Application of differential equations as mathematical models, Models from population dynamics, Newton's Law of cooling, electric circuit, Oscillation of spring.

Unit-2: Series Solutions of Ordinary Differential Equations & Special Functions

Ordinary and singular points of an equation, Power series solutions, Frobenius method, Bessel's and Legendre's equations and their series solutions, Properties of Legendre's polynomials and Bessel's functions, Generating functions, Fourier- Bessel series and Fourier-Legendre series expansions, sturm-Liouville Problem and related theorems.

Unit-3: Laplace Transform

Laplace transform, Existence conditions and ROC, Inverse Laplace transform, Operational properties, Convolution, Unit step function, Dirac-Delta function, Periodic functions, Applications to solve IVP and BVP: Linear ordinary differential equations, Transfer function and control system analysis.

Unit-4: Fourier Series and Partial Differential Equations

Orthogonal functions, Fourier series, existence conditions, Fourier series of even and odd functions, convergence of Fourier series, Fourier half range series, Harmonic analysis, Complex Fourier series

and frequency spectrum.
Development of partial differential equations and Solutions, Solution of first order partial differential equations, Solutions of linear higher order partial differential equations with constant coefficients.

Unit-5: Boundary-Value Problems

Classification of second order partial differential equations, Derivation of heat and wave equations, solutions in rectangular coordinates by separation variable method, solution of Laplace equation, D'Alemberts solution of wave equation, Non-homogeneous equations and boundary conditions, Orthogonal series expansions, Fourier series in two dimensions, Boundary value problems in polar, cylindrical and spherical coordinate systems and their solutions.

Text and Reference Books:

1. E. A. Coddington, An Introduction to Ordinary Differential Equations, Practice Hall, 1995.
2. I. N. Sneddon, Elements of Partial Differential equations, McGraw-Hill 1957.
3. Dennis G, Zill & Michael R. Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers. 2nd Edition.
4. R. K. Jain & S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House, 2002.
5. Erwin Kreyszig; Advaced Engineering Mathematics, John Wiley & Sons 8th Edition.

ELECTRONICS & INSTRUMENTATION ENGINEERING (EET-152)

Type	L	T	P	Credits
ESC	3	0	0	3

Prerequisite: NIL

Course Objectives:

1. To enhance the fundamental knowledge in electronics engineering and its application relevant to various streams of science and technology
2. To make student conversant with the basic knowledge of instrumentation devices.
3. To acquaint the students with basic knowledge of digital electronics.
4. To develop an understanding of the basic concepts of BJT, FET, CRO, ammeter & voltmeter

Course Content:

Unit-1:

P-N Junction Diode, V-I Characteristics, Diode Application as Rectifier (Half Wave & Full Wave), Zener Diode and its Applications.

Unit-2:

Introduction of Bipolar Junction Transistor, FET: Applications, demo, explanation, OPAMP and its Applications.

Unit-3:

Boolean Algebra, Logic Gates, Concept of Universal Gate. Basic Combinational Circuits: Adder, Subtractor, Sequential Circuits: Flip-Flops, Registers.

Unit-4:

Functional Elements of Instruments, Classification & Characteristics, Types of Errors, Active and Passive Transducers and their Characteristics, LVDT

Unit-5:

Display Devices: Seven Segment Display, Alphanumeric Display, LCD, Dot Matrix Displays, Electronic Ammeter and Voltmeter, Digital Multi-meter, Cathode Ray Oscilloscope.

Text and Reference Books:

1. Malvino, A.P. / "Electronics Principles" / Tata McGraw-Hill / 6th Ed.
2. Boylestad, Robert & Nashelsky, Louis / "Electronic Devices & Circuit Theory" / Prentice Hall of India / 8th Ed.
3. H.S. Kalsi / "Electronic Instrumentation" / Tata McGraw-Hill
4. Malvino & Leach / "Digital Principles & Applications" / Tata McGraw-Hill / 5th Edition.
5. Sedra, Adel S., Smith, Kenneth C. / "Microelectronic Circuits"/ Oxford University Press / 5th Edition.
6. Sawhney AK/ "Electrical and electronic Measurement and Instrumentation"/ Dhanpat Rai & sons.
7. Lectures of NPTEL

Course Outcomes:

The students will have basic knowledge of Electronics and instrumentation engineering related to Diode, BJT, FET, digital electronics, transducers, CRO etc. and they will apply fundamental principles of the related electronics circuit to solve practical problems related to engineering applications.

ENGINEERING GRAPHICS (ECE-152)

Type	L	T	P	Credits
ESC	0	0	6	3

Prerequisite: NIL

Course Objectives:

1. To follow basic drawing standards and conventions.
2. To develop skills in three –dimensional visualization of engineering components.
3. To prepare sectional views of solids.
4. To draw the development of surfaces and estimate the sheet metal requirement.
5. To development an understanding of solid modeling using CAD software.

Course Content:

Unit-1: Lettering and Dimensioning

Introduction, lettering practice, Elements of dimensioning- system of dimensioning.
Geometric Construction: Free hand sketching, Conic section, Special curves.
Engineering scales.

Unit-2: Projection of points and Projection lines

Projection of Points: First and Third Angle projection; Projection of Points. Projection of Lines; Projection of straight lines (First angle projection only); Projection of lines inclined to one plane and both plane, true length and true inclinations.

Unit-3: Projection of Solids and section of solids

Projection of solids: Classification of solids, Projection of solids in simple position, Projection of solids inclined to one plane. Sections of solids: Right regular solids and auxiliary views for the true shape of the sections.

Unit-4: Development of surfaces Development of surfaces for various regular solids. Isometric Projection and Perspective projection Isometric Projection: Isometric scales, Isometric projections of simple and combination of solids: Perspective projection: Orthographic representation of perspective views – Plane figure and simple solids – Visual ray method.

Unit-5: Orthographic Projection
Conversion of pictorial views into orthographic projection.
Introduction to auto CAD

Text and Reference Book(s)

1. Venugopal K and Prabhu Raja V, " Engineering Graphics", New AGE International Publishers 2015.
2. N.D. Bhatt, Engineering Drawing, Charotar publishing House.
3. Natarajan , K.V., A Text book of Engineering Graphics, Dhanalakshmi Publishers, 2012.
4. K.L. Narayana , P. Kannaiah &K . Venkata Reddy New Age International Publishers.

Course Outcomes:

1. Prepare drawing as per standards.
2. Solve specific geometrical problems in plane geometry involving lines, plane figures and special Curves.
3. Prepare sectional views of solids.
4. Draw isometric drawings of combined solids and simple components.
5. Produce orthographic projection of engineering components working from pictorial drawings.
6. Prepare solids modeling of machine components using CAD software.

CONCEPTS OF COMPUTER & C PROGRAMMING (ECS-152)

Type	L	T	P	Credits
ESC	3	0	2	4

Course Outcomes:

1. Identify the parts of the computer system and explain the functioning of its components alongwith the process of problem solving. (Remember, Understand)
2. Design an algorithmic solution for a given problem and translate it into a program. (Design)
3. Understand different operating systems, related concepts and their functions. (Understand)
4. Use the appropriate control statements to solve the given problem. (Apply)
5. Implement different Operations on arrays and use functions to solve the given problem. (Apply)
6. Understand pointers, structures and unions & Implement file Operations in C programming. (Understand, Apply)

Course Content:

Unit-1:
Introduction to Computers: Computer hardware Components, peripherals and their functions, Number Systems and conversion methods, Concept of an algorithm; termination and correctness. Algorithms to programs: specification, top-down development and stepwise refinement, Introduction to programming environment, use of high level programming language for the systematic development of programs. Introduction to the design and implementation of correct, efficient and maintainable programs, Structured Programming, Trace an algorithm to depict the logic.

Unit-2:
Basic operating System Concepts: Introduction of MS-DOS, WINDOWS, and LINUX Operating Systems, Functional Knowledge of these operating systems, Introduction of basic commands of

LINUX and Editors, Managing Files and Directories in LINUX, Programming Environment in LINUX, Writing and executing programs in LINUX.

Unit-3:

Programming in C: History, Introduction to C Programming Languages, Structure of C programs, compilation and execution of C programs, Debugging Techniques, Data Types and Sizes, Declaration of variables, Modifiers, Identifiers and keywords, Symbolic constants, Storage classes (automatic, external, register and static), Enumerations, command line parameters, Macros, The C Preprocessor.

Unit-4:

Operators: Unary operators, Arithmetic & logical operators, Bit wise operators, Assignment operators and expressions, Conditional expressions, Precedence and order of evaluation. Control statements: if-else, switch, break, and continue, the comma operator, goto statement. Loops: for, while, do-while. Functions: built-in and user-defined, function declaration, definition and function call, and parameter passing: call by value, call by reference, recursive functions, Multi-file programs. Arrays: linear arrays, multidimensional arrays, passing arrays to functions, Arrays and strings.

Unit-5:

Structure and Union: definition and differences, self-referential structure. Pointers: value at (*) and address of (&) operator, pointer to pointer, Dynamic Memory Allocation, calloc and malloc functions, array of pointers, function of pointers, structures and pointers. File Handling in C: opening and closing a data file, creating a data file, read and write functions, unformatted data files.

Lab Work:

1. Write C program to find largest of three integers.
2. Write C program to check whether the given string is palindrome or not.
3. Write C program to find whether the given integer is
   (i). a prime number
   (ii). an Armstrong number.
4. Write C program for Pascal triangle.
5. Write C program to find sum and average of n integer using linear array.
6. Write C program to perform addition, multiplication, transpose on matrices.
7. Write C program to find Fibonacci series of iterative method using user-defined function.
8. Write C program to find factorial of n by recursion using user-defined functions.
9. Write C program to perform following operations by using user defined functions:
   (i) Concatenation
   (ii) Reverse
   (iii) String Matching
10. Write C program to find sum of n terms of series: n – n*2/2! + n*3/3! - n*4/4! + ...
11. Write C program to interchange two values using
    (i). Call by value.
    (ii). Call by reference.
12. Write C program to sort the list of integers using dynamic memory allocation.
13. Write C program to display the mark sheet of a student using structure.
14. Write C program to perform following operations on data files:
    (i) Read from data file.
    (ii) Write to data file.
15. Write C program to copy the content of one file to another file using command line argument.

Text and References Books:

1. Kernighan, Ritchie, "The C Programming Language", PHI
2. V. Rajaraman, "Fundamentals of Computers", PHI
3. Peter Norton's, "Introduction to Computers", TMH
4. Gottfried, "Programming in C", Schaum's Series, Tata McGraw Hill
5. Yashwant Kanitkar, "Working with C", BPB
6. E. Balagurusamy, "Programming in ANSI C", TMH

WORKSHOP PRACTICE (EWS-152)

Type	L	T	P	Credits
ESC	0	0	4	2

Course Objectives:

To provide fundamental knowledge and exposure to various manufacturing processes and equipments.

Course Content:

1. Carpentry Shop:

Practice (I): To prepare half lap corner joint from given pieces of mango wood.

Practice (II): To prepare mortise and tenon joint from given pieces of mango wood.

Instructions: Description and demonstration of different tools, joints along with advanced Carpentry joints, classification and definition of timber, wood seasoning, demonstration of wood working lathe and advanced power tools used in carpentry work, safety precaution during actual working

2. Fitting and Bench working Shop:

Practice (I): To prepare male-female joint from given pieces of mild steel.

Practice (II): To prepare practice work piece involving marking, measuring, sawing, drilling and tapping operations.

Instruction: Classification and description of different tools used in fitting shop e.g. marking and measuring tools , holding and supporting tools, striking tools and cutting tools etc., safety precaution during actual working.

3. Black Smithy Shop:

Practice (I): To prepare 'L' shape job from given piece of mild steel rod by hand forging.

Practice (II): To prepare a 'Ring' from given piece of mild steel rod by hand forging.

Instructions: Description of various forging processes done in black-smithy work e.g. upsetting, drawing down, punching, bending, fullering etc, classification and description of different tools, equipments used in black smithy shop, safety precaution during actual working.

4. Welding Shop:

Practice (I): To prepare simple butt joint and lap joint by electric arc welding from given

pieces of mild steel.

Practice (II): To prepare simple lap joint by oxy-acetylene gas welding and gas flame cutting practice.

Instructions: Concept of welding, classification and explanation of various types of welding with the help of flow chart, description of different tools. Equipment required for arc welding and gas welding, demonstration of various types of flames in Oxy-acetylene gas welding, setting of current and selection of electrodes along with different welding joints, safety precaution during actual working.

5. Sheet Metal Shop:

Practice (I): To prepare a funnel complete with soldering from given G.I. sheet.

Practice (II): To fabricate tray / tool box or electric panel box from given G.I. sheet.

Instructions: Classification and description of different types of tools, equipment used in sheet metal work, different types of metals used in sheet metal shop e.g. Galvanized iron, black iron, copper, aluminum etc, concept of development of surfaces along with different types of joints in sheet metal work, safety precaution during actual working.

6. Machine Shop:

Practice (I): To prepare a job by plain turning, facing, step turning and chamfering operation from given mild steel rod.

Practice (II): To prepare a job by taper turning, threading, knurling operations from given mild steel rod.

Instructions: Classification of lathe machines, different parts of lathe machine, tools and equipment used, explanation and demonstration of various operations on lathe machine, tool geometry of single point cutting tool, cutting speed, feed and depth of cut in turning, safety precaution during actual working.

7. Foundry Shop:

Practice (I): To prepare a mould of given pattern in Green Sand.

Practice (II): To prepare a mould with two step pulley with runner and riser.

Instructions: Description and use of various foundry tools, shovel, flat rammer, hand rammer, strike off bars, vent wire, trowels, hand riddle etc. Types of various molding sands, types of patterns, pattern materials, pattern allowances, safety precautions during actual working.

Course Outcomes:

1. Students will be aware of Turning operations on Lathe.
2. They will be able to prepare various types of Joints in Fitting Shop.
3. Students will be made aware of Forging and Welding processes.
4. Students will be able to manufacture products by Casting, Welding etc.

ENVIRONMENT AND ECOLOGY (ECE-154)

Type	L	T	P	Credits
MC	2	0	0	0

Course Objectives:

1. To make students understand and appreciate the unity of life in all its forms, the implication of the life style on the environmental.
2. To understand the various causes for environmental degradation.
3. To understand individual contribution in the environmental pollution.
4. To understand the impact of pollution at the global level and also in the local environment.
5. To understand the concept of sustainable development.

Course Content:

Unit-1:

Definition, Scope and importance, Need for Public awareness, Environment definition, Ecosystem, Concept of ecosystem, Structure and function of an ecosystem, Energy flow in ecosystem, Ecological succession, Balanced ecosystem, Human activities, Food shelter, Economic and Social Security.

Effects of Human Activities on Environment: Agriculture, Housing Industry, Mining and Transportation Activities, Basic of Environmental Impact Assessment, Sustainable Development.

Unit-2:

Natural Resources: Water Resources – Availability and Quality Aspects, Conservation of water, Water Borne Diseases, Water induced Diseases, Fluoride problems in Drinking water, Mineral Resources, Forest Wealth, Material Cycles- Carbon, Nitrogen and Sulphur Cycles.

Energy – Different Types of Energy, Electro-magnetic Radiation, Conventional and Non-Conventional Sources, Hydro Electric Fossil Fuel Based, Nuclear, Solar, Biomass, Bio-gas, Hydrogen as an Alternative Future Sources of energy.

Unit-3:

Environmental Pollution: Water Pollution, Land Pollution, Noise Pollution , Public health aspects, Air Pollution, Soil pollution, Marine Pollution, Thermal Pollution, Nuclear Hazards.

Solids Waste Management: Cause, 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:

Current Environmental Issue of Importance, Population Growth, Variation among nations, Population explosion , family welfare Programme, Climate Change and Global Warming- Effects, Urbanization, Automobile pollution, Acid Rain, Ozone Layer Depletion.

Environmental Protection –Role of Government, Legal Aspects, Initiatives by Non- Government Organization (NGO), Environmental Education, Value Education, Human Rights, HIV/AIDS, Women and child welfare, Case Studies.

Course Outcomes:

1. Understand the need for eco-balance.
2. Acquire basic knowledge about global climate change with a particular reference to the Indian context.
3. Find ways to protect the environment and play pro-active roles.
4. Involve themselves in activities for environment protection.

Detailed Syllabus

2nd Year

MATHEMATICS – III (BMA-251)

Type	L	T	P	Credits
BSC	3	1	0	4

Prerequisite:

Course Objectives:

The objective of this course is to provide conceptual understanding of:

- various mathematical tools likes Laplace/ Fourier transforms and their applications.
- concepts and principle of complex analysis in solving various real life problems.
- various statistical methods and tests for analyzing experimental data.

Objective / Outcomes

CO1	solve boundary value problems using Laplace transform and Fourier transform methods and solve difference equations and BVP_S using z transform.	Apply, Evaluate
CO2	construct conformal mapping between many kinds of domains.	Understand, Apply
CO3	evaluate complex integrals, improper real integrals using various formulae/theorems. find Taylor and Laurents series expansion of complex functions.	Apply, Evaluate
CO4	estimate relationship between two variable using curve fitting, regression and its strength using correlation.	Understand, Apply
CO5	various parametric and nonparametric tests parameter estimation, hypothesis testing and ANOVA.	Understand, Apply

Course Content:

Unit–I: Transform Methods: Fourier integral, conditions of convergence, Fourier sine and cosine integrals, complex form, applications, Fourier transform pairs, existence conditions, operational properties. Applications of Laplace transform and Fourier transform to solve boundary value problems, Discrete and Fast Fourier transforms and its applications. Development of difference equations as models, operator method, method of undetermined coefficients, Z-transform pairs, ROC. Operational properties, limiting- value theorems, its applications to solve difference equations and BVP, systems of difference equations.

Unit–II: Functions of a Complex Variable and Conformal Mapping: Limit, continuity, differentiability and analyticity, Cauchy-Riemann equations, harmonic functions, complex functions as mappings, linear transformation, inverse transformation, bilinear transformation, conformal mapping, applications.

Unit–III: Integration of Complex Functions: Contour integrals and evaluations, Cauchy- integral theorem, Cauchy's integral formulae, Liouville's theorem, convergence of power series, Taylor series, Laurent series, zeros and singularities of a complex function, residues and residue theorem, evaluation of definite and improper integrals.

Unit–IV: Curve – Fitting, Correlation, Regression and Probability: Curve-fitting, method of least-squares , fitting of straight lines, polynomials, non-linear and exponential curves etc., correlation analysis, linear, non-linear and multi-regression analysis, probability, random variables and probability

distributions, expectation, moments and transform methods, Binomial, Poisson and Normal distributions, overview of t-distribution, Fdistribution and $\chi 2$ -distribution.

Unit–V: Statistical Methods: Sampling theory, parameter estimation, confidence intervals, tests of hypotheses and significance; z-, t-, F-, and $\chi 2$ tests, goodness of fit test - χ 2 test, analysis of variance, nonparametric tests (Simple application), time series analysis, index numbers, quality control charts and acceptance sampling, Introduction to design of experiments, Forecasting models.

Text Books:

1. R. K. Jain & S. R. K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House, 2002. 3. Erwin Kreyszig; Advanced Engineering Mathematics, John Wiley & Sons 8th Edition.

Reference Books:

1. Dennis G, Zill & Michael R. Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers. 2nd Edition.

STRENGTH OF MATERIALS (EME251)

Type	L	T	P	Credits
ESC	3	1	2	5

Prerequisite: Students must have knowledge of engineering mechanics basic engineering applications.

Course Objectives:

The objective of this subject is elaborate on the knowledge of engineering mechanics (statics). Understanding the stresses and deformations developed in mechanical and structural elements under different loads.

Course Outcomes:

Student will be able to

CO1	Apply basic concepts in solid mechanics to solve simple problems.
CO2	Determining stresses in beams for symmetrical and unsymmetrical condition
CO3	Determine the types of stresses developed in statically determinate member due to different actions
CO4	Analyzing deflection in beams and the problems of springs subjected to various actions.
CO5	Evaluating stresses in columns and cylinders and understand various physical phenomenons in the context of strength of materials and applied mechanics.
CO 6	Demonstrate an understanding of the assumptions and limitations of the structural mechanics theory

Course Content:

Unit I

Stresses in Beams: Review of pure Bending**.** Direct and shear stresses in beams due to transverse and axial loads, composite beams.

Curved Beams: Bending of beams with large initial curvature, position of neutral axis for rectangular, trapezoidal and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression.

Unit II

Unsymmetrical Bending: Properties of beam cross-section, slope of neutral axis, stress and deflection in unsymmetrical bending, determination of shear center and flexural axis (for symmetry about both axis and about one axis) for I-section and channel section.

Deflection of Beams: Equation of elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method Fixed beams. Castigliano's Theorem

Unit III

Helical and Leaf Springs: deflection of springs by energy method, helical springs under axial load and under axial twist (respectively for circular and square cross sections) axial load and twisting moment acting simultaneously both for open and closed coiled springs, laminated springs.

Unit IV

Columns and Struts: Combined bending and direct stress, middle third and middle quarter rules. Struts with different end conditions. Euler's theory and experimental results, Ranking Gardon Formulae, Examples of columns in mechanical equipment's and machines.

Unit V

Thin cylinders & spheres: Introduction to pressure vessels, Hoop and axial stresses. Volumetric strain.

Thick cylinders: Radial, axial and circumferential stresses in thick cylinders subjected to internal or external pressures, Compound cylinders Stresses due to interference fits.

Text and Reference Books:

Textbooks:

1. Mechanics of Materials by Gere & Timoshenko

2. Engineering Mechanics by Ryder

Reference books:

1. Engineering Mechanics by Irving H. Shames, Prentice-Hall
2. Mechanics of Materials by E.P.Popov, PHI
3. Engineering Mechanics by A. Nelson
4. Engineering Mechanics by U.C. Jindal
5. Engineering Mechanics Statics by J.L. Meriam & L.G.Kraige

STRENGTH OF MATERIALS LAB:

Any 8 experiments out of following:

1. To verify the law of polygon of forces.

2. To verify the laws of friction and to determine the coefficient of friction.

3. To determine the value of gravity at a place by simple pendulum.

4. To determine the mechanical advantage, Velocity ratio and Efficiency of Worm &

Worm Wheel and to determine its machine law.

5. To determine the mechanical advantage, Velocity ratio and Efficiency of Screw Jack and to determine its machine law.
6. To determine the mechanical advantage, Velocity ratio and Efficiency of a Double Purchase Crab and to determine its machine law.

7. To determine the M.I. of flywheel.

8. To determine the modulus of rigidity of a rod.

9. To determine the reaction of simply supported beam.

10. To determine the modulus of elasticity of Wires by Searl's apparatus.

11. To determine the spring constant and modulus of rigidity.

MATERIAL SCIENCE (EME253)

Type	L	T	P	Credits
PCC	3	0	2	4

Prerequisite: Fundamental knowledge of Intermediate level physics and chemistry.

Course Objectives:

The objective of the subject is to know the fundamental science and engineering principles relevant to materials. To understand the structure, properties, processing and performance of the principal classes of materials.

Course Outcomes:

Student will be able to-

CO1	Be able to apply general math, science and engineering skills to the solution of engineering problems.
CO2	Be knowledgeable of crystalline and non crystalline structures.
CO3	Understanding the structural imperfections and their effect on material properties.
CO4	Gain knowledge regarding the effect of heat treatment on the properties of ferrous materials and the corresponding engineering applications.
CO5	Understand the properties of non ferrous and non metallic materials
CO 6	Conduct different hardness test on various metallic materials, perform compression tests on material, metallographic evaluation of materials and determine tensile strength of materials

Course Content:

Unit I

Introduction: Importance of materials, Brief review of modern atomic concepts, atomic models, chemical bonding, metallic bonds; Crystalline and non-crystalline structures; Concept of unit cell, Bravis space lattices, common crystal structures- cubic and hexagonally closed packed structures, co- ordination number, packing factor, Miller indices for crystallographic planes and directions, X-ray crystallography techniques. Micro structural examination and grain size determination. Structure- property interrelationship, comparative study of microstructure of various metals & alloys such as mild steel, cast iron, brass and bronzes.

Unit II

Structural imperfections- point, line, planer and volume defects. Dislocations in solids- edge screw and mixed dislocations, energy of dislocations, Frank Reed source of dislocation, strain hardening, slip systems, twin and tilt boundary, grain boundary defects and their significance.

Diffusion in solids - Fick's first and second laws of diffusion.

Mechanical properties and testing: Introduction to material characterization, stress- strain diagram, ductile v/s brittle materials. Stress v/s strength, toughness, hardness, fracture, fatigue and creep, Mechanical testing- tensile test, hardness test, impact test, fatigue test, creep test, non-destructive evaluation.

Unit III

Phase diagram and equilibrium diagrams: Unary and binary diagrams, phase rules, types of equilibrium diagrams, types of solid solution, Hume-Rothery criteria of solid solution formation, intermetallic compounds.

Ferrous materials: Classification of steels, alloy steels, their applications, cast irons- its properties and uses. Iron carbon equilibrium diagram, time-temperature-transformation (T-T-T) curves- pearlite, bainite and martensite formations.

Heat treatment processes- annealing, normalizing, quenching, tempering, important case hardening processes; Non-ferrous metals and alloys, brasses, bronzes, bearing materials- its properties and uses, aluminum alloys such as Duralumin.

Unit IV

Magnetic Properties: magnetism – dia-, para- and ferro-magnetism, hysteresis, Soft and hard magnets, Magnetic storages; Electric properties: Energy band concept of conductor, insulator and semi- conductors, p-n junction and transistors, Basic devices and its application, Superconductivity and its applications, Messier effect, type I & II superconductors, high temperature superconductors.

Unit V

Ceramics- structure, properties and applications of ceramics, Polymers- types and its applications. Composite materials- its types and uses; Performance of materials in service- brief theoretical consideration of fracture, fatigue, corrosion and its control.

Text books:

1. Material Science & Engineering by W.D. Callister, Jr., Addison-Wesley Pub.Co.
2. Engineering Materials, Vol. I &II by Ashby & Jones, Pergemon Press.

Reference books:

1. Elements of Material Science & Engineering by Van Vlack, John Wiley & Sons
2. Material Science by V. Raghvan, Prentice Hall of India

MATERIAL SCIENCE & TESTING LAB

Any 8 experiments out of following:

1. To identify different kind of materials by observation also identify the metals of different types.

2. To prepare specimen for metallographic examination.

3. To perform Jominy end Quench test to determine hardenability of steel.

4. To determine Rockwell hardness, Brinell hardness and Vicker's hardness of given test specimens.

5. To perform Tensile Test/ Compression Test on given specimen using UTM.

6. To perform Izod & Charpy Impact test.

7. To perform Torsion test on given specimen.

8. To perform fatigue test on given specimen.

9. To perform Creep test.

10. To perform Bend (flexural) test on the given specimen.

ENGINEERING THERMODYNAMICS (EME255)

Type	L	T	P	Credits
PCC	3	1	0	4

Prerequisite: Physics of Class XII

Course Objectives:

The objective of this course is to understand and apply knowledge of Basic thermodynamics for the design and development of systems for thermal application.

Course Outcomes:

On completion of the course the student will have ability;

CO1	To apply scientific and technical knowledge using basics of engineering thermodynamics
CO2	To use the basic laws of thermodynamics in modeling, analysis and design of any engineering system/sub-system involving thermodynamics and application of thermodynamic relations in evaluation of thermodynamic properties.
CO3	To apply the fundamentals of conservation of mass & energy, availability & irreversibility in respect to properties of pure substances, ideal gas mixtures and combustion for design and analysis of thermodynamic systems.
CO4	To develop and assess engineering system designs based on technical and non-technical criteria through general understanding of thermodynamics.
CO5	To critically evaluate energy systems.

Course Content:

Unit – I:

Fundamental Concepts and Definitions: Introduction and definition of thermodynamics, Dimensions

and units, Microscopic and Macroscopic approaches, Systems, surroundings and universe, Concept of continuum, Control system boundary, control volume and control surface, Properties and state, Thermodynamic properties, Pressure and its measurement, Thermodynamic path, process and cycle, Thermodynamic equilibrium, Reversibility and irreversibility, Quasistatic process, Energy and its forms, Work and heat, Gas laws, Ideal gas.

Zeroth law of thermodynamics: Zeroth law of thermodynamics, Temperature and its measurement, Temperature scales.

First law of thermodynamics: Thermodynamic definition of work, Thermodynamic processes, Calculation of work in various processes and sign convention, Non-flow work and flow work, Joules' experiment, First law of thermodynamics, Internal energy and enthalpy, First law of thermodynamics applied to open systems, Steady flow systems and their analysis, Steady flow energy equation, Boilers, Condensers, Turbine, Throttling process, Pumps etc. First law analysis for closed system (non flow processes), Analysis of unsteady processes such as filling and evacuation of vessels with and without heat transfer, Limitations of first law of thermodynamics, PMM-I.

Unit – II:

Second law: Devices converting heat to work, Thermal reservoir, Heat Source, Heat Sink, Heat engines, Efficiency, Devices converting work to heat, Heat pump, refrigerator, Coefficient of Performance, Reversed heat engine, Kelvin Planck statement of second law of thermodynamics, Clausius statement of second law of thermodynamics, Equivalence of two statements of second law of thermodynamics, Reversible and irreversible processes, Carnot cycle and Carnot engine, Carnot theorem and it's corollaries, thermodynamic temperature scale, PMM-II.

Entropy : Clausius inequality, Concept of Entropy, Entropy change in different thermodynamic processes, Tds equation, Principle of entropy increase, T-S diagram, Statement of the third law of thermodynamics.

Unit – III

Properties of steam and thermodynamics cycles: Pure substance, Property of steam, Triple point, Critical point, Sub-cooled liquid, Saturation states, Superheated states, Phase transformation process of water, Graphical representation of pressure, volume and temperature, P-T & P-V diagrams, T-S and H-S diagrams, use of property diagram, Steam-Tables & Mollier charts, Dryness factor and it's measurement, processes involving steam in closed and open systems. Simple Rankine cycle, Brayton cycle.

Unit – IV

Availability and Irreversibility: Available and unavailable energy, Availability and Irreversibility, Second law efficiency, Helmholtz & Gibb's function, Availability analysis.

Thermodynamic relations: Mathematical conditions for exact differentials. Maxwell Relations, Clapeyron Equation, Joule-Thompson coefficient and Inversion curve. Coefficient of volume expansion, Adiabatic & Isothermal compressibility; Real gas, Law of corresponding states, Dalton's law, Amagat's law, Property of mixture of gases.

Unit - V

Fuels and Combustion: Combustion analysis, Heating Values and its measurement, Air requirement, Air/Fuel ratio, Standard heat of Reaction and effect of temperature on standard heat of reaction, heat of formation, Chemical Equilibrium, adiabatic flame temperature, Exhaust gas analysis.

Textbooks:

1. Fundamentals of Thermodynamics by Sonntag, Van Wylen, Borgnakke, JohnWiley & Sons
2. Thermodynamics : An engineering approach by Cengel & Boles, Mc Graw Hill

Reference books:

1. Engineering Thermodynamics by Jones and Dugans, PHI Learning Pvt. Ltd.
2. Thermodynamics by J.P. Holman, McGraw Hill.

MACHINE DRAWING (EME257)

Type	L	T	P	Credits
PCC	0	0	4	2

Prerequisite: Fundamental knowledge of engineering graphics.

Course Objectives:

The objective of this subject is to make student acquire knowledge of joints such as riveting, threaded joints etc.. The student also is enabled to prepare the assembly of various machine or engine components and miscellaneous machine components.

Course Outcomes:

1. Student will be aware with fundamentals of machine drawing.
2. Student will be able to understand principles of orthographic projections for machine drawing.
3. To draw the projections of machine elements including keys, couplings, cotters, riveted, bolted and welded joints.
4. To draw the assembled view using drawings of machine components and Engines.
5. To free hand sketches of machine elements

Course Content:

In this subject all the topics will be covered with a lecture at start of class

Introduction: Graphic language, Classification of drawings, Principles of drawing, IS codes for Machine drawing, Lines, Scales, Sections, Dimensioning, Standard abbreviations.

Orthographic Projections: Principles of first and third angle projections, drawing and sketching of machine elements in orthographic projections, spacing of views.

Screwed (Threaded) fasteners: Introduction, Screw thread nomenclature, forms of threads, Thread series, Thread designation, Representation of threads, Bolted joints, Locking arrangement for nuts, Foundation bolts.

Keys and cotters: Keys, Cotter joints.

Shaft couplings: Introduction, Rigid and flexible coupling.

Riveted Joints: Introduction, Rivets and riveting, Rivet heads, Classification of riveted joints.

Assembly drawing Introduction, Engine parts, Stuffing box etc.

Free hand sketching: Introduction, Need for free hand sketching, Free hand of sketching of some threaded fasteners and simple machine components.

Exposure to suitable 2D/3D drafting software.

Reference books:

2. Machine Drawing by N.Siddeshwar, P.Kannaiah, V V S Shastry,TMH, New Delhi
3. Machine Drawing by K L Narayana, P. Kannaiah, K VenkatReddy,New Age IntnlPubl
4. Engineering Drawing Practice for Schools & Colleges, SP46-1998 (BIS)

ENGINEERING ECONOMICS & MANAGEMENT (HHS-251)

Type	L	T	P	Credits
HSMC	3	0	0	3

Prerequisite:

Course Objectives:

- To provide useful knowledge to engineering students in their professional career particularly in corporate and manufacturing sector.
- To understand essential economic principles for solving economic problems with suitable policy alternatives.
- To study and analyze the contemporary market situations, market strategy to manage the business and industry.
- To understand fundamental of business management and apply management techniques for the benefit of business and society.

Course Content:

Unit-1: Introduction to Economics

Overview: production possibility curve, choices-what, how and for whom, micro- and macro-economics, inflation, unemployment, GDP and business cycle; demand and supply, elasticity of demand, consumer surplus and its applications, utility theory.

Unit-2: Production and Cost

Factors of production, production function, law of variable proportion, isoquant analysis, return to scale, economies of scale; Types of costs: direct and indirect costs, explicit and implicit costs, opportunity cost, economic cost, fixed cost and variable costs, average and marginal costs, short-run and long-run costs, optimal combination of factor-inputs.

Unit-3: Market Structure

Perfectly Competitive Market, Imperfect market: Monopoly, Oligopoly, Monopolistic Market

Unit-4: Fundamentals of Management:

Development of Management Thoughts, Objectives, Functions of Management: Planning, Organising, Directing, Controlling and Coordination.

Unit-5: Business Enterprises-

Business Ownership: Sole Proprietorship, Partnership, Company: Promotion, Formation & Development, Cooperative Firms.

Text and Reference Books:

1. Koutsoyiannis, A., 'Modern Microeconomics', English Language Book Society, Macmillan.
2. Joseph, L Massod, "Essential of Management", Prentice Hall, India.
3. Armstrong, Michel, "A Handbook of Management Techniques", Kogan Page Limited.
4. Babcock, D L and Lucy C Morse, "Managing Engineering and Technology", third edition, Pearson Education, 2006.
5. Pindyck, R S, Rubinfeld, D L & Mehta, 'Microeconomics', 6 th Edition, Pearson Education India.
6. Barthwal, R R , Microeconomic Analysis.
7. Samuelson, Paul A, 'Economics', 5th edition, McGraw Hill New York.
8. Henderson, J M and Quadnt, R E, 'Microeconomic Theory: A Mathematical Approach', Tata MacGraw Hill, New Delhi, 2003.

9. H. Varian, 'Intermediate Micro Economics'.
10. G. Mankiw,''Principles of Micro Economics.

Course Outcomes:

1. Understanding essential economic principle for solving economic problem with suitable policy alternatives and know how rational consumers can maximize their satisfaction with limited incomes and make best use of their resources. (Understand)
2. Understand production principles and cost analysis. (Understand)
3. Gain market knowledge and study the contemporary market situations, market strategy to manage the industries. (Understand, Apply)
4. Understand and gain basic knowledge of management technique. (Understand)
5. Develop Entrepreneurship skills towards formation of partnership, companies and their functions. (Apply)

INDIAN CONSTITUTION (HHS-255)

Type	L	T	P	Credits
HSMC	2	0	0	0

Prerequisite:

Course Objectives:

- To understand the configuration of the preambles & fundamental rights.
- To understand the functioning of constitutional functionaries and legislative bodies.
- To understand the judiciary system & its role in governance.

Course Content:

Unit-1: Indian Constitution
Sources and Features, Preamble, Fundamental Rights, Fundamental Duties and Directive Principles of State Policy

Unit-2: Union Executive
President, Vice President, Prime Minister, Council of Ministers, State Executives- Governor, Chief Minister and Council of Ministers

Unit-3: Union Legislature
Parliament- Composition and Functions, Speaker of Lok Sabha, Amendment Process, State Legislature- Vidhaan Sabha, Panchaayati Raj, Institutions- History, Basic Features and 73rd Amendment

Unit-4: Judiciary
Supreme Court, High Courts, Judicial Review and Judicial Activism

Unit-5: Election Commission
Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the Welfare of SC/ST/OBC and Women.

Text and Reference Books:

1. Indian Constitution: D.D Basu.
2. Indian Administration: Avasthi and Avasti.
3. The Indian Constitution: Corner Stone of a Nation, G. Austin, Oxford University Press.
4. Indian Politics: Contemporary Issues and Concerns, M. P. Singh and Rekha Saxena, Prentice Hall of India, Delhi.

Course Outcomes:

1. Configure the preambles & fundamental rights.
2. Actuate the governance & functioning of constitutional functionaries.
3. Describe the functions of legislative bodies.
4. Decipher the judiciary system & its role in governance.
5. Develop a democratic process through electoral mechanism into system.

COMPUTER ORIENTED NUMERICAL METHODS (BMA-256)

Type	L	T	P	Credits
BSC	3	1	0	4

Prerequisite:

Course Objectives:

The objective of this course is to provide conceptual understanding of:

- various numerical methods for solving linear and non linear equations.
- various numerical techniques of interpolation, integration and differentiation with their applications.
- various numerical methods to solve IVP_S and BVP_S.

Course Objectives / Outcomes

CO1	find roots of nonlinear equations and solve systems of algebraic equations.	Apply, Evaluate
CO2	use interpolation techniques and to find numerical differentiation/ integration of data, function.	Apply, Evaluate
CO3	use numerical methods for finding solutions of ordinary differential equations, simultaneous and higher order equations.	Apply, Evaluate
CO4	learn numerical methods for finding solution of initial and boundary value problems, partial differential equations.	Apply, Evaluate
CO5	learn basic concepts of some Finite element methods.	Apply, Evaluate

Course Content:

Unit-1: Nonlinear Equations and Simultaneous Linear Equations

Roots of nonlinear equation, Methods of solution, Order of convergence of iterative methods, Simple roots: Bisection, False position, Secant, Newton-Raphson, Chebyshev, Iteration and multi point iteration methods, Multiple roots: Newton-Raphson and Chebyshev, Complex roots: Newton-Raphson and Muller's method, a system of nonlinear equations: Newton-Raphson and iteration methods, Polynomial equations: Bairstow's method, convergence analysis of above methods.

Linear systems: Introduction, Direct methods, Operation count, Pivoting, III conditioned linear systems & condition number, Iteration methods: Jacobi, Gauss-Seidel, SOR methods, convergence conditions. Special system of equations: Thomas algorithm. Eigen value problems: Power methods.

Unit-2: Interpolation, Differentiation and Integration

Curve fitting: Polynomial interpolation, error, Existence and Uniqueness, Truncation error bounds,

difference operators, Newton forward and backward difference interpolations, Lagrange, Newton divided difference and Iterated interpolations, Stirling and Bessel's interpolations, Spline interpolation, Least squares and Chebyshev approximations. Numerical Differentiation: Methods based on interpolation, Error analysis.
Numerical Integration: Methods based on interpolations (Trapezoidal, Simpson's 1/3, Simpson's 3/8 rule), Gauss quadrature methods, Romberg integration, Error bounds and estimates.

Unit-3: Numerical Solution of Ordinary Differential Equations
Initial-value problems, Single step methods; Taylor's, Picard's, Modified Euler's method and Runge-Kutta method (fouth order), Error estimates, Multi-step methods: Adam's –Bashforth and Milne's methods, convergence and stability analysis, simultaneous and Higher equations: RK Fourth order method.

Unit-4: Boundary value- and Initial Boundary value Problems
BVP: Finite difference method, Shooting method, Solution of Laplace & Poisson equations: Standard 5 – point and diagonal 5-point formulae, Jacobi method, Gauss Seidel method (Liebmann's iterative method) Relaxation method. Solution of heat equation: Crank-Nicolson method, Solution of wave equation.

Unit-5:Finite Element Method
Basic concepts, Variational formulation and functionals, base functions, approximations by Ritz method, Galerkin method, Least squares method, collocation method, time dependent problems, Finite element solution of simple problems.

Text Books:
1. M.K. Jain, S.R.K. Iyengar & R.K. Jain, Numerical methods for Scientific and Engineering Computation, New age international Publication.
2. S. S. Sastry, Introductory Methods of Numerical Analysis, Eastern Economy Edition.

Reference Books:
1. S. Rajasekaran, Numerical Method in Science and Engineering, Wheeler Publishing House.
2. B. S. Grewal, Numerical Method in Engineering & Science, Khanna Publishers.

ENGINEERING FLUID MECHANICS (ECE-252)

Type	L	T	P	Credits
ESC	3	1	2	5

Course Objectives / Outcomes :

1. Study of fluid properties and compute hydrostatic forces
2. Apply and compute kinematics of fluid
3. Apply and analyse fluid dynamics as well principle of dimensional analysis and model similitude
4. Analyze and design simple pipe systems
5. Compute and analyse boundary layer and forces on submerged bodies

Course Content:

UNIT-I
Introduction:
Scope and importance of Fluid Mechanics, Physical properties of fluids (density, specific weight,

specific volume, sp. gravity, viscosity-Newton's law of viscosity, Newtonion and non-Newtonion fluids, Compressibility, Surface tension and Capillarity, vapour pressure), Rheological classification of fluids, Ideal fluid, Real Fluid.

Fluid Statics:

Pressure, Pascal's Law, Hydrostatic Law, Pressure measurement devices – Piezometer, manometers, Mechanical gauges, Forces on plane and curved surfaces, Centre of pressure and pressure diagram, Buoyancy, Metacentre, Stability of Submerged and floating bodies, Fluid masses subjected to accelerations.

UNIT-II

Fluid Kinematics:

Concept of control volume, Velocity and acceleration of fluid Particle, Lagrangian and Eulerian approach, Classification of fluid flow (steady- unsteady, Uniform-Nonuniform, Rotational – Irrotational, turbulent–laminar, l-D,2-D, 3-D flow, Compressible - incompressible flow), Streamlines, Path lines and Streak lines, Equipotential lines, Stream Function and Velocity Potential, Flow Net, Continuity equation, Rotation, Vorticity and Circulation, Free and Forced vortex motion.

UNIT-III

Fluid Dynamics:

Concept of control volume and control surface, Forces acting on fluid in motion, Euler's equation, Bernoulli's Theorem and applications – Pitot Tube, Venturimeter, Orificemeter, Orifices and Mouthpieces, Concept of HGL & TEL.

Dimensional Analysis: Units and Dimensions, Dimensional analysis, Rayleigh's method, Buckingham's Π theorem, Non-dimensional numbers & their significance.

Hydraulic Similitude and Model Studies: Model and prototype; Similitude; Geometric, Kinematic and Dynamic similarity; Model Laws; Un-distorted model studies.

UNIT-IV

Flow in pipes:

Laminar flow: Reynold's Experiment, Coutte & Hazen Poisulle's Equation for viscous flow between parallel plates and circular pipes, Stokes law; Flow through porous media; Darcy's Law; Fluidization; Measurement of viscosity; Transition from laminar to turbulent flow.

Turbulant flow: Velocity distribution and Shear stresses in turbulent flow, Prandtl mixing length theory, Introduction to Moody's Chart.

Losses in pipes:

Darcy - Wiesbach Equation, factors affecting friction, Minor Losses in pipes, Concept of equivalent length of pipe for different pipe fittings, Equivalent diameter of pipes, Hydraulic Power, transmission by pipe, Pipes in parallel, Series, Syphon, two reservoir problems, Water hammer in pipes, Surge tanks - function, location and uses, Pipe network.

Unit-V

Boundary layer theory:

Concept, Boundary layer along thin plate- Characteristics, Laminar, Turbulent Boundary Layer, laminar sub layer, Various Thicknesses- Nominal, displacement, Momentum, Energy, Hydraulically smooth and Rough boundaries, Separation of Boundary layer, control of Separation.

Forces on submerged bodies: Introduction to Drag and Lift on submerged bodies (like Flat plates, Sphere, Cylinder, aerofoil), stokes law, Drag and Lift coefficients.

List of Experiments

1. To determine the metacentric height of a ship model experimentally.
2. To study the transition from laminar toturbulent flow and to determine the lower critical Reynolds number.

3. To determine the coefficients of velocity, contraction and discharge of an orifice (or a mouth piece) of a given shape.
4. To find the velocity distribution in a pipe and hence to compute the discharge by integrating the velocity profile obtained.

5. To verify the Bernoulli's theorem.
6. To calibrate an orifice meter and venturimeter and to study the variation of the coefficient of discharge with the Reynolds number.
7. To verify Darcy's law and to find out the coefficient of permeability of the given medium.
8. To study the variation of friction factor, 'f' for turbulent flow in smooth and rough commercial pipes.
9. To determine the loss coefficients for the various pipe fittings.
10. Study of free and forced vortex flow.

References :

2) Fluid Mechanics – A.K. Jain – Khanna Pub., Delhi
3) Fluid Mechanics – Hydraulic & Hydraulic Mechanics -Modi / Seth – Standard Book House, Delhi
4) Fluid Mechanics – Streeter-McGraw-Hill International Book Co., Auckland
5) Fluid Mechanics – Garde-Mirajgaonkar – Nemchand & Bros., Roorkee
6) Fluid Mechanics – Shames - McGraw-Hill International Book Co., Auckland
7) Som and Biswas: Introduction to Fluid Mechanics and Machines, TMH.
8) R K Bansal: Fluid Mechanics and Hydraulic Machines.
9) Fluid Mechanics & Hydraulic Machines – Domkundwar & Domkundwar, Dhanpat Rai & Co.
10) Fluid Mechanics & Hydropower Engineering – D. S. Kumar, S.K. Kataria and Sons.
11) Fluid Mechanics and Machinery – Ojha, Berndtsson and Chandramouli, Oxford University Press.

APPLIED THERMODYNAMICS (EME256)

Type	L	T	P	Credits
PCC	3	0	0	3

Prerequisite: A course on Engineering Thermodynamics

Course Objectives:

This course focuses upon the application of different laws and principles of thermodynamics as well as physics for realizing useful thermodynamic processes in different thermal systems.

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Explain working of different boilers and significance of mountings and accessories and also carry out performance assessment.
CO2	Elucidate construction and working of steam nozzle, steam turbine, steam condenser, steam engine, compressors, condenser, cooling tower, gas turbine, jet engine and unconventional energy conversion systems.
CO3	Evaluate thermal performance of steam nozzle, steam turbine, steam condenser, steam engine, compressors, condenser, cooling tower, gas turbine, jet engine and suggest methods for improvement of thermal performance.
CO4	Analyze thermal systems for energy conservation to determine sources of waste heat and design waste heat recovery systems.
CO5	Design and analyze thermal systems based on principles of thermodynamics.

Course Content:

Unit-I

Boilers: Steam generators-classifications. Working of fire-tube and water-tube boilers, boiler mountings & accessories, supercritical boilers, waste heat recovery steam boilers, Draught & its calculations, air pre heater, feed water heater, super heater. Boiler efficiency, Equivalent evaporation. Boiler trial and heat balance.

Condenser: Classification of condenser, Air leakage, Condenser performance parameters

Unit-II

Steam Engines: Modified Rankine cycles, Working of stream engine, Classification of steam engines, Indicator diagram, Saturation curve, Missing quantity.

Steam & Gas Nozzles: Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, Off design operation of nozzle, Effect of friction on nozzle, Super saturated flow.

Unit-III

Vapour Power cycles: Carnot vapour power cycle, Effect of pressure & temperature on Rankine cycle, Reheat cycle, Regenerative cycle, Feed water heaters, Binary vapour cycle, Combined cycles, Cogeneration.

Unit-IV

Steam Turbines : Classification of steam turbine, Impulse and reaction turbines, Staging, Stage and overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple & compound multistage impulse & reaction turbines and related calculations of work done, efficiencies, State point locus, Degree of reaction, Losses in steam turbines, Governing of steam turbines.

Unit-V

Gas Turbine: Gas turbine classification, Effect of different parameters on Brayton cycle performance, Principle of gas turbine, Gas power cycles with intercooling, reheat and regeneration and their combinations, Stage efficiency, Isentropic efficiency, Polytropic efficiency. Deviation of actual cycles from ideal cycles.

Textbooks:

1. Applied thermodynamics by Onkar Singh, New Age International (P) Publishers Ltd.
2. Basic and Applied Thermodynamics by P.K. Nag, Tata McGraw Hill

Reference books:

1. Theory of Stream Turbine by W.J. Kearton
2. Steam & Gas Turbine by R.Yadav, CPH Allahabad
3. Gas Turbine, by V. Ganeshan, Tata McGraw Hill Publishers.
4. Gas turbine Theory & Practice, by Cohen & Rogers, Addison Weslay Long man
5. Reciprocating and Rotary Compressors, by Chlumsky, SNTI Pub., Czechoslovakia
6. Turbines, Compressors and Fans, by S.M.Yahya, Tata McGraw Hill Pub.

MANUFACTURING SCIENCE-I (EME254)

Type	L	T	P	Credits
PCC	3	0	2	4

Prerequisite: Course on Workshop Technology, Strength of materials

Course Objectives:

The course aims at understanding of fundamental manufacturing process such as casting, forming, sheet metal forming and powder metallurgy.

Course Outcomes:

After completion of course a student will be able to:

CO1	Analyze processes required to manufacture a component
CO2	Understand the capability of casting process and components that can be manufactured using casting process
CO3	Understand basic concept of metal forming processes and their applications in engineering.
CO4	Understand sheet metal working process and their analysis.
CO5	Understand about concept of powder metallurgy and components that can be manufactured using powder metallurgy
CO6	Understand the practical aspects of various manufacturing process.

Course Content:

Unit-I

Importance of manufacturing towards technological and social economic development. Classification of manufacturing processes. Survey of manufacturing processes. Manufacturing processes for common items, Concepts of Manufacturing Systems.

Unit II:

Casting: Basic principle and survey of casting processes. Types of patterns and allowances. Types and

properties of moulding sand. Elements of mould and design considerations, Gating, Riser, Runners Core. Solidification of casting, Sand casting, defects & remedies and inspection. Cupola furnace. Die Casting, Centrifugal casting. Investment casting, CO_2 casting and Stir casting etc.

Unit-III

Metal Forming Processes: Elastic & plastic deformation, yield criteria. Hot working vs cold working. Analysis (equilibrium equation method) of Forging process for load estimation with sliding friction sticking friction and mixed condition for slab and disc. Work required for forging, Hand, Power, Drop Forging. Analysis of Wire/strip drawing and maximum-reduction, Tube drawing, Extrusion and its application. Condition for Rolling force and power in rolling. Rolling mills & rolled-sections. Design, lubrication and defects in metal forming processes.

Unit-IV

Sheet Metal working: Presses and their classification, Die & punch assembly and press work methods and processes. Cutting/Punching mechanism, Blanking vs Piercing. Compound vs Progressive die. Flat-face vs Inclined-face punch and Load(capacity) needed. Analysis of forming process like cup/deep drawing. Bending & spring-back.

Unit-V

Powder Metallurgy : Powder metallurgy manufacturing process. The need, process, advantage and applications. Introduction to Rapid Prototyping classification and tooling. Manufacturing of Plastic components: Review of plastics, and its past, present & future uses. Injection moulding. Extrusion of plastic section. Welding of plastics. Applications of plastics.

MANUFACTURING SCIENCE - I LAB

Any 8 experiments out of following:

1. Design of pattern for a desired casting (containing hole)
2. Pattern making
3. Making a mould (with core) and casting.
4. Injection moulding with plastics
5. Hand forging processes
6. Forging - power hammer study & operation
7. Tube bending with the use of sand and on tube bending machine.
8. Press work experiment such as blanking/piercing, washer, making etc.
9. Bending & spring back.
10. Jigs & Fixture experiment

Text books:

1. Manufacturing Science by Ghosh and Mallik
2. Production Engg. Science by P.C. Pandey

Reference books:

1. Production Technology by R.K. Jain
2. Manufacturing Technology by P.N. Rao., TMH
3. Materials and Manufacturing by Paul Degarmo. Prentice Hall of India Pvt. Ltd.
4. Manufacturing Engineering & Technology by Kalpakjian, Pearson Pub.

KINEMATICS OF MACHINES (EME258)

Type	L	T	P	Credits
PCC	3	0	0	3

Prerequisite: A course on Engineering Mechanics, Statics and Dynamics.

Course Objectives:

To provide knowledge of transfer of motions and conversion of motions using mechanisms.

Course Outcomes:

Student will be able to

CO1	Understand the principles of kinematic chains and its inversions.
CO2	To draw position, velocity and acceleration diagrams of kinematic chains.
CO3	Understand the concepts of power transfer through belts, ropes and chains.
CO4	Understand the friction based brakes and clutches systems.
CO5	Understand the gear profiles, motion and power transfer using gear trains

Course Content:

UNIT 1: Introduction: Aims & scope of the course & Basic concepts of Mechanisms. Basic definitions, Difference between structure & Machine, Links & their types, Types of constrained motion, Kinematic pair & their classification, Grubler's mobility criteria, Inversion of a kinematic chain and applications, Hooks joint, Devis and Ackermann steering mechanism. An introduction to approximate and exact straight line mechanism.

UNIT 2: Graphical (vector) method for velocity and acceleration of various mechanisms e.g. slider crank and four bar, Coriolis acceleration. Instantaneous centre method, Kennedy's theorem, Klien's construction

UNIT 3:

Transmission drives: Belt, Rope and Chain drives: Types and materials, Fundamentals of Power transmission Phenomena of slip & creep, centrifugal and initial tensions, Tight side and slack side tensions, Conditions of max. Power transmission.

UNIT 4: Brakes and Clutches: Types of braking systems force and torque analysis for block, band and band and block brake, disc brakes. Friction clutches: types, uniform pressure and uniform wear theory.

UNIT 5

Theory of gearing: Classification of gears and terminology, Law of gearing, systems of gear teeth, gear profiles, Interference, and efficiency of gears, epicyclical gear train, Compound gear train, Torque analysis and various applications of complex gear trains.

Textbooks:

1. Theory of Machines by S. S. Rattan
2. Theory of Machines by J E Shingley

Reference books:

1. Theory of Machines by Thomas Bevan
2. Kinematics by HN Tyson

HHS-254: ORGANIZATIONAL BEHAVIOR

Type	L	T	P	Credits
HSMC	3	0	0	3

Course Objectives (COs)

At the end of this course students should be able to:

1. Apply organizational objectives, components and models in Indian context for better results for attaining organizational goals.
2. Demonstrate individual behavioural dimensions, learning theories, perceptual process, values & ethics with motivational techniques in stressed situations.
3. Identify mechanism for, conducive survival of individual in an organization with interpersonal understanding.
4. Ascertain group, group behaviour, Team & Team building with its key role in organization.
5. Demonstrate organisational structure, organisational change, organisational development for achieving higher productivity and accomplishing goals of organisation

Unit 1: Introduction to organizations

What is an organization, components of organization, nature and variety of organizations (in terms of objectives, structure etc.), models of analyzing organizational phenomena, organizational and business variables, organizations in the Indian context, institutions and structures.

Unit 2: Dimensions of Individual Behavior

Individual Behavior, Dimensions of individual behavior: Perceptions, Learning, Motivation, Personality, Commitment, Attitudes, Values & Ethics, Stress Management

Unit 3: Dimensions of Interpersonal Behavior

Transactional Analysis, Interpersonal communication, Listening, Feedback, Counseling,

Unit 4: Group Behavior

Leadership, Communication, Group: Formal Vs Informal Groups, Group Decision making, Team: Team building, team problem solving.

Unit 5: Organizational Dimensions

Organizational Structure: Elements of Organizational Structure, Dimensions of Organizational Structure, Organizational change, Organizational Development, Power, Authority, Politics

Note: Integrating cases (s). Case method and lectures should be supplemented with a variety of other methodologies such as feedback on questionnaires and tests, role plays, and behavior simulation exercise.

References:

1. Luthans Fred., "Organizational Behavior", McGraw Hill, 1998
2. Pareek, Udai, "Understanding Organizational Behavior, Oxford university press

Additional Reference Books

1. Robbins (4th ed.), "Essentials of organizational behavior", Prentice Hall of India Pv1. Ltd., New Delhi,
1995
2. Keith Davis, "Organisational Behaviour,
3. Hersey and Blanchard (6th ed.). "Management of organizational behavior L utilising human resources",
Prentice Hall of India Pv1. Ltd., New Delhi, 1996.
4. Nancy J. Adler, “International Organisational Behaviour’, Cengage Learning
5. Nelson Quick, ‘Organizational Behaviour Function Learning’Fifth Edition

CYBER SECURITY (ECS-260)

Type	L	T	P	Credits
MC	2	0	0	0

Course Content:

Unit-1:
Introduction to information systems, Types of information systems, Development of Information systems, Introduction to information security, Need for Information security, Threats of Information Systems, Information Assurance, Cyber Security and Security Risk Analysis.

Unit-2
Application security (Database, E-mail and Internet), Data Security Considerations - Backups, Archival Storage and Disposal of Data, Security Technology - Firewall and VPNs, Intrusion Detection, Access Control, Security Threats - Viruses, Worms, Trojan Horse, Bombs, Trapdoors, Spoofs, E-mail viruses, Macro viruses, Malicious Software, Network and Denial of Services Attack, Security Threats to E-Commerce – Electronic Payment System, e-Cash, Credit/Debit Cards, Digital Signature, public Key Cryptography.

Unit-3
Developing Secure Information Systems, Application Development Security, Information Security Governance & Risk Management, Security Architecture & Design, Security Issues in Hardware, Data Storage & Downloadable devices, Physical Security of IT Assets, Access Control, CCTV and intrusion Detection Systems, Backup Security Measures.

Unit-4
Security Policies, why Policies should be developed, WWW Policies, Email Security Policies, Policy Review Process- Corporate policies- Sample Security Policies, Publishing and Notification requirement of the Policies. Information Security Standards- ISO, IT Act, Copyright Act, Patent Law, IPR. Cyber Laws in India: IT Act 2000 Provisions, Intellectual Property Law: Copy Right Law, Software License, Semiconductor Law and Pattern Law.

Text and Reference Books:

1. Charles, P., and Shari Lawrence Pfleeger, "*Analyzing Computer Security"*. Pearson Education India.
2. V.K. Pachghare, "*Cryptography and information security",* PHI Learning Pvt. Ltd., Delhi India.
3. Dr Surya Prakash Tripathi, Ritendra Goyal, and Praveen Kumar Shukla, "Introduction to Information Security and Cyber Law", Willey Dreamtech Press.
4. Schou, Shoemaker, "Information Assurance for the Enterprise", Tata McGraw Hill.
5. Chander Harish, "Cyber Laws and their Protection", PHI Learning Private Limited, Delhi, India.

Course Outcomes:

1. Understand information, information systems, information security, Cyber Security and Security Risk Analysis. (Understand)
2. Understand and apply application security, data security, security technology, security threats from malicious software. (Understand, Apply)
3. Understand the concepts of security threats to e-commerce applications such as electronic payment system, e-Cash, Credit/Debit Cards etc. (Understand)
4. Understand and apply Information Security Governance & Risk Management, Security of IT

Assets and Intrusion Detection Systems. (Understand, Apply)

5. Understand various types of Security Policies, Cyber Ethics, IT Act, IPR and Cyber Laws in India. (Understand)

Detailed Syllabus
3rd Year

MANUFACTURING SCIENCE-II (EME-351)

Type	L	T	P	Credits
PCC	3	0	2	4

Prerequisite: Basic course in Workshop Practice and strength of material

Course Objective:

The course aims at understanding basic manufacturing process viz. chip removal process, Grinding process, understanding of abrasive process, joining processes and chip less metal removal processes.

Course Outcomes:

After completion of course a student will:

CO1	Understand basic importance of tools, cutting fluid, tool materials in order to have high quality of production
CO2	Understand the applications of grinding and super finishing processes,
CO3	Understand the various methods of welding and their applications,
CO4	Understand the capabilities of various machine tools and components that can be manufactured on a particular machine tool
CO5	Understand manufacturing processes and their capabilities.
CO6	Understand the working of various manufacturing machines.

Course Content:

Unit-I

Metal Cutting: Mechanics of metal cutting. Geometry of tool and nomenclature.ASA system orthogonal vs. oblique cutting. Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces, power required for turning, milling and drilling. Cutting fluids/lubricants. Tool materials. Tool wear and tool life. Machinability. Force measurement. Economics of metal cutting.

Unit-II

Grinding &Super finishing

(i) Grinding: Grinding wheels, abrasive & bonds, cutting action. Grinding wheel specification. Grinding wheel wear - attritions wear, fracture wear. Dressing and Truing. Max chip thickness and grinding criteria. Surface and Cylindrical grinding. Centerless grinding.

(ii) Super finishing: Honing, lapping, polishing.

Unit-III

Joining Methods: Survey of welding and allied processes. Gas welding and cutting, process and equipment. Arc welding : Power sources and consumables. TIG & MIG processes and their parameters. Resistance welding - spot, seam, projection etc. Other welding processes such as atomic hydrogen, submerged arc, electroslag, friction welding. Soldering & Brazing. Shrinkage/residual stress in welds. Distortions & Defects in welds and remedies. Weld decay in HAZ. Joining of non metallic components, Introduction to unconventional welding.

Unit-IV

Machine Tools: (i) Lathe : Principle, construction, types, operations, Turret / capstan, semi / Automatic, Tool layout ; (ii) Shaper, slotter, planer : Construction, operations & drives; (iii) Milling : Construction, Milling cutters, up & down milling. Dividing head & indexing. Various types of milling cutters; (iv) Drilling and boring: Drilling, boring, reaming tools. Geometry of twist drills.

Unit V:
Limitations of conventional manufacturing process and need of unconventional manufacturing processes. Mechanical processes such as Ultrasonic machining, Abrasive jet machining, Abrasive water jet machining; Thermal energy based processes such as Electro chemical, Electro discharge, Laser and Electron beam machining.

Textbooks:
1. Manufacturing science by Ghosh and Mallik
2. Manufacturing science by Degarmo

Reference books:
1. Fundamentals of Metal Cutting and Machine tools by Boothroyd
2. Production Technology by R.K. Jain
3. Production Engineering Science by P.C. Pandey
4. Modern Machining Processes by P.C. Pandey& H.S. Shan
5. Fundamentals of metal cutting & machine tools – Juneja, Shekhon& Seth, New Age Publ.
6. Process & materials of manufacturing - Lindburg.
7. Metal Cutting Principles by M.C. Shaw, Oxford Univ. Press.

EME351: MANUFACTURING SCIENCE-II LAB

Any 8 experiments out of the following:

1. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe Machine.
2. Taper turning operation on lathe.
3. Bolt (thread) making on Lathe machine.
4. Tool grinding (to provide tool angles) on tool- grinder machine.
5. Gear cutting on Milling machine.
6. Machining a block on shaper machine.
7. Finishing of a surface on surface- grinding machine.
8. Drilling holes on drilling machine and study of twist-drill.
9. Study of different types of tools and its angles & materials.
10. Experiment on tool wear and tool life.
11. Gas welding of a lap/butt joint.
12. Arc welding of a lap/butt joint.
13. Resistance spot welding of two thin metallic sheets.
14. Experiment on Electro discharge machining.
15. Experiment on CNC machines.

HEAT AND MASS TRANSFER (EME353)

Type	L	T	P	Credits
PCC	3	0	2	4

Prerequisite: Course on Engineering Thermodynamics.

Course Objectives:

This course aims at developing capability to understand, mathematically simulate and analyze the effect of heat and mass transfer occurring in different processes / systems.

Course Outcomes:

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

CO1	Explain the laws of heat transfer, modes of heat transfer and fundamentals of heat exchangers.
CO2	Mathematically model and analyze the consequence of heat and transfer in thermal analyses of engineering systems.
CO3	Formulate, evaluate and develop solution for conduction, convection and radiation heat transfer problems in different situations.
CO4	Apply empirical correlations for forced, free convection and phase change process.
CO5	Understand, apply principles and analyze mass transfer phenomenon in different processes systems.
CO6	Find out different conduction parameters, observe heat transfer phenomenon, and practically relate to concepts discussed in the Heat & Mass Transfer course.

Course Content:

UNIT-1

Introduction to Heat Transfer:

Concepts of the mechanisms of heat flows; Conduction, convection and radiation; Effect of temperature on thermal conductivity of materials; Introduction to combined heat transfer mechanism.

Conduction:

One-dimensional general differential heat conduction equation in the rectangular, cylindrical and spherical coordinate systems; Initial and boundary conditions.

Steady State one -dimensional Heat conduction :

Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation; Thermal resistance concept; Analogy between heat and electricity flow; Thermal contact resistance; Critical thickness of insulation.

UNIT-2

Numerical methods in heat conduction:

Finite difference formulation of differential equation, One-dimensional steady-state heat conduction, Solution methods for systems of algebraic equations, Two-dimensional heat conduction, Transient heat conduction.

Fins:

Heat transfer from extended surfaces, Fins of uniform cross-sectional area; Errors of measurement of temperature in thermometer wells.

Transient Conduction:

Transient heat conduction; Lumped capacitance method; Time constant; Unsteady state heat conduction in one dimension only, Heisler charts.

UNIT-3

Forced Convection:

Basic concepts; Hydrodynamic boundary layer; Thermal boundary layer; Approximate integral boundary layer analysis; Analogy between momentum and heat transfer in turbulent flow over a flat surface; Mixed boundary layer; Flow over a flat plate; Flow across a single cylinder and a sphere; Flow inside ducts; Empirical heat transfer relations; Relation between fluid friction and heat transfer; Liquid metal heat transfer.

Natural Convection:

Physical mechanism of natural convection; Buoyant force; Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere; Combined free and forced convection.

UNIT-4

Thermal Radiation:

Basic radiation concepts; Radiation properties of surfaces; Black body radiation, Planck's law, Wein's displacement law, Stefan Boltzmann law, Kirchoff's law; ; Gray body; Shape factor; Black-body radiation; Radiation exchange between diffuse non black bodies in an enclosure; Radiation shields; Radiation combined with conduction and convection; Absorption and emission in gaseous medium; Solar radiation; Green house effect.

UNIT-5

Heat Exchanger:

Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method; Compact heat exchangers.

Condensation and Boiling:

Introduction to condensation phenomena; Heat transfer relations for laminar film condensation on vertical surfaces and on outside & inside of a horizontal tube; Effect of non-condensable gases; Dropwise condensation; Heat pipes; Boiling modes, pool boiling; Hysteresis in boiling curve; Forced convective boiling.

Introduction to Mass Transfer:

Introduction; Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion though a stagnant gas film.

Textbooks:

1. Heat Transfer By J.P. Holman, McGraw-Hill International edition.
2. Heat and Mass Transfer by Cengel & Ghazar, TMH

Reference books:

1. Elements of Heat transfer by Bayazitouglu & Ozisik, McGraw-Hill Book Company.
2. Schaum's outline of Heat Transfer by Pitts & Sisson McGraw-Hill International edition.
3. Principles of Heat Transfer by Frank Kreith, McGraw-Hill Book Co.
4.Fundamentals of Momentum, Heat and Mass Transfer by James R.Welty; John Wiley & Sons (Pvt). Ltd.

EME353: HEAT & MASS TRANSFER LAB

Any 8 experiment out of the following:

1. Conduction - Composite cylinder experiment

2. Convection - Pool Boiling experiment

3. Convection - Experiment on heat transfer from tube-natural convection.

4. Convection - Heat Pipe experiment.

5. Convection - Heat transfer through fin- natural convection .

6. Convection - Heat transfer through tube/fin- forced convection.

7. Experiment on Stefan's Law, on radiation determination of emissivity, etc.

8. Experiment on solar collector.

9. Heat exchanger - Parallel flow experiment

10. Experiment on Cooling tower

11. Experiment on critical insulation thickness.

12. Conduction - Determination of thermal conductivity of fluids.

13. Conduction - Thermal Contact Resistance Effect.

DYNAMICS OF MACHINES (EME355)

Type	L	T	P	Credits
PCC	3	0	2	4

Prerequisite: A Course on Engineering Mechanics

Course Objectives:

To provide knowledge of dynamic mechanical systems such as gyroscope, flywheel, governor and engines.

Course Outcomes:

Students will be able to

CO1	Understand the profiles of cams and its effect on follower intermittent motion.
CO2	Understand the concept of gyroscopic couple for ships, aero planes and road vehicles.
CO3	To analyze the different types of governors and flywheels.
CO4	To balancing of the reciprocation and rotatory systems.
CO5	Understand free and forced vibrations of single degree freedom systems.
CO6	Demonstrate functioning of single slider crank mechanism and its inversions based systems.

Course Content:

Unit 1: Introduction of cam and follower, Terminology, classification, types of follower motion, Analysis of cam and follower motion.

Unit 2: Introduction to gyroscope, precisional motion and Gyroscopic couple, Effect of gyroscope couple in aero plane, effect of gyroscopic couple on naval ship during steering, pitching and rolling, Stability of Four wheel and two-wheel vehicle during turning.

Unit 3: Flywheels: Fluctuation of energy and speed, Application of flywheel to various operations and mechanisms of machine; Governor: Terminology, Classification of governors, function, analysis of various types of governors viz. Wald's, Proel, Hartnell.

Unit 4:

Velocity and acceleration of Slider crank mechanism, Analytical method for velocity and acceleration of the piston, angular velocity and acceleration of connecting rod. Force analysis of reciprocating engine mechanism and inertia torque calculations; Balancing of rotating and reciprocating masses: methods of balancing the primary and secondary unbalanced forces, partial balancing, field balancing.

Unit 5:

Introduction to Mechanical Vibration: SHM, 1D and 2D problems of free, damped and forced vibrations. Vibration isolation, transmissibility, critical speed of shaft. Vibration measuring instruments. Exact and approximate numerical methods in vibrations. Raleigh, Dunkerlay, Stadola methods.

Text books:

1. Theory of Machines by S. S. Rattan
2. Mechanical Vibrations by Grover, G.K., Nem Chand Publishers, Roorkee

Reference books:

1. Theory of Machines by Thomas Bevan
2. Theory of Machines by J.Lal and Shah

EME355: DYNAMICS OF MACHINE LAB

Any 8 experiments out of following:

1. To draw the slider displacement v/s crank angle and time v/s velocity curves for a slider crank mechanism and compare with theoretical; values.

2. To determine the ratio of time and maximum velocities for quick return motion using crank and lever mechanism

3. To study various approximate line drawing mechanism.

4. To determine the ratio of angular speeds of shafts in a Hooke's Joint.

5. To determine the coefficient of friction between flat belt and pulley.

6. To determine the Moment of Inertia of a plane disc by using a gyroscope.

7. To study quick return mechanism to get ratio of angle for forward stroke to return stroke.

8. To determine the forces on a spring in a Hartnell Governor to determine the spring stiffness.

9. To study the motion of the follower with the given profile of the cam and to determine the displacement, velocity and acceleration at all the points.

10. To study the working of Oldham's coupling.

11. To determine the speed ratio of a spur gear.

12. Determination of critical speed of shaft.

13. Finding the damping ratio and natural frequency of a cantilever beam.

MACHINE DESIGN–I (EME357)

Type	L	T	P	Credits
PCC	3	0	2	4

Prerequisite: Fundamental knowledge of strength of materials, material science and kinematics of machine.

Course Objectives:

The objective of this subject is to demonstrate the application of the concept of stress analysis, theories of failure, and material science to analyze and design commonly used machine components.

Course Outcomes:

Student will be able to

CO1	Understand the importance of material selection in design
CO2	Understand component behavior subjected to static or dynamic loads and identify the failure criteria.
CO3	Design keys, couplings and joints including riveted, bolted and welded joints.
CO4	Design of important machine components springs and screw jack.
CO5	Understand the customers' need, formulate the problem and draw the design specifications
CO6	Design of important machine components like shafts, couplings, springs and screw jack

Course Content:

UNIT-I

Introduction: Definition, Methods, standards in design, considerations in design.

Selection of materials: Importance, Classification of Engineering Materials, different kind of steels & cast irons, steel designation, Materials for components subjected to creep, static and fatigue loads, Importance of ceramics, plastics & rubbers for Engineering applications, ASTM testing methods.

UNIT-II

Design for static load: Modes of failure, Factor of safety, stress-strain relationship, principal stresses, theories of failure.

Design for dynamic loads: types, effect w.r.t. static loads, stress concentration, Fluctuating / alternating stresses, fatigue failure, endurance limit, design for finite & infinite life, Soderberg& Goodman criteria., design for fatigue, creep and fracture, design for contact stresses and residual stresses

UNIT-III

Joints: Riveted joints, failure of rivets, welded joint, screwed joints, eccentric loading of above joints, and design for fatigue loading.

Shaft, keys & coupling: Design against static and fatigue loads, strength & rigidity design, Selection of square & flat keys & splines, rigid & flexible couplings.

UNIT-IV

Mechanical springs: Design of Helical and leaf springs, against static & fatigue loading.

Design analysis of Power Screws: Form of threads, square threads, trapezoidal threads, stresses in screw, design of screw jack.

UNIT-V

Introduction to Product Development & Design Process : Definition of Design, Design Process, Need Analysis, Need based developments, Design by Evolution, Technology based developments, Examples. Case Studies.Brain-storming.

Note -

1. Students may be advised to use design data book for design.
2. Drawing shall be made wherever necessary on small drawing sheets
3. In case of shortage of time the design part of the experiment can be completed in the tutorials.

Text books:

1. M/C Design by J.E. Shigley, Tata McGrow Hill.
2. Machine Design by Bhandari

Reference books:

1. Design of M/C Elements by M.F. Spots.
2. Mechanical Engineering Design by Shigley
3. M/C Design by Sadhu Singh.
4. M/C Design by Sharma &Agarwal.
5. Product Development & Design by TarunSoota
6. Material Science & Engineering by Callister Jr.
7. Design data handbook by Mahadevan
8. Machine Drawing by Siddeshwar, Kannaiah, Shastry

EME357: MACHINE DESIGN- I LAB

Any 8 experiments out of following:

1. Design & drawing of Riveted joints for given operating conditions.
2. Design of an eccentrically loaded welded, riveted of bolted joint.
3. Design of bolted joint for fluctuating loads.
4. Design & drawing of a simple screw jack.
5. Design of shaft for different loading conditions.
6. Design & drawing of rigid coupling (flanged type).
7. Design & drawing of a flexible coupling (pin-bush type)
8. Design & drawing of a leaf spring for an automobile.
9. Design & drawing of a helical spring for a given application
10. Product Development Design problems/exercise

I C ENGINE (EME359)

Type	L	T	P	Credits
PCC	3	0	0	3

Course Objectives: This course provides an in-depth knowledge of the functioning of IC Engine & non-conventional engines, and also deals with the combustion techniques used for various fuels, pollution testing & performance assessment etc.. This course finds immense application in automobile industry and power plants.

Prerequisite: Course on Applied Thermodynamics.

Course Outcome:
Student will be able to

CO1	Understand and use different thermodynamic cycles for performance evaluation of an engine.
CO2	Demonstrate various phenomenon in SI and CI engine
CO3	Analyze the emission performance of an engine and effectively implement various methods studied towards control of vehicle pollution
CO4	Interpret various subsystems of an engine
CO5	Understand and make innovations in engines from the pollution perspective

Syllabus:

Unit-1

Introduction to I.C Engines and thermodynamic cycles: Engine classification, Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, Sterling cycle, Ericsson cycles, Actual cycle analysis, Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, stratified charge engine.

Fuels: Fuels for SI and CI engine, Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Vegetable oils, Biodiesel, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Dopes, Additives, Alternative fuels for IC engines.

Unit–2

SI Engines: Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and it's control,combustion chamber design for SI engines; Carburetion, Mixture requirements, Carburetor types, Theory of carburetor, MPFI; Ignition system requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition.

Unit–3

CI Engine: Combustion in CI engines, Ignition delay, Knock and it's control, Combustion chamber design of CI engines; Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timings; Scavenging in 2 Stroke engines

Unit-4

Engine Cooling: Different cooling systems, Radiators and cooling fans.

Lubrication: Engine friction, Lubrication principle, Type of lubrication, Lubrication oils, Crankcase ventilation.

Supercharging: Effect of altitude on power output, Types of supercharging.

Testing and Performance: Basic measurements, Optical measurement techniques, Laser Doppler anemometry, Testing of SI and CI engines.

Unit-5

Air Pollution from IC engine: IC engine emissions, Mufflers, Silencers, EGR, Effect of pollutants, Pollution measurement, Emission control in SI and CI engines, Pollution from Gas Turbines and its control, Noise pollution and its control, Emission legislations and standards.

Textbooks:

1. A Course in International Combustion Engines, by Mathur& Sharma, DhanpatRai&Sons.
2. I.C Engine, by Ganeshan, McGraw Hill Publishers.

Reference books:

1. Fundamentals of Internal Combustion Engine by Gill,Smith,Ziurs, Oxford IBH Publ. Co.
2. IC Engines, by Rogowsky, International Book Co.
3. I.C Engine Analysis & Practice by E.F Obert.
4. I.C Engine, by R. Yadav, Central Publishing House, Allahabad
5. Internal-combustion engine in theory and practice by Taylor C.F.,Cambridge University Press.
6. Internal combustion engines : Applied Thermosciences, by Ferguson C.R., and Kirkpatrick A.T, John Wiley & Sons.

FLUID MACHINERY (EME352)

Type	L	T	P	Credits
PCC	3	0	2	4

Prerequisite: Course on Fluid Mechanics.

Course Objectives:

This course aims at developing capability to understand, mathematically model and analyze different fluid machineries and processes involved in them.

Course Outcomes:

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

CO1	Understand the hydrodynamics and capability of fluid in realizing different objectives of producing shaft work and fluid handling.
CO2	Understand different hydraulic turbines and perform related calculations for their analysis.
CO3	Carry out elementary design and analyze centrifugal pumps and different positive
CO4	Apply principles of fluid mechanics in special purpose hydraulic machines like accumulator, special duty pumps, press, lifts, cranes, couplings, torque converters and hydraulic ram.
CO5	Realize the requirements, usage and limitation of hydraulic machines for different applications.
CO6	Understand the working of hydraulic turbines, pumps and hydraulic Ram.

Course Content:

UNIT-I

Impact of jet: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat &

curve), Effect of inclination of jet with the surface.
Hydraulic Turbines: Classification of turbines, Impulse turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Governing of Pelton wheel.

UNIT-II
Reaction Turbines: Francis and Kaplan turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Degree of reaction, Draft tube, Cavitation in turbines, Principles of similarity, Unit and specific speed, Performance characteristics, Selection of water turbines.

UNIT-III
Centrifugal Pumps: Classifications of centrifugal pumps, Vector diagram, Work done by impellor, Efficiencies of centrifugal pumps, Specific speed, Model testing, Cavitation & separation and their control, Performance characteristics.

UNIT-IV
Positive Displacement Pumps: Reciprocating pump theory, Slip and coefficient of discharges, Indicator diagram, Effect and acceleration, Work saved by fitting air vessels, Comparison of centrifugal and reciprocating pumps, Positive rotary pumps, Gear and Vane pumps, Performance characteristics.

UNIT-V
Other Machines: Hydraulic accumulator, Special duty pumps, Intensifier, Hydraulic press, Lift and cranes, Theory of hydraulic coupling and torque converters, Performance characteristics.
Water Lifting Devices: Hydraulic ram, Jet pumps, Air lift pumps.

Text books:
1. Fluid Mechanics & Hydraulic Machines by R.K. Bansal
2. Hydraulic Machines by R K Rajput, S.Chand& Co. Ltd.

Reference books:
1. Hydraulic Machines: Theory & Design, V.P. Vasandhani, Khanna Pub.
2. Applied Hydraulics by Addison
3. Hydraulic Machines by D S Kumar
4. Fluid Mechanics, Fluid Machines & Hydraulics by V.P. Gupta, Alam Singh, Manish Gupta

EME352: FLUID MACHINERY LAB

Any 8 experiments out of following:

1. Impact of Jet experiment.

2. Experiment on Pelton wheel.

3. Experiment on Francis turbine.

4. Experiment on Kaplan turbine.

5. Experiment on Reciprocating pump.

6. Experiment on centrifugal pump.

7. Experiment on Hydraulic Jack/Press

8. Experiment on Hydraulic Brake

9. Experiment on Hydraulic Ram

10. Experiment/test rig such as comparison & performance of different types of pumps and turbines.

11. Experiment for measurement of drag and lift on aerofoil in wind tunnel

12. Experiment on Jet Pump

13. Experiment on Gear oil Pump

MACHINE DESIGN–II (EME354)

Type	L	T	P	Credits
PCC	3	0	2	4

Prerequisite: Fundamental knowledge of Machine Design-I, dynamics of machine, and strength of materials.

Course Objectives:

The objective of this subject is to make student understand basic mechanical components like gears, bearings etc.

Course Outcomes:

Students will be able to

CO1	Design different types of gears such as spur, helical and bevel etc.
CO2	Analyze the pressure distribution and design of sliding bearings and ball bearing.
CO3	Design of thick and thin pressure vessels.
CO4	Analysis of IC engine parts such as cylinder, piston, crank shaft.
CO5	Approach a design problem as a mini project involving decisions when there is not a unique solution.
CO6	Develop general software programme for the design of machine components.

Course Content:

UNIT 1

Spur Gears: Conjugate action, involute gears, gear cutting methods, tooth loads, strength of spear gears in bending and in wear. Dynamic loading, Gear materials, design of gears and involute splines. Gear profile corrections, AGMA and Indian standards.

UNIT II

Helical Gears: Tooth relationship, tooth proportions. Design of helical gears, crossed helical gears, AGMA and Indian standards.

Worm And Bevel Gears: Analysis of loads and stresses, power rating, efficiency. Gear standard and proportions.

Unit III

Bearing: Types of ball bearings, roller bearing, needle roller bearing, life of bearing, reliability considerations, Selection of ball, roller, tapered roller and thrust bearings,

Sliding Bearings: Hydrodynamic theory of lubrication, types of bearings, design of bearings using design charts, boundary lubrication, hydrostatic bearings, hydrodynamic thrust bearing.

Unit IV

Design of Pressure Vessel: thick cylinder, thin cylinders, cylinder heads and cover plates, safety devices and standards of high pressure vessels.

UNIT V

Engine Parts: Design of engine parts such as connecting rod, crankshaft and cylinder & piston.

Text books:

1. Machine Design by Shigley, Tata MacGrow Hill
2. Machine Design by Bhandari

Reference books:

1. Machine Design by P.C. Sharma & D.K. Agarwal.
2. Machine Design by Black and Adames
3. Design of Machine Members by Valance & Doughty.
4. Machine Design by Khurmi.
5. Practical gear Design by Dudley
6. Design Data book (PSG) for practical class.
7. Learning C language by Kanitkar
8. Machine Design by Sadhu Singh

EME354: MACHINE DESIGN-II LAB

I. Computer and Language -

Introduction to computer and languages such as C Input-output statements, control statements, if, for, while, switch statement etc., Function and its uses, Structures to make student able to write computer program in C. Preparation of library file for important design data e.g. material properties and relevant data

II. WRITING COMPUTER PROGRAM FOR CONVENTIONAL DESIGN (Any 5)

1.Program for designing circular shaft

2.Program for designing Helical gear

3.Program for designing Bevel gear

4.Program for designing Spur gear

5.Program for designing Sliding bearing

6.Application of CAD drafting package

7.Program for designing thick & thin cylindrical pressure vessels.

8.Program for design of crankshaft.

III. Design Problem as a mini project

Student will be given a real life design problem and they have to complete design of it manually, using hand-book etc, they can also take help of computer & programming, if needed.

IV. 2D& 3D modeling using drafting CAD Tool (viz. Creo 2.0)

COMPUTER AIDED DESIGN (EME356)

Type	L	T	P	Credits
PCC	3	0	0	3

Prerequisite: Basic course on computer

Course Objectives:

To introduce the student to the roles of CAD for part design and complete product development.

Course Outcomes:

Student will be able to

CO1	Understand the role of computers for design and manufacturing.
CO2	Understand basic hardwares and computer graphics for CAD.
CO3	Understand the parametric mathematical formulation for geometric transformations, curve & surface generation and 3D modeling.
CO4	Understand the fundamentals of finite element method with engineering applications.
CO5	Physically observe CAD workstations and develop the programs to generate curves and surfaces. Create 2D and 3D model of components using CREO.

Course Content:

UNIT-1

Introduction to CAD- Computer systems & hardware for CAD-Input & output devices, types of display devices- CRT, principles of raster scan and vector graphics. Scan conversions, Plotting of points, Line drawing, Computer Graphic & its standards- GKS, IGES. Computer Graphics Software & its configuration. Graphics Standard.

UNIT-2

Transformations: Homogenous coordinate system, Scaling, Translation, shear, Reflection about axis & line. Viewing 3D on 2D screen: Representation of 3D shapes, rendering of surfaces and solids, hidden lines, edges and surface removals, Shading models, Shadows, Representation scheme for colors and its mixing; *Curves*: Analytical & Parametric curves, Continuity, Hermite curves, Bezier curves, B-spline curves, NURBS.

UNIT-3

Surface generations- Hermite & Bezier, ruled, lofted, revolved and swept surfaces. Mesh based Numerical methods for integration & differential equations, Finite Difference Method. Basic Concepts of FEM: Governing equations, Stiffness matrix, Selection of approximation functions, Shape functions & its derivation. Derivation of stiffness matrix, Approaches of FEM,

UNIT-4

1-D FEM applications with one degree approximation function: Stress & strain, Heat conduction, Truss, Beam elements-1-D with 2 degree of freedom applications & problems

UNIT-5

2D Applications: 2D elements and applications: Triangular element-Constant strain triangle (CST) problems, Meshless methods. Reverse Engg & Rapidprotoyping - FDM based 3D printer, scope of 3D printing

Textbooks:
1. Computer Graphics by Hearn and Baker
2. Finite Element Method with applications in Engg. by Desai, Eldho, Shah, Pearson

Reference books:
1. CAD/CAM by Groover & Zimmers, PHI Ltd.
2. CAD/CAM: Theory &Parctice by Zeid & Sivasubramanian, TMH
3. CAD by Tai-Ram Hsu &Dipendra K Sinha, West Publ. Co.
4. Finite Element Method Dhanraj & Prabhkaran, Oxford Higher Education
5. Finite Element in Engineering by Singiresu S. Rao, Elsevier

ENERGY CONVERSION (EME360)

Type	L	T	P	Credits
PCC	2	0	2	3

Course Objectives: This course provides knowledge of the functioning of certain energy conversion systems in addition to those covered in Applied Thermodynamics course.

Prerequisite: Course on Applied Thermodynamics and I C Engines.

Course Outcomes:

Student will be able to

CO1	Explain working of different compressors and also carry out performance assessment
CO2	Explain and analyze the working of jet propulsion system and unconventional energy.
CO3	Elucidate the working of non conventional engines for further innovations
CO4	Evaluate power plants parametrically
CO5	Understand and analyze solar energy systems and non-conventional power plants
CO6	Evaluate performance of different energy conversion systems also to determine energy efficiency of various energy conversion systems

Syllabus:

Unit-1

Compressors:

Classification, Reciprocating compressors, Single and Multi stage compressors; Rotary compressors, Classification, Centrifugal compressor fundamentals, Velocity diagrams, Introduction to axial compressors, Introduction to radial flow compressors, Surging and stalling, Roots blower, Vaned compressor, Air Motors, Compressor characteristic curves.

Unit-II

Jet Propulsion: Introduction to the principles of jet propulsion, Turbojet and turboprop engines & their processes, Principle of rocket propulsion, Introduction to Rocket Engine.

Unconventional Energy Systems: Thermo-ionic converters, Thermoelectric generators, Photovoltaic generators, Magneto-hydrodynamic generators, Fuel Cells and its types.

Unit-III

Non-Conventional Engines: Dual fuel and Multifuel engines, Stratified charge engine, Free piston engine, Stirling engine, Wankel rotary engine.
Exergy analysis: Exergy analysis of energy conversion systems – systems based on gas turbine, steam turbine.

Unit-IV
Basics of Power Plants: Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant units.

Unit-V
Solar Energy : Solar Radiation, Solar Constant, Basic SunEarth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation,Principle of Conversion of Solar Radiation into Heat, Solar thermal collectors, Heliostats
Non Conventional Power Plants : Introduction to non-conventional power plants namely Solar, Wind, Geothermal, Tidal, Fuel cell based power plants etc.

Textbooks:
1. Basic and Applied Thermodynamics by P.K. Nag, Tata McGraw Hill
2. Solar Energy by S. P. Sukhatme, Tata McGraw Hill Publishing Company Ltd.
3. Thermal Turbomachines by Onkar Singh, New Age International (P) Publishers Ltd.
4. Power Plant Engineering by P K Nag, Tata McGraw Hill
5. Applied Thermodynamics by Onkar Singh, New Age International (P) Publishers Ltd.
6. Non-Conventional Energy Sources by, G D. Rai, Khanna Publishers, New Delhi

Reference books:
1 Power Plant Engineering by R.Yadav, CPH Allahabad
2. Gas turbine Theory & Practice, by Cohen & Rogers, Addison Weslay Long man
3. Reciprocating and Rotary Compressors, by Chlumsky, SNTI Pub., Czechoslovakia
4. Turbines, Compressors and Fans, by S.M.Yahya, Tata McGraw Hill Pub.
5. Solar Energy - "Fundamentals Design, Modelling & Applications", by G. N. Tiwari, Narosa Publishing House

ENERGY CONVERSION LAB
Course Objectives: It aims to provide in depth understanding of functioning of different energy conversion systems through study / experiment on such systems.
Any 8-10 experiments out of the following:
1. Determination of Indicated H.P. of I.C. Engine by Morse Test and Energy Balance Sheet preparation.
2. Determination of ihp, bhp, mechanical efficiency and heat balance of a Diesel Engine.
3. Determination of volumetric efficiency and draw indicator (P-V) diagram of reciprocating compressor
4. To draw the valve timing diagram of a four stroke diesel engine.
5. Dismantling and assembling of carburettor and its study.
6. Study of different types of fuel injection systems.
7. To study and determine the effect of A/F ratio on the performance of a Petrol engine.
8. Study of Fire Tube and Water Tube boiler models.
9. Study of Impulse and Reaction turbine models.
10. Study of Steam Engine models.
11. Study of Gas Turbine Model

12. Study of mini steam power plant and experimentation
13. Determination of calorific value of fuels.

MEASUREMENTS (EME358)

Type	L	T	P	Credits
PCC	2	0	2	3

Prerequisite: Basic knowledge of Engineering physics, Engg. Thermodynamics etc.

Course Objectives:

The objective of the subject is to know the fundamentals of measurement, measuring instruments and controls.

Course Outcomes:

Students will be able to

CO1	Estimate errors and uncertainty in measurements.
CO2	Understand working principles in the measurement of field quantities.
CO3	Identify sensors for measurement of force, pressure, vibration, and surface temperatures.
CO4	Understand the conceptual development of zero, first and second order systems.
CO5	Understanding the control systems and development of system transfer function.
CO6	Understand working principles in the measurement.

Course Content:

Unit I

Measurement: basic definitions- accuracy, precision, repeatability, reproducibility, reliability, maintainability, sensitivity, span, zero drift, ageing etc.; Measurement system-basic components, types of measurement direct & indirect active and passive transducers, digital and analog systems, null and deflection type devices; Transducers- mechanical and electrical transducers, basic requirements for transducers; Calibration- steps in calibration; Standards -primary, secondary, reference and working standards; Errors: types of errors-application v/s operational errors, dynamic error, environmental error, absolute v/s relative errors, random errors, uncertainty and bias.

Unit II

Measurement of displacement, force and torque, Measurement of pressure and temperature, Measurement of fluids flow Study of working of Bourdon tube pressure gauge, LVDT, Cathode Ray Oscilloscope.

Unit III

Electrical strain gauges-working principle, materials, transverse sensitivity, Wheatstone bridges full, half, and quarter bridge circuits, strain rosette; Optical methods in measurement: Laser Beam as light pointer, length and displacement measurement, Laser Doppler anemometer, Temperature sensor.

UNIT IV

Coordinate measuring machine (CMM): Need, constructional features and types, Metrology and Inspection: Standards of linear measurement, line and end standards. Interchange ability and standardization. Linear and angular measurements devices and systems Comparators: Sigma, Johansson's Microkrator. Limit gauges classification, Taylor's Principle of Gauge Design.

UNIT V

Limits, Fits &Tolerance and Surface roughness: Introduction to Limits, Fits, Tolerances and IS standards, Limit-gauges, and surface-roughness. Measurement of geometric forms like straightness, flatness, roundness. Toolmakers microscope, profile projector, autocollimator. Interferometry: principle and use of interferometry, optical flat. Measurement of screw threads and gears. Surface texture: quantitative evaluation of surface roughness and its measurement.

Textbooks:

1. Instrumentation by Sarma, Rangam & Mani
2. Engineering Control System by K. Ogata
3. Metrology of Measurements by Bewoor and Kulkarni, MCGRAW HILL INDIA
4. Hume KJ, "Engineering Metrology", MacDonald and Co
5. Jain, RK, "Engineering Metrology" Khanna Publishers

Reference books:

1. Mechanical Measurements- System and Design by E O Deobelin
2. Mechanical Measurement by Buck & Beckwith
3. Control System Engineering by Nagrath & Gopal
4. Jain, R.K., "Mechanical Measurement" Khanna Publishers
5. Gupta SC, Engineering Metrology, Dhanpat Rai Publications

EME358: MEASUREMENTAND METROLOGY LAB

Any 8 experiments out of followings:

1. To measure the taper of a given shaft.
2. To measure the pitch diameter of a screw thread by a 3-wire method.
3. To measure the thread angle of screw by three wire method.
4. To measure the dimensions of a gear tooth using vernier calipers.
5. Study of slip gauges.
6. Study of limit gauges.
7. To measure out of roundness of a shaft.
8. To perform the concentricity test on a spur gear.
9. To calibrate a dial gage.
10. To study and use of autocollimator.
11. To determine the speed of pedestal fan using stroboscope.
12. To calibrate and measure temperature using Thermocouple.

POWER PLANT ENGINEERING (EME362)

Type	L	T	P	Credits
PCC	2	0	0	2

Course Objectives: This course aims at developing the understanding of different power plants and carry out their requirements, design, analysis, performance evaluation and economic studies.

Prerequisite: Course on Applied Thermodynamics

Course Outcomes:

Students will be able to

CO1	Understand the requirements of different power plant options and their relative merits and demerits
CO2	Design and analyze different conventional and non-conventional power plants from energy perspective
CO3	Visualize the environmental impact of different power plants and find suitable solutions to such problems
CO4	Carry out power plant calculations in light of prevailing energy regulations
CO5	Perform economic studies of different power plants and compare them on the basis of technology, environment impact and cost

Syllabus:

Unit-I

Power plant economics and selection: Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.

Unit-II

Steam power plant: General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.

Unit-III

Diesel power plant : General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant.

Gas turbine power plant: Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant

Unit-IV

Nuclear power plant: Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants.

Hydro electric station
Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems.

Unit-V
Electrical system : Generators and generator cooling, transformers and their cooling, bus bar,etc. Instrumentation Purpose, classification, selection and application, recorders and their use, listing of various control rooms.
Pollution: Pollution due to power generation

Textbooks:
1. Power Plant Engineering by P.K. Nag, Tata McGraw Hill.
2. Steam & Gas Turbines & Power Plant Engineering by R.Yadav, Central Pub.House.
Reference books:
1. Power Plant Engineering by F.T. Morse, Affiliated East-West Press Pvt. Ltd, New Delhi/Madras.
3. Power Plant Technology by El-Vakil, McGraw Hill.
4. Theory and Practice of Heat Engine by D. A. Rangham, Camb. Univ. Press

Detailed Syllabus

4th Year

REFRIGERATION & AIR CONDITIONING (EME451)

Type	L	T	P	Credits
PCC	3	0	2	4

Prerequisite: Course on Engineering Thermodynamics

Course Objectives:

This course aims to develop the understanding of different methods of refrigeration and air conditioning along with their design and analysis for different applications of cooling, heating, ventilation and air conditioning.

Course Outcomes:

After completion of this course, students will have ability to

CO1	Demonstrate an understanding of the need and importance of refrigeration and air conditioning.
CO2	Design and analyze different refrigeration systems as per need.
CO3	Design and analyze air conditioning for human comfort conditions with respect to temperature and humidity along with its impact on human comfort, productivity, and health.
CO4	Understand psychometrics and its application in HVAC engineering and carry out design along with performing psychometric measurements.
CO5	Understand and analyze contemporary issues of ozone depletion, global warming and other environmental adversities created by refrigeration and air conditioning systems to evolve environment friendly systems.
CO6	Understand and analyze different refrigeration cycles and systems used for it.

Course Content:

Unit-1

Refrigeration:

Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect & C.O.P.

Air Refrigeration cycle:

Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART).

Unit-2

Vapour Compression System:

Single stage system, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration cycle, Multistage vapour compression system requirement, Removal of flash gas, Intercooling, Different configuration of multistage system, Cascade system.

Unit-3

Vapour Absorption system:

Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature –concentration diagram & Enthalpy – concentration diagram, Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison.

Refrigerants:

Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common

refrigerants, Secondary refrigerants and CFC free refrigerants, Environmental impact of refrigerants.

Unit-4

Air Conditioning:

Introduction to air conditioning, Psychometric properties and their definitions, Psychometric chart, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP).

Unit-5

Refrigeration Equipment & Application:

Elementary knowledge of refrigeration & air conditioning equipments e.g compressors, condensers, evaporators & expansion devices, Air washers, Cooling, towers & humidifying efficiency, Food preservation, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning, Thermoelectric effects.

Textbooks:

1. Refrigeration and Air conditioning, by Manohar Prasad, New Age Intnl. (P) Ltd. Pub.
3. Refrigeration and Air conditioning by Arora & Domkundwar.

Reference books:

1. Refrigeration and Air conditioning by C.P Arora.
2. Refrigeration and Air conditioning by Stoecker& Jones.
3. Refrigeration and Air conditioning by Roy J. Dossat.
4. Thermal Environment Engg. byKuhen, Ramsey &Thelked.
5. Refrigeration and Air conditioning by R.C. Arora, PHI

EME451: REFRIGERATION & AIR CONDITIONING LAB

Any 8 experiments out of following:

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. To study different types of expansion devices used in refrigeration system.
3. To study different types of evaporators used in refrigeration systems.
4. To study different types of condensers.
5. To study basic components of air-conditioning system.
6. Experiment on air-conditioning test rig & calculation of various performance parameters.
7. To study air washers
8. Study of window air conditioner.
9. Experiment on Ice-plant.
10. Study of Hermetically sealed compressor.
11. Experiment on Desert coolers.

VISIT : Visit of a central air conditioning plant / cold-storage and its detailed study or a minor project related to any topic on course of Refrigeration and air conditioning.

COMPUTER AIDED MANUFACTURING (EME453)

Type	L	T	P	Credits
PCC	3	0	0	3

Prerequisite: Course of Manufacturing Science

Course Objectives:

The course aims at understanding functions and features of Machines, Concept of Machine control, robot application and programming. It also aims to understand basic Introduction of Artificial Intelligence.

Course Outcomes:

After going through this course a student will be able to:

CO1	Identify and explain features of NC Machines
CO2	Write programs to manufacture components on machines.
CO3	Handle various NC system devices
CO4	Understand Robotics and its applications.
CO5	Use the knowledge of group technology and concept of Mechatronics

Course Content:

Unit 1

Introduction: Introduction to Automation. Need and future of NC systems and CAM. Advantages & disadvantages. Historical development and future trends.

Features of NC Machines: Difference between ordinary and NC machine tools. Methods for improving Accuracy and Productivity. Direct numerical control (DNC) and computer numerical control (CNC), adaptive control of manufacturing processes, Motion control in NC machine, designation of NC axes.

Unit 2

NC Part Programming

(a) Manual (word address format) programming, Preparatory codes, Miscellaneous codes, Examples: Turning, Drilling and Milling.

(b) APT programming. Geometry, Motion and Additional statements, Macro- statement.

Unit 3

System Devices- Introduction to DC motors, stepping motors, feedback devices such as encoder, counting devices, digital to analog converter and vice versa; **Interpolators -** Principle, Digital Differential Analyzers. Linear interpolator, circulator Interpolator; **Control of NC Systems-** Open and closed loops. Automatic control of closed loops with encoder & tachometers, Speed variation of DC motor. Adaptive control.

Unit 4

Computer Integrated Manufacturing system- Introduction to Group Technology, Manufacturing cell, Transfer lines, FMS, CIM, CAD/CAM, CAPP, Concept of Mechatronics & MEMS.

Unit 5

Robotics- NC machine vs Robots. Types and generations of Robots. Robot applications.
Economics, Robot programming methods.VAL and AML with examples.

Intelligent Manufacturing: Introduction to Artificial Intelligence for Intelligent manufacturing.

Textbooks:

1. CAD/CAM by M.P.Groover and E.W. Zimmer.
2. NC Machines by Koren

Reference books:

1. Computer control of manufacturing systems by Koren
2. NC Machine Tools by S.J. Martin.
3. CAD/CAM Principles and applications by P.N. Rao
4. Automation, Production System and Computer Integrated Manufacturing, M P Groover, PHI

INDUSTRIAL TRAINING (EME461)

Type	L	T	P	Credits
	0	0	2	1

Prerequisite: Basic knowledge of programme core courses

Course Objectives:

The main objectives of the industrial training are:-

CO1	To give students the opportunity to apply the acquired knowledge and skills in development of a real-life project.
CO2	To provide students with an opportunity of practical and hands-on learning from practitioners in the students' field of study.
CO3	To provide the students the exposure of the work environment, common practices, employment opportunities and work ethics in the relevant field of study.
CO4	To inculcate presentation and soft skills relevant to the needs of employers.
CO5	To provide an opportunity of offered jobs in the organization where they undergo Industrial Training.

Course Content:

To visit factory and learn design, assembly of machines and manufacturing of product.
As a part of academic curriculum, students undergo industrial training/internship of 4-6 weeks after completion of III year B. Tech. program during summer vacations.

SEMINAR (EME471)

Type	L	T	P	Credits
Seminar	0	0	2	1

To learn latest techniques and advancement about a particular subject and write a report.

Course Outcomes:

CO1	Improve their knowledge and skills to give presentation.
CO2	Relate the knowledge thus acquired to their on-campus studies.
CO3	Gain insight to different topics related to Mechanical Engineering.

Course Content:

1. Seminar provides students the opportunity to give presentation of the state of art technology applied in the area of their respective chosen Topic of Seminar.

PROJECT (EME497)

Type	L	T	P	Credits
Project	0	0	8	4

Prerequisite: Basic knowledge of programme core courses

Course Objectives:

To learn about machine component, material selection, Design and assembly of a machine or prototype.

Course Outcomes:

CO1	Show preparedness to work independently on real time problem scenarios to be addressed using knowledge of fundamentals & techniques in the area of Mechanical Engineering.
CO2	Use the innovative ideas and thoughts to address real life issues and provide efficient solutions for Industry oriented works.

Course Content:

The practical implementation of theoretical knowledge gained during the B.Tech. programme.

Students are required to implement their original ideas, modification/enhancement of the existing mechanical engineering techniques, real time industrial problems, and current applications of their courses of study. Projects work can be of two types: Projects based on implementation of any industry oriented problem which will be more or less experimental in nature and the others will be based on some innovative/ theoretical work.

The project work may be carried out in two modes:

1. **In-house Project:** The project work assigned by some Faculty member of the department which will have to be carried out during VIIth and VIIIth semester alogwith regular course of study.
2. **Industrial Project:** Student will work on a problem assigned by some industry under the guidance and supervision of some industrial practitioner and one Faculty supervisor. The first phase of the work will be completed during VIIth semester in the department alongwith the regular course of study. But, the design & implementation work will be done in the respective industry itself during the VIIIth semester.

EME-455 to 463 **PROGRAMME ELECTIVE I** **[3-0-0]**

MECHANICAL VIBRATION (EME455)

Type	L	T	P	Credits
PEC	3	0	0	3

Prerequisite: Basic science and dynamics of machines

Course Objectives:
To provide theoretical knowledge to the concepts of causes and effects of vibration in mechanical systems.

Course Outcomes:
Students will be able to

CO1	Understand the basic concepts of vibrations.
CO2	Develop analyze the one degree to multi-degree of freedom vibration problems.
CO3	Understand the vibration control mechanisms and systems.
CO4	Practice the numerical techniques used for solving the vibrational models of mechanical systems.
CO5	Understanding of the critical speed of shaft under vibration.

Course Content:

UNIT- I
INTRODUCTION: Periodic motion, harmonic motion, superposition of simple harmonic motions, beats, fourier analysis; **Single Degree Freedom System:** Free vibration, Natural frequency, Equivalent Systems, Energy method for determining natural frequency, Response to an initial disturbance, Torsional vibrations, Damped vibrations, Damping models – Structural, Coulomb and Viscous damping, Vibrations of system with viscous damping, Logarithmic decrement, Viscous dampers.

UNIT- II
Single Degree Freedom: Forced Vibration
Forced vibration, Harmonic Excitation with viscous damping, Steady state vibrations, Forced vibrations with rotating and reciprocating unbalance, Support excitation, Vibration isolation, Transmissibility, Vibration measuring instruments- Displacement, Velocity, Acceleration and Frequency measuring instrument.

UNIT- III
Two Degree Freedom System: Introduction, Principal modes, Double pendulum, Torsional system with damping, Coupled System, Undamped dynamic, vibration absorbers, Centrifugal pendulum absorber, Dry friction damper, Untuned viscous damper.

UNIT- IV
Multi-degree Freedom System: Exact Analysis
Undamped free and forced vibrations of multidegree system, Influence numbers, Reciprocal Theorem, Torsional vibration of multi rotor system, Vibration of geared system, Principal coordinates, Continuous systems- Longitudinal vibration of bars, Torsional vibrations of Circular shafts, Lateral vibration of beams.

UNIT- V
Multi-degree Freedom System: Numerical Analysis

Rayleigh's, Dunkerley's, Holzer's and Stodola's methods, Rayleigh – Ritz method.

Critical Speed of Shafts:

Shafts with one disc with and without damping, Multi-disc shafts, Secondary critical speed.

Textbooks::

1. Mechanical Vibrations by Rao S.S., Addison-Wesley
2. Mechanical Vibrations by Grover, G.K., Nem Chand Publishers, Roorkee

Reference books:

1. Mechanical Vibrations by Church A.H.
2. Vibration Theory and Applicationos by Thomson, W.T., Prentice Hall
3. Mechanical Vibrations by Tse, Morse and Hinkle, Prentice-Hall.

INDUSTRIAL ENGINEERING (EME457)

Type	L	T	P	Credits
PEC	3	0	0	3

Prerequisite: Course on Manufacturing Science.

Course Objective:

The course considers Industrial productive concepts and measurements. Principles of economy production planning and control. It introduces Industrial review technique.

Course Outcomes:

After completion of the course a students will be able to:

CO1	Analyze and explain productivity concepts and measurements
CO2	Explain various Industrial Layout and time study
CO3	Exhibit skills towards program evaluation and review technique
CO4	Understand the concept of PERT ,CPM and scheduling with resource constraint.
CO5	Analyze and perform Break even analysis.

Course Content:

Unit 1

Introduction, engineering economy and costing , cost analysis, methods of depreciation, productivity concepts and measurements, job evaluation , methods of job evaluation, merit rating , wage incentive plan , types of wage incentive plans.

Unit 2

Work measurement, time study ,pre determined motion and time study (PMTS), work sampling, method study , micro motion study , principles of motion economy.

Unit 3

Plant location, Types of Layout, Principles of Facility Layout, Objective Functions, Steps in PPC, Planning, Routing, Scheduling, Loading, Dispatching, Effectiveness of PPC.

Unit 4

PERT, CPM, Resource Allocation and GERT- Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) , Scheduling with Resource Constraints.

Unit 5

Break Even Analysis: Introduction, Assumption of BEA, Purpose, Fixed and variable costs, margin of safety, profit volume graph ; Replacement analysis; Depreciation causes, obsolescence, service life of assets, Replacement of items.

Textbooks:

1. Industrial Engineering by M.S. Mahajan, DhanpatRai and Co. (P) Ltd.
2. Introduction to Industrial System Engineering by Turner w.c. et Al 1993,

Reference books:

1. Motion and Time Study , Design and Measurement of Work by Ralph M. Barnes, Wiley Publishers
2. Project Management for Business and Technology by John M Nicholas, PHI

ADDITIVE MANUFACTURING (EME459)

Type	L	T	P	Credits
PEC	3	0	0	3

Prerequisite: Manufacturing and Material science

Course Outcome: Student will be able to	
CO 1	Understanding the basics of additive manufacturing/rapid prototyping and its advantages and disadvantages
CO 2	Understanding the role of additive manufacturing in the design process and the implications for design.
CO 3	Understanding the processes used in additive manufacturing for a range of materials and applications
CO 4	Understand the various software tools, processes and techniques that enable advanced/additive manufacturing and personal fabrication.
CO 5	Apply knowledge of additive manufacturing for various real-life applications

COURSE CONTENT:

UNIT I

Introduction

History and Advantages of Additive Manufacturing, Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines, Direct and Indirect Processes; Prototyping, Manufacturing and Tooling.

Layer Manufacturing Processes: Polymerization, Sintering and Melting, Extrusion, Powder Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosol printing and Bio plotter.

UNIT II

Development of Additive Manufacturing Technology

Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems. Generalized Additive Manufacturing Process Chain; The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design of AM.

UNIT III

Additive Manufacturing Processes

Vat Photo polymerization; Materials, Reaction Rates, Photo polymerization Process Modelling, Scan Patterns

Powder Bed Fusion Processes; Material, Powder Fusion Mechanism, Process Parameters and Modeling, powder Handling

Extrusion Based System; Basic principles, plotting and Path Control, Other Systems

Material Jetting; Materials, Material Processing Fundamentals, Material Jetting Machines

Directed Energy Deposition Processes; General DED Process Description, Material Delivery, DED systems, Process Parameters, Processing Structure Properties Relationships

UNIT IV: Design & Software Issues

Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AM based New Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM.

Software Issue for Additive Manufacturing; Introduction, Preparation of CAD Models: The STL file, Problem with STL file, STL files Manipulation, Beyond the STL file, Additional Software to Assist AM

UNIT V

Material Design & Quality Aspects

Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes, Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities

Applications

Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewellery, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others.

Books and References:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, by Ian Gibson , DSavid W. Rosen , Brent Stucker, Springer.
2. Understanding Additive Manufacturing, by Andreas Gebhardt, Hanser.
3. Additive Manufacturing, by- AmitBandyopadhyay, Susmita Bose, CRC Press.
4. Rapid Prototyping: Principles and Applications, by Chee Kai Chua, Kah Fai Leong, Chu Sing Lim

ROBOTICS (EME463)

Type	L	T	P	Credits
PEC	3	0	0	3

Course Objectives:

Student will be able to

CO1	Develop the understanding of the various terminology associated with robotic system.
CO2	Develop the understanding of end effectors and robot controls
CO3	Develop the understanding of coordinate system, robot Transformations and sensors
CO4	Robot cell design and applications
CO5	Micro/Nano robotic systems

UNIT I

INTRODUCTION

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics, Accuracy and repeatability of Robotics-Simple problems-Specifications of Robot Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems-Hydraulic, Pneumatic and Electric system.

UNIT II

END EFFECTORS AND ROBOT CONTROLS

Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control.

UNIT III

ROBOT TRANSFORMATIONS AND SENSORS

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors – Robotic vision sensor-Force sensor-Light sensors, Pressure sensors.

UNIT IV

ROBOT CELL DESIGN AND APPLICATIONS

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions-Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and undersea robot.

UNIT V

MICRO/NANO ROBOTICS SYSTEM

Micro/Nanorobotics system overview-Scaling effect-Top down and bottom up approach- Actuators of Micro/Nano robotics system-Nanorobot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot-Nanorobot in targeted drug delivery system.

Books:

1. S.K. Saha, Introduction to Robotics, Tata McGraw-Hill
2. Deb .S.R, “Robotics Technology and flexible automation”, Tata McGraw-Hill Education, 2009
3. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, “Technology Programming and Applications”, McGraw Hill, 2012.

EME465 to 473 **PROGRAMME ELECTIVE II** **3[3-0-0]**

WELDING PROCESSES (EME465)

Type	L	T	P	Credits
PEC	3	0	0	3

Prerequisite: Course on Manufacturing Science.

Course Objective:

The course considers the different welding processes and design of weld joints.

Course Outcomes:

After completion of the course a students will be able to:

CO1	Ability to understand the concept of welding process and basic characteristics of power sources.
CO2	To undertand the different various welding processe.
CO3	To create the heat flow welding and design using Heat Affected Zone (HAZ) and thermal cycles.
CO4	To understand the concept of repair & maintenance of welding.
CO5	To understand the types of welds & joints, joint Design, welding Symbol etc.

Course Content:

UNIT-I

Introduction: Welding as compared with other fabrication processes, Importance and application of welding, classification of welding processes, Health & safety measures in welding.

Welding Power Sources: Physics of welding Arc**,** Basic characteristics of power sources for various arc welding processes, Transformer, rectifier and generators.

UNIT-II

Welding Processes: Manual Metal Arc Welding (MMAW), TIG, MIG, Plasma Arc, Submerged Arc Welding, Electrogas and Electroslag, Flux Cored Arc Welding, Resistance welding, Friction welding, Brazing, Soldering and Braze welding processes, Laser beam welding, Electron beam welding, Ultrasonic welding, Explosive welding, Friction Stir Welding, Underwater welding & Microwave welding.

UNIT-III

Heat Flow Welding: Calculation of peak temperature; Width of Heat Affected Zone (HAZ); cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.

UNIT-IV

Repair & Maintenance Welding: Hardfacing, Cladding, Surfacing, Metallizing processes and Reclamation welding.

Weldability: Effects of alloying elements on weld ability, welding of plain carbon steel, Cast Iron and aluminium. Micro & Macro structures in welding.

UNIT-V

Weld Design : Types of welds & joints, Joint Design, Welding Symbols, weld defects, Inspection/testing of welds, Introduction to Welding Procedure Specification & Procedure

Qualification Record.

Books and References:

1. Welding and Welding Technology, by- Richard L. Little, McGraw Hill Education.
2. Welding Principals and Practices, by- Edwars R. Bohnart, McGraw Hill Education.
3. Welding Engineering and Technology, by- R. S. Parmar, Khanna Publishsers.
4. Welding Handbooks (Vol. I & II).

MECHATRONICS (EME467)

Type	L	T	P	Credits
PEC	3	0	0	3

Prerequisite: Basic science courses

Course Outcome: Student will be able to:

CO1	Identify key elements of mechatronics and its representation by block diagram.
CO2	Understand the concept of sensors and use of interfacing systems.
CO3	Understand the concept and applications of different actuators
CO4	Illustrate various applications of mechatronic systems.
CO5	Develop PLC ladder programming and implementation in real life problem.

Course Content:

Unit I

Introduction: Integrated Mixed Systems. Integration of Mechanical Engineering, Electronics &Control Engg. And Computer Science.

Unit II

Dynamic Systems Modeling and Simulation: Equations of motion, transforming, physical model to Math. Model, linearization, Frequency response.

Unit III

Control Systems: Performance specifications, Transfer functions, Stability, Controller types and their design using frequency domain and Laplace domain method, PID control. Digital Control, z-transforms, problems in analogue to digital conversion-Nyquist frequency, Digital controller design.

Unit IV

Sensors and Actuators: Temperature-Sensing Thermocouples, Stress, Strain and Force measurements using strain gauges, Piezoelectric strain sensors and Accelerometers. Analog / Digital Position Measurements, Velocity Measureme nts. Direct Current Motors, Stepper Motors, Piezoelectric Actuators.

Unit V

Electronics: AD and DA converters, Op Amps, Microprocessors, Digital signal processing, Logic Circuit Devices, Gates- AND, OR, NAND etc. and combinations. Study of Some Mechatronics Devices: Hard disk drive, dot matrix printer, optical sensing and control mechanism in NC machine tools etc.

Books:

1. Mechartonics by Hindustan Machine Tools Ltd., McGraw Hill Education
2. Mechartonics Principles, Concepts and Applications by N.P.Mahalik, McGraw Hill Education
3. Introduction to Mechatronics and Measurement Systems by Alciatore David G.and Histand Michael B., McGraw Hill Education

NON-CONVENTIONAL ENERGY RESOURCES & UTILIZATION (EME469)

Type	L	T	P	Credits
PEC	3	0	0	3

Prerequisite: Basic science courses

Course Objectives:

This course considers the background of depleting fossil fuel reserves and lays emphasis on the utilization of alternative energy sources for meeting varying requirements and ensure sustainable development while assessing the impact of both conventional and non-conventional sources of energy on civilization.

Course Outcomes:

Student will be able to

CO1	Understand effect of fossil fuels on global warming and their relative impact on the environment.
CO2	Comprehend the energy scenario of world in general and India in particular along with assessment of potential of alternative sources of energy.
CO3	Design, analyze and develop theoretical framework for use of alternative sources of energy for different applications.
CO4	Evaluate the performance of the various non-conventional and renewable energy sources.
CO5	Understand and analyze recent advancements in energy generations like magneto hydro dynamic power generation, fuel cell technology, hydrogen energy etc. and develop energy management skills.

Course Content:

UNIT-1

Energy resources and their utilization:

Indian and global energy sources, Energy exploited, Energy planning, Energy parameters (energy intensity, energy-GDP elasticity), Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation.

Solar radiations:

Extra terrestrial radiation, Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations, Solar radiation geometry, Flux on a plane surface, Latitude, Declination angle, Surface azimuth angle, Hour angle, Zenith angle, Solar altitude angle expression for angle between incident beam and the normal to a plane surface (no derivation), Local apparent time, Apparent motion of sun, Day length, Solar radiation data for India.

UNIT-2

Solar energy:

Solar thermal power and it's conversion, Solar collectors, Flat plate, Performance analysis of flat plate collector, Solar concentrating collectors, Types of concentrating collectors,Thermodynamic limits to concentration, Cylindrical collectors, Thermal analysis of solar collectors, Tracking CPC and solar swing .

Solar thermal energy storage, Different systems, Solar pond.

Applications, Water heating, Space heating & cooling, Solar distillation, solar pumping, solar cooking, Greenhouses, Solar power plants.

Solar photovoltaic system:

Photovoltaic effect, Efficiency of solar cells, Semiconductor materials for solar cells, Solar photovoltaic system, Standards of solar photovoltaic system, Applications of PV system, PV hybrid system.

UNIT-3

Biogas:

Photosynthesis, Bio gas production Aerobic and anaerobic bio-conversion process, Raw materials, Properties of bio gas, Producer gas, Transportation of bio gas, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production, Bio gas applications, Biomass conversion techniques, Biomass gasification, Energy recovery from urban waste, Power generation from liquid waste, Biomass cogeneration, Energy plantation, Fuel properties, Biomass resource development in India.

Wind energy:

Properties of wind, Availability of wind energy in India, wind velocity, Wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Wind energy farms, Economic issues, Recent development.

UNIT-4

Electrochemical effects and fuel cells:

Principle of operation of an acidic fuel cell, Reusable cells, Ideal fuel cells, Other types of fuel cells, Comparison between acidic and alkaline hydrogen-oxygen fuel cells, Efficiency and EMF of fuel cells, Operating characteristics of fuel cells, Advantages of fuel cell power plants, Future potential of fuel cells.

Tidal power:

Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy Limitations of tidal energy conversion systems.

Hydrogen Energy:

Properties of hydrogen in respect of its use as source of renewable energy, Sources of hydrogen, Production of hydrogen, Storage and transportation, Problems with hydrogen as fuel, Development of hydrogen cartridge, Economics of hydrogen fuel and its use.

UNIT-5

Thermoelectric systems:

Kelvin relations, power generation, Properties of thermoelectric materials, Fusion Plasma generators.

Geothermal energy:

Structure of earth's interior, Geothermal sites, earthquakes & volcanoes, Geothermal resources, Hot springs, Steam ejection, Principal of working, Types of geothermal station with schematic representation, Site selection for geothermal power plants. Advanced concepts, Problems associated with geothermal conversion.

Ocean energy:

Principle of ocean thermal energy conversion, Wave energy conversion machines, Power plants based on ocean energy, Problems associated with ocean thermal energy conversion systems,
Thermoelectric OTEC, Developments of OTEC, Economics .
Impact of renewable energy generation on environment, Kyoto Protocol, Cost of electricity production from different energy sources, Energy options for Indian economy.

Books / Reference:

Bansal Keemann, Meliss," Renewable energy sources and conversion technology", Tata McGraw Hill.
Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd.
Rai G.D, "Non-Conventional energy Sources", Khanna Publishers.
Ashok V. Desai, "Nonconventional Energy", New Age International Publishers Ltd

ENGINEERING MATERIALS (EME473)

Type	L	T	P	Credits
PEC	3	1	0	3

Course Objectives:

The objective of the subject is to know the fundamental science and engineering principles relevant to materials. To understand the structure, properties, processing and performance of the principal classes of materials

Course Outcomes:

Student will be able to

CO1	Ability to understand the difeerent type of engineering materials.
CO2	Ability to understand the types of engineering metals and alloys
CO3	Ability to understand the structure of ceramics and polymers.
CO4	Ability to understand the classification composite materials.
CO5	Ability to understand the applications advanced materials.

Course Content:

Unit I

Introduction to materials, types of materials – metals, ceramics, polymers, composites, semiconductors, biomaterials. Structure-Property-Processing Relationship.

Mechanical testing and properties – Tensile test, Impact test, Fatigue test, Creep test, Hardness test, etc. Physical properties – electrical, magnetic, optical and thermal properties.

Unit II

Engineering materials- Metals and alloys: Ferrous and Non- ferrous alloys. Classification of Iron and Steel, Plain Carbon Steel, Alloy Steel, Cast Iron.

Non-Ferrous Alloys: Al alloys, Mg alloys, Be alloys, Cu alloys, Ni & Co alloys and Ti alloys.

Unit III

Ceramic material, Crystalline and non-crystalline struc ture, Application and properties of ceramics, Processing of ceramics.

Polymers: Structure of polymers, Degree of polymerization, Structure and properties of thermoplastics, thermosets and elastomers (rubbers), Additives to polymers. Processing of Polymers.

Unit IV

Composite Materials: Importance, Classification of composites - Particulate reinforced, Fibre reinforced composites, Composite Laminates, Sandwich and Honeycomb structures, Wood composites, Concrete, Degradation and failure of materials, Scope of recycling.

Unit V

Advanced Engineering materials: Materials for high temperature applications, Functionally graded materials, Concept of Smart and Intelligent materials.

Reference Books:

1.Engineering Materials Vol. I & II by Ashby & Jones, Pergemon Press
2.The Science & Engg. of Materials by Donald R Askeland PWS Engg.
3.W.Callister D. Jr., Material Science & Engineering, Addison-Wesley Pub. Co

EME452 to 460 **PROGRAMME ELECTIVE III** **4[3-1-0]**

UNCONVENTIONAL MANUFACTURING (EME452)

Type	L	T	P	Credits
PEC	3	1	0	4

Prerequisite: Course on Advance manufacturing processes.

Course Objectives:

This course aims at develop understanding about various non-contact type metal removal processes where tool is softer than the workpiece. It also aims at understanding material removal through various energies such as mechanical, thermal and chemical.

Course Outcomes:

After completion of the course a student will be able to:

CO1	Understand the process capability of unconventional manufacturing process.
CO2	Understand various non-conventional manufacturing processes.
CO3	To understand thermal energy based non-conventional machining process.
CO4	To understand chemical based non-conventional machining process and its application.
CO5	To understand advanced forming processes and its application.

Course Content:

Unit-I

Introduction: Limitations of conventional manufacturing processes, need of unconventional manufacturing processes & its classification, applications.

Unit II

Mechanical Processes: Principle, working, analysis and applications of unconventional machining process such as Ultrasonic machining, Abrasive jet machining, Abrasive waterjet flow machining, Magnetic abrasive finishing, Abrasive flow finishing, Waterjet machining.

Unit - III

Thermal Energy based processes: Principle, working and application of unconventional machining processes such as Electrical Discharge Machining, Plasma Arc Machining, Laser beam machining, Electron beam machining.

Unit IV

Chemical based process: Electrochemical machining and allied processes, Chemical machining, Hybrid machining, ProCAM, ECDM, EDDG etc., Introduction to micro-manufacturing. Unconventional welding processes: Explosive welding, Cladding etc, under water welding, Metalizing, Plasma arc welding/cutting etc.,

Unit V

Unconventional Forming Processes : Principle, working and application of High energy forming processes such as Explosive Forming, Electromagnetic forming, Electro-discharge forming, water hammer forming, explosive compaction etc.

Text books:

1 Advanced Machining Processes by V.K. Jain

2 Modern Machining Processes by P.C. Pandey

Reference books:

1. Introduction to Advance Manufacturing Process by Gary F. Benedict.

FINITE ELEMENT METHOD (EME454)

Type	L	T	P	Credits
PEC	3	1	0	4

Prerequisite: Strength of Material

Course Objectives:

To provide the theoretical and practical knowledge of the finite element based modeling and analysis for the mechanical systems.

Course Outcomes:

Students will be able to

CO1	To get the historical mathematical background of FEM and application of advanced computers for this.
CO2	Apply finite element method to solve problems in solid mechanics, heat transfer and fluid mechanics. Apply the FEM for two dimensional problems.
CO3	Develop the codes using MATLAB for solving the FEM problems and also use of FEM software.
CO4	Develop the codes using MATLAB for solving the FEM problems
CO5	Use FEM software to solve problems.

Course Content:

UNIT-1

Fundamental Concepts: Introduction, Historical Background, FEM/FDM/Mesh free Methods, Stresses and Equilibrium, Boundary Conditions, Strain Displacement Relations, Stress-Strain Relations, Rayleigh-Ritz Method, Galerkin Method, Saint Venant's Principle. MatrixAlgebra: Basic Matrix Operations, Basic Types of Matrices, Eigenvalues and Eigenvectors

UNIT-2

One Dimensional Problems: Finite element Modeling, Coordinates and Shape Functions, Potential Energy Approach, Galerkin Approach, Assembly of the Global Stiffness Matrix and Load Vector

UNIT-3

Two Dimensional Problems: Finite Element Modeling, Constant Strain Triangle (CST), Problem Modeling and Boundary Conditions, Axisymmetric Solids subjected to Axisymmetric Loading: Axisymmetric Formulation.

UNIT-4

Finite Element Modeling: Triangular Element, Problem Modeling and Boundary, Conditions,
Two-Dimensional Isoparametric Elements: Four-Node Quadrilateral, Numerical, Integration, Higher-Order Elements.

UNIT-5

Scalar Field Problems: Steady-State Heat Transfer, Torsion, Potential Flow, Electric and Magnetic Fields, Dynamic Analysis: Formulation, Element Mass Matrices, Evaluation of Eigen values and Eigenvectors, Overview of a Commercial Finite Element Code: ANSYS

Textbooks:

1. Introduction to Finite Elements in Engineering by T.R. Chandrupatla and A.D. Belegundu, Prentice-Hall of India
2. An Introduction to the Finite Element Method by J.N. Reddy, McGraw-Hill

Reference Books:

1. Finite Element Procedures in Engineering Analysis by K.J. Bathe, Englewood Cliffs, Prentice Hall
2. Concepts and Applications of Finite Element Analysis by R.D. Cook, Wiley
3. Introduction to the Finite Element Method by C.S. Desai and J.F. Abel, Van Nostrand Reinhold
4. The Finite Element Method - Linear Static and Dynamic Finite Element Analysis by T.J.R. Hughes, Englewood Cliffs, Prentice-Hall
5. The Finite Element Method in Engineering by S.S. Rao, Pergamon.
6. An Analysis of the Finite Element Method by G. Strang and G.J. Fix, Englewood Cliffs, Prentice Hall
7. The Finite Element Method by O.C, Zienkiewicz, McGraw-Hill

THERMAL TURBO MACHINES (EME456)

Type	L	T	P	Credits
PEC	3	1	0	4

This course requires the background of applied thermodynamics and aims at the developing capability of design and analysis of thermal turbomachines.

Course Outcomes:

Student will be able to

CO1	Understand the principles of operation of thermal turbomachines.
CO2	Design different work absorbing turbomachines like compressors and pumps.
CO3	Design different work producing turbomachines like gas and steam turbines.
CO4	Understand the functional parameters and components in different turbomachines.
CO5	Understand the gas turbine working and performance

Course Content:

UNIT-I

Brief history of turbo machinery, introduction to blowers, pumps, compressors, steam & gas turbines, turbojet, Review of laws of thermodynamics & SFEE in reference to turbo machinery, Energy transfer in turbo machines, Euler's equation, Definition of various efficiencies, Preheat factor, Reheat factor, Blade classification, Blade terminology, Cascade testing, Velocity diagrams for axial and radial turbo machinery and pumps.

UNIT-II

Centrifugal compressors - Principle of operation, work done and pressure rise, Velcoity diagram for centrifugal compressor, Slip factor, Stage pressure rise, Loading coefficient, Diffuser, degree of

reaction, Effect of impeller blade profile, Pre-whirl and inlet guide vanes, Centrifugal Compressor characteristic curves.

Axial flow compressor- Principle of operation and working, Energy transfer, Velocity diagram for axial compressor, Factors affecting stage pressure ratio, Blockage in compressor annulus, Degree of reaction, 3-D flow, Design process, blade design, calculation of stage performance, Axial compressor performance characteristic curves.

UNIT-III

Axial flow turbines-Elementary theory of axial flow turbine, Energy transfer, Velocity diagram, Types of blades, Vortex theory, Choice of blade profile, pitch and chord, Estimation of stage performance, Characteristic curves.

UNIT-IV

Steam turbines- Constructional details, working of steam turbine.

Pumps : Classification of Pumps, Main components, indicator diagram and modification due to piston acceleration, Performance characteristics, Cavitation and its control, Miscellaneous types of pumps.

Radial flow turbines: Elementary theory of radial flow turbines, Enthalpy- Entropy diagram, State losses, Estimation of stage performance, Performance characteristics.

UNIT-V

Gas Turbine Starting & Control Systems : Starting ignition system, Combustion system types, Safety limits & control.

Turbine Blade coding: Different cooling techniques, Types of coolants, Comparative evaluation of different cooling techniques.

Mechanical Design consideration: Overall design choices, Material selection, Design with traditional materials.

Textbooks:

1. Thermal Turbomachines, Onkar Singh, Wiley India Pvt. Ltd.
2. Gas turbine theory : Cohen & Rogers, Addison Weslay Longman Ltd.

Reference books:

1. Design of high efficiency turbomachinery and gas turbines, David Gordon Wilson, Theodosios Korakianitis, Prentice Hall International.
2. Turbomachinery : S.M. Yahya.
3. Turbine, Compressors and Fans, S.M. Yahya, Tata Mc Graw Hill.
4. Turbomachines , D. G. Shepherd
5. Gas Turbine- Ganeshan, Tata Mc Graw Hill.

ADVANCED STRENGTH OF MATERIALS (EME458)

Type	L	T	P	Credits
PEC	3	1	0	4

Course Objectives:

CO1	To learn the concepts of 3D Stress
CO2	To learn the concepts of 3D , Strain and deformation.
CO3	To know the stresses developed during bending in curved beams.
CO4	To know the stresses developed in rotating components
CO5	To understand the failure mechanisms

UNIT: 1-STRESSES IN THREE DIMENSIONS:

Concept of Continuum, Homogeneity and Isotropy, Types of forces on a body, State of stress at a point, Cauchy formula, principal stresses and planes, Stress invariants, Hydrostatic and deviatoric stress tensor, Mohr's circle for general state of stress, stress transformations, Octahedral stresses, Differential equation of equilibrium

UNIT: 2 - STRAINS IN THREE DIMENSIONS:

Types of strain, Strain displacement relationship, Shear strain, Rigid body rotation, Principle strain and axes, Strain deviator and invariants, Compatibility conditions, Concept of Plane stress and strain, Stress strain relationship

UNIT: 3 - ROTATIONAL STRESSES

Introduction, Rotational stresses in discs and rims of uniform thickness; discs of uniform Strength

UNIT : 4- TORSION OF NON-CIRCULAR MEMBERS:

St. Venant's theory, approximate solution of rectangular and elliptical sections, rigorous solution, stress function approach, membrane analogy, torsion of thin hollow sections, Torsional of thin and open sections

UNIT:5- INTRODUCTION TO FRACTURE MECHANICS

Modes of failure, theories of failure and their Applications, Spectacular failures that triggered the birth of fracture mechanics, Modes of loading, classification as LEFM and EPFM, Crack growth and fracture mechanisms, Energy release rate, Resistance, Griffith theory of fracture,

TEXT BOOKS

1. Advanced Mechanics of Solids- L.S. Srinath, Tata McGraw Hill
2. Advanced Mechanics of Solids- S.M.A. Kazimi, Tata McGraw Hill
3. Elements of Fracture Mechanics- Prashant Kumar, McGraw Hill

REFERENCE BOOKS:

1-Mechanics of Materials by E.P.Popov, PHI
2- Strength of Materials by Ryder

PRODUCTION PLANNING & CONTROL (EME460)

Type	L	T	P	Credits
PEC	3	1	0	4

Prerequisite: Course on Manufacturing Science-I & II

Course Objectives:

The course aims at understanding function of production, place of production, forecasting and market analysis, factory location and layout depending on final production requirement.

Course Outcomes:

A student after going through the course will be able to:

CO1	Understand production planning and control as system approach.
CO2	Make master production schedule, material planning.
CO3	Handle inventory control problems.
CO4	Understand productivity pattern and related measurement and
CO5	Determine capacity planning, analyse product cost.

Course Content:

Unit-I

Introduction: Types and characteristics of production systems Objective and functions of Production, Planning & Control, Place of production, planning in Engineering, manufactures organization; Preplanning: Forecasting & Market Analysis. Factory Location & Layout, Equipment policy and replacement. Preplanning production, capacity planning.

Unit-II

Production Planning: Aggregate Planning, Master Production Schedule, Material Resource Planning, Selection of material methods, machines & manpower. Routing, Scheduling and Dispatching and its sheets & charts, Production Line Balancing

Unit-III

Production and Inventory Control: Progress control through records and charts. Types of inventories, Inventory Classification. Inventory Control under constraints Economic lot (batch) size. Trends in purchasing and store keeping, JIT production MRP II, comparison of Push & Pull systems, ERP, CAPPC.

Unit-IV

Productivity: Importance, Productivity patterns, productivity measurements & ratios, improvement maintenance process; Human Factors & Ergonomics: Human abilities, Training & motivation safety programs, workplace design & working conditions.

Unit-V

System Economics & Operations Economy: System Economics: Life cycle analysis, Capacity planning, Decision support system; Operations Economy: Replacement Planning, Sensitivity Analysis, Capital rationing, Product cost analysis and estimation, Allocation of resources.

Textbooks:

1. Production Planning & Control by Jain and Agarwal
2. Operations Management by Buffa.

Reference books:

1. Elements of Production Planning & Control by Eilon
2. Production System by J.L. Riggs.

EME462 to 470 **PROGRAMME ELECTIVE IV** **4[3-1-0]**

AUTOMOBILE ENGINEERING (EME462)

Type	L	T	P	Credits
PEC	3	0	2	4

Prerequisite: Course on I C Engine and Energy Conversion

Course Objectives:

This course aims at developing the understanding of different functional components of automobile and their use in automobile along with its impact on the environment.

Course Outcomes:

After completion of this course, students will have ability to,

CO1	Understand the basic requirements from automobile and technology used in them.
CO2	Demonstrate understanding of different functional systems of automobile such as brakes, suspension system, steering mechanism, gear box and transmission system.
CO3	Analyze different functional systems of automobiles and the advancements in them.
CO4	Carry out calculations pertaining to vehicle dynamics.
CO5	Understand and analyze impact of automobile on environment, different measures and regulations for its control.
CO6	Understand and demonstrate the working of various automobile components.

Course Content:

Unit 1

Introduction: Automobile and Automobile Engineering, history and development, classification of autovehicles, status of modern autovehicles, automobile chassis, frames, types of frames, design of frame, components, function and layout of automobiles, related terminologies like wheel base, track, turning radius and ground clearance.

Unit 2

Brakes: Principle of braking, weight transfer, types of brakes, factors influencing the braking effect, disc and drum brake, hydraulic brakes.

Suspension System: Introduction, types of suspension system, leaf springs, helically coiled spring, torsion bar, shock absorbers, independent front suspension system, independent rear suspension system.

Unit 3

Steering Mechanism: Wheel alignment, principal of correct steering, layout of steering system, arrangement of steering linkage, steering gears.

Gear Box: Need of gear box, principle of gearing, types of gear boxes, constant mesh gear box, sliding mesh gear box, synchromesh gear box.

Unit 4

Driveline System: Propeller shaft, universal coupling, analysis and design of hooke's joint, differential assembly.

Rear And Front Axle: Front Axle, rigid axle beam, stub axle, loads on rear axle and their mounting style, types of rear axle, types of drives, rear axle casing.

Unit 5

Vehicle Dynamics: Power and torque characteristics,, Air gradient and rolling resistance, variation of tractive effort, automatic transmission system, torque converter, Overdrive.
Pollution: Pollution caused by the vehicles, types of pollutants, controlling pollution and vehicular emission control norms.

Textbooks:

1. Automobile Engineering by K.M. Gupta
2. Automobile engineering by R.K. Rajput

Reference books:

1. The motor vehicle by Newton & W. Steeds
2. Automotive chassis &body by W.H. Crouse
3. Automobile engineering by Kripal Singh

EME462: AUTOMOBILE ENGINEERING LAB

1. Study of braking systems & experiment on vacuum brake.
2. Study of steering systems & experiment on power steering.
3. Study on lubrication and cooling system.
4. Study on five speed gear box and differential gear box.
6. Study of cut section model of multi cylinder petrol and diesel engine.
7. Study of fuel supply system for petrol and diesel engine.
8. Study of front and rear axle assembly.
9. Comparative study of features of common small cars (such as fiat, Ambassador, Maruti, Matiz, Santro, Indica and its variations) available in India.
10. Comparative study of technical features of common scooters & motorcycles available in India.
11. Comparative Study of Technical features of common heavy vehicles available in India.
12. Visit of an Automobile factory.

Note: - Other experiments can be taken up subject to availability of its experimental set ups.
Minimum 8 experiments

OPTIMIZATION METHODS IN ENGINEERING (EME464)

Type	L	T	P	Credits
PEC	3	1	0	4

The course aims at development of understanding regarding optimization of non-linear functions. It starts with introduction to one variable optimization methods and leads to multi-variable optimization.

Course Outcomes:

After successful completion of this course students will be able to

CO1	Learn one dimensional optimization methods
CO2	Learn constrained optimization of multi-variable function
CO3	Apply integer programming methods
CO4	Dynamic programming and operation research problems and
CO5	Learn soft computing based optimization.

Course Content:

Unit-I

Unconstrained Optimization: Optimizing Single-Variable Functions, Conditions for Local Minimum and Maximum, Optimizing Multi-Variable Functions.

Unit-II

Constrained Optimization: Optimizing Multivariable Functions with Equality Constraint: Direct Search Method, Lagrange Multipliers Method, Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions, Kuhn –Tucker Sufficient Conditions.

Unit-III

Optimization: Quasi-Newton Methods and line search, least squares optimization, Gauss-Newton, Extensions of LP to Mixed Integer Linear Programming (MILP), Non-Linar Programming, The Newton Algorithm, Non-Linear Least Squares, Sequential Quadratic Programming (SQP), Constrained Optimization, Multi-Objective Optimization, Branch and Bound Approaches.

Unit-IV

Optimization in Operation Research: Dynamic Programming, Minimax and Maximax Algorithm, Discrete Simulation, Integer Programming – Cutting Plane Methods, Separable Programming, Goal Programming, Integer Linear Programming.

Unit-V

Soft computing based optimization, Practical aspects of optimization.

Text books:

1. Engineering Optimization Theory and Practice by Rao S.S.
2. Methods of Optimization by Walsh G R

Reference books:

1. Operations Research: Applications and Algorithms by Winston W L
2. Model Building in Mathematics Programming by Williams H.P.
3. Integer and Combinational Optimization by G.L.Nemhauser and L.A.Wolsey
4. Discrete Optimization by R.G. Parker and R.L. Rardin.
5. Combinational Optimization: Algorithms and Complexity by C.H. Papadimitrious and K.Stegilite
6. Multi-objective evolutionary optimization for Product Design and Manufacturing by LihuiWang,
7. Genetic Algorithms by Kalyanmoy Deb
8. Genetic Algorithms in search, optimization and machine learning by David E Goldberg, Pearson

EXPERIMENTAL STRESS ANALYSIS (EME466)

Type	L	T	P	Credits
PEC	3	1	0	4

Prerequisite: Knowledge of engineering mechanics and strength of materials.

Course Objectives:

The objective of the subject is to make the student learn to apply modern experimental stress analysis techniques to measure strain and stresses in engineering components.

Course Outcomes:

Students will be able to

CO1	Analyse the 3-D state of stress in components with application of plane stress and plane strain conditions
CO2	Analyse 3D state of strain in the components. Understand various practical methods of analyzing strain in the components.
CO3	Understand the parameters, and practical applications of strain gages.
CO4	Understanding various aspects of photo elasticity and its application for stress analysis.
CO5	Understanding of two dimensional photoelasticity.

Course Content:

Unit I

Elementary Elasticity:

Stress: Introduction, Stress Equations of Equilibrium, Laws of Stress Transformations, principal Stresses, Two-Dimensional State of Stress, Stresses Relative to Principal Coordinate System, Special States of Stress.

Strain: Introduction, Displacement and Strain, Strain Transformation Equation, Principal Strains, Compatibility, Volume Dilation, Stress Strain Relations, Strain Transformation Equations and Stress Strain Relations for Two-Dimensional State of Stress.

Unit II

Strain Measurements: Introduction, Properties of Strain Gage Systems, Types of Strain Gages, Grid-Method of Strain Analysis.

Brittle Coating Method: Coating Stresses, Failure Theories, Brittle Coating Crack Patterns, Resin and Ceramic Based Brittle Coating, Test Procedure, Analysis of Brittle Coating Data.

Unit III

Electrical Resistance Strain Gages: Introduction, Strain Sensitivity in Alloys, Strain Gage Adhesives, Gage Sensitivity and Gage Factor.

Strain Gage Circuit: Potentiometer and its Application, Wheat-Stone Bridge, Bridge Sensitivity, Null Balance Bridges.

Analysis of Strain Gage Data: Three Element Rectangular Rosette, Delta Rosette, Stress Gage, Plane Shear-Gage.

Unit IV

Theory of Photoelasticity: Introduction, Temporary Double Refraction, Stress Optic Law, Relative Retardation, Stressed Model in Plane Polariscope, Effect of Principal Directions, Effect of Principal Stress Difference, Stressed Model in Circular Polariscope, Light and Dark Field arrangements, Tardy Compensation, Fringe Sharpening and Multiplication by Partial Mirrors.

Unit V

Two Dimensional Photoelasticity: Introduction, Isochromatic Fringe Patterns, Isoclinic Fringe

Patterns, Compensation Techniques, Calibration Methods, Separation Methods, Shear Difference Method, Electrical Analogy Method, Oblique Incidence Method, Materials for Two-Dimensional Photoelasticity.

Text Books:

1. Experiment Stress Analysis by James W. Dally and William F. Riley, International Student Edition, McGraw-Hill Book Company.
2. Experimental Stress Analysis by L.S.Srinath et.al.

Reference books:

1. Experiment Stress Analysis by Dr. Sadhu Singh, Khanna Publishers.

PRODUCT DESIGN AND DEVELOPMENT (EME468)

Type	L	T	P	Credits
PEC	3	1	0	4

Prerequisite: Manufacturing science

Course objective:

To provide the exposure to the real design issues of product development.

Course Outcomes:

Students will be able to

CO1	Understand the basic theory of process of product design and different phases of design.
CO2	Carry out cost and benefit analysis through various cost models.
CO3	Be familiar with the design protection and Intellectual Property.
CO4	Understand the Applications of Computers in product design.
CO5	Apply the knowledge of design in engineering.

Course Content:

Unit I

Introduction to Product Design: Introduction to PDD, Applications, Relevance, Product Definition, Scope, Terminology. Design definitions, the role and nature of design, old and new design methods, Design by evolution. Examples such evolution of bicycle, safety razor etc. Need based development, technology based developments. Physical reliability & Economic feasibility of design concepts.

Unit II

Morphology of Design: Divergent, transformation and convergent phases of product design. Identification of need, Analysis of need. Design for what? Design criteria, functional aspects. Aesthetics, ergonomics, form (structure). Shape, size, color. Mental blocks, Removal of blocks, Ideation Techniques. Creativity, Checklist.

Unit III

Transformations: Brainstorming & Synectics. Morphological techniques. Utility concept, Utility value, Utility index.Decision making under multiple criteria.Economic aspects of design.Fixed and variable costs.Break-even analysis.

Unit IV

Reliability: Reliability considerations, Bath tub curve, Reliability of systems in series and parallel. Failure rate, MTTF and MTBF. Optimum spares from reliability consideration. Design of displays and controls, Man-Machine interface, Compatibility of displays and controls.Ergonomic

aspects.Anthropometric data and its importance in design. Applications of Computers in product design.

Unit V

Design for manufacturing: Overview of the DFM process, Estimate the manufacturing cost, Reduce the cost of components, Reduce the cost of assembly, Reduce the cost of supporting Considerations of impact of DFM on other factors. Introduction to Patent and Intellectual property.

Text books:

1. Product Design & Manufacturing by A.K.Chitab&R.C.Gupta, PHI (EEE).
2. Product Design and Development by Karl T Ulrich, Steven D.Eppinger

Reference books:

1. The Technology of Creation Thinking by R.P. Crewford, Prentice Hall
2. The Art of Thought by Grohem Walls, Bruce & Co., New York
3. Product Design & Decision Theory by M.K. Starr, Prentice Hall
4. Human Factor Engg. byMccormick E.J., McGrawHill.
5. Engineering: An Introduction to Creative profession by G.C. Beakley, H.W. Leach, Macmillan.
6. Industrial Design In Engineering – A marriage of Techniques by Charles H.Flurscheim, The Design Council - London.
7. Quality Control & Reliability Analysis by Bijendra Singh, Khanna Publications.

NON DESTRUCTIVE TESTING (EME470)

Type	L	T	P	Credits
PEC	3	1	0	4

Prerequisite: Basic Science courses

Course objectives:

To provide the knowledge of non-destructive techniques to identify the health of the mechanical components and systems.

Course Outcomes:

Students will be able to

CO1	Have concepts of basic technology of inspection and evaluation according to the material of the system and components.
CO2	Have specific knowledge of eddy current techniques.
CO3	Understanding of Eddy Current Testing.
CO4	Understanding of Ultrasonic Testing.
CO5	Understanding of Thermography.

Course Content:

Unit I

Destructive vs Non Destructive Evaluation, Factors to consider in selecting tests, Economics of testing, In service testing; Defect detection, Terminology for non-destructive evaluation – Discontinuity, Imperfections, Flaw, Defects, Non-critical flaw, critical flaw, False vs. relevant indications. Interpretation and evaluation.

Unit II

Methods of Non destructive evaluation, Visual Inspection, Surface Inspection Methods, Dye penetrant method, Eddy current testing, Magnetic testing methods, Ultrasonic testing, Acoustic Emission. Radiography, X-ray.

Unit III

Eddy Current Testing- Basics of Eddy current testing, factors affecting eddy current response.
Magnetic testing methods- Magnetization curves and hysterises, Magnetic particle tests, scope of test,

detection of flaws and cracks using magnetic flux leakage; Radiographic Testing Methods: Principle, equipment and methodology, X-ray images, radiographic film, properties of x-ray film.

Unit IV

Ultrasonic Testing: Generation of ultrasounds in materials, Transducers, Display and interpretation of ultrasonic data. Principle of operation, Ultrasonic probes, Advantages, Limitation and Typical applications.

Unit V

Thermography: Principle and application, Acoustic emission technique, Basics and applications; Real Time Evaluation: Concept of Smart Structures

Textbooks:

1. Introduction to the Principles of Material Evaluation by David C Jiles, CRC Press.
2. Evaluation of Material & Structures by Quantitative Ultrasonics, by J.D. Achenbach, Springer-Verlag, New York-1994

Reference books:

1. Ultrasonic methods of Non destructive testing by J. Blitz and G. Simpson, Chapman & Hall London, 1995.
2. Industrial Radiology: Theory & Practices by R. Halmshaw, Chapman & Hall, London, 1995

OME481 to 485 **OPEN ELECTIVE - I** **Credits 3[3-0-0]**

SOLAR ENERGY (OME481)

Type	L	T	P	Credits
OEC	3	0	0	3

Prerequisite: Engineering Thermodynamics

Course Objectives:

This course on solar energy aims at developing understanding about availability of solar energy, its utilization and systems run on solar energy for power generation, cooling, heating and other applications.

Course Outcomes:

After completion of course, the students will have ability to,

CO1	Understand solar energy availability, associated geographical issues and its measurement.
CO2	Design, analyze and develop solar thermal systems for various applications.
CO3	Design, analyze and develop solar photovoltaic systems for different applications.
CO4	Understand and analyze solar energy economics.
CO5	Demonstrate holistic understanding of the various solar energy applications and think of certain modifications in them for better performance and utility.

Course Content:

UNIT-1

Introduction, Energy alternative, Devices for thermal collection and storage, Thermal applications; Solar radiation: Instruments for measuring solar radiation, Solar radiation geometry, Empirical equations for prediction of the availability of solar radiation, Solar radiation on tilted surfaces.

UNIT-2

Liquid flat-Plate Collectors: General performance analysis, Transmissivity absorptivity product and overall loss coefficient and heat trasfer correlations, Collector efficiency factor, Analysis of collectors similar to the conventional collector. Testing procedures, Alternatives to the conventional collector,

UNIT-3

Solar Air Heaters: Performance analysis of a conventional air heater, Other types of air heaters. Concentrating Collectors: Flat plate collectors with plane reflectors, Cylindrical parabolic collector, Compound parabolic dish collector,Central receiver collector.

UNIT-4

Thermal energy storage: Sensible heat storage, Latent heat Storage, Thermo-chemical storage. Solar distillation: Introduction, working principal of solar distillation, Thermal efficiency of distiller unit, External heat transfer, Top loss coefficient, Bottom and side loss coefficient, Internal heat transfer, Radioactive loss coefficient, convective loss coefficient, Evaporative loss coefficient, Overall heat evaluation of distillation output, Passive solar stills, Conventional solar still, Basin construction, Thermal analysis of conventional solar still.

UNIT-5

Photovoltaic Systems: Introduction doping Fermi level, P-N junction characteristics, Photovoltaic effect, Photovoltaic material, Module, Cell temperature, Economic analysis: Introduction, cost analysis.

Text books:

1. Solar Energy, by S.P Sukhatme, Tata McGraw Hill.
2. Treatise on Solar Energy, by H.P Garg, John Wiley and Sons.

Reference books:

1. Solar Energy:Thermal Processes by Duffie John A, and Beckman W.A,, JohnWiley&Sons.

INDUSTRIAL ENGINEERING & AUTOMATION (OME483)

Type	L	T	P	Credits
OEC	3	0	0	3

Prerequisite: Manufacturing science

Course Objectives:

The course considers Industrial productive concepts and measurements. Principles of economy production planning and control. It introduces Industrial review technique using software

Course Outcomes:

After completion of the course a students will be able to understand and apply fundamentals of Industrial engineering concepts:

CO1	Analyze and explain productivity concepts and measurements
CO2	Explain various Industrial Layout and time study.
CO3	Exhibit skills towards program evaluation and review technique
CO4	Analyze and perform Break even analysis.
CO5	Analysis of Automated Flow lines for Reliability and Efficiency.

Course Content:

Unit 1

Introduction, engineering economy and costing, cost analysis, methods of depreciation, productivity concepts and measurements, job evaluation, methods of job evaluation, merit rating, wage incentive plan, types of wage incentive plans.

Unit 2

Work measurement, time study, pre determined motion and time study(PMTS), work sampling, method study, micro motion study, principles of motion economy.

Unit 3

Plant location, Types of Layout, Principles of Facility Layout, Objective Functions, Steps in PPC, Planning, Routing, Scheduling, Loading, Dispatching, Effectiveness of PPC.

Unit 4

PERT, CPM, Resource Allocation and GERT- Program Evaluation and Review Technique (PERT), Critical Path Method (CPM), Scheduling with Resource Constraints.
Introduction to quality management, Ergonomics.

Unit 5

High Volume Production Systems- Transfer Devices, Feeder classification, Construction and Applications, Automated Flow lines, Analysis of Automated Flow lines for Reliability and Efficiency, Assembly Systems, Robot Technology, Flexible Manufacturing Systems (FMS)

Textbooks:

1. Industrial Engineering by M.S. Mahajan, DhanpatRai and Co. (P) Ltd.
2. Introduction to Robotics by S.K. Saha, Tata Magraw Hill

Reference Books:

1. Introduction to Industrial System Engineering by Turner w.c. et Al 1993,Prentice Hall
2. Motion and Time Study, Design and Measurement of Work by Ralph M. Barnes, Wiley Publishers
3. Project Management for Business and Technology by John M Nicholas, PHI
4. Robotics by John M Nicholas, Pearson Education

ARTIFICIAL INTELLIGENCE IN MANUFACTURING (OME485)

Type	L	T	P	Credits
OEC	3	0	0	3

Prerequisite: Basic Engineering courses

Course Objectives:

The course considers the applications of artificial intelligence and machine learning techniques in manufacturing with advanced technology.

Course Outcomes:

After completion of the course a students will be able to understand and apply fundamentals of Industrial engineering concepts:

CO1	To understand the knowledge of Artificial intelligence in Engineering applications.
CO2	To create the concept of Machine learning using Bayes theorem and regression algorithms.
CO3	To able to develop application based on IoT and its case studies.
CO4	To develop the knowledge of robotics and automation in manufacturing processes.
CO5	Introduction to computer aided engineering analysis and optimum design

Course Content:

Unit-1 AI in Engineering

Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree. Search Algorithms, Probability, conditional probability, Markov Decision process, Reinforcement Learning

Unit-2 Machine learning

Overview of Machine learning concepts, Types of Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear, Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms, Analysis of Time Series, programmer in Python to predict the class, Neural Networks-Learning And Generalization, Overview of Deep Learning.

Unit-3 IOT

Introduction to IOT, Elements of IoT, IoT Application Development, IoT Case Studies, program on Arduino for hardware and software

Unit-4 Robotics and Automation

Introduction to Robotics, Robot kinematics and dynamics, Sensors and Vision System, Robot Control, Robot Actuation Systems, Control Hardware and Interfacing**,** Mechatronics (MEMS & NEMS)

Unit-5 Digital design and Manufacturing

Geometrical design of curves, Surfaces and solids, Introduction to computer aided engineering analysis and optimum design. Consideration of manufacturing and assembly aspects in design. Shape digitization: 3D object scanning, Solid reconstruction from point cloud and tessellated data, Downstream applications; Digital manufacturing: Subtractive manufacturing: Basic architecture, Control hardware and software details Manufacturing data preparation, Shop-floor control, automatic identification systems (sensors, trackers), Product life cycle

Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach" , 3rd Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill
3. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
4. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
5. Ghosal, A., "Robotics", Oxford, New Delhi, 2006. Jeeva Jose, "Machine Learning", Khanna Publishing House, Delhi. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media

OME482 to 486 **OPEN ELECTIVE - II** **4[3-1-0]**

ALTERNATIVE ENERGY RESOURCES (OME482)

Type	L	T	P	Credits
OEC	3	1	0	4

Prerequisite: Course on Engineering Thermodynamics.

Course Objectives:

This course considers the background of depleting fossil fuel reserves and lays emphasis on the utilization of alternative energy sources for meeting varying requirements and ensure sustainable development while assessing the impact of both conventional and non-conventional sources of energy on civilization.

Course Outcomes:

Student will be able to

CO1	Understand effect of fossil fuels on global warming and their relative impact on the environment.
CO2	Comprehend the energy scenario of world in general and India in particular along with assessment of potential of alternative sources of energy.
CO3	Design, analyze and develop theoretical framework for use of alternative sources of energy for different applications.
CO4	Evaluate the performance of the various non-conventional and renewable energy sources.
CO5	Understand and analyze recent advancements in energy generations like magneto hydro dynamic power generation, fuel cell technology, hydrogen energy etc. and develop energy management skills

Course Content:

UNIT-1

Energy resources and their utilization: Indian and global energy sources, Energy exploited, Energy planning, Energy parameters (energy intensity, energy-GDP elasticity), Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation.

Solar radiations: Extra terrestrial radiation, Spectral distribution, Solar constant, Solar radiations on

earth, Measurement of solar radiations, Solar radiation geometry, Flux on a plane surface, Latitude, Declination angle, Surface azimuth angle, Hour angle, Zenith angle, Solar altitude angle expression for angle between incident beam and the normal to a plane surface (no derivation), Local apparent time, Apparent motion of sun, Day length, Solar radiation data for India.

UNIT-2

Solar energy: Solar thermal power and it's conversion, Solar collectors, Flat plate, Performance analysis of flat plate collector, Solar concentrating collectors, Types of concentrating collectors, Thermodynamic limits to concentration, Cylindrical collectors, Thermal analysis of solar collectors, Tracking CPC and solar swing . Solar thermal energy storage, Different systems, Solar pond. Applications, Water heating, Space heating & cooling, Solar distillation, solar pumping, solar cooking, Greenhouses, Solar power plants.

Solar photovoltaic system: Photovoltaic effect, Efficiency of solar cells, Semiconductor materials for solar cells, Solar photovoltaic system, Standards of solar photovoltaic system, Applications of PV system, PV hybrid system.

UNIT-3

Biogas: Photosynthesis, Bio gas production Aerobic and anaerobic bio-conversion process, Raw materials, Properties of bio gas, Producer gas, Transportation of bio gas, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production, Bio gas applications, Biomass conversion techniques, Biomass gasification, Energy recovery from urban waste, Power generation from liquid waste, Biomass cogeneration, Energy plantation, Fuel properties, Biomass resource development in India.

Wind energy: Properties of wind, Availability of wind energy in India, wind velocity, Wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Wind energy farms, Economic issues, Recent developments.

UNIT-4

Electrochemical effects and fuel cells: Principle of operation of an acidic fuel cell, Reusable cells, Ideal fuel cells, Other types of fuel cells, Comparison between acidic and alkaline hydrogen-oxygen fuel cells, Efficiency and EMF of fuel cells, Operating characteristics of fuel cells, Advantages of fuel cell power plants, Future potential of fuel cells.

Tidal power: Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy Limitations of tidal energy conversion systems.

Hydrogen Energy: Properties of hydrogen in respect of its use as source of renewable energy, Sources of hydrogen, Production of hydrogen, Storage and transportation, Problems with hydrogen as fuel, Development of hydrogen cartridge, Economics of hydrogen fuel and its use.

UNIT-5

Thermoelectric systems: Kelvin relations, power generation, Properties of thermoelectric materials, Fusion Plasma generators.

Geothermal energy: Structure of earth's interior, Geothermal sites, earthquakes & volcanoes, Geothermal resources, Hot springs, Steam ejection, Principal of working, Types of geothermal station with schematic representation, Site selection for geothermal power plants. Advanced concepts, Problems associated with geothermal conversion.

Ocean energy: Principle of ocean thermal energy conversion, Wave energy conversion machines, Power plants based on ocean energy, Problems associated with ocean thermal energy conversion systems, Thermoelectric OTEC, Developments of OTEC, Economics; Impact of renewable energy generation on environment, Kyoto Protocol, Cost of electricity production from different energy sources, Energy options for Indian economy.

Textbooks:
1. Renewable energy resources and emerging technologies by Kothari D.P., PHI
2. Non-Conventional energy Sources by Rai G.D, Khanna Publishers.

Reference books:
1. Renewable energy sources and conversion technology by BansalKeemann, Meliss, TMH
2. Nonconventional Energy by Ashok V. Desai, New Age International Publishers Ltd.

COMPOSITE MATERIALS (OME484)

Type	L	T	P	Credits
OEC	3	1	0	4

Prerequisite: Fundamental knowledge of material science and engineering materials.

Course Objective:

The objective of the subject is to know the fundamental science and engineering principles relevant to composite materials.

Course Outcomes:

Students will be able to

CO1	Understand the concepts of composite materials fabrications of composite and their properties.
CO2	Understanding fibrous and particulate composites, their stress strain behavior and important properties.
CO3	Analysis of laminated composites and understanding of orthotropic lamina and laminated theory.
CO4	Characterize composites by evaluating various mechanical properties.
CO5	Analyze and identify the damages in composite structures.

Course Content:

Unit I

Introduction: Definition, Characteristics classification Particulate and fibrous composites. **Fibers Matrices and Fabrication of Composites:** Advance fibers, Glass fibers carbon and graphite fibers Aramid fibers Boron Fibers and other fibers. Matrix materials: Polymer and Metals, Fabrication of composites.

Unit II

Behavior of unidirectional composites : Nomenclatures, volume and weight fractions, Longitudinal Strength and Stiffness, Transverse Stiffness and Strength, Prediction of shear and Poisson Ratio, Failure modes.

Short Fiber Composites Theories of stress transfer Modulus and Strength of Short fiber.

Unit III

Analysis of an orthotropic Lamina : Hooke's law for orthotropic Materials, Stress- strain Relations and engineering Constants, Strength of an Orthotropic Lamina.

Unit IV

Analysis of Laminated Composites : Strain and stress Variation in a laminate, Synthesis of Stiffness Matrix, Construction and Properties of Special Laminates, Dtermination of laminae stress and strains, Analysis of laminates after initial failure. Hygro-thermal stresses in Laminates.

Unit V

Experimental Characterization of Composites Uniaxial Tension test, Uniaxial Compression Test,

Inplane Shear test, Uniaxial Bending Tests Determination of Interlaminar Shear Strength and Fracture toughness.Damage Identification Using Nondestructive Evaluation Techniques.

Textbooks:

1. Analysis and Performance of fiber composite by Agrawal,B.D., Broutman L.J., John Wiley & Sons
2. Introduction to composite Materials by Tsai S.W.,Hahn H.T., Thechnomic West Port, Conn.

Reference books:

1. Primer on Composite Material Analyisis, Haplin J.C., Technomic Stanford, Conn.1984
2. Mechanics of composite materials, Jones R.M., Sripta Book Company Washington D.C.

OPTIMIZATION METHODS IN ENGINEERING (OME486)

Type	L	T	P	Credits
OEC	3	1	0	4

The course aims at development of understanding regarding optimization of non-linear functions. It starts with introduction to one variable optimization methods and leads to multi-variable optimization.

Course Outcomes:

After successful completion of this course students will be able to

CO1	Learn one dimensional optimization methods
CO2	Learn constrained optimization of multi-variable function
CO3	Apply integer programming methods
CO4	Dynamic programming and operation research problems and
CO5	Learn soft computing based optimization.

Course Content:

Unit-I

Unconstrained Optimization: Optimizing Single-Variable Functions, Conditions for Local Minimum and Maximum, Optimizing Multi-Variable Functions.

Unit-II

Constrained Optimization: Optimizing Multivariable Functions with Equality Constraint: Direct Search Method, Lagrange Multipliers Method, Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions, Kuhn –Tucker Sufficient Conditions.

Unit-III

Optimization: Quasi-Newton Methods and line search, least squares optimization, Gauss-Newton, Extensions of LP to Mixed Integer Linear Programming (MILP), Non-Linar Programming, The Newton Algorithm, Non-Linear Least Squares, Sequential Quadratic Programming (SQP), Constrained Optimization, Multi-Objective Optimization, Branch and Bound Approaches.

Unit-IV

Optimization in Operation Research: Dynamic Programming, Minimax and Maximax Algorithm, Discrete Simulation, Integer Programming – Cutting Plane Methods, Separable Programming, Goal Programming, Integer Linear Programming.

Unit-V

Soft computing based optimization, Practical aspects of optimization.

Text books:

3. Engineering Optimization Theory and Practice by Rao S.S.
4. Methods of Optimization by Walsh G R

Reference books:

9. Operations Research: Applications and Algorithms by Winston W L
10. Model Building in Mathematics Programming by Williams H.P.
11. Integer and Combinational Optimization by G.L.Nemhauser and L.A.Wolsey
12. Discrete Optimization by R.G. Parker and R.L. Rardin.
13. Combinational Optimization: Algorithms and Complexity by C.H. Papadimitrious and K.Stegilite
14. Multi-objective evolutionary optimization for Product Design and Manufacturing by LihuiWang,
15. Genetic Algorithms by Kalyanmoy Deb
16. Genetic Algorithms in search, optimization and machine learning by David E Goldberg, Pearson

PROJECT (EME-498)

Type	L	T	P	Credits
Project	0	0	20	10

Prerequisite: Programme core courses

Course Outcomes:

CO1	Show preparedness to work independently on real time problem scenarios to be addressed using knowledge of fundamentals & techniques in the area of Mechanical Engineering.
CO2	Use the innovative ideas and thoughts to address real life issues and provide efficient solutions for Industry oriented works.

Course Content:

The practical implementation of theoretical knowledge gained during the B.Tech. programme. Students are required to implement their original ideas, modification/enhancement of the existing mechanical engineering techniques, real time industrial problems, and current applications of their courses of study. Projects work can be of two types: Projects based on implementation of any industry oriented problem which will be more or less experimental in nature and the others will be based on some innovative/ theoretical work.