MANIPUR UNIVERSITY
CANCHIPUR, IMPHAL

CURRICULUM & SYLLABUS

FOR

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING
(Second Year to Fourth Year)

(Effective from the Academic Session 2021-2022)

C O N T E N T S

1. Introduction to Mechanical Engineering

Mechanical engineering is an engineering branch that combines engineering physics and mathematics principles with materials science to design, analyze, manufacture, and maintain mechanical systems. The mechanical engineering field requires an understanding of core areas including mechanics, dynamics, thermodynamics, materials science, manufacturing, structural analysis, simple electronic devices and electricity. In addition to these core principles, mechanical engineers use tools, such as computer-aided design (CAD), computer-aided manufacturing (CAM), and product lifecycle management to design and analyze manufacturing plants, industrial equipment and machinery, heating and cooling systems, transport systems, aircraft, watercraft, robotics, medical devices, weapons, and others. It is the branch of engineering that involves the design, production, and operation of machinery.

The term "mechanical engineering" came from the name of a technical engineering college established in England in 1837. Like machine science, mechanical engineering has deep historical roots. In ancient times, real life problems had been solved in practice, for example, how to construct edifices, fortresses, bridges, channels, and mills, as well as how to develop simple machines to maximize the effect of human labor. Mechanical Engineering is one of the oldest disciplines of engineering, although it gained separate identity in the nineteenth century. The word engineer itself means the constructor of military engines, which falls in the scope of modern day mechanical engineers. It has wide scope and therefore, finds applications in many fields. Mechanical engineers perform a variety of tasks starting from design to management of machines and equipment. They also perform supportive role in other engineering disciplines. Several engineering disciplines have undergone successful marriage with mechanical engineering. A number of disciplines have emerged as offspring of mechanical engineering, e.g., production engineering, industrial engineering, manufacturing engineering, automobile engineering, aerospace engineering, marine engineering and mechatronics. Mechanical engineering education has been continuously evolving with the changing level of technology.

2. About the Department

Department of Mechanical Engineering, Manipur Institute of Technology was opened in the year 2019. At present, it has four years degree course in Mechanical Engineering only with the total seat of 30 numbers. As of now, there are only two batches.

3. Vision of the Department

Department of Mechanical Engineering is committed to prepare graduates, post graduates and research scholars by providing them the best outcome based teaching-learning experience and scholarship enriched with professional ethics.

4. Mission of the Department

M-1: Prepare globally acceptable graduates, post graduates and research scholars for their lifelong learning in Mechanical Engineering, Maintenance Engineering and Engineering Management.

M-2: Develop futuristic perspective in Research towards Science, Mechanical Engineering, Maintenance Engineering and Engineering Management.

M-3: Establish collaborations with Industrial and Research organizations to form strategic and meaningful partnerships.

5. Programme Specific Outcomes (PSOs)

PSO1: Apply modern tools and skills in design and manufacturing to solve real world problems.

PSO2: Apply managerial concepts and principles of management and drive global economic growth.

PSO3: Apply thermal, fluid and materials fundamental knowledge and solve problem concerning environmental issues.

6. Programme Educational Objectives (PEOs)

PE01: To apply industrial manufacturing design system tools, managerial skills and other necessary skills in the field of mechanical engineering in solving real life problems.

PE02: To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

PE03: To be able to pursue advanced education, research and engage in the process of life-long learning.

7. Program outcomes (POs)

PO 1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and engineering specialization to solve complex engineering problems.

PO 2: **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

8. Structure of B.E. in Mechanical Engineering

Semester	Credits
I	**17.5**
II	**21.0**
III	**22.5**
IV	**22.0**
V	**21.0**
VI	**21.0**
VII	**20.0**
VIII	**18.0**
Total	**163.0**

8.1 Credit, Paper and Semester-wise Course Distribution for B.E. in Mechanical Engineering

Semester 3 (Second Year) Branch: Mechanical										
Sl. No.	Course No.	Subject	Hours/Week			Marks				Credit
			L	T	P	Theory	Sess.	Pract	Total	
1	MA 231	Engineering Mathematics –III	3	1	0	70	30	-	100	4
2	ME 231	Engineering Mechanics	3	1	0	70	30	-	100	4
3	ME 232	Basic Mechanical Engineering	3	0	0	70	30	-	100	3
4	ME 233	Metrology and Measurements	3	0	0	70	30	-	100	3
5	EC 231	Basic Electronics Engineering	3	0	0	70	30		100	3
6	HU 231	Economics for Engineers	2	0	0	35	15	-	50	2
SUB-TOTAL			*17*	*2*	*0*				*550*	*19*
PRACTICAL/DESIGN										
7	EC 231P	Basic Electronics Lab	0	0	3	-	30	70	100	1.5
8	ME 231P	Workshop Practice II	0	0	2		30	70	100	1
9	ME 234P	Internship-I	-	-	-		100	-	100	1
SUB-TOTAL			*0*	*0*	*5*				*300*	*3.5*
TOTAL			**17**	**2**	**5**				**850**	**22.5**

Semester 4 (Second Year) Branch: Mechanical										
Sl. No.	Course No.	Subject	Hours/Week			Marks				Credit
			L	T	P	Theory	Sess.	Pract	Total	
1	MA 241	Numerical Methods & Computation	3	0	0	70	30	-	100	3
2	ME 241	Strength of Materials	3	0	0	70	30	-	100	3
3	ME 242	Materials Engineering	3	0	0	70	30	-	100	3
4	ME 243	Applied Thermodynamics	3	1	0	70	30	-	100	4
5	ME 244	Fluid Mechanics	3	1	0	70	30	-	100	4
6	HU 241	Universal Human Values-II	2	1	0	70	30	-	100	3
SUB-TOTAL			*17*	*3*	*0*				*600*	*20*
PRACTICAL/DESIGN										
7	ME 241P	Basic Material Testing Lab	0	0	2	-	30	70	100	1
8	ME 242P	Computer Aided Drafting Lab-I	0	0	2		30	70	100	1
SUB-TOTAL			*0*	*0*	*4*				*200*	*2*
MANDATORY COURSE										
9	NC 241	Organizational Behavior	3	0	0		50*			**0**
TOTAL			**20**	**3**	**4**				**800**	**22**

Semester 5 (Third Year) Branch: Mechanical										
Sl. No.	Course No.	Subject	Hours/Week			Marks				Credit
			L	T	P	Theory	Sess.	Pract	Total	
1	ME 351	Kinematics and Theory of Machines	3	0	0	70	30	-	100	3
2	ME 352	Fluid Machinery	3	1	0	70	30	-	100	4
3	ME 353	Manufacturing Process I	3	1	0	70	30	-	100	4
4	ME 354	Heat and Mass Transfer	3	1	0	70	30	-	100	4
5	ME 355	Design of Machine Element	3	0	0	70	30	-	100	3
SUB-TOTAL			15	3	0				***500***	***18***
PRACTICAL/DESIGN										
6	ME 351P	Mechanical Engg. Lab I (Design)	0	0	2	-	30	70	100	1
7	ME 352P	Computer Aided Drafting Lab - II	0	0	2	-	30	70	100	1
8	ME 356P	Internship-II	-	-	-	-	100	-	100	1
SUB-TOTAL			0	0	4				***300***	***3***
MANDATORY COURSE										
9	NC 351	Environmental science	3	0	0		50*			
TOTAL			**18**	**3**	**4**				**800**	**21**

Semester 6 (Third Year) Branch: Mechanical										
Sl. No.	Course No.	Subject	Hours/Week			Marks				Credit
			L	T	P	Theory	Sess.	Pract	Total	
1	ME 361	Manufacturing Process II	3	0	0	70	30	-	100	3
2	ME 362	IC Engine	3	1	0	70	30	-	100	4
3	ME 363	Design of Transmission Systems	2	1	0	70	30	-	100	3
4	ME 364	Industrial Engineering	2	1	0	70	30	-	100	3
5	ME 365	Program Elective-I	3	0	0	70	30	-	100	3
6	ME 366	Open Elective-I	3	0	0	70	30	-	100	*3*
SUB-TOTAL			**16**	**3**	**0**				**600**	**19**
PRACTICAL/DESIGN										
7	ME 361P	Mechanical Engg. Lab-II (Manufacturing)	0	0	2	-	30	70	100	1
8	ME 362 P	Mechanical Engg. Lab IIII(Thermal)	0	0	2	-	30	70	100	1
SUB-TOTAL			**0**	**0**	**4**				**200**	**2**
MANDATORY COURSE										
9	NC 361	Constitution of India	3	0	0		50*			
TOTAL			**19**	**3**	**4**				**800**	**21**

Semester 7 (Fourth Year) Branch: Mechanical										
Sl. No.	Course No.	Subject	Hours/Week			Marks				Credit
			L	T	P	Theory	Sess.	Pract	Total	
1	ME 471	Dynamics and Vibrations	3	0	0	70	30	-	100	3
2	ME 472	Operation Research	3	0	0	70	30	-	100	3
3	ME 473	Refrigeration and Air conditioning	2	1	0	70	30	-	100	3
4	ME 474	Open Elective-II	3	0	0	70	30	-	100	3
SUB-TOTAL			***11***	***1***	***0***				***400***	***12***
PRACTICAL/DESIGN										
5	ME 471P	Mechanical Engineering Lab IV	0	0	4	-	30	70	100	2
6	ME 475P	Project-I (Project work, seminar)	0	0	10	-	100	200	300	5
7	ME 476P	Internship-III	-	-	-	-	100	-	100	1
SUB-TOTAL			*0*	*0*	*14*				*500*	*8*
TOTAL			**11**	**1**	**14**				**900**	**20**

Semester 8 (Fourth Year) Branch: Mechanical										
Sl. No.	Course No.	Subject	Hours/Week			Marks				Credit
			L	T	P	Theory	Sess.	Pract	Total	
1	ME 481	Program Elective-II	3	0	0	70	30	-	100	3
2	ME 482	Program Elective-III	3	0	0	70	30	-	100	3
3	ME 483	Program Elective-IV	3	0	0	70	30	-	100	3
4	ME484	Open Elective-III	3	0	0	70	30	-	100	3
SUB-TOTAL			*12*	*0*	*0*				*400*	*12*
PRACTICAL/DESIGN										
5	ME485P	Project-II (Continued from VII Semester, Project work, seminar and internship in industry or at appropriate work place)	0	0	12	-	120	280	400	6
SUB-TOTAL			*0*	*0*	*12*				*400*	*6*
TOTAL			**12**	**0**	**12**				**800**	**18**

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Credits	17.5	21	22.5	22	21	21	20	18	**163**
Marks	500	650	850	800	800	800	900	800	**6100**
Hours/week	22	26	24	27	25	26	26	24	**200**

8.2 Detailed Contents for B.E. 3rd semester (Mechanical) Papers

MA 231	Mathematics III (PDE, Probability & Statistics)	3L:1T:0P	4 credits

Course objectives:

1. To familiarize with basics of Fourier series, Boundary value problems, calculus of complex variable
2. To provide an overview of probability and statistics to engineers

Contents:

Module 1: Fourier series (8 Hrs)

Derichlet's condition-General Fourier series- odd and even functions, Half range-sine and cosine series-complex form of Fourier series, Practical Harmonic analysis

Module 2: Boundary Value Problems (10 Hrs)

Classification of second order quasi linear partial differential equations- solution of one dimensional wave equation one dimensional heat equation- steady state solution of two dimensional heat equation(insulated edges exclude)-Solution by separation of variables

Module 3: Complex Analysis (10 Hrs)

Analytic function-properties, Cauchy-Riemann equations, construction of analytic function, determination of conjugate harmonic functions, application to two dimensional potential problems. Conformal transformations, Bilinear Transformation. Cauchy's Integral theorem and Cauchy's integral formula (statement only), Taylor's and Laurent's expansions, isolated singularities, residues-Cauchy's residues theorem (statement only), contour integration-over unit circle and semi-circle (excluding poles on real axis)

Module 4: Basic Probability (9 Hrs)

Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality

Module 5: Basic Statistics (10 Hrs)

Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

Text books/References:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publication, 41 Edition, New Delhi.
2. Erwin Kreyszig, Advance Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Ramana B. V., Higher Engineering Mathematics, Tata McGraw Hill, New Delhi, 11th Reprint, 2010.
4. N. O. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
5. P. G. Hoel, S. C. Port and C. J. Stone, "Introduction to Probability Theory", Universal Book Stall, 2003.
6. S. Ross, "A First Course in Probability", Pearson Education India, 2002.
7. W. Feller, "An Introduction to Probability Theory and its Applications", Wiley, 1968.

Course outcomes:

Upon successful completion of the course, student should be able to learn:

1. The methods to expand a function in Fourier series.
2. The methods to solve partial differential equations that are arising in engineering problems.
3. The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.
4. The basics of probability and statistics that is essential in most branches of engineering.

ME 231	Engineering Mechanics	3L:1T:0P	4 credits

Course objectives:

1. To enable students to apply fundamental laws and basic concepts of rigid body mechanics to solve problems of bodies under rest or in motion.
2. To learn the working knowledge of statics with emphasis on force equilibrium and free body diagrams.
3. To tackle equilibrium equations, moments and inertia problems
4. To gain a firm foundation in Engineering Mechanics for furthering the career in Engineering
5. To compute the properties of areas and bodies.

Contents:

Module 1: System of Forces (10 Hrs)

Introduction to mechanics, laws of mechanics, concept of force, system of forces, Principle of Transmissibility of force, Parallelogram law, Triangle law, and Polygon law of forces, resultant and equilibrium of system of coplanar concurrent forces, resultant and equilibrium of system of coplanar non- concurrent forces.

Module 2: Friction (7 Hrs)

Frictional force, types of friction, laws of friction, coefficient of friction, angle of friction, angle of repose, cone friction, impending motion of connected bodies, wedge, screw jack and rope friction.

Module 3: Centroid & Area Moment of Inertia (6 Hrs)

Centroid, Centre of gravity, Centroid of simple figures and composite sections. Area moment of inertia, polar moment of inertia, radius of gyration, theorems of moment of inertia, moment of inertia of standard figures and moment of inertia of composite sections.

Module 4: Centre of Gravity & Mass Moment of Inertia (6 Hrs)

Centre of gravity from first principles, centre of gravity of composite bodies and theorem of Pappus- Guldinus. Definitions, Mass moment of inertia from first principles, transfer formula and mass moment of inertia of composite bodies.

Module 5: Kinematics (6 Hrs)

Introduction to Dynamics, Linear motion- motion with uniform velocity and uniform acceleration, Acceleration due to gravity, motion with varying acceleration. Curvilinear motion- motion of body associated with horizontal projection and inclined projection.

Module 6: Kinetics (6 Hrs)
Introduction, laws of motion, rectilinear motion of a particle, D'Alembert's Principle, Work- Energy Principle- work energy equation for translation, motion of connected bodies.

Module 7: Principle of virtual work (5 Hrs)
Virtual work – Principle of virtual work – System of connected rigid bodies – Degrees of freedom – Conservative forces – Potential energy – Potential energy criteria for equilibrium.

Text Books/ References:

1. Meriam, James Lathrop, L. Glenn Kraige, and William J. Palm. *Engineering mechanics. Vol. 1, Statics*. Wiley, 1987.
2. Meriam, James L., and L. Glenn Kraige. *Engineering mechanics: dynamics*. Vol. 2. John Wiley & Sons, 2012.
3. Beer, Ferdinand P., et al. *Vector mechanics for engineers*. Vol. 1. Tata McGraw-Hill Education, 1977.
4. Engineering Mechanics by Ferdin and L. Singer, 3rd Edition.
5. Engineering Mechanics by S.S. Bhavikatti and K.G. Rajashekarappa, New Age International (P) Limited, Publishers

Course outcomes:
Upon successful completion of the course, student should be able to:
1. Compute the resultant of system of forces in plane and space acting on bodies.
2. Use scalar and vector analytical techniques for analysing forces in statically determinate structures
3. Analyse equilibrium problems with friction.
4. Apply transfer theorems to determine properties of various sections.
5. Apply basic knowledge of maths and physics to solve real-world problems
6. Understand basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts)
7. Understand basic dynamics concepts – force, momentum, work and energy;
8. Analyse equilibrium of connected bodies virtual work method.
9. Predict motion parameters of bodies under rectilinear, curvilinear and general plane motion

ME 232	Basic Mechanical Engineering	3L:0T:0P	3 credits

Course objectives:
1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To cover the basic principles of Thermodynamics
3. To demonstrate application of the laws of thermodynamics to wide range of systems.
4. To write steady flow energy equation for various flow and non-flow thermodynamic systems
5. To compute efficiencies of heat engines, power cycles etc.
6. To study the fundamentals of quantification and grade of energy
7. To demonstrate the interrelations between thermodynamic functions to solve practical problems.

Contents:

Module 1: Concepts of Thermodynamics (7 Hrs)

Macroscopic and Microscopic concepts; System and its classification; Thermodynamic state, properties, point and path functions, process and cycles; Thermodynamic equilibrium, Energy interactions (Work transfer and its different modes, Heat transfer); Zeroth law of thermodynamics.

Module 2: First law of Thermodynamics (7 Hrs)

First law of thermodynamics and its application to non-flow as well as flow processes; Perpetual motion Machine of First kind; Different forms of energies, concepts of internal energy, enthalpy, specific heats, Limitations of first law.

Module 3: Ideal and Real gases (7 Hrs)

Definition of Ideal gas, equation of state, universal and specific gas constants, perfect and semi-perfect gases. For various quasi-static processes: Evaluate heat, work, and change in internal energy, enthalpy. Definition of Real gas, Vander Waal's Equation and its constants in terms of critical properties, law of corresponding states, compressibility factor and chart.

Module 4: Second Law of Thermodynamics (8 Hrs)

Definition of direct and reversed heat engine (Refrigerator and heat pump), definition of thermal efficiency and COP; Second law of thermodynamics, equivalence of Kelvin-Planck and Clausius statements; Perpetual Motion Machine of Second Kind; Reversibility and Irreversibility, causes for Irreversibility; Carnot cycle; Absolute Thermodynamic Temperature scale.

Module 5: Entropy (7 Hrs)

Clausius theorem and inequality, Definition of entropy, entropy as a property, Two reversible adiabatic paths cannot intersect each other, Entropy change in reversible and Irreversible process, Principle of increase of entropy, Illustration of process on T-s diagram, Entropy generation in a closed system and open system, First and Second Laws combined relations.

Module 6: Availability and Exergy (6 Hrs)

Available and unavailable energy, concept of availability, availability of heat source at constant and variable Temperatures, Dead state, Exergy balance equation and Exergy analysis for non-flow and steady flow systems, Helmholtz and Gibbs function, second law efficiency.

Text Books/ References:

1. Yunus A. Cengel, Thermodynamics: An Engineering Approach, 8th Edition, McGraw - Hill Education, 2017.
2. Moran, Shappiro, Boettner and Bailey: Principles of Engineering Thermodynamics, 8e: Wiley
3. P. K. Nag, Engineering Thermodynamics, 6th Edition, McGraw - Hill Education, 2017.
4. Boegnakke and Sonntag: Fundamentals of Thermodynamics: 7e: Wiley
5. Rogers and Mayhew: Engineering Thermodynamics, 4e: Pearson Education
6. Basic Mechanical Engineering by Basant Agrawal & C. M. Agrwal, Wiley India Pvt. Ltd.
7. Elements of heat Engines (Vol I, II, III), R.C. Patel and C.J. Karamchandani, Acharya Publications, 2010

Course Outcomes:

On successful completion of this course, a student would be able to:

1. Develop the basic concepts of thermodynamic systems, point and path functions, equilibrium and fundamental laws of engineering thermodynamics.
2. Apply the energy balance to thermodynamic systems involving heat and work interactions to determine thermodynamic properties.
3. Evaluate the performance of energy conversion devices undergoing a thermodynamic process or cycle and entropy of system.
4. Analyze a thermodynamic system for Availability & Irreversibility
5. Calculate thermodynamics properties based on thermodynamics relations.

ME 233	Metrology and Measurements	3L:0T:0P	3 credits

Course objectives:

1. To understand standards of measurement Limits, Fits, Tolerance and Gauging
2. To describe measurement systems, errors and with sketches explain measurement of force torque and pressure.
3. To explain various types Comparators and their working principles
4. To describe with sketches interferometer, screw thread and gear measurement.
5. To describe various modifying and terminating devices / transducers.

Contents:

Module 1: Standards of measurement (8 Hrs)

Definition and Objectives of metrology, Standards of length International prototype meter, Wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), Slip gauges, Wringing Phenomena, Numerical problems on building of slip gauges, Principle of interchangeability and selective assembly limits of size, concept of limits of size, tolerances, compound tolerances, accumulation of tolerances, fits, types of fits and their designation, hole basis system, shaft basis system, classification of gauges, Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

Module 2: Measurements and measurement systems (6 Hrs)

Definition, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response times delay. Errors in measurement, classification of errors. Transducers- transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers.

Module 3: Modifying and terminating devices (8 Hrs)

Modifying devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers and telemetry. Terminating devices: mechanical, cathode ray oscilloscope, oscillographs, X-Y plotters.

Module 4: Comparators (10 Hrs)

Introduction to comparators, classification of comparators, mechanical comparators- Johnson Mikrokator, sigma comparators, dial indicator, optical comparators principles- Zeiss ultra-optimeter, electric and electronic comparators principles LVDT, pneumatic comparators- back pressure gauges, solex comparators. Angular measurement: bevel protractor, sine principle and use of sine bars, sine center, use of angle gauges (numerical on building of angles), and clinometers.

Module 5: Interferometer and screw thread, gear measurement (8 Hrs)
Interferometer, autocollimator. Optical flats. Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2- wire and 3-wire methods, best size wire. Tool maker's microscope, gear tooth terminology, use of gear tooth, Vernier caliper and micrometer.

Text Books/ References:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard, Pearson Education, 6th Edition. 2006.
2. Engineering Metrology, R.K. Jain, Khanna Publishers, 1994.
3. Mechanical Measurements and Metrology, T Chandrasekhar, Subash Stores, 2011

Course outcomes:
At the end of this subject students will be able to:
1. Design tolerances and fits for selected product quality.
2. Choose appropriate method and instruments for inspection of various gear elements and thread elements.
3. Understand the standards of length, angles, they can understand the evaluation of surface finish and measure the parts with various comparators

EC 231	Basic Electronic Engineering	3L:0T:0P	3 credits

Course objectives:
1. To understand working and applications of diodes and BJT.
2. To understand working and applications of Op-amps.
3. To understand working of the timer circuit, I.C 555 and its applications and different types of oscillator.
4. To understand different types of logic gates, logic circuits and arithmetic circuits.
5. To understand different types of flip-flops, shift registers and counters.
6. To understand basic analog and digital communication system with their different modulation techniques.

Contents:
Module 1: Semiconductor Devices and Applications (10 Hours)
Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

Module 2: Operational amplifier and its applications (7 Hours)
Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.

Module 3: Timing Circuits and Oscillators (6 Hours)
RC-timing circuits, IC 555 and its applications as a stable and mono stable multi-vibrator, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.

Module 4: Digital Electronics Fundamentals (10 Hours)
Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, demultiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.

Module 5: Electronic Communication Systems (7 Hours)
The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM, FM, PCM, ASK, FSK and PSK modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.

Text Books/ References:

1. Floyd," Electronic Devices" Pearson Education 9th edition, 2012.
2. R.P. Jain, "Modern Digital Electronics", Tata Mc Graw Hill, 3rd Edition, 2007.
3. Frenzel, "Communication Electronics: Principles and Applications", Tata Mc Graw Hill, 3rd Edition, 2001

Course Outcomes:
At the end of this course students will demonstrate the ability to:
1. Understand the principles of semiconductor devices and their applications.
2. Design an application using Operational amplifier.
3. Understand the working of timing circuits and oscillators.
4. Understand logic gates, flip flop as a building block of digital systems.
5. Learn the basics of Electronic communication system.

HU 231	Economics for Engineers	2L:0T:0P	2 Credits

Course objectives:
1. To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions
2. To explain engineering economics decision making process, state and explain the law of demand and supply, law of diminishing returns and solve problems on interest factors.
3. To explain the various cost concepts, cost estimation methods
4. To familiarise Monetary policy and banking system

Contents:
Module 1: Introduction to Economics (5 Hrs)
Definitions, Nature, Scope, Difference between Microeconomics & Macroeconomics Theory of Demand & Supply; meaning, determinants, law of demand, law of supply, equilibrium between demand & supply Elasticity; elasticity of demand, price elasticity, income elasticity, cross elasticity

Module 2: Theory of production, Cost and Break even analysis (5 Hrs)
production function, meaning, factors of production (meaning & characteristics of Land, Labour, capital & entrepreneur), Law of variable proportions & law of returns to scale Cost; meaning, short run & long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost. Break even analysis; meaning, explanation, numerical

Module 3: Markets (5 Hrs)
Meaning, types of markets & their characteristics (Perfect Competition, Monopoly, Monopolistic Completion, Oligopoly) National Income; meaning, stock and flow concept, NI at current price, NI at constant price, GNP, GDP, NNP,NDP, Personal income, disposal income.

Module 4: Basic economic problems (5 Hrs)
Poverty-meaning, absolute & relative poverty, causes, measures to reduce Unemployment: meaning, types, causes, remedies Inflation; meaning, types, causes, measures to control

Module 5: Money and Banking (5 Hrs)
Money; meaning, functions, types, Monetary policy- meaning, objectives, tools, fiscal policy-meaning, objectives, tools Banking; meaning, types, functions, Central Bank-RBI; its functions, concepts; CRR, bank rate, repo rate, reverse repo rate, SLR.

Text Books/ References:

1. James L Riggs, Engineering Economy, McGraw Hill, 2002.
2. Gerald J Thuesen, Engineering economy, Prentice-Hall-India, Pvt Ltd, 2002.
3. Engineering Economics, R.Paneerselvam, PHI publication
4. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning
5. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications

Course Outcomes:
At the end of this course, students will learn
1. Basic understanding of Economics such as concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions
2. Understand the monetary policy, banking system and markets characteristics.

EC 231P	Basic Electronics Lab.	0L:0T:3P	1.5 credits

Course objective:
1. Know broadly the concepts and functionalities of the electronic devices, tools and instruments.
2. Understand use, general specifications and deploy abilities of the electronic devices and assemblies.
3. Confidence in handling and usage of electronic devices, tools and instruments in engineering applications.

List of Experiments:
1. Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Switches (SPDT, DPDT and DIP), Bread Boards and Printed Circuit Boards (PCBs); Identification, Specifications, Testing of Active Devices – Diodes, BJTs, Power Transistors, SCRs and LEDs.
2. Study and Operation of Digital Multi Meter, Function / Signal Generator, Regulated Power Supply (RPS), Cathode Ray Oscilloscopes; Amplitude, Phase and Frequency of Sinusoidal Signals using Lissajous Patterns on CRO; (CRO).
3. Experimental Verification of PN Junction Diode Characteristics in Forward Bias and Reverse Bias

4. Zener Diode Characteristics and Zener Diode as Voltage Regulator,
5. Study of BJT characteristics and biasing.
6. Study of Half Wave and Full Wave Rectifiers, Regulation with Filters,
7. Study of BJT as an amplifier.
8. Study of feedback amplifiers.
9. Study of RC phase shift oscillator, Wien bridge oscillator and LC/Crystal oscillator.
10. Study of Adder, Subtractor, Voltage Follower and Comparator using Operational Amplifier; Design of Astable and Monostable Multivibrators using 555 Timer.
11. Study of Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs);
12. Study of Truth Tables and Functionality of Flip-Flops – SR, JK and D Flip-Flop ICs;
13. Study of Serial-In-Serial-Out and Serial-In-Parallel-Out Shift operations using 4-bit/8-bit Shift Register ICs;
14. Study of Functionality of Up-Down / Decade Counter ICs.

Course outcomes:
After completion of the course students will be able to:
1. Plot the characteristics of electronic devices and understand their behaviour.
2. Design, construct and test amplifier circuits and interpret the results.
3. Design and test rectifiers with filters.
4. Design BJT and FET amplifiers and oscillators.
5. Understand digital logic designs.

ME 231P	Workshop practice II	0L:0T:2P	1 credits

Course objective:
1. To provide students with the knowledge and necessary skills to perform sand testing and preparation of moulds.
2. To provide students with the knowledge and necessary skills to perform metal forging operations and sheet metal work.

Contents:
Module 1: Testing of Moulding sand and Core sand (4 Hrs)
Preparation of sand specimen's and conduction of the following tests:
1. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2. Permeability test
3. Core hardness & Mould hardness tests.
4. Sieve Analysis to find Grain Fineness number of Base Sand
5. Clay content determinations in Base Sand

Module 2: Production of simple mechanical models (4 Hrs)
Cutting of V Groove/ dovetail / Rectangular groove using a shaper; Cutting of Gear Teeth using Milling Machine.

Module 3: Foundry Practice (6 Hrs)
Use of foundry tools and equipment; Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes); Preparation of one casting (Aluminum or cast iron-Demonstration only)

Module 4: Forging Operations (6 Hrs)
Calculation of length of the raw material required to do the model; Preparing minimum three forged models involving upsetting, drawing and bending operations: Out of these three models, at least one model is to be prepared by using Power Hammer.

Module 5: Sheet Metal Work (4 Hrs)
Preparation of four models involving development of surfaces of regular solids, transition pieces and trays.

Course outcomes:
Upon completion of this course, students should be able to:
CO1: Demonstrate the knowledge and necessary skills to perform sand testing and preparation of moulds.
CO2: Demonstrate the knowledge and necessary skills to perform metal forging operation and sheet metal work.

8.3 Detailed Contents for B.E. 4th semester (Mechanical) Papers

MA 241	Numerical Methods & Computation	3L:0T:0P	3 credits

Courses objectives:
The main objective of this course is:
1. Introduction to Computer arithmetic and errors
2. Introduction to solution of Algebraic and Transcendental equation, Linear System of equations and differential equations
3. Introduction to Eigen values and Eigen vectors.

Contents:
Module 1: Accuracy and Errors in Computation (6 Hrs)
Basic concepts on accuracy of numbers, significant figures, rounding of numbers, Errors representation-Inherent and truncation, Absolute and relative errors, errors in the approximation and series approximation of functions

Module 2: Solution of Algebraic and Transcendental Equations (9 Hrs)
Bisection, Regula-Falsi method, Newton-Raphson and iterative methods with their convergence conditions, Generalizations of Newton-Raphson and iterative methods to simultaneous non-linear equations

Module 3: Solution of Linear System of Equations (9 Hrs)
Gaussian elimination method with partial pivoting, Factorization method, Matrix Inverse method, Gauss-Jacobi and Gauss-Siedel iterative methods, Fitting of curve by method of least square

Module 4: Numerical solution of Differential Equations (10 Hrs)
Picard's and Taylor series, Euler's method and its modified form, Runge-Kutta methods, Solution of two-point boundary value problems using finite difference: One dimensional parabolic equations-Schmidt method, Crank-Nicolson method; Elliptic equations-Solution of Laplace equation-Jacobi's and Guass-Siedel methods; Hyperbolic Equations: Solution of wave equation

Module 5: Eigen values and Eigen-vectors problems (6 Hrs)
Gershgorin's theorem (without proof) with simple problems, Power method for dominant Eigen-values, Jacobi and given methods for symmetric matrices

Text Books & References:

1. Shartry S.S., "Numerical Methods", Prentice Hall Inc., India.
2. Noble Ben, "Numerical Methods", New York International Publications, New York.
3. Stanton Ralph G., "Numerical Methods for Engineering", Englewood Cliffs, N.J., Prentice Hall Inc.
4. Buckingham R.A. "Numerical Methods", Sir Isaac Pitman Sons. Ltd. London.
5. Grewal B.S., "Numerical Methods", Khanna Pub., New Delhi.
6. C.F.GeraldandP.O.Wheatley,"AppliedNumericalAnalysis",AddisonWesley,
7. J.H. Wilkinson, "Algebraic Eigen –Value Problems", Oxford Univ. Press
8. G.D. Smith, "Numerical Solution of Partial Differential Equations", Oxford Univ. Press

Course outcomes:

At the end of the course students will be able to:

1. Understand fundamental arithmetic operations and Errors Estimation.
2. Solve algebraic and transcendental equations.
3. Solve the system of linear equations of various methods.
4. Solve the differential equations.
5. Determine the Eigen values and Eigen vectors.

ME 241	Strength of Materials	3L:0T:0P	3 credits

Course objectives:

1. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
2. To calculate the elastic deformation occurring in various simple geometries for different
   types of loading

Contents:

Module 1: Deformation in solids (9 Hrs)

Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.

Module 2: Shear force and Bending Moment (10 Hrs)

Beams and types, transverse loading on beams- shear force and bend moment diagrams. Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

Module 3: Moment of Inertia (9 Hrs)

Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.

Module 4: Torsional stress (9 Hrs)

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

Module 5: Stresses (9 Hrs)

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure

Text Books/ References:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.

Course outcomes:
On successful completion of the course, the student will be able to,

1. Observe the different types of material behaviour such have elastic, plastic, ductile and brittle to predict the strength of materials.
2. Visualize the concept of moment of inertia for different shapes.
3. Apply shear force and bending moment diagrams to analyse the resistance offered by the beam and able to solve practical problems in real world scenario.

ME 242	Materials Engineering	3L:0T:0P	3 credits

Course objectives:

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
2. To provide a detailed interpretation of equilibrium phase diagrams
3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Contents:

Module 1: Crystal Structure (6 Hrs)

Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Module 2: Mechanical Property measurement (6 Hrs)

Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

Module 3: Static failure theories (8 Hrs)

Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to nondestructive testing (NDT).

Module 4: Alloys, substitutional and interstitial solid solutions- Phase diagrams (6 Hrs)

Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

Module 5: Heat treatment of Steel (6 Hrs)

Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.

Module 6: Metal Alloys (8 Hrs)
Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based super alloys and Titanium alloys.

Text Books/ References:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011

1. Apply dimensional analysis to predict physical parameters that influence the flow in fluid mechanics.

Course outcomes:
On successful completion of the course, the student will be able to,
1. Interpret the atomic arrangement and structure of metals and alloys.
2. Describe the iron-carbon equilibrium diagram and phase diagrams.
3. Explain the behavior of material upon heat treatment from iron-carbon equilibrium diagram and predict the behavior of materials upon impact, fracture and creep testing.

ME 243	Applied Thermodynamics	3L:1T:0P	4 credits

Course objectives:
1. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
2. To familiarize various types of steam generators
3. To analyse the performance of steam turbines
4. To learn the about reciprocating compressors with and without intercooling
5. To familiarize application of the concepts of thermodynamics in vapour power, gas power cycles
6. To teach them principles of compressors and turbines.

Contents:
Module 1: Thermodynamic Relations (6 Hrs)
The Maxwell relations, Volume expansivity, Isothermal Compressibility; Energy relations for simple system, TdS equations, Relationships involving specific heats, enthalpy, entropy; Joule –Thomson coefficient, Clausius Clapeyron Equation.

Module 2: Properties of Pure Substance (10 Hrs)
Definition of pure substance, phase change of a pure substance, p-T (Pressure-Temperature) diagram for a pure substance, p-V-T(Pressure-Volume-Temperature) surface, phase change terminology and definitions, property Diagrams in common use, Formation of steam, Important terms relating to steam formation, Thermodynamic properties of steam and steam tables, External work done during evaporation, Internal latent heat, Internal energy of steam, Entropy of water, Entropy of evaporation, Entropy of wet steam, Entropy of superheated steam, Enthalpy-Entropy (h-s) charts for Mollier diagram.

Module 3: Steam Generators (5 Hrs)
Classification of steam generators, mountings and accessories; draft systems; Working of steam generators with at least one low and high pressure steam generators each.

Module 4: Steam Turbines (6 Hrs)
Steam Turbine – Impulse and Reaction principle.
Gas Turbine – Open and Closed cycle gas turbine, Reheating, Regeneration and Intercooling

Module 5: Reciprocating Air Compressors (8 Hrs)
Single stage compressor – computation of work done, isothermal, adiabatic and Polytropic efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram, Multistage compression with intercooling done, Condition for maximum efficiency, Inter cooling and after cooling.

Module 6: Condensers (5 Hrs)
Classification of condenser- Jet, Evaporative and surface condensers; Vacuum and its measurement- Vacuum efficiency- Sources of air leakage in condensers- Condenser efficiency; Daltons law of partial pressures.

Module 7: Vapor and Gas power cycles (8 Hrs)
Vapour power cycle- Rankine cycle with superheat, reheat and regeneration; Gas power cycles-Air standard Carnot, Otto, Diesel and Dual cycles; Gas powercycle- Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles

Text Books/ References:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. P. K. Nag, Engineering Thermodynamics, 6th Edition, McGraw - Hill Education, 2017.
5. Yunus A. Cengel, Thermodynamics: An Engineering Approach, 8th Edition, McGraw - Hill Education, 2017.
6. P.L. Ballaney, Thermal Engineering, Khanna Publishers, 2000.
7. Thermo Dynamics, S. C. Gupta, 1st Edition, Pearson Edu. Pvt. Ltd., 2005.

Course outcomes:
On successful completion of the course, the student will be able to-
1. Apply thermodynamics laws in engineering applications
2. Solve thermodynamic problems using Mollier diagram, steam and gas tables/charts
3. Classify various steam generators, steam turbines, reciprocating air compressor and condenser
4. Can analyse energy conversion in various thermal devices such as steam generators, steam turbines, condenser and reciprocating compressors
5. Analyse performance of various vapour power cycles in context to power plant

ME 244	Fluid Mechanics	3L:1T:0P	4 credits

Course objectives:

1. To learn about the application of mass and momentum conservation laws for fluid flows
2. To understand the importance of dimensional analysis
3. To obtain the velocity and pressure variations in various types of simple flows

Contents:

Module 1: Introduction (4 Hrs)

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility, and surface tension.

Module 2: Pressure and fluid statics (8 Hrs)

Pressure, pressure measurement devices, introduction to fluid statics- Pascal law and Hydrostatic law; hydrostatic forces on submerged plane and curved surfaces, Buoyancy and stability, fluids in rigid-body motion.

Module 3: Fluid Kinematics and Dynamics (10 Hrs)

Kinetics: Lagrangian and Eulerian descriptions, flow patterns and flow visualization, plots of fluid flow data, control volume, Continuity equation, Vorticity and Rotationality.

Dynamics: Conservation of mass, Euler's equation of motion, Bernoulli equation, Applications of Bernoulli equation.

Module 4: Dimensional analysis and modelling (8 Hrs)

Dimension of physical quantities, dimensional homogeneity, Dimensionless groups, Buckingham π theorem, Rayleigh's method of Indices, Important force-ratio dimensionless numbers, Similitude – types of similitude, modelling criteria.

Module 5: Internal flow (10 Hrs)

Laminar and turbulent flow, entrance region, laminar flow through circular conduits and circular annuli, measurement of viscosity, turbulent flow in pipes, Moody's diagram, Concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, Minor losses in pipes, energy line and hydraulic gradient line, power transmission through pipes, pipes in series and parallels.

Module 6: Flow through open channels (6 Hrs)

Classification of open-channel flow, Froude number and wave speed, specific energy, conservation of mass and energy equations, uniform flow in channels, best hydraulic cross-sections, gradually varied flow, rapidly varied flow, Hydraulic jump.

Text Books & References:

1. V.L. Streeter and E.B. Wylie, Fluid Mechanics, McGraw Hill.
2. P.N. Modi and S.M. Seth, Hydraulics and Fluid Mechanics, Standard Book House.
3. B.F. White, Fluid Mechanics, McGraw Hill.
4. K S. Massey, Mechanics of Fluids, Van Nostrand Reinhold Co.
5. J. Frabzini, Fluid Mechanics with Engineering Applications, McGraw Hill.
6. J.H. Spurk, Fluid Mechanics – Problems and Solutions, Springer.

Course outcomes:

On successful completion of the course, the student will be able to:

1. Identify and obtain the values of fluid properties and relationship between them and understand the principles of continuity, momentum, and energy as applied to fluid motions.
2. Recognize these principles written in form of mathematical equations.
3. Apply dimensional analysis to predict physical parameters that influence the flow in fluid mechanics.

HU 241	Universal Human Values-II	2L:1T:0P	3 credits

Course objectives:

The objectives of the course are:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being,family, society and nature/existence
3. Strengthening of self-reflection
4. Development of commitment and courage to act

Contents:

The course has 28 lectures and 14 practice sessions in 5 modules:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for ValueEducation

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correctpriority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of thecurrent scenario
6. Method to fulfill the above human aspirations: understanding and living inharmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - happiness and physicalfacility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer andenjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life; Differentiate between prosperity and accumulation; Discuss program for ensuring health vs dealing with disease

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention andcompetence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships; Discuss with scenarios. Elicit examples from students' lives

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Co-existence

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfillment among the four orders of nature-recyclability and self-regulation in nature
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role oftechnology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and HumanisticUniversal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Text Books:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

MODE OF CONDUCT (2L: 1T:0P 3 credits)

Lectures hours are to be used for interactive discussion, placing the proposal about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions.

While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements. In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration. Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

 # This course is to be taught by faculty from every teaching department, including HSS faculty.

Teacher preparation with a minimum exposure to at least one 8-day FDP on Universal Human Values is deemed essential.

ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor	: 10 marks
Self-assessment	: 10 marks
Assessment by peers	: 10 marks
Socially relevant project/Group Activities/Assignments	: 20 marks
Semester End Examination	: 50 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

OUTCOME OF THE COURSE:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would becomemore responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life,at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow itup by

a) Faculty-student or mentor-mentee programs throughout their time with the institution
b) Higher level courses on human values in every aspect of living. E.g. as a professional

ME 241P	Basic Material Testing Laboratory	0L:0T:2P	1 credit

Course objectives:

1. To understand the measurement of mechanical properties of materials
2. To understand the deformation behavior of materials
3. To understand the kinematic and dynamic characteristics of mechanical devices

Contents:

1. Uniaxial tension test on mild steel rod
2. Torsion test on mild steel rod
3. Impact test on a metallic specimen
4. Brinell and Rockwell hardness tests on metallic specimen
5. Bending deflection test on beams
6. Strain measurement using Rosette strain gauge

Course outcomes:

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

1. Describe the behavior of materials upon normal external loads.
2. Predict the behavior of the material under impact conditions.
3. Recognize the mechanical behavior of materials.

ME 242P	Computer Aided Drafting Lab - I	0L:0T:2P	1 credit

Course objectives:
To provide an overview of how computers can be utilized in mechanical component design

Contents:
Module 1: Fundamentals of Computer Graphics (6 Hrs)
Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, Coordinate systems, 2D and 3D transformations, viewing transformation.

Module 2: Geometric Modeling (10 Hrs)
Representation of curves - Hermite curves, Bezier curves, B-spline curves, rational curves; Techniques of surface modelling- plain, angular, curved, Bezier and B-spline surfaces; Solid modelling techniques; Visual realism- hidden line-surface-solid removal, shading, colouring, computer animation.

Module 3: Assembly of parts (8 Hrs)
Assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interference checking CAD standards- Graphical Kernel System (GKS), standards for exchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., and Communication standards.

Text Books/ References:

1. Rogers, David F. "Mathematical elements for computer graphics." (1990)
2. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
3. C. Mc Mohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
4. W. M. Neumann and R.F. Sproul, Principles of Computer Graphics, McGraw Hill, 1989.
5. D. Hearn and M.P Baker, Computer Graphics, Prentice Hall Inc., 1992.

Course outcomes:
At the end of the course, the students will be able to explain the concepts of computer graphics, geometric modelling, and assembly of parts.

NC 241	Organizational Behaviour	3L:0T:0P	0 credit

Contents:
Module-1: OB & Learning (6 Hrs)
Learning objectives, Definition & Meaning, Why to study OB, An OB model, New challenges for OB Manager. Nature of learning; How learning occurs, Learning & OB Case Study Analysis.

Module-2: Personality, Perception and Motivation (10 Hrs)
Meaning & Definition, Determinants of Personality, Personality Traits, personality & OB
Meaning & Definition of Perception, Perceptual process, Importance of Perception in OB
Nature & Importance of Motivation, Herzberg's Two Factor theory, Maslow's Need Hierarchy theory, Alderfer's ERG theory,Case Study Analysis

Module-3 (12 Hrs)

COMMUNICATION: Importance, Types, Barriers to communication, Communication as a tool for improving Interpersonal Effectiveness

GROUPS IN ORGANISATION: Nature, Types, Why do people join groups, Group Cohesiveness & Group Decision Making- managerial Implications, Effective Team Building

LEADERSHIP: Leadership & management, Theories of leadership- Trait theory, Behavioral Theory, Contingency Theory, Leadership & Followership, How to be an Effective Leader

CONFLICT: Nature of Conflict & Conflict Resolution

TRANSACTIONAL ANALYSIS: An Introduction to Transactional Analysis, Case Study Analysis

Module-4 (8 Hrs)

ORGANISATIONAL CULTURE: Meaning & Definition, Culture & Organizational Effectiveness

HUMAN RESOURCE MANAGEMENT: Introduction to HRM, Selection, Orientation, Training & Development, Performance Appraisal, Incentives

ORGANISATIONAL CHANGE: Importance of Change, Planned Change & OB Techniques

INTERNATIONAL OB: An Introduction to Individual & Interpersonal Behaviour in Global Perspectives Case Study Analysis

8.4 Detailed Contents for B.E. 5th semester (Mechanical) Papers

ME 351	Kinematics and Theory of Machines	3L:0T:0P	3 credits

Course objectives:

1. To understand the kinematics and rigid- body dynamics of kinematically driven machine components
2. To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link
3. To be able to design some linkage mechanisms and cam systems to generate specified output motion
4. To understand the kinematics of gear trains

Contents:

Module 1: Introduction (8 Hrs)

Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms

Module 2: Velocity and acceleration analysis of mechanisms (8 Hrs)

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centres, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics, Coincident points- Coriolis component of acceleration- introduction to linkage synthesis three position graphical synthesis for motion and path generation.

Module 3: Cams (8 Hrs)

Classification of cams and followers- Terminology and definitions- Displacement diagrams. Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.

Module 4: Gears (8 Hrs)

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

Module 5: Belts, Chains and Brakes (8Hrs)

Belts: Introduction, types and all other fundamentals of belting, Dynamic analysis – belt tensions, condition of maximum power transmission Chains: types of chains, chordal action, variation in velocity ratio, length of chain Brakes: Introduction, types and working principles, Introduction to braking of vehicles, friction in brakes.

Text Books/ References:

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. Cleghorn W.L., Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East West Pvt. Ltd, New Delhi, 1988.

Course outcomes:

On successful completion of this course the student will be able to,

1. Synthesize and analyze 4 bar mechanisms
2. Understand cams and gears

ME 352	Fluid Machinery	3L:1T:0P	4 credits

Course objectives:

1. To differentiate the positive displacement Machines and Turbo machines, and application of I and II law of TD and Dimensional Analysis to Turbo machines.
2. To understand the energy transfer in impulse and reaction type machines along with Euler's energy equations and the concept of inlet and outlet velocity triangles for the power developing and power absorbing turbo machines.
3. To know the concept of working principles, working proportions along with velocity triangles and apply the knowledge to solve the numerical problems of Hydraulics Turbines.
4. To understand working principle and classification of Pumps and apply the knowledge to solve the problems numerical of Pumps
5. To understand and analyze the working principles, pressure and velocity compounding and condition for maximum utilization factor for multistage steam turbines and to solve the numerical problems.

Contents:

Module 1: Introduction (12 Hrs)

Definition, comparison between turbo machines and positive displacement machines, application of I and II law of thermodynamics to turbo machine; Dimensional analysis as applied to turbo machines, performance characteristics, the flow coefficient, speed ratio, speed coefficient, power coefficient, the specific speed; Unit quantities (unit rate of flow, unit speed, unit power), specific speed of turbines and pumps-selection of turbines; Similarity condition of model and prototype of hydraulic turbines and pumps.

Module 2: Energy Transfer in Turbo Machines (12 Hrs)

The Euler turbine equation, fluid energy changes, impulse and reaction types, utilization factor for different types of turbines, condition for maximum utilization factor for impulse and reaction stages, degree of reaction, degree of reaction for impulse and reaction types; Velocity triangle for centrifugal and axial compressor stages.

Module 3: Hydraulic turbines (12 Hrs)

Hydraulic power utilization, classification of hydraulic turbines, the Pelton wheel turbine efficiency and volumetric efficiency, working proportions of Pelton wheels; Francis and Deriaz turbines; velocity triangles and efficiencies; Design on Francis turbine for slow speed; The draft tube, propeller and Kaplan turbines, Application of aero foil theory to propeller blades.

Module 4: Centrifugal and axial pumps (10 Hrs)

Definition, working principle, classification, Definition of terms used in the design of centrifugal pumps like mano metric head, Suction head, Delivery head, Mano metric efficiency; Minimum starting speed of centrifugal pumps, Types of casing, Cavitation, Characteristic curves; Axial flow pumps.

Text Books/ References:

1. Principles of Turbo machinery by D.G Shepherd.
2. Turbo machinery An Introduction to energy conversion, Vol III-by V Kadambi and Manohar Prasad.
3. Turbines, compressors and Fans by S.M. Yahya, Tata Mcgraw Hill.
4. Hydraulic Machinery by Bansal.

Course Outcomes:

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

1. Explain basic concepts of turbo machines and visualize dimensional analysis.
2. Describe the working of Pelton, Francis and Kaplan along their performance parameters.
3. Discuss the operation of centrifugal pumps, centrifugal and axial compressors.
4. Associate the effect of cavitation in turbines and pumps.
5. Express the basic cycles and calculations involved in the operation of steam and gas turbines.

ME 353	Manufacturing Process I	3L:1T:0P	4 credits

Course objectives:

1. To define various terms associated with casting processes.
2. To explain methods of construction of moulds.
3. To examine the principles associated with basic operations involving metal forming processes.

Contents:

Module 1: Sand moulding (10 Hrs)

Introduction to metal casting process, moulding sand, constituents, properties, and testing, Pattern, Core, and Allowances. Moulding process, gating system, venting, moulding methods: Sand moulding, Plaster moulding, metallic moulding, and Loam moulding.

Module 2: Metal casting (10 Hrs)

Metal casting process, sand casting, investment casting, pressure die casting, centrifugal casting, and continuous casting. Cast structures, fluid flow and heat transfer. Casting quality, defects and remedies. Furnaces: Resistance furnace, induction furnace, Electric arc furnace and Cupola furnace.

Module 3: Metal forming – Bulk deformation (10 Hrs)

Overview of metal forming, Forging: theory and analysis, forging methods, and defects; Rolling: flat rolling and its analysis, rolling methods, and defects; Extrusion: theory and analysis, types and defects; Wire, bar, and tube drawing; swaging.

Module 4: Bulk deformation process – Sheet metal working (10 Hrs)

Sheet metal working, Cutting operations: theory and analysis, shearing, blanking, punching; Bending operations: theory and analysis, V-Bending, Drawing: theory and analysis.

Text Books/ References:

1. Manufacturing Process-I, Dr.K. Radhakrishna, Sapna Book House, 5th Revised.
2. Manufacturing & Technology: Foundry Forming and Welding", P.N.Rao, 3rd Ed., Tata McGraw Hill, 2009.
3. Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed.PearsonEdu. 2006.

4. Manufacturing Technology, Serope Kalpakjian, Steuen. R. Sechmid, Pearson Education Asia, 5th Ed. 2006.
5. Principles of Metal Casting, Heine, Rosenthal & others – TMH2001.

Course outcomes:

Upon completion of this course, students should be able to:

CO1: Describe the fundamentals of foundry and identify different types of pattern, gating systems and core making.

CO2: Explain basic concepts used in construction of moulds and analyze the working of various moulding machines and melting furnaces.

CO3: Explain various metal forming processes.

ME 354	Heat and Mass Transfer	3L:1T:0P	4 credits

Course objectives:

1. The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
2. Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
3. The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Contents:

Module 1: Introduction and Conduction (12 Hrs)

Importance of heat transfer, Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, thermal conductivity, concept of conduction and film resistances, critical insulation thickness, heat transfer through pin fins, Steady State Two dimensional heat conduction.

Module2: Convection (8 Hrs)

Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Module 3: Radiation (10 Hrs)

Basic theory of radiation heat transfer, Interaction of radiation with materials, definitions of radiative properties (reflectivity, absorptivity, transmissivity, emissivity), Planck law of radiation, Stefan Boltzmann's law, black and gray body radiation, Kirchoff's law of Radiation, Wien's Displacement law, Calculation of radiation heat transfer between two black bodies; Special properties of the view factors.

Module 4: Heat exchangers (8 Hrs)

Types of heat exchangers, Analysis of heat exchangers using both LMTD and ε- NTU methods; Introduction and application of Heat Pipe

Module 5: Boiling and condensation heat transfer (4 Hrs)

Boiling and Condensation heat transfer, Types of condensation process, Pool boiling curve

Module 6: Mass transfer (4 Hrs)
Introduction mass transfer, Similarity between heat and mass transfer

Text Books/ References:

1. Bejan, Heat Transfer John Wiley, 1993
2. J.P. Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P. Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. Massoud Kaviany, Principles of Heat Transfer, John Wiley, 2002
5. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002
6. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age International Publishers

Course outcomes:
After completing the course, the students will be able to
1. Formulate and analyse a heat transfer problem involving any of the three modes of heat transfer
2. Obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer
3. Estimate the insulation needed to reduce heat losses where necessary and analyse devices such as heat exchangers and also

ME 355	Design of Machine Elements I	3L:0T:0P	3 credits

Course objectives:
This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice. The objectives are as follows:

1. Understand the stresses in machine members due to various types of loads and failure of components according to theories of failures.
2. Analyse the components under variable loading for infinite and finite life.
3. Design of machine elements under torsion, bending, axial loads and a combination of these.
4. Design of various joints and fasteners for a given load to be transmitted
5. Design of various screws, riveted and welded joints

Contents:
Module1: Introduction (8 Hrs)
Design considerations of Machine Elements; Materials used in machine design and their specifications according to Indian Standards. Codes and standards used in design; Important mechanical properties of materials used in design; Preferred numbers; Manufacturing considerations in design; Review of types of loads and simple stresses; Stresses due to Bi-axial and Tri-axial loads; Factor of safety, Theories of failures, Design of components subjected to impact loading.

Module 2: Design for fatigue (8 Hrs)
Fluctuating stresses, fatigue strength and endurance limit Stress concentration factor and Notch sensitivity. Factors affecting fatigue strength. S-N diagram, Soderbergand Modified Goodman's diagrams for fatigue design. Cumulative fatigue -Miner's rule.

Module 3: Design of shafts (8 Hrs)
Solid, hollow and splined shafts under torsion and bending loads. ASME code for design of shafts. Design of keys. Design of couplings -Muff, Split muff, Flange, Flexible, Marine type couplings. Design of pulleys and chain drives.

Module 4: Design of bolts, nuts, and joints (8 Hrs)
Design of Bolts and nuts, locking devices for nuts, bolts of uniform strength, bolted joints under eccentric loads. Design of Cotter and Knuckle joints.

Module 5: Design of screws (8 Hrs)
Design of power Screws and screw jack. Differential and Compound Screws. Design of riveted and welded joints under direct and eccentric loads.

Text Books/ References:

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. Bhandari, V. B. *Design of machine elements*. Tata McGraw-Hill Education, 2010.
3. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
4. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
5. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
6. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

Course outcomes:
On successful completion of the course, the student will be able to
1. Describe the design process, material selection, calculation of stresses and stress concentrations under variable loading.
2. Design the solid, hollow shafts and to finding the critical speeds.
3. Differentiate between rigid and flexible couplings and also the knuckle joints.
4. Analyze bolted joints in eccentric loading.
5. Examine the welded joints for vessels and steel structures also have design knowledge on sliding and rolling contact bearing.
6. Summarize the knowledge in helical, leaf, disc and torsional springs and also in lever

ME 351P	**Mechanical Engineering Laboratory II (Design)**	**0L:0T:2P**	**1 credit**

Course objectives:
1. To practically relate the concepts discussed in design of machine elements and kinematics and theory of machines course
2. To visualize and understand the concepts of natural frequency.

Contents:
1. Velocity ratios of simple, compound, epicyclic and differential gear trains
2. Kinematics of four bar, slider crank, crank rocker, double crank, double rocker and oscillating cylinder mechanisms
3. Cam & follower and motion studies
4. Balancing of rotating masses.
5. Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)
6. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Hartnell Governor.
7. Determination of pressure distribution in Journal bearing

8. Experiments on Gyroscope
9. Determination of natural frequency of a spring mass system.
10. Determination of critical speed of rotating shaft.

Course Outcomes:

Students who have undergone the course will be able to

1. To practically relate the concepts discussed in Design of machine elements and Kinematics and theory of machines.
2. To explain the concepts of natural frequency.

ME 352P	Computer Aided Drafting Lab - II	0L:0T:2P	1 credit

Course Objectives:

1. To introduce the student to the basic tools of computer-aided design (CAD) and computer aided manufacturing (CAM).
2. To expose the student to contemporary computer design tools for aerospace and mechanical engineers.
3. To prepare the student to be an effective user of a CAD/CAM system.

Contents:

Module 1: Introduction to CAD packages (4 Hrs)

Overview of Computer Graphics covering, listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];

Module 2: Basic construction (5 Hrs)

Customization & CAD Drawing consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Module 3: Construction practice (6 Hrs)

Annotations, layering & other functions covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multi view, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Module 4: Advanced applications (6 Hrs)
Demonstration of a simple team design project that illustrates Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; simple geometry and machine parts.

Text/Reference Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
4. (Corresponding set of) CAD Software Theory and User Manuals

Course outcomes:
On successful completion of the course, the student will be able to,
1. Explain lifecycle of a product and the role of computer-aided design (CAD) in product development.
2. Describe the concepts of geometric and solid modelling.
3. Visualize geometric models through animation and transform them into real world systems.

NC 351	Environmental Science	3L:0T:0P	0 credit

Course Objectives:
1. Understanding the importance of ecological balance for sustainable development.
2. Understanding the impacts of developmental activities and mitigation measures.
3. Understanding the environmental policies and regulations

Contents:
MODULE-I: Ecosystems:
Definition, Scope, and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity, Field visits.

MODULE-II: Natural Resources:
Classification of Resources: Living and Non-Living resources, water resources: use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, Land resources: Forest resources, Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

MODULE-III: Biodiversity And Biotic Resources:
Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats

to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

Text Books:

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
2. Environmental Studies by R. Rajagopalan, Oxford University Press.

Reference Books:

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
4. Environmental Studies by Anubha Kaushik, 4th Edition, New age international publishers.
5. Text book of Environmental Science and Technology – Dr. M. Anji Reddy 2007, BS Publications.
6. Introduction to Environmental Science by Y. Anjaneyulu, BS.Publications.

Course Outcomes:

Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

8.5 Detailed Contents for B.E. 6th Semester (Mechanical) Papers

ME 361	Manufacturing Process - II	3L:0T:0P	3 credits

Course objectives:

1. Understand principles of material removal by cutting, effect of material properties, tool shape on chip formation and select tool for a given set of cutting conditions and economic considerations
2. Learn constructional and operational features of lathe, drilling machines.
3. Learn constructional and operational features of shaper, planer and milling machines.
4. Classify and describe methods and applications of grinding and finishing processes and principles of various non-conventional processes.

Contents:

Module 1: Metal cutting (10 Hrs)

Introduction, chip formation, shear zone, orthogonal and oblique cutting, shear angle and its expressions, cutting tool materials, thermal aspects, machinability, tool wear and tool life, surface finish, cutting fluids, economics.

Module 2: Conventional machining processes and machine tools (8 Hrs)

Conventional machining processes: Turning, Drilling, Milling and finishing processes, Introduction to CNC machining. Machine tools: Basic elements of machine tools, support structures, power transmission, actuation systems, guide ways, general work holding methods. Lathe, Drilling machine, Shaper and Planar, Milling machine tool.

Module 3: Unconventional machining processes (10 Hrs)

Abrasive Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, Electrical Discharge Machining, Electro-chemical machining (ECM), Laser Beam Machining, Plasma Arc Machining and Electron Beam Machining

Module 4: Welding process (10 Hrs)

Definition, principles, classification. Arc Welding: Principle, Metal Arc welding, Flux Shielded Metal Arc Welding, Inert Gas Welding, Submerged Arc Welding and Atomic Hydrogen Welding processes. Gas Welding**:** Principle, Oxy – Acetylene welding, Chemical Reaction in Gas welding, Flame characteristics. Gas torch construction & working, forward and backward welding. Resistance welding: Principles, Seam welding, Butt welding, Spot welding and Projection welding. Non-conventional welding: Friction welding, Explosive welding, Thermit welding, Laser welding, Electron beam welding, ultrasonic welding.

Module 5: Additive manufacturing (3 Hrs)

Additive manufacturing: Rapid prototyping and rapid tooling.

Text Books:

1. Material and Processes in manufacturing by E Paul Degarmo & others PHI-2006
2. Manufacturing Engg., & Technology -By Serope Kalpakjian & others PEA 4e 2005
3. Metal forming – W.F. Hosford& Robert M Caddell, CU press 2011
4. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems by Mikell P. Groover
5. Materials and Processes in Manufacturing by Degarmo, Black & Kohser.

References Books:

1. Manufacturing science by Amitabha Ghosh & A K Malik, EWP2001
2. Deformation processing by W A Backofen, AW1973
3. Principles of industrial metal working processes by G W Rowe CBS2002

Course outcomes:

At the end of the course, the students will be able to

CO1: To apply the knowledge of forces, material properties, surface generation to understand production processes by material removal, cutting conditions and tool selection criteria with due consideration to cost and time involved

CO2: To analyse production processes for cutting flat features, grooves and profiles and select appropriate machine tools with understanding of construction, tooling and operations on them

CO3: To select suitable finishing operations and to perform them with the help of suitable machine tools, compare conventional with non-conventional production processes and use them depending on the need.

CO4: To apply the knowledge of welding process for selecting suitable process for fabricating simple to complicated parts.

ME 362	Internal Combustion Engines	3L:1T:0P	4 credits

Course objective:

1. To familiarize with the detail components of IC engines and their working
2. To familiarize with various important systems of IC engine such as ignition, injection, cooling, lubrication, etc.
3. To acquaint with the various methods for measurement of engine performance
4. To provide insight into the harmful effects of engine pollutants and its control

Contents:

Module 1: Introduction (4 Hrs)

Basic components and terminology of IC engines, classification and application of IC engines, working of four stroke/two stroke - petrol/diesel engine.

Module 2: Fuel Air Cycles and Actual Cycles (10 Hrs)

Assumptions for fuel–air cycles, Reasons for variation of specific heats of gases, change of internal energy and enthalpy during a process with variable specific heats, isentropic expansion with variable specific heats, effect of variable specific heats on Otto, Diesel and Dual cycle, dissociation, comparison of air standard and fuel air cycles, effect of operating variables, comparison of air standard and actual cycles, effect of time loss, heat loss and exhaust loss in Petrol and Diesel engines, valve and port timing diagrams.

Module 3: Fuels and its supply system for SI and CI engine (4 Hrs)

Important qualities of IC engine fuels, rating of fuels, Carburation, mixture requirement for different loads and speeds, simple carburetor and its working, types of carburetors, MPFI, types of injection systems in CI engine, fuel pumps and injectors, types of nozzles, spray formation.

Module 4: Ignition and Governing System (4 Hrs)

Battery and magneto ignition system, spark plug, firing order, quality, quantity & hit and miss governing.

Module 5: Supercharging (3 Hrs)
Objectives, Limitations, Methods and Types, Different arrangements of turbochargers and superchargers

Module 6: Combustion in SI and CI Engines (7 Hrs)
Stages of combustion in SI engines, abnormal combustion and knocking in SI engines, factors affecting knocking, effects of knocking, control of knocking, combustion chambers for SI engines, Stages of combustion in CI engines, detonation in C.I. engines, factors affecting detonation, controlling detonation, combustion chamber for SI and CI engine

Module 7: Engine Lubrication and Cooling (3 Hrs)
Lubrication of engine components, Lubrication system, Types of lubricants and their properties; Types of cooling systems –liquid and air cooled, comparison of liquid and air-cooled systems

Module 8: Testing and performance of IC engines (4 Hrs)
Measurement of Brake Power, Indicated Power, Frictional Power, Fuel Consumption, Air flow, BMEP, Performance characteristic of SI and CI Engine Effect of load and speed on Mechanical, Indicated Thermal, Brake Thermal and Volumetric efficiencies, Heat balance sheet

Module 9: Engine Emission and their control (2 Hrs)
Air pollution due to IC engines, Euro I to VI norms, HC, CO and NOx emission, catalytic convertor

Text/Reference Books:

1. A course in I.C. Engines, M. L. Mathur and R. P. Sharma, Dhanpat Rai Pub, 2001.
2. Internal Combustion Engines, Colin R. Ferguson C. John Wiley & Sons, 1986
3. I.C. Engines, Edward. F. Obert, Harper International edition, 1973.
4. Internal Combustion Engines, Ganeshan, Tata McGraw Hill, 2nd Edition, 2003.
5. Engineering Fundamentals of the I.C. Engine, Willard W. Pulkrabek. 1998.
6. Combustion Engine Process, Lichty, Judge 2000

Course outcomes:
At the end of the course, the students will be able to
1. Demonstrate the working of different systems and processes of S.I. engines
2. Demonstrate the working of different systems and processes of C.I. engines
3. Illustrate the working of lubrication, cooling and supercharging systems
4. Analyse engine performance
5. Illustrate emission norms and emission control

ME 363	Design of Transmission Systems	2L:1T:0P	3 credits

Course objectives:
To learn about the design procedures for mechanical power transmission components

Contents:
Module 1: Flexible transmission elements (8 Hrs)
Design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets

Module 2: Gear transmission (8 Hrs)
Speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears.

Module 3: Straight bevel gear (8 Hrs)
Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears; Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears.

Module 4: Gear box (8 Hrs)
Geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine tool applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications.

Module 5: Cam design (8 Hrs)
Cam design types: pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expanding rim clutches; Electromagnetic clutches; Band and Block brakes, external shoe brakes, internal expanding shoe brake.

Text Books:

1. Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.
2. Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
3. Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill, 2001.

Course Outcomes:
Upon completing this course the students will be able to design transmission systems for engines and machines.

ME 364	Industrial Engineering	2L:1T:0P	3 credits

Course objectives:
1. To provide the knowledge of basic principles of productivity & work study as a tool for increasing the efficiency and effectiveness of the organizational system.
2. To apply the basic knowledge of work system design.
3. To systematically examine the activities and processes involved in completing any given engineering task.
4. To question the sequence in the series of tasks to be carried out in completing any job and critically examining if there is a better way of doing the same.
5. To propose better ways of completing tasks and improving productivity.

Contents:

Module 1: Productivity & Work Study (12 Hrs)

Introduction to Industrial Engineering, Definition of productivity, factors affecting productivity, definition, objective & scope of work study, human factors in work study, work study & management, work study & supervisor, work study & worker. Method Study: Definition, objective & scope, charts to record movements in shop, process charts, flow process charts, multiple activity charts, two handed process charts, SIMO chart, and principles of motion economy.

Module 2: Work Measurement (12 Hrs)

Definition, objectives, techniques of work measurement, work sampling, need of confidence levels, sample size determination, random observation with simple problems. Time Study: Definition, time study equipment, selection of jobs, steps in time study, breaking jobs into elements, recording information, rating, standard performance, scales of rating, factors affecting rate of working, allowances, standard time determination.

Module 3: Introduction to Industrial Design (10 Hrs)

Elements of design structure for industrial design in engineering application in modern manufacturing systems. Ergonomics and Industrial Design: Introduction, general approach to the man-machine relationship, workstation design-working position.

Module 4: Visual Effects of Line and Form (4 Hrs)

The mechanics of seeing, psychology of seeing, general influences of line and form

Module 5: Inventory and Inventory Models (4 Hrs)

Definition and types of Inventory, Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model

Text and Reference Books:

1. Work study, ILO, 3rd edition, 2006.
2. Human Factor Engineering: Sanders & McCormick, 7th Ed., McGraw Hill Publications.
3. Applied Ergonomics Hand Book, Brain Shakel, Butterworth Scientific, London 1988.
4. Introduction to Ergonomics, R. C. Bridger, McGraw Hill Publications.
5. Industrial Design for Engineers, Mayall W. H. London Hiffee Books Ltd., 1988.
6. Work Study & Ergonomics, Suresh Dalela & Saurabh, standard publishers & Distributors, 1999.
7. Industrial Engineering and Management; B. Kumar, Khanna Publication, ISBN8174091963, 2011.

Course outcomes:

Upon completion of this course, students should be able to:

CO1: Apply their knowledge about utilizing tools and techniques of Work Study and Time study.

CO2: Demonstrate their skill to effectively and efficiently design small activities, production systems, projects etc and explain how it is productive.

CO3: Design simple products and processes that meet the needs of the society.

CO4: Demonstrate analytical skills and develop better ways of performing a task.

ME 365	Program Elective – I	3L:0T:0P	3 credits

Students will have to select subjects from the basket of professional electives given in Annexure-I

ME 366	Open Elective – I	3L:0T:0P	3 credits

Students will have to select subjects from the basket of professional electives given in Annexure-II

ME 361P	Mechanical Engineering Lab-II (Manufacturing)	0L:0T:2P	1 credit

Course objectives:

1. To develop a skill in dignity of labour, precision, safety at work place, team working and development of right attitude.
2. To acquire skills in basic engineering practice
3. To identify the hand tools and instruments
4. To gain measuring skills
5. To develop general machining skills in the students

Contents:

Module1: Turning Operations (any 3) (6 Hrs)

1. Plain turning
2. Step turning
3. Knurling
4. Drilling
5. Eccentric turning
6. Taper turning and external thread cutting using lathe
7. Measurement of cutting forces in Turning process

Module 2: Milling operations (any 3) (6 Hrs)

1. Slotting operation
2. Contour milling using vertical milling machine
3. Spur gear cutting in milling machine
4. Measurement of cutting forces in Milling process
5. CNC part programming

Module 3: Advanced process (any one) (4 Hrs)

1. Cutting profiles using EDM/LASER beam machining
2. Microprocessor controlled pick & place robot

Module 4: Measurements of dimensions on parts fabricated with turning/milling/EDM/LASER beam machining processes (any 3) (6 Hrs)

1. Measurement of dimensions using stereomicroscope on parts produced using
2. Use of Tool Maker's Microscope
3. Comparator and sine bar
4. Surface finish measurement of machined surfaces using perthometer
5. Bore diameter measurement using micrometre and telescopic gauge
6. Use of Autocollimator

Course outcomes:
On successful completion of the course, the student will be able to,
1. Understand the basics of removal of material from work piece surface to attain specific shape.
2. Fabricate parts that can be manufactured using turning and milling operations
3. Familiarize with the production of simple models in fitting, grooving, cutting of gear teeth

ME 362P	Mechanical Engineering Lab-III (Thermal)	0L:0T:2P	1 credit

Course objectives:
1. To understand the principles and performance characteristics of flow and thermal devices
2. To know about the measurement of the fluid properties

Contents:
1. Calibration of Venturi meter / Orifice meter
2. Determination of the density & viscosity of an oil and friction factor of oil flow in a pipe
3. Verification of Bernoulli's theorem
4. Determination of the performance characteristics of a centrifugal pump
5. Determination of the performance characteristics of Pelton Wheel
6. Determination of the performance characteristics of a Francis/Kaplan Turbine
7. Determination of the thermal conductivity and specific heat of given objects
8. Determination of the calorific value of a given fuel and its flash & fire points
9. Determination of the p-V diagram and the performance of a 4-stroke diesel engine
10. Determination of the convective heat transfer coefficient for flow over a heated plate
11. Determination of the performance characteristics of a vapour compression system

Course outcomes:
The students who have undergone the course will be able to measure various properties of fluids and characterize the performance of fluid/thermal machinery.

NC 361	Constitution of India	3L:0T:0P	0 credit

Constitution of India – Basic features and fundamental principles
The Constitution of India is the supreme law of India. Parliament of India cannot make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement; however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Contents:

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.

8.6 Detailed Contents for B.E. 7th semester (Mechanical) Papers

ME 471	Dynamics and Vibration	3L:0T:0P	3 credits

Course objectives:

1. To provide the knowledge of basic principles of virtual work and conservative systems.
2. To apply the basic knowledge of vibration under free- and forced- damped conditions.
3. To provide an understanding of various modes of vibration.

Contents:

Module 1: Introduction (8 Hrs)

Generalized coordinates; Constraints; Degrees of freedom; Principal of virtual work in statics: Virtual displacements; Virtual work; Constraint forces; Workless constraints; Principal of virtual work; Lagrange multipliers; Equilibria and stability of conservative systems; D'Alembert's principle; Hamilton's principle, Lagrange's equations.

Module 2: Single degree freedom vibrational analysis (8 Hrs)

Introduction, Relevance of and need for vibrational analysis –Basics of SHM - Mathematical modelling of vibrating systems -Discrete and continuous systems - single-degree freedom systems-free and forced vibrations, damped and undamped systems.

Module 3: Two degree freedom vibrational analysis (8 Hrs)

Two Degree freedom Systems General solution to free vibration problem, damped free vibration, Forced vibration of undamped system, dynamic vibration absorbers.

Module 4: Multi- degree freedom vibrational analysis (8 Hrs)

Multi Degree freedom Systems Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes -Matrix methods of solution-normal modes –Orthogonality principle-Energy methods, Eigen values and Eigen vectors.

Module 5: Continuous systems (8 Hrs)

Continuous Systems Torsional vibrations -Longitudinal vibration of rods -transverse vibrations of beams -Governing equations of motion -Natural frequencies and normal modes -Energy methods, Introduction to nonlinear and random vibrations.

Text Books/ References:

1. Kelly, S. Graham. Schaum's outline of mechanical vibrations. McGraw-Hill, 1996.
2. Meirovitch, Elements of Vibration Analysis, McGraw Hill, 2nd edition, 1986.
3. L. Meirovitch, Principles and Techniques of Vibrations, Prentice Hall International (PHIPE), 1997.
4. W. T. Thomson and M. D. Dahleh, Theory of Vibration with Applications, 5th edition, Pearson, 1997.
5. F.S. Tse, I.E. Morse and R. T. Hinkle, Mechanical Vibrations, 2nd edition, CBS Publications, 2004. Theory and Practice of Mechanical Vibrations, 2nd edition, New Age Publication, 1999.

Course Outcomes:

The essence of this course is also to lay the foundation of other advanced techniques like finite element method. After successful completion of the course, the student will be able to:

1. Derive equations for the kinematics and kinetics for different objects.
2. Derive and use equations for the kinetics of rigid bodies.

3. Set up and solve equations of motion for rigid bodies.
4. Apply work-energy principles in the solution of rigid-body dynamics problems
5. Apply impluse-momentum principles in the solution of rigid-body dynamics problems.
6. Analyze damped and undamped vibration as well as forced vibration.

ME 472	Operation Research	3L:0T:0P	3 credits

Course objectives:

1. To explain the characteristics of OR and obtain a solution to an LP problem.
2. To obtain a dual of the given LP problem and solve special types of LP problems like – Transportation Problem.
3. To solve Assignment and travelling salesman problem by using Hungarian algorithm.
4. To solve (m x n) sequencing problems using Johnson's algorithm and Campbel, Dudek and Smith algorithm and rectangular games using dominance principle and graphical method.
5. To solve a network problem using CPM and PERT.

Contents:

Module 1: Introduction to Operations Research (8 Hrs)

Definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problems – Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, big-M method, two-phase method, degeneracy in LPP.

Module 2: Concept of Duality in LPP. Transportation Problem (8 Hrs)

Balanced and unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner method, least cost method and Vogel's approximation method. Optimality test; the stepping stone method and MODI method.

Module 3: Assignment model (8 Hrs)

Balanced and unbalanced Assignment problem Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem.

Module 4: Sequencing models (4 Hrs)

Solution to Sequencing Problem by Johnsons Rule, – Processing n Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machines.

Module 5: Games Theory (4 Hrs)

Competitive games, rectangular game, saddle point, minimax maximin criteria, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games. Graphical solution for 2 X m and n X 2 games.

Module 6: Network Techniques (8 Hrs)

PERT, CPM, Project crashing, Shortest path problem, Maximum flow problem, Minimum spanning tree problem, minimum cost flow problem, Resource leveling

Text and Reference Books:

1. G D EPPEN and F J GOULD, Introductory Management Science, Prentice-Hall, 2002.
2. R.L. Ackoff And M.W. Sasieni, Fundamentals of Operations Research, A Wiley International Edition, 1968
3. Hilier And Liberman, Introduction to Operations Research, Mc Grawhill, 2001.
4. S D SHARMA, Operations Research Theory & Applications, Kedarnath Ramnath Publishers, 2007.
5. Roger g. Schroeder, Operations management-Decision making in the operations function, McGraw-Hill, Inc,
6. S N CHARY, Theory and Problems in Production and Operations Management, Tata McGraw-Hill publishing company Ltd, 2001.
7. Operations Research: Theory and Applications by J K Sharma, Macmillan, ISBN9789350593363, 2013.
8. Operations Research: An introduction by H A Taha, Pearson Education

Course outcomes:

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

1. Solve Linear Programming Problems
2. Solve Transportation and Assignment Problems
3. Understand the usage of game theory and Simulation for Solving Business Problems

ME 473	Refrigeration and Air Conditioning	2L:1T:0P	3 credits

Course objectives:

1. To familiarize with the terminology associated with refrigeration systems and air conditioning
2. To understand working and operating principles of Air Refrigeration, Vapour Compression and Vapour Absorption system
3. To study components of refrigeration and air conditioning systems
4. To understand the basics of Psychrometry and practice of applied psychometrics
5. To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

Contents:

Module 1: Introduction (6 Hrs)

Refrigeration, Unit of refrigeration, elements of refrigeration system, Classification of refrigeration systems, C.O.P, Ice refrigeration and Air refrigeration cycle

Module 2: Vapour Compression Refrigeration (8 Hrs)

Working of Simple vapour compression cycle, Effect of liquid sub cooling& superheating, effect of evaporator and condenser pressures, methods of sub cooling, use of P-h charts, Actual VCR cycle, Use of P-h Charts, Comparison between air-cooled and watercooled condenser based air conditioning systems, Types of condensers, evaporators, expansion devices and Compressors

Module 3: Vapour Absorption and Non-Conventional Refrigeration (7 Hrs)

Vapour Absorption Refrigeration- Working of simple and actual VARS, Importance of VAR system, COP of ideal VAR system, Ammonia-water VAR system, Electrolux refrigeration system;

Non-Conventional Refrigeration Systems- Thermoelectric Refrigeration, Thermo-acoustic Refrigeration, Vortex Tube Refrigeration

Module 3: Refrigerants (5 Hrs)
Survey of refrigerants, desirable properties of refrigerants, classification of refrigerants used, nomenclature, ozone depletion, global warming, ODP and GWP, Montreal protocol and India's commitment, recent substitutes for refrigerants

Module 4: Psychrometry (8 Hrs)
Introduction, Psychrometric properties and relations, Psychrometric chart and its applications, First law applied to Psychrometric process, Heating, cooling, heating & humidification & cooling & dehumidification processes. Adiabatic saturation, By-pass factor, Sensible Heat Factors, Heat Load estimation: Simple cases

Module 5: Air Conditioning (6 Hrs)
Factors affecting Human comfort, Types of Air-conditioning systems: window air conditioners & split air conditioners, Single duct, double duct and VAV air conditioning

Text Books:

1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.

Course Outcomes:
On successful completion of the course, the student will be able to,
1. Illustrate the basic concepts of refrigeration system.
2. Analyze the vapour compression cycle and interpret the usage of refrigerants.
3. Explain the working of VCRS, VARS and Non-Conventional refrigeration system.
4. Demonstrate the use of Psychrometry in analyzing refrigeration systems.
5. Discuss the theory and concept of air-conditioning systems.

ME 474	Open Elective – II	3L:0T:0P	3 credits

Students will have to select subjects from the basket of open electives given in Annexure-II

ME 471P	Mechanical Engineering Lab IV (Modelling, simulation, and programming)	0L:0T:4P	2 credits

Course objectives:
1. To understand the measurement of mechanical properties of materials
2. To understand the deformation behaviour of materials
3. To understand the kinematic and dynamic characteristics of mechanical devices

Contents:

Module 1: Modelling using CAD software (any 3) (12 Hrs)

1. Assembly of simple machine tools
2. Motion study of kinematics of
   a. Four bar, slider crank,
   b. Crank rocker,
   c. Double crank,
   d. Double rocker and
   e. Oscillating cylinder mechanisms
   f. Interaction of gears

Module 2: Simulation on FEA/CFD packages (any 3) (12 Hrs)

1. Simulation of tensile test
2. Cam & follower and motion studies
3. Heat transfer on fins
4. Velocity profile of laminar fluid flowing in a pipe
5. Model analysis on simple geometries
6. Simulation of water/ wind turbine

Module 3: Programming (any 3) (12 Hrs)

Development of interactive program for determining the

1. Roots of a system of linear equations
2. LU decomposition method
3. Gauss-siedel method
4. Jacobi method
5. Shooting method

Course outcomes:

Students who have undergone the course will be able to

1. Understand the model simple CAD models and undergo motion study
2. Perform simulations of simple structural, fluid, or thermal problems using FEA and CFD packages
3. Develop interactive programs of numerical methods on standard software packages.

ME 475P	Project-I (Project work and seminar)	0L:0T:10P	5 credits

Course objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

8.7 Detailed Contents for B.E. 8th semester (Mechanical) Papers

ME 481	Program Elective – II	3L:0T:0P	3 credits

Students will have to select subjects from the basket of electives given in Annexure-I

ME 482	Program Elective – III	3L:0T:0P	3 credits

Students will have to select subjects from the basket of electives given in Annexure-I

ME 483	Program Elective – IV	3L:0T:0P	3 credits

Students will have to select subjects from the basket of electives given in Annexure-I

ME 484	Open Elective – III	3L:0T:0P	3 credits

Students will have to select subjects from the basket of open electives given in Annexure-II

ME 485P	Project – II	0L:0T:12P	6 credits

Course objectives:

It is intended to start the project work early in the seventh semester and carry out both designs and fabrication of a mechanical device whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester

ANNEXURE – I

List of Professional Elective Courses

Sl. No.	Subject Code	Course Title	
1	ME 365	Mechatronics	Elective I
2	ME 365	Composite materials	
3	ME 365	Energy conservation and management	
4	ME 365	Energy Audit and Management	
5	ME 365	Automobile engineering	
6	ME 481	Industrial automation	**Elective-II**
7	ME 481	Statistical Quality Control	
8	ME 481	Biomaterials	
9	ME 481	Project management	
10	ME 482	Modelling and simulation	**Elective-III**
11	ME 482	Renewable energy	
12	ME 482	Gas dynamics and jet propulsion	
13	ME 482	Wind and Solar Energy Systems	
14	ME 482	Finite element analysis	
15	ME 483	Process planning and cost estimation	**Elective-IV**
16	ME 483	Total Quality Management	
17	ME 483	Computational Fluid dynamics	
18	ME 483	Numerical heat transfer	
19	ME 483	Fundamentals of Combustion	

ME 365	Mechatronics	3L:0T:0P	3 credits

Course Objectives:

1. To understand the structure of microprocessors and their applications in mechanical devices
2. To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
3. To understand the use of micro-sensors and their applications in various fields

Contents:

Module 1: Introduction (8 Hrs)

Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface;

Module 2: Sensors and transducers (8 Hrs)

Classification, Development in Transducer technology, Opto- electronics-Shaft encoders, CD Sensors, Vision System, etc

Module 3: Drives and Actuators (8 Hrs)

Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems;

Module 4: Smart materials (8 Hrs)

Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.

Module 5: Micro-mechatronic systems (8 Hrs)

Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

Text Books:

1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3. A Textbook of Mechatronics ,R.K.Rajput, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.

Course Outcomes:

Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.

ME 365	Composite Materials	3L:0T:0P	3 credits

Course objectives:

1. To understand the concept of the composite materials and its terminologies used.
2. To analyze the different processing/fabrication techniques of composite materials especially fibre components
3. To analyze brief descriptions for the polymer materials and its applications which are having better improved properties to suit with conventional materials.
4. To analyze the fibre and matrix properties for structural applications.
5. To analyze the optimum fabrication techniques for metal matrix materials to enhance material properties.

Contents:

Module 1: Introduction (8 Hrs)

Definition, classification and characteristics of composite materials: fibrous composites, laminated composites, particulates composites, applications, properties and types of reinforcement and matrix materials. Influence of fiber length, Influence of fiber orientation and concentration, fiber phase, matrix phase.

Module 2: Fiber reinforced plastic processing (8 Hrs)

Lay-up and curing, fabricating process-open and closed mould process- Hand lay-up techniques-structural laminated bag moulding, production procedures for bag moulding- filament winding pultrusion, pulforming, thermoforming, injection, injection moulding, liquid moulding blow moulding.

Module 3: Fabrication of composites (8 Hrs)

Cutting, machining, drilling, mechanical fasteners and adhesive bonding computer aided design and manufacturing, tooling, fabrication equipment.

Module 4: Metal Matrix composites (8 Hrs)

Types of reinforcement materials, Boron fibers, carbon and graphite fibers, alumina fibers, silicon carbide fibers, SiC whiskers, particulates, metallic fibers, metallic glass ribbons, Selection of base material, issues related to MMC's, applications, future potential and need of MMC's.

Module 5: Fabrication Processes for Metal Matrix composites (8 Hrs)

Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques, Mechanical properties, effects of particulates

Text Books:

1. Composite Science and Engineering, K. K. Chawla Springer Verlag 1998.
2. Mechanics of composite materials, Autar K. Kaw CRC Press New York.
3. Rober M. Jones "Mechanics of composite Materials" McGraw Hill Kogakusha Ltd.
4. Michael W, Hyer "Stress analysis of fiber Reinforced composite materials", McGraw Hill International.
5. Krishnan K Chawla, "Composite material science and Engineering", Springer
6. P.C. Mallik, "Fibre reinforced composites" Marcel Decker

Reference Books:

1. Fiber Reinforced Composites, P. K. Mallick, Marcel Dekker, Inc.
2. Mechanics of Composite Materials, Robert M. Jones, McGraw Hill Kogakusha.
3. Composite materials hand book, Meing Schwaitz," McGraw Hill book company.1984.
4. Principles of composite Material mechanics, Ronald F. Gibron. McGraw Hill International, 1994.
5. Mechanics of Composite Materials and Structures, Madhujit Mukhopadhyay, Universities Press 2009.
6. Mechanics of Composite materials by Dr.V.P. Raghupathy

Course Outcomes:

Upon completion of this course, students should be able to:

CO1: Explain concept of the composite materials and its terminologies used.

CO2: Analyze the different processing/ fabrication techniques of composite materials especially fiber components

CO3: Describe the polymer materials and its applications which are having better improved properties to suit with conventional materials.

CO4: Analyze the fiber and matrix properties for structural applications.

CO5: Describe various fabrication techniques for metal matrix materials.

ME 365	Energy Conservation and Management	3L:0T:0P	3 credits

Course objectives:

1. To familiarise present Energy scenario and basics of energy auditing
2. To facilitate the energy management of various major utilities, electrical and thermal installations
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities
4. To evaluate energy economics of some mechanical systems

Contents:

Module 1: Energy Scenario and Energy Auditing (8 Hrs)

Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.

Module 3: Energy Management and Energy Conservation in Electrical System (6 Hrs)

Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment and appliances, star ratings.

Module 4: Energy conservation in major utilities (8 Hrs)

Pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets

Module 5: Energy Management and Energy Conservation in lighting systems (6 Hrs)

Occupancy sensors, daylight integration, and use of intelligent controllers; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting

Module 6: Energy Management and Energy Conservation in Thermal Systems (8 Hrs)
Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Assessment of steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories, Waste heat recovery

Module 7: Energy Economics (4 Hrs)
Concept, discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept

Text Books:

1. Witte L.C. , Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere Publ., Washington, 1988..
2. Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.
3. Murphy W.R. and McKay G., Energy Management, Butterworths, London, 1987.
4. Energy Manager Training Manual, Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004 (available at www.energymanager training.com).
5. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
6. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
7. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
8. Energy Management Principles, C.B.Smith, Pergamon Press

Course outcomes:
Upon completion of this course, the students will be able to
1. Identify and describe present state of energy security and its importance.
2. Identify and describe the basic principles and methodologies adopted in energy audit of a utility.
3. Describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. Describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. Analyse the data collected during performance evaluation and recommend energy saving measures

ME 365	Energy Audit and Management	3L:0T:0P	3 credits

Course objectives:
1. To familiarise present Energy scenario and basics of energy auditing.
2. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
3. To facilitate the energy management of various major utilities, electrical and thermal installations
4. To understand the energy data from industries and carry out energy audit for energy savings

Contents:
Module 1: Energy Scenario (4 Hrs)
Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features; Basics of Energy and its various forms, Material and Energy balance

Module 2: Energy Audit Principles (8 Hrs)
Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution; Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis; Financial analysis techniques- Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)

Module 3: Energy Management and Energy Conservation in Electrical System (5 Hrs)
Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment and appliances, star ratings.

Module 4: Energy efficiency measures in lighting system, Lighting control (5 Hrs)
Occupancy sensors, daylight integration, and use of intelligent controllers; Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives

Module 5: Energy Management and Energy Conservation in Thermal Systems (10 Hrs)
Review of different thermal loads; Energy conservation opportunities in- Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system; General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application; HVAC system-Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities

Module 6: Energy Performance Assessment (4 Hrs)
On site Performance evaluation techniques, Case studies based on- Motors and variable speed drive, pumps, HVAC system calculations; Lighting System- Installed Load Efficacy Ratio (ILER) method, Financial Analysis

Module 7: Energy conservation in Buildings (3 Hrs)
Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources

Text Book/ References:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. Witte L.C. , Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere Publ., Washington, 1988..
9. Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.
10. Murphy W.R. and McKay G., Energy Management, Butterworths, London, 1987.
11. Energy Manager Training Manual, Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004 (available at www.energymanager training.com).
12. www.bee-india.nic.in

Course outcomes:

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

1. Understand and describe present state of energy security and its importance.
2. Identify and describe the basic principles and methodologies adopted in energy audit of a utility.
3. Describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. Describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. Analyse the data collected during performance evaluation and recommend energy saving measures

ME 365	Automobile Engineering	3L:0T:0P	3 credits

Course objectives:

1. To understand functions of piston and piston rings, valves, cooling system and lubrication system.
2. To understand between supercharger and turbocharger and their respective constructions.
3. To understand the working principles of various ignition methods used and their operations.
4. To understand different energy transmission systems and their applications.
5. To understand steering types and different braking methods

Contents:

Module 1: Engine Components and Cooling & Lubrication systems (8 Hrs)

Cylinder - arrangements and their relatives merits, cylinder, Liners, Piston rings, connecting rod, crankshaft, valves, cooling requirements, Methods of cooling- Different lubrication arrangements.

Module 2: Super Chargers and Turbochargers (8 Hrs)

Naturally aspirated engines, Forced Induction, Supercharging of SI Engines and CI Engines, Effects of supercharging on performance of the engines, supercharging limits; Methods of supercharging, Types of superchargers, Turbocharger construction and operation.

Module 3: Ignition Systems (8 Hrs)

Introduction, Requirements of an ignition system, Battery Ignition systems components of Battery Ignition systems, magneto Ignition system- rotating armature type, rotating magnet type, Electronic Ignition system.

Module 4: Transmission Systems (8 Hrs)

General arrangement of clutch, Principle of friction clutches, Torque transmitted, Constructional details, and Single plate, multi-plate and centrifugal clutches. Gear Box–Principle of gear box, Sliding mesh gear box, constant mesh gear box, synchromesh gear box and Epicyclical gear box, over drives, fluid coupling and torque converters, principle of automatic transmission.

Module 5: Drive To Wheels (8 Hrs)

Propeller shaft, universal joints, differential, rear axle drives, Hotchkiss and torque tube drives, steering geometry, power steering, Brakes:Types of brakes, Disk brakes, drum brakes, Hydraulic brakes and Air brakes, Antilock -Braking systems, purpose and operation of antilock-braking system

Text books:
1. Automotive Mechanics, S. Srinivasan, Tata McGraw Hill 2003.
2. Automobile engineering, Kirpal Singh. Vol I and II 2002.

Reference books:
1. A course in I.C. Engines, M.L. Mathur and R.P. Sharma 2001
2. Internal Combustion Engines, Ganeshan, Tata McGraw Hill, 2ndEdition, 2003

Course outcomes:
Upon completion of this course, students should be able to:
CO1: Explain functions of piston and piston rings, valves, cooling system and lubrication system.
CO2: Differentiate between supercharger and turbocharger and their respective constructions.
CO3: Demonstrate the working principles of various ignition methods used and their operations.
CO4: Explain different energy transmission systems and their applications.
CO5: Explain steering types and different braking methods.

ME 481	Industrial Automation	3L:0T:0P	3 credits

Course objectives:
1. To study the need for the automation, its advantages and limitations
2. To study the basic functional elements of automation
3. To familiarise with the levels of automation and strategies of automation
4. To acquaint with control of mechanical operations involving pneumatic, electric, hydraulic and electronic systems

Module 1: Introduction to Automation (6 Hrs)
Definition and fundamentals of automation, reasons for Automating, basic elements of an automated system-Power, Program and control system; Advanced automation functions-safety, maintenance & repair diagnosis, error detection and recovery; Automation principles and strategies-USA principle, ten strategies of automation and production system, automation migration strategy

Module 2: Mechanization and Automation (8 Hrs)
Mechanization and automation, product cycle, hard Vs flexible automation, Capital-intensive Vs low cost automation Types of systems-mechanical, electrical, hydraulic, pneumatic and hybrid systems Automation using CAMS, Geneva mechanisms, gears etc. Assembly line Automation: automated assembly systems, transfer systems, vibratory bowl feeders, non-vibratory feeders, part orienting, feed track, part placing & part escapement systems Introduction to Material storage/ handling and transport systems, and its automation using AS/RS, AGVS and conveyors etc.

Module 3: Pneumatics and hydraulics (14 Hrs)
Hydraulic and pneumatic devices-Different types of valves , Actuators and auxiliary elements in Pneumatics & hydraulics , their applications and use of their ISO symbols Synthesis and design of circuits (up to 3 cylinders)–pneumatic, electro pneumatics and hydraulics Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping

Module 4: Sensors & Actuators Sensors (6 Hrs)
Selection of sensors (Displacement, temperature, acceleration, force /pressure) based on static and dynamic characteristics; Interfacing- Concept of interfacing, bit accuracy and sampling speed, amplifying electronics, and microcontroller; Actuators- Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC

Module 5: Industrial control systems (10 Hrs)
Process industries versus discrete manufacturing industries, Continuous verses discrete control, Computer process control, Forms of computer process control Discrete control using PLC- discrete process control, Programmable logic controller, its architecture, ladder digs, Ladder Logic Programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming

Text Books/ References:

1. M.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education,New Delhi
2. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press
3. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications", Prentice Hall.
4. Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition
5. Pneumatic Circuits and Low Cost Automation: by Fawcett J.R.

Course outcomes:
At the end of the course the students will be able to…
1. Demonstrate basics of industrial automation
2. Identify various types of automation
3. Demonstrate use of automated controls using pneumatic and hydraulic systems.
4. Illustrate the control systems in automated system.
5. Demonstrate applicability of PLC in process industry
6. Design elecrto-pneumatic circuits

ME 481	Statistical Quality Control	3L:0T:0P	3 credits

Course objectives:
1. To understand quality and quality improvement techniques
2. To understand process quality analysis
3. To understand and develop control charts
4. To understand the meaning of statistical control and random variability
5. To ability to design control charts and monitor the process behavior over time

Contents:
Module 1: Introduction (4 Hrs)
Definitions of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; The DMAIC Process, Total Quality Management (quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement)

Module 2: Modelling Process Quality (4 Hrs)
Mean, Median, Mode, Standard deviation, Calculating area, The Deming funnel experiment, Normal distribution tables, finding the Z score, Central limit theorem

Module 3: Methods of Statistical Process Control (5 Hrs)
SPC-The Magnificent Seven, Applications of SPC, Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length-ARL)

Module 4: Control Charts for Variables (7 Hrs)
Control Charts for X-Bar and R- Charts, Statistical basis of the charts, Development and use of X bar and R charts, Interpretation of charts. Type I and Type II errors, the probability of Type II error

Module 5: Process Capability (4 Hrs)
The foundation of process capability, Natural Tolerance limits, c p –process capability index, c pk , p p – process performance index, summary of process measures

Module 6: Control Charts for Attributes (6 Hrs)
Binomial distribution, Poisson distribution (from the point of view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non-conformities per unit

Module 7: Lot-by-Lot Acceptance Sampling for Attributes and variables (10 Hrs)
The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Military Standard 105E, the Dodge-Romig sampling plans

Text book:

1. Statistical Quality Control, E.L. Grant & R.S. Leavenworth, 7th Ed., McGraw-Hill.
2. Statistical Quality Control, R C Gupta, Khanna Publishers, New Delhi, 2005
3. Introduction to Statistical Quality Control, Douglas C Montgomery, Publisher: Wiley;
   8th Ed
4. Statistical Process Control and Quality Improvement, Gerald M. Smith, Pearson Prentice Hall. ISBN 0 – 13-049036-9.
5. Statistical Quality Control for Manufacturing Managers, W S Messina, Wiley & Sons, Inc. New York, 1987
6. Principles of Quality Control, Jerry Banks, Wiley & Sons, Inc. New York.

Course outcomes:
CO 1: Analyse different statistical methods for statistical process control.
CO 2: Assess general advantages and disadvantages for alternative process control methods
CO 3: Compare alternative process control methods
CO 4: Identify the different quality control techniques for varying sampling methods
CO 5: Formulate an adequate statistical control problem for a production or similar process.
CO 6: Estimate the quality measures in general by means of modern and relevant statistical tools.

ME 481	Biomaterials	3L:0T:0P	3 credits

Course objectives:

1. Describe different types of materials used in biomedical applications
2. Describe methodologies to analyze physical, chemical, and mechanical properties of biomaterials
3. Reflect upon the latest advances in the field of biomaterials

Contents:

Module 1: introduction (8 Hrs)

Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials; Effects of physiological fluid on the properties of biomaterials; Biological responses (extra and intra-vascular system); Surface properties of materials, physical properties of materials, mechanical properties

Module 2: Metallic implant materials (8 Hrs)

Stainless steel, Co-based alloys, Ti and Ti-based alloys; Importance of stress-corrosion cracking; Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion; Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.

Module 3: Polymeric implant materials (8 Hrs)

Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls; (Classification according to thermo sets, thermoplastics and elastomers).Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking; Physiochemical characteristics of biopolymers; Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications

Module 4: Ceramic implant materials (8 Hrs)

Definition of bio ceramics; Common types of bio ceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics; Importance of wear resistance and low fracture toughness; Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction). Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out); Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions

Module 5: Biocompatibility and Toxicological screening of bio materials (8 Hrs)

Definition of biocompatibility, blood compatibility and tissue compatibility; Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.

Textbooks:

1. Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press, San Diego, 1996.
2. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
3. J B Park, Biomaterials – Science and Engineering, Plenum Press, 1984.

Course outcomes:
At the end of the course, the students will be able to understand the importance of biomaterials in today's world, various types of biomaterials, and factors to be considered while selecting a biomaterial

ME 481	Project Management	3L:0T:0P	3 credits

Course objectives:
To develop practical project management skills, and prepare the students to apply proven methodologies to projects

Contents:

Module 1: Introduction (7 Hrs)
Definitions, classifications, and scope of project management; project life cycle and uncertainty

Module 2: Project planning (7 Hrs)
Scope, problem statement, project goals, objectives, success criteria, assumptions, risks, obstacles, approval process, projects and strategic planning

Module 3: Project implementation (7 Hrs)
Project resource requirement, types of resources: men, materials, finance, resource distribution

Module 4: Project monitoring (7 Hrs)
Evaluation, control, project network technique, planning for monitoring and evaluation, project audits, project management information system, Nature of project inventory, supply and transportation of materials, use of Material Requirement Planning; Project scheduling- PERT & CPM, project communication

Module 5: Project team management (7 Hrs)
Recruitment, organizing, human resources: team operating rules, project organization, various forms of project organizations, project organization charting, project contracts, principles, compilation of contracts, practical aspects, legal aspects, global tender, negotiations, insurance

Module 6: Project completion (7 Hrs)
Closing the project, types of project termination, strategic implications, project in trouble, termination strategies, evaluation of termination possibilities, termination procedures, post project reviews

Text Books/ References:

1. Beenet P Lientz, Kathyn P rea , Project Management for 21st Century, - Academic Press, ISBN 012449983X, 2001.ME-109
2. Project Management –Dennis Lock , Gower Publishing Ltd; 9th Revised edition edition; ISBN 0566087693, 2007
3. David I Cleland, Project management, Mcgraw Hill International Edition, ISBN 0442221142, 1988.
4. Gopalakrishnan , Project Management, Mcmillan India Ltd, ISBN 0333926218,1993

Course outcomes:

Upon completion of the course, students will be to

1. Apply selection criteria and select an appropriate project from different options
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them
4. Capture lessons learned during project phases and document them for future reference

ME 482	Modelling and Simulation	3L:0T:0P	3 credits

Course objectives:

To introduce students the concepts of modelling and simulation of a system

Contents:

Modules: 1. Introduction (4 Hrs)

Introduction, modelling in science and engineering, modelling processes: steps, mathematical modelling terminology and approaches to simulation, terminologies.

Module 2. Introduction to programming environments (6 Hrs)

MATLAB interface: basic syntax, common functions, program executions, creating codes, debugging. Plotting and matrix operations

Module 3: Deterministic linear models (6 Hrs)

Selecting a mathematical representation for a model, linear models and linear equations, linear interpolation, system of linear equations, limitations of linear models

Module 4: Non-linear and Dynamic models (8 Hrs)

System dynamics, components of a system, unconstrained growth and decay, constrained growth, Modelling physical and social phenomena

Module 5: Estimating models from empirical data (8 Hrs)

Using data to build forecasting models, fitting a mathematical function to data, fitting a linear model, linear models with multiple predictors, non-linear estimation

Module 6: Introduction to newer approaches (8 Hrs)

Fuzzy Logic, Artificial Neural Networks, Genetic Algorithms. Typical case studies covering different manufacturing processes

Textbooks:

1. S.S. Sastry, Introductory Methods of Numerical Analysis Prince Hall of India, New Delhi, 1993.
2. Krishnamoorthy C. S., `Finite Element Analysis`, Tata McGraw Hill, 1987.
3. David E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley Professional; 2000
4. Lotfi Zadeh, Janusz Kacprzyk, Fuzzy Logic for the Management of Uncertainty, Wiley-Interscience, 1992
5. James A. Anderson, An Introduction to Neural Networks, The MIT Press, London, 1997
6. Simon Haykin, Neural Networks: A Comprehensive Foundation, Prentice Hall; 2 edition, 1998
7. Timothy J. Ross, Fuzzy Logic With Engineering Applications, John Wiley, 2004

Course outcomes:
At the end of the course, the students will be able to understand various approaches for modelling and simulating various processes.

ME 482	Renewable Energy	3L:0T:0P	3 credits

Course objectives:
1. To study working principles of various renewable energy sources and their utilities.
2. To study economics of harnessing energy from renewable energy sources

Contents:

Module 1: Solar Radiation (12 Hrs)
Extra-terrestrial and terrestrial, Solar radiation measuring instruments, Estimation of Solar Radiation, Various earth-sun angles; Solar Energy Conversion Systems: Solar Thermal Systems: Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, selective coating, advanced collectors, Concentrators: optical design of concentrators, solar water heater, solar dryers, solar stills, solar ponds, solar cooling and refrigeration, Solar thermal power generation. Solar Photovoltaic Systems: Principle of photovoltaic conversion of solar energy, Solar cells, Home lighting systems, Solar lanterns, Solar PV pumps, Govt. policies. Introduction to Solar Photovoltaic Thermal Systems: Air based, Water based, Refrigerant based Systems. Solar energy storage options: Electrical and Thermal Energy storage options for Solar Energy

Module 2: Biomass energy (10 Hrs)
Biogas System: Anaerobic digestion, biogas production, Types of digesters, installation, operation and maintenance of biogas plants, Biogas plant manure utilisation and manure values, factors affecting biogas production, Biogas utilisation and storage, biogas for motive power generation, design calculations for biogas plants, Govt. policies. Liquid Biofuels: Biodiesel – The mechanism of transesterification, fuel characteristics of biodiesel, technical aspects of biodiesel/Ethanol and other liquid fuels utilization in engine. Biomass gasification: Different types, power generation

Module 3: Wind energy conversion systems (8 Hrs)
History of wind energy, Current status and future prospects, Wind energy in India; Power available in the wind, Components of Wind Energy Conversion Systems, Horizontal and Vertical axis wind turbine, Wind turbine power and torque characteristics, Tip speed ratio, Wind speed prediction and forecasting, Betz limit, Govt. Policies

Module 4: Waste to energy conversion (6 Hrs)
Introducing Municipal Solid Waste Management; Waste Generation and characterization, Waste Processing Techniques; Source Reduction, Biological Conversion Products: Compost and Biogas, Incineration pyrolysis and Energy Recovery, waste plastic, RDF utilization, Govt. Policies

Module 5: Hydrogen energy and fuel cells (4 Hrs)
Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage; Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy, Basic principle of working of fuel cell.

Text Books:

1. J. A. Duffie and W.A. Beckman, Solar Engineering and Thermal Processes, John Wiley and Sons, 2013.
2. G. N. Tiwari, Solar Energy, Narosa Publishing House Pvt. Ltd., 2012.
3. H. S. Mukunda, Understanding Clean Energy and fuels from biomass. Wiley India Pvt. Ltd, 2011
4. K. M. Mital, Biogas Systems, Principle and Applications. New Age International Ltd, 1996
5. G. D. Rai, Non-Conventional Energy Sources, Khanna Publication, 1988
6. S. P. Sukhatme and J. K. Nayak, Solar Energy, Tata McGraw Hill Publication, 3rd Edition

Course outcomes:

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

1. Demonstrate need of different renewable energy sources
2. Discuss importance of renewable energy sources
3. Discuss various renewable energy sources in Indian context
4. Calculate and analyse utilization of solar and wind energy
5. Illustrate design of biogas plant
6. Demonstrate basics of hydrogen energy and fuel cells

ME 482	Gas Dynamics and Jet Propulsion	3L:0T:0P	3 credits

Course objectives:

1. To understand the features of compressible isentropic flows and irreversibilities like shocks
2. To make the students understand the effect of compressible flow through a constant area duct with friction and heat transfer
3. To provide a basic knowledge of jet and rocket propulsion technologies

Contents:

Module 1: Introduction to compressible fluid flow and control volume analysis (4 Hrs)

Coefficient of Compressibility - Stagnation state – Critical state - Various regions of flow;Physical significance of Mach number - Mach cone - Differences between Incompressible and Compressible flows; Properties of atmosphere - Effect of Mach number on compressibility, Conservation laws for mass - Momentum and energy in steady flow

Module 2: Isentropic Variable area flows (6 Hrs)

Isentropic flow through a variable area duct – Mach number variation - Area ratio as a function of Mach number - Impulse function - Mass flow rate through nozzles and diffusers. Phenomenon of choking – subsonic and supersonic designs - Pressure values for nozzles and diffusers. T-S and HS diagrams showing Nozzle and Diffuser process

Module 3: Shocks and Expansion waves in compressible flows (6 Hrs)

Flow with normal shock waves - Governing equations - Prandtl–Meyer equation - Impossibility of rarefaction shock - Mach number downstream of shock – Property variation across shock - Strength of shock wave - entropy change, Oblique shock-Property relations, Relation between M_x and M_y, θ-β-M relation, Maximum Value of Oblique shock, detached shock, Prandtl-Meyer Expansion fans

Module 4: Flow through constant area ducts with Friction (4 Hrs)
Fanno flow - Fanno curves - Equation and its solution - Variation of flow properties with duct length – Applications; Normal shocks in Fanno flow

Module 5: Flow through constant area ducts with heat transfer (5 Hrs)
Rayleigh flow - Rayleigh flow equation - Rayleigh line - Variation of flow properties - Maximum heat transfer – Applications. Normal shocks in Rayleigh flow

Module 6: Aircraft Propulsion (5 Hrs)
Air craft propulsion – Types of jet engines - Energy flow through jet engines - Thrust - Thrust power and Propulsive efficiency - Turbojet components - Diffuser compressor - Combustion chamber - Turbines - Exhaust system - Performance of jet engines

Module 7: Rocket Propulsion (5 Hrs)
Rocket propulsion – Rocket engines - Basic theory of equation - Thrust effective jet velocity - Specific impulse - Rocket engine performance - Solid and Liquid propellant rockets - Comparison of various propulsion systems

Text Books:

1. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press, 2008.
2. H.S. Mukunda, "Understanding Aerospace Chemical Propulsion", Interline Publishing, 2004.
3. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley, 1992.
4. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley, 1975.
5. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986
6. S.M.Yahya, Fundamentals of compressible flow with Aircraft and Rocket propulsion, 4th edition, New Age International Publisher, 2012.

Course Outcomes:
Upon completion of this course, the students will be able to
1. Familiarize with the isentropic and non- isentropic compressible flows
2. Apply gas dynamics principles to jet and space propulsion systems

ME 482	Wind and Solar Energy Systems	3L:0T:0P	3 credits

Course objectives:
1. To study the basic physics of wind and solar power generation.
2. To familiarize the power electronic interfaces for wind and solar generation.

Contents:
Module 1: Physics of Wind Power: (7 Hrs)
History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Module 2: Wind generator topologies: (12 Hrs)
Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control

Module 3: The Solar Resource: (7 Hrs)
Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability. Module 4: Solar photovoltaic: (8 Hours) Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control

Module 5: Network Integration Issues: (8 Hrs)
Overview of grid code technical requirements; Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues; Power system interconnection experiences in the world; Hybrid and isolated operations of solar PV and wind systems

Module 6: Solar thermal power generation: (6 Hrs)
Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis

Text / References:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

Course outcomes:
At the end of this course, students will demonstrate the ability to
1. Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
2. Understand the basic physics of wind and solar power generation.
3. Understand the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems.

ME 482	Finite Element Analysis	3L:0T:0P	3 credits

Course objectives:
1. To illustrate the principle of mathematical modeling of engineering problems
2. To introduce the basics and application of Finite Element Method

Contents:
Module 1: Introduction (8 Hrs)
Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method.

Module 2: One dimensional formulation (8 Hrs)
One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer, longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and natural frequencies.

Module 3: Two dimensional formulations (8 Hrs)
Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors; application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.

Module 4: Solution procedure (8 Hrs)
Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, Introduction to FE software

Text Books:

1. Dixit, Uday Shankar. Finite Elements Methods for Engineers. Cengage Learning
2. Logan, Daryl L. A first course in the finite element method. Cengage Learning, 2016.

Course Outcomes:
Upon completion of the course, students will understand the FEM formulation and its application to simple structural and thermal problems

ME 483	Process Planning and Cost Estimation	3L:0T:0P	3 credits

Course Objectives:
To introduce process planning concepts to make cost estimation for various products

Contents:
Module 1: Introduction of Process Planning (8 Hrs)
Methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection

Module 2: Process Planning Activities (8 Hrs)
Process parameter calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies

Module 3: Introduction to cost estimation (8 Hrs)
Introduction to cost estimation- importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates, estimating procedure, estimation of labor cost, material cost, allocation of overhead charges, calculation of depreciation cost

Module 4: Machining time estimation (8 Hrs)
Importance of machine time calculation, machining time for different lathe operations, drilling and boring time calculations, Machining time calculation for Milling, Shaping, Planing and Grinding

Module 5: Production costs (8 Hrs)
Different production processes for different jobs, estimation of forging cost, estimation of welding cost, estimation of foundry cost and estimation of machining cost

Text Books:

1. Peter Scalon, Process Planning, Design/ Manufacture Interface, Elsevier Sci. & Tech. 2002.
2. Ostwaal P.F. and Munez J., Manufacturing Processes and Systems, 9th ed., John Wiley 1998.
3. Chitale A.V. and Gupta R.C., Product Design and Manufacturing, 2nd ed., Prentice Hall

Course outcomes:
Upon completion of this course, the students will be able to use the concepts of process planning and cost estimation for various products

ME 483	Total Quality Management	3L:0T:0P	3 credits

Course objectives:
To facilitate the understanding of total quality management principles and processes

Contents:
Module 1: Introduction (8 Hrs)
Need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.

Module 2: TQM principles (8 Hrs)
Leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

Module 3: Tools for quality management (8 Hrs)
The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.

Module 4: TQM tools and techniques (8 Hrs)
Control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

Module 5: Quality systems (8 Hrs)
Need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation; Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

Text Books:

1. Besterfield D.H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

Course outcomes:

Upon completion of this course, the students will be able to use the tools and techniques of TQM in manufacturing and service sectors.

ME 483	Computational Fluid Dynamics	3L:0T:0P	3 credits

Course objective:

1. To study basic principles of Computational Fluid Dynamics
2. To study grid generation and discretization methods

Contents:

Module 1: Introduction (4 Hrs)

What is CFD, Scope and Application of CFD, steps involved in CFD, and Comparison of Numerical, Analytical and Experimental techniques, Working of Commercial CFD Software, Solution methodology-Preprocessing, Solver, Post processing

Module 2: Mathematical description of Physical Phenomenon (6 Hrs)

Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems

Module 3: Grid Generation and Discretization Methods (10 Hrs)

Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation. The Nature of Numerical Methods: The Discretization Concept, the Structure of the Discretization Equation. Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods. Methods of Deriving the Discretization Equations, Taylor-Series Formulation, Variational Formulation, Method of Weighted Residuals, Control Volume Formulation

Module 4: Heat Conduction, Convection and Diffusion (8 Hrs)

Steady One-dimensional Conduction, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations, over relaxation and under relaxation, Steady One-dimensional and Two Dimensional Convection Diffusion, Unsteady One-dimensional Convection

Module 5: Incompressible Fluid Flow (6 Hrs)

Governing Equations, Stream Function-Vorticity Method, Determination of Pressure for Viscous Flow, the SIMPLE, SIMPLER Algorithm, Introduction to Turbulence Modeling, Basic Theories of Turbulence, the Time-Averaged Equations for Turbulent Flow

Module 6: Finite Volume Methods (8 Hrs)
FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems, FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling

Text Books/ References:

1. An introduction to computational fluid dynamics-The finite volume method, Versteeg H.K., Malalasekera.W., Prentice Hall
2. Computational Fluid Dynamics, T. J. Chung , Cambridge University Press.
3. Numerical Heat Transfer and Fluid Flow, Suhas V. Patankar, Taylor & Francis.
4. Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics – Vol 1 & Vol 2, Charles Hirsch, Butterworth-Heinemann.
5. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I. and Pletcher, R.H., Hemishphere Publishing Corporation, New York, USA, 1984
6. Introduction to Computational Fluid Dynamics, Niyogi P., Laha M.K., Chakrabarty S.K., Pearson Education, India
7. Computational Fluid Flow and Heat Transfer, Muralidhar, K. and Sundararajan, T., Narosa Publishing House ,New Delhi
8. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd
9. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd. U.K.
10. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag
11. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House
12. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill

Course outcomes:
1. Demonstrate methodology to work with CFD
2. Illustrate principles of grid generation and discretisation methods
3. Identify and apply specific boundary conditions relevant to specific application
4. Decide solution parameters relevant to specific application
5. Analyse the results and draw the appropriate inferences
6. Demonstrate basic principles of FVM

ME 483	Numerical Heat Transfer	3L:0T:0P	3 credits

Course objectives:
1. To introduce numerical modelling and its role in the field of heat transfer and fluid flow
2. To understand the various discretization techniques and solution methods
3. To create confidence to solve complex problems in the field of heat transfer and fluid dynamics by using high speed computers

Contents:
Module 1 (6 Hrs)
Overview of Navier-Stokes and Scalar Transport Equations; Introduction to Finite Difference, Taylor Series, Expansion, Evaluation of First and Second Order Derivates, Truncation Error

Module 2 (6 Hrs)
Numerical Solution of One Dimensional Problems, Solution of Fin Equation, One Dimensional Transient Heat Conduction Equation; Finite Volume and Integral Method of Discretisation, Solution by Tri-Diagonal-Matrix Algorithm; Consistency and Stability of Numerical Methods, Fourier Stability Analysis

Module 3 (10 Hrs)
Solution of Two-Dimensional Steady and Transient Heat Conduction Equations, Alternating Direction Implicitly (ADI) method, Solution of Poisson Equation, Solution of Linear System of Equations; Formulation for Steady One-Dimensional Convection-Diffusion Problems, Central Upwind, Exact Hybrid and Power Law Schemes, Deferred correction method.

Module 4 (16 Hrs)
Discretisation of convection-diffusion equations in two and three dimensions, solution of Navier Stokes and scalar transport equations in primitive variables; SIMPLE, SIMPLER and SIMPLEC algorithm on staggered grid, Different boundary conditions, wall, symmetry, exit periodic boundary conditions, convective and radiative boundary, conditions; Introduction to non-staggered (collocated) grid, Introduction to generalized curvilinear coordinates

Module 5 (2 Hrs)
Introduction to phase change problems, Numerical treatment of surface radiation

Text Books/ References:

1. Numerical Heat Transfer and Fluid Flow, Suhas V. Patankar, Taylor & Francis
2. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd.
3. Tannehill, J.E., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, 2nd ed., Taylor & Francis, 1997.
4. Hoffmann, K.A. and Chiang, S.T., Computational Fluid Dynamics for Engineers, Engineering Education Systems, 2000.
5. Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics – The finite volume method, Longman Scientific & Technical, 1995

Course outcomes:
Upon completion of the course, students will able to
1. Write numerical modeling and its role in the field of fluid flow and heat transfer.
2. Apply the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems.
3. Illustrate the working concepts of thermal engineering.

ME 483	Fundamentals of Combustion	3L:0T:0P	3 credits

Course objectives:
The objective of the course is to introduce students to the fundamentals of combustion theories.

Contents:
Module 1: Introduction (4 Hrs)
Introduction to combustion, Applications of combustion, Types of fuel and oxidizers, Characterization of fuel,Various combustion mode,Scope of combustion.

Module 2: Thermodynamics of Combustion (6 Hrs)
Thermodynamics properties, Laws of thermodynamics, Stoichiometry, Thermochemistry, adiabatic temperature, chemical equilibrium

Module 3: Chemistry of Combustion (7 Hrs)
Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.

Module 4: Physics of Combustion (6 Hrs)
Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow

Module 5: Premixed Flame (7 Hrs)
One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame.

Module 6: Diffusion Flame (6 Hrs)
Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion

Module 7: Combustion and Environment (6 Hrs)
Atmosphere, Chemical Emission from combustion, Quantification of emission, Emission control methods

Text books:
1. D.P. Mishra, Fundamentals of Combustion,Prentice Hall of India, New Delhi, 2008.
2. Kuo K.K."Principles of Combustion" John Wiley and Sons, 2005
3. Strehlow R A., "Fundamentals of combustion" McGraw Hill Book Company, 1984

Course outcomes:
At the end of the course, the students will be able to understand the theories of the thermodynamics, chemistry, and physics of combustion.

ANNEXURE – II

List of Open Elective Courses

Sl. No.	Subject Code	Course Title	
1	ME 366	Micro-machining	Open Elective-I
2	ME 366	Reliability Engineering	
3	ME 366	Robotics	
4	ME 366	Power Plant Engineering	
5	ME 474	Soft skills and Technical Writing	Open Elective-II
6	ME 474	Numerical methods	
7	ME 474	Principle of Management	
8	ME 474	Optimization	
9	ME 484	Cyber Security & Laws	Open Elective-III
10	ME 484	Financial Management	
11	ME 484	Human Resource Management	
12	ME 484	Environmental Pollution & E- Waste Management	
# May also be selected from the subjects offered by other departments			

ME 366	Micro-machining	3L:0T:0P	3 credits

Course objectives:

Principle of mechanics of manufacturing in macro and micro are entirely different. Materials change behaviour if processed at micro level. The present course based on the mechanical / chemical behavior changes during micromachining/manufacturing. Therefore, tool based micro machining and unconventional micromachining processes have been explored.

Contents:

Module 1: Introduction to micromachining (2 Hrs)

Definition, classification, importance and applications in modern world

Module 2: Mechanical type advanced micro-machining processes (6 Hrs)

Abrasive jet micromachining (AJMM), Ultrasonic micromachining, abrasive water jet micro machining (AWJMM)

Module 3: Abrasive based nano finishing processes (8 Hrs)

Abrasive flow finishing (AFF), Chemo-mechanical polishing (CMP), Magnetic abrasive finishing (MAF), Magnetorheological finishging (MRF), Magnetorheological abrasive flow finishing (MRAFF), Magnetic float polishing (MFP)

Module 4: Thermoelectric type micromachining processes (8 Hrs)

Electric discharge micromachining (EDMM), wire EDM, EDDG, ELID, Laser beam micro machining (LBMM), Electron beam micromachining (EBMM)

Module 5: Chemical and electrochemical type advanced machining processes (6 Hrs)

Electrochemical micromachining (EDMM), electrochemical micro deburring, Chemical and photochemical micromachining; Abrasive based nano finishing

Module 6: Traditional mechanical micromachining processes (4 Hrs)

Micro turning, micro milling, micro drilling

Module 7: Miscellaneous topics (4 Hrs)
Focusses ion beam (FIB) machining, selection of micromachining

Textbooks:
1. Introduction to micromachining, VK Jain, Narosa Publisher, New Delhi 2nd edition

Reference books:
1. Micromachining methods, JA Mc Geough, Champan and Hall, London
2. Micro manufacturing processes, VK Jain CRC Press
3. Advanced machining processes, VK Jain, Allied Publisher New Delhi

Course outcomes:
At the end of the course, the students will be able to:
1. Acquired knowledge about different micro-machining processes.
2. Acquired knowledge about different micro-machining processes.
3. Understanding about the capabilities of different micro-manufacturing processes.
4. Understanding about the capabilities of different advanced micro-manufacturing processes.
5. Understanding about the capabilities of traditional micro-manufacturing processes

ME 366	Reliability Engineering	3L:0T:0P	3 credits

Course objectives:
1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Contents:
Module 1: Probability theory and Distributions (8 Hrs)
Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions- Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance; Measures of Dispersion-Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis

Module 2: Reliability Concepts, Parameters and Predictions (8 Hrs)
Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve; Failure Data Analysis-Hazard rate, failure density, Failure Rate, Mean Time to Failure (MTTF), MTBF, Reliability Functions; Reliability Hazard Models- Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model; Distribution functions and reliability analysis

Module 3: System Reliability (5 Hrs)
System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems

Module 4: Reliability Improvement (8 Hrs)

Redundancy Techniques- Element redundancy, Unit redundancy, Standby redundancies, Markov analysis; System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.

Module 5: Maintainability and Availability (5 Hrs)
System downtime, Design for Maintainability- Maintenance requirements; Design methods- Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement; Availability – qualitative aspects

Module 6: Failure Mode, Effects and Criticality Analysis (5 Hrs)
Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis

Text Books/ References:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd

Course outcomes:
At the end of the course students will be able to
1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

ME 366	Robotics	3L:0T:0P	3 credits

Course objectives:
1. To understand the basics of automation and brief history of robot and applications.
2. To understand the kinematics and dynamics of robots.
3. To understand about robot drive system and control systems.
4. To understand about Robot Programming methods & Languages of robot.
5. To understand about various Sensors and their applications in robots.

Contents:
Module 1: Introduction (8 Hrs)
Introduction: Automation and Robotics, brief history of robotics, social and economic aspects of robots, advantages and disadvantages of using robots in industries. An over view of Robots – present and future applications. Classification and structure of Robotic system: Classification, geometrical configurations, wrist and its motions, end effectors and its types, links and joints.

Module 2: Robot drive system (8 Hrs)

Hydraulic, Electric and Pneumatic types of locomotion devices. Resolution, accuracy and repeatability, advantages and disadvantages of drive system. Control systems and components: Basic control system concepts and models, transformation and block diagram of spring mass system, controllers – ON and OFF, proportional, integral, proportional and integral, transient and response to second order system. Robot actuation and feedback components: position, velocity sensors, actuators.

Module 3: Robot arm kinematics (8 Hrs)
Robot Arm Kinematics : Kinematics – Introduction, direct and inverse, kinematics, rotation matrix, composite rotation matrix, rotation matrix about an arbitrary axis, Euler angles representati0n, homogeneous transformations, links, joints and their parameters, D-H representation. Robot Arm Dynamics: Lagrange - Euler formulations – Joint velocities, kinetic energy, potential energy and motion equations of a robot manipulator.

Module 4: Trajectory arm kinematics (8 Hrs)
Introduction, general considerations on trajectory planning, joint interpolated trajectories, 4-3-4 trajectory example. Planning of Cartesian path trajectories. Robot Programming: Introduction, manual teaching, lead through teaching, programming languages – AML and VAL (simple examples) programming with graphics, storing and operating task programs.

Module 5: Sensors (8 Hrs)
Internal state sensors, tactile sensors, proximity sensing, range sensing, and force torque sensors. Elements of computer vision. Sensing and digitizing function in machine vision – image devices – lighting techniques, analog to digital conversion – sampling – quantization – encoding – image storage image processing and analysis, Feature Extraction and object recognition

Text Books:
1. Industrial Robotics / Groover M P /Pearson Edu.
2. Robotics / Fu K S/ McGraw Hill.

Reference books:
1. Robotics, CSP Rao and V.V. Reddy, Pearson Publications (In press)
2. Robotics and Control / Mittal R K & Nagrath I J / TMH.
3. An Introduction to Robot Technology, / P. Coiffet and M. Chaironze / Kogam Page Ltd. 1983 London.
4. Robotic Engineering / Richard D. Klafter, Prentice Hall
5. Robot Analysis and Intelligence / Asada and Slow time / Wiley Inter-Science.
6. Introduction to Robotics / John J Craig / Pearson Edu.
7. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley & Sons (ASIA) Pte Ltd.

Course Outcomes:
CO1: Gain knowledge with the automation and brief history of robot and applications.
CO2: Familiarize with the kinematic and dynamic motions of robot.
CO3: Have good knowledge about robot end effectors.
CO4: Demonstrate programming methods & various languages of robots.
CO5: Explain the principles of various Sensors and their applications in robots

ME 366	Power Plant Engineering	3L:0T:0P	3 credits

Course Objectives:

1. To equip students about the working of various power plants
2. To educate the students to understand the steam generators, combustion and firing methods in order to make the fullest use of thermal power potentialities
3. To enable the students to understand in detail about nuclear, gas turbine, hydro and diesel power plants which play an important role in power generation

Contents:

Module 1: Introduction (6 Hrs)

Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants

Module 2: Steam power plants (9 Hrs)

Flow sheet and working of modern-thermal power plants, high pressure and super critical pressure steam stations, High pressure and Supercritical boilers - Positive circulation boilers - Fluidized bed boiler - Waste heat recovery boiler, Heat Exchangers - Feed water heaters - Super heaters - Reheaters -Economiser - Condenser- Cooling tower

Module 3: Fuel- Ash handling and Firing methods (6 Hrs)

Coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector

Module 4: Gas Turbine Power plants (7 Hrs)

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Module 5: Other power plants (8 Hrs)

Nuclear power plants - working and types of nuclear reactors, boiling water reactor, pressurized water reactor, fast breeder reactor, controls in nuclear power plants; hydro power plant -classification and working of hydroelectric power plants; tidal power plants; diesel power plants

Module 6: Energy, Economic and Environmental Aspects of Power Generation (6 Hrs)

Load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing; Greenhouse effect, Flue gas desulphurization(FGD) systems, Electrostatic precipitators (ESP), Radiation hazards, Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants

Text Books/ References:

1. Nag P.K., Power Plant Engineering, 4th edn, Tata McGraw Hill, 2014.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2013.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998
4. R. K. Rajput, A Text Book of Power Plant Engineering, Laxmi Publications (P) Ltd. New Delhi, 2015
5. J. Wiesman and R. Eckart, Modern Power Plant Engineering, Prentice hall India Ltd, ISBN- 97801359725.

Course Outcomes:

Upon completion of the course, the students can

1. Identify various equipment required for power generation in different power plants
2. Understand the working of various components used in different power plant with feasibility and comparison of site selection criteria
3. Select appropriate devices for storage and combustion of fuel to improve the plant performance.
4. Evaluate economic and environmental aspects for existing and upcoming power plant.

ME 474	Soft skills and Technical Writing	3L:0T:0P	3 credits

Course Objective:

To train the students to face job interviews, public speaking, and write research papers

Contents:

Module 1: Communication skills (8 Hrs)

Soft skills, communication skills, presentation skills, time management skills

Module 2: Interview skills (8 Hrs)

Body language and Etiquettes, group discussion and interview skills, preparation of curriculum vitae.

Module 3: Working with MS office (8 Hrs)

MS-word and PowerPoint for preparing figures, tables, and report writing, solving numerical using MS excel.

Module 4: Scientific writing (8 Hrs)

Scientific writing, scientific paper, preparing title, listing of authors and addresses, writing an abstract, introduction, materials and material selection section, results, discussion, and conclusions

Module 5: Publishing skills (8 Hrs)

Writing a Conference paper, book review, and thesis, preparing a poster and art of oral presentation.

Text books:

1. Robert A. Day. "How to write and publish a scientific paper", Cambridge University Press.
2. Krista Van Laan, "The Insider's Guide to Technical Writing", XML Press.

ME 474	Numerical methods	3L:0T:0P	3 credits

Course objectives:

To train students to understand mathematics in a new perspective and develop programs for solving mathematical problems.

Contents:

Module 1: Basics of Programming (4 Hrs)

Operators, Control statements, looping structures, arrays, functions, fundamentals and applications of various numerical methods, basics of MATLAB

Module 2: Interpolation and Extrapolation methods (12 Hrs)

Newton's divided-difference interpolation polynomial, Lagrange interpolating polynomials, Interactive MATLAB Program Development.

Module 3: Numerical Integration Techniques (12 Hrs)
Newton-Cote's quadrature formula, Rectangular rule, Trapezoidal rule, Simpson's rule, Weddle's rule, Double-integration, Interactive MATLAB Program Development.

Module 4: Linear Algebraic Equations (12 Hrs)
Matrix operations, Solving system of linear equations: Graphical method, Cramer's rule, Elimination of unknowns, Naïve Gauss elimination method, Gauss-Jordan method, Matrix inversion method, LU decomposition, Tridiagonal systems, Symmetric matrix, Interactive MATLAB program development, Iterative methods: Gauss-Seidel, Jacobi method, Interactive MATLAB Program Development.

Module 5: Initial and two point boundary value problems (12 Hrs)
Ordinary differential equations: Euler's method, Heun's method, Runge-Kutta method, Interactive MATLAB Program Development, Boundary value problems: Shooting method, Finite difference method, Interactive MATLAB Program Development.

Text Books & References:
1. Numerical Methods – S.P. Gupta
2. Numerical Methods – E Balagurusamy
3. Numerical methods for Engineers – S. Chapra, R.P. Canale

Course outcomes:
Upon completion of this course, students should be able to:
CO1: Interpolate the given data using appropriate techniques.
CO2: Obtain values of various functions arising out of engineering problems using appropriate techniques.
CO3: Handle matrix computations that come up in linear algebra like accurate/approximate solutions of systems of linear equations, eigen values, eigen vectors, inverses, etc.
CO4: Solve ordinary differential equations numerically.

ME 474	Principles of Management	3L:0T:0P	3 credits

Course objectives:
To understand the principles of management and their application to the functioning of an organization

Contents:
Module 1: Introduction to management and organizations (8 Hrs)
Definition of management, science or art, manager vs entrepreneur; Types of managers-managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management.

Module 2: Planning (8 Hrs)
Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes.
Module 3: Organising (8 Hrs)

Nature and purpose of Organizing, Formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

Module 4: Directing (8 Hrs)
Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

Module 5: Controlling (8 Hrs)
Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Text Books:

1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999.

Course Outcomes:
Upon completion of this course, the students will get a clear understanding of management functions in an organization

ME 474	Optimization	3L:0T:0P	3 credits

Course objectives:
To introduce students to various optimization methods for problem solving

Contents:
Module 1: Introduction (8 Hrs)
Need of optimum designs. Basic terminologies - design variables, objective functions, constraints, and variable bounds; Different types of optimization problems - single variable, multivariable, linear, non-linear, real/integer/discrete, single-objective, and multi-objective; Problem formulation; Fundamental concepts - global/absolute optimum point, local/relative optimum point, inflection point, and convex programming problems

Module 2: Single-variable unconstrained optimization (8 Hrs)
Graphical method; Exact method based on necessary condition; Direct search methods - bracketing the optimum point by exhaustive search method and bounding phase method, and refining the optimum point by interval halving method and golden section search method. Gradient-based methods - Newton-Raphson method, bisection method, and secant method

Module 3: Multi-variable unconstrained optimization (8 Hrs)

Fundamental concepts - gradient vector and Hessian matrix; exact method based on necessary condition. Direct search methods - Simplex search method, Hooke-Jeeves pattern search method, and Powell's conjugate search method; Gradient-based methods - Cauchy's steepest decent method, Newton's method, and Marquardt's method

Module 4: Multi-variable constrained optimization (8 Hrs)
Linear programming problems - Graphical and Simplex methods; Non-linear programming problems - Kuhn-Tucker conditions and sensitivity analysis; Transformation methods - Penalty function method and method of multipliers (augmented Lagrangian method). Direct search methods - Variable elimination method, complex search method, and random search method. Gradient-based linearized methods - Taylor series expansion and unidirectional search, move limit method, Frank-Wolfe method, cutting plane method, and feasible direction method

Module 5: Integer programming Methods (6 Hrs)
Penalty function method, cutting plane method, and branch-and- bound method.

Text Books:

1. Kalyanmoy Deb: Optimization for Engineering-Algorithms and Examples: Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Ashok D. Belegundu and Tirupathi R Chandrupatla: Optimization: Concepts and Applications in Engineering: Pearson Education, New Delhi.
3. Christos H. Papadimitriou and Kenneth Steiglitz: Combinatorial Optimization: Algorithms and Complexity: Prentice-Hall of India Pvt. Ltd., New Delhi.
4. Conley. W: Computer Optimization Techniques: Pntrecelli Book, 1980

Course outcomes:
At the end of the course, the students will be able to apply optimization methods to solve a wide range of engineering problems.

ME 484	Cyber Security and Laws	3L:0T:0P	3 credits

Course objectives:
1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Contents:
Module 1: Introduction to Cybercrime (4 Hrs)
Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.

Module 2: Cyber offenses & Cybercrime (9 Hrs)
How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops
Module 3: Tools and Methods Used in Cyberline (6 Hrs)

Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)

Module 4: The Concept of Cyberspace (8 Hrs)
E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law

Module 5: Indian IT Act (6 Hrs)
Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments

Module 6: Information Security Standard compliances (6 Hrs)
SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI

Course outcomes:
At the end of the course the students will
1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

ME 484	Financial Management	3L:0T:0P	3 credits

Course objectives:
1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Contents:
Module 1: Overview of Indian Financial System
Characteristics, Components and Functions of Financial System; Financial Instruments- Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills; Financial Markets- Meaning, Characteristics and Classification of Financial Markets, Capital Market, Money Market and Foreign Currency Market; Financial Institutions- Meaning, Characteristics and Classification of Financial Institutions; Commercial Banks, Investment-Merchant Banks and Stock Exchanges

Module 2: Concepts of Returns and Risks (6 Hrs)
Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio; Time Value of Money- Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.
Module 3: Corporate Finance and Financial Ratio Analysis (9 Hrs)

Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision; Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.

Module 4: Capital Budgeting and Working Capital (10 Hrs)
Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR); Concepts of Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.

Module 5: Sources of Finance (2 Hrs)
Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance

Module 6: Capital Structure (3 Hrs)
Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach; Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure

Module 7: Dividend Policy (3 Hrs)
Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach

Text Books/ References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi

Course outcomes:
At the end of the course the students will
1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

ME 484	Human Resource Management	3L:0T:0P	3 credits

Course objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers.

Contents:

Module 1: Introduction to HR (5 Hrs)

Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions; Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.

Module 2: Organizational Behaviour (9 Hrs)

Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues, Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness , Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour, Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team; Case study.

Module 3: Organizational Structure & Design (6 Hrs)

Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress, Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership; Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.

Module 4: Human resource Planning (5 Hrs)

Recruitment and Selection process, Job-enrichment, Empowerment – Job Satisfaction, employee morale; Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning; Training & Development: Identification of Training Needs, Training Methods.

Module 5: Emerging Trends in HR (6 Hrs)

Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment; Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation 6.

Module 6: HR & MIS (10 Hrs)

Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act.

Text Books/ References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013.
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing.
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011.
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015.
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing.
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications.

Course outcomes:

At the end of the course students will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

ME 484	Environmental Pollution & E- Waste Management	3L:0T:0P	3 credits

Course objectives:

The overall aims of the course are for students

1. To acquire understanding of the new and emerging contaminants from various industrial processes and their transformation products.
2. To study emerging environmental issues related to newer methods of manufacture of industrial products.

Contents:

Module 1 (9 Hrs)

New and emerging pollutants and related transformation products, Effects & risks of emerging contaminants on ecosystems and humans, Persistent pollutants. Analytical methods for identifying emerging pollutants and the products of their transformation

Module 2 (9 Hrs)

Micro pollutants- Pesticides, Pharmaceutical - Veterinary and human drugs, personal care products, Surfactants and surfactant metabolites, Flame retardants, Industrial additives and agents. Emerging pollutants' toxicity, and their water-related characteristics (degradability, solubility, sorption…)

Module 3 (8 Hrs)

Emerging Issues - E-waste, Hazardous Waste, Nuclear Waste, Nano pollution, Thermal Pollution, pollutant emission and treatment.

Module 4 (8 Hrs)
Emerging pollutants' emergence and fate in surface and ground water, as well as mathematical modelling, Sustainable Development, Risk mitigation.

Module 5 (8 Hrs)
Transformation Products of Emerging Contaminants in the Environment, Removal of emerging contaminants from water, soil and air, methods and preventive measures.

Text Books/ References:

1. G. Buttiglieri, T.P. Knepper, (2008), Removal of emerging contaminants in Wastewater Treatment: Conventional Activated sludge Treatment, Springer-Verlag Berlin Heidelberg, HdbEnvChem, vol. 5, Part S/2:1-35, DOI: 10.1007/698_5_098
2. Alok Bhandari; Rao Y. Surampalli; Craig D. Adams; Pascale Champagne; Say Kee Ong; R. D. Tyagi; and Tian Zhang, Eds., (2009) Contaminants of Emerging Environmental Concern, American Society of Civil Engineers, ISBN (print): 978-0- 7844-1014-1, ISBN (PDF): 978-0-7844-7266-8
3. Dimitra A. Lambropoulou, Leo M. L. Nollet Eds. () Transformation Products of Emerging Contaminants in the Environment: Analysis, Processes, Occurrence, Effects and Risks, 1st Edition, Wiley, ISBN-13: 978-1118339596, ISBN-10: 111833959

Course Outcome:

1. Introduction to new and emerging contaminants and their transformation products.
2. Study of pollutants from manufacturing of goods.
3. Emerging area in environmental pollution.
4. Study of life cycle of a contaminant, modeling and mitigation.

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