Curriculum

B. Tech. Mechanical Engineering Program

School of Technology

Pandit Deendayal Petroleum University

Course Structure of B. Tech. in Mechanical Engineering, w.e.f. Academic Year: 2016-17

Program Educational Objectives (PEOs)

1. To prepare the graduates with strong foundation in science and engineering for successful careers in core mechanical and interdisciplinary industries, higher education and research.
2. To prepare graduates who can become entrepreneur/innovators to design and develop system/process/product/service to address social and industrial challenges.
3. To prepare graduates with leadership qualities, strong communication skills, professional and ethical values.
4. To prepare lifelong learners graduates to excel in their professional career as well as to pursue higher education.

Program Outcomes (POs)

1. **Engineering knowledge:** An ability to apply knowledge of mathematics, science, and engineering in solving/analyzing problems in industries, research and development institutions, public sector units, higher education and in academia.
2. **Problem Analysis:** An ability to design and conduct experiments, as well as to analyze and interpret data in mechanical engineering theory and practice at various industrial work-places.
3. **Design/ Development of solutions:** An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, health and safety, manufacturability, and sustainability.
4. **Multidisciplinary Approach:** An ability to function on multidisciplinary teams.
5. **Modern tool usage:** An ability to identify, formulate, and solve engineering problems using modern tools and techniques.
6. **Communication:** An ability to communicate effectively.
7. **The Engineer and Society:** The broad education necessary to understand the impact of mechanical engineering solutions in a local, global, economic, environmental, and societal context.
8. **Life-long learning:** A recognition of the need for, and an ability to engage in life-long learning.
9. **Investigations of complex problem:** Use of Applied research including design of experiments, analysis and interpretation of data, synthesis of the information to provide valid solutions with the knowledge of contemporary issues.
10. **Project Management:** An ability to apply engineering knowledge and management principles skills to manage engineering projects.
11. **Environment and Sustainability:** An ability to design sub-systems, systems, components and processes to fulfil demand of environmental sustainability.
12. **Ethics:** Apply engineering principles toward the professional values and ethics.

Program Specific Outcomes (PSOs)

1. To **analyse the problems** and **create solution** by applying engineering knowledge with a multidisciplinary approach in the area of thermal engineering, manufacturing systems and product design.
2. To analyze, interpret and provide solutions to the real life mechanical engineering problems **using engineering software/tools.**
3. **To work effectively in a team** to address **complex issues** by engaging in **lifelong learning** and following **ethical and environmental** practices

Course Structure of B. Tech. in Mechanical Engineering, w.e.f. Academic Year: 2016-17

COURSE STRUCTURE FOR B.TECH. FIRST YEAR (Mechanical Engineering)

SEMESTER I (Subjects)			B.TECH. FIRST YEAR (Mechanical Engineering)											
Sr. No.	Course Code	Course Name	Teaching Scheme					Exam Scheme						
			L	T	P	C	Hrs/wk	Theory			Practical		Total Marks
								CE	MS	ES	CE	ES	
1	16MA101T	MATHEMATICS - I	3	1	0	4	4	25	25	50	-	-	100
2	17CE106T	ELEMENT OF CIVIL ENGG. & MECHANICS	4	0	0	4	4	25	25	50	-	-	100
3	16EE102T	BASIC ELECTRONICS	3	0	0	3	3	25	25	50	-	-	100
4	16SC102T	PHYSICS (Theory)	3	0	0	3	3	25	25	50	-	-	100
5	16HS108T	ENVIRONMETAL STUDIES	3	0	0	3	3	25	25	50			100
6	16SC102P	PHYSICS Lab.	0	0	2	1	2	-	-	-	25	25	50
7	16MA106P	COMPUTER PROGRAMMING	0	0	2	1	2	-	-	-	25	25	50
8	16ME101T	ENGINEERING GRAPHICS	1	0	0	1	1	25	25	50	-	-	100
9	16ME101P	ENGINEERING GRAPHICS (Practical)	0	0	2	1	2	-	-	-	25	25	50
10	16SP101 16SP102 16SP103	NCC-I NSS-I SPORTS-I	-	-	-	1 1 1	-						
Total			**17**	**1**	**6**	**24**	**24**						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Course Code: 16MA101T					**Course Name:** Mathematics I			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	1	--	4	4	**Continuous Evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Nil

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Get in-depth knowledge of application of Single Variable Calculus with Curve Tracing as a Base.

CO2: Gain ability for solving and analyzing problems of Multivariable Calculus .

CO3: Solve Improper Integrals and understanding of Sequence and Series and their convergence.

CO4: Get the idea of the roles of Vectors in Calculus and how we can relate in physical system.

Code/ Table/ Charts if any: NIL

UNIT I **(8 L, 2 T)**

Calculus for single variable: Successive differentiation, Leibnitz theorem (without proof), Taylor's and Maclaurin's expansion of functions of single variable. Fundamental theorem of Integral calculus, Application of integrals to length, area, volume and surface area of revolution.

Curve Tracing: Asymptotes, Cartesian, polar and parametric forms.

UNIT II **(11 L, 4 T)**

Calculus for of Several variable: Partial derivatives, Euler's theorem, directional derivative and gradient, Taylor's and Maclaurin's expansion of functions of several variables, Mamixa and minima of functions of several variables, Lagrange's method of undetermined multipliers, Multiple Integrals – double and triple**,** Jacobian, Change of order of integration, change of coordinates, evaluation of area, volumes of solids, Mass, center of gravity and moment of inertia.

UNIT III **(11 L, 4 T)**

Infinite Series & Improper Integrals: Convergence and divergence of Infinite series. Comparison test, D' Alembert's ratio test, Raabe's test, logarithmic test, Cauchy's root test. Alternating series; Leibnitz test, power series. Convergence of improper integrals, Beta and Gamma functions and its properties.

UNIT IV **(9 L, 3 T)**

Vector Calculus: Scalar and vector fields, Line and surface Integrals, Gradient divergent curl, Green's Theorem and stoke's theorem (without proof) with application and physical significance

Lecture: 39 Hrs

Tutorial: 13 Hrs

Approximate Total : 52 Hrs

Texts and References

1. Higher Engineering Mathematics, B. S Grewal, Khanna Pub., Delhi.
2. Calculus (5th Edition), James Stewart, Thomson (2003).
3. Higher Engineering Mathematics, R. K. Jain & S. R. K. Iyernagar
4. Thomas' Calculus, eleventh edition, Pearson.
5. E.Kreyszig, Advanced engineering mathematics (8th Ed.), John Wiley (1999)
6. Advance Engineering Mathematics, Michael D. Greenberg

Course Code: 17CE106T					**Course Name:** Element of Civil Engg. & Mechanics			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
4	0	--	4	4	**Continuous Evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Nil

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand the basic information about Civil Engineering Structures and their scopes.
CO2: Understand concurrent and non-concurrent system of forces and to compute the resultant & equilibrium forces for given problem.
CO3: Estimate the support reactions of simply supported beam.
CO4: Analyze the truss.
CO5: Evaluate centroid, centre of gravity & moment of inertia in different shapes and lamina.
CO6: Appreciate friction and its engineering application. Calculate co-efficient of friction for different shapes.

Code/ Table/ Charts if any: NIL

UNIT I **(12 L)**

Basics and scope of Civil Engineering: Introduction to Civil Engineering, Role of Civil Engineer, Scope of Civil Engineering.
Brief introduction to sub branches of Civil Engineering: Transportation Engineering, Environmental Engineering, Water resources Engineering, Geotechnical Engineering, Structural Engineering, Engineering Surveying. Construction
Materials: Basic ingredients of Concrete, smart materials/alternate materials. Brief details of residential, commercial buildings, Green buildings, smart cities

UNIT II **(13 L)**

Concurrent system of forces: Definition of a force, system of forces and their classifications, principle of transmissibility, resolution of a force and its rectangular components, triangular, parallelogram and polygon law of forces. Determination of resultant of concurrent coplanar system of forces.
Non-concurrent system of forces: Moment of a force, Varignon's theorem of moments, couples and their characteristics. Determination of magnitude, direction and position of resultant of non- concurrent coplanar system of forces. Example problems.
Equilibrium of concurrent system of forces: Conditions of equilibrium for concurrent coplanar system of forces, Lami's theorem. Example problems

UNIT III **(12 L)**

Equilibrium of non-concurrent system of forces: Types of supports, loads and beams. Conditions of equilibrium for non-concurrent coplanar system of forces, Determination of support reactions for statically determinate beams i.e simply supported beam, cantilever beam. Overhanging beams.
Trusses: Definition: Plane truss, determinate truss and indeterminate truss. Analysis of plane determinate trusses for member forces and

UNIT IV **(13 L)**

Friction: Introduction, angle of friction, coefficient of friction, cone friction, limiting friction, types of friction, laws of static friction, Example problems related to impending motion on horizontal and inclined planes, wedge friction and ladder friction.

Centroid and Centre of Gravity: Definition, derivation of expressions for centroidal distances of simple planar laminas like rectangle, triangle, quarter and semi circles. Determination of centroidal distances of compound laminas.

Moment of Inertia: Definition, derivations of expressions for moment of inertia of simple planar laminas like rectangle, triangle, quarter, semi circle and circle. Theorems of perpendicular and parallel axis. concept of axis of symmetry, Definitions of polar moment of inertia, radius of gyration, Determination of moment of inertia, polar moment of inertia, radius of gyration of compound laminas about centroidal axes and about any specified reference line .

Lecture: 50 Hrs
Tutorial: 00 Hrs
Approximate Total : 50 Hrs

Texts and References

1. Meriam & Craige, Engineering Mechanics, John Wiley & Sons.
2. N.H Dubey, Engineering Mechanics-Statics and Dynamics, Tata McGraw Hill Private limited
3. R. S. Khurmi, Engineering Mechanics, S. Chand Publication
4. Elements of Civil Engineering by Jagadeesh T.R. and Jayaram, Sapna Book House, Bangalore
5. Elements of Civil Engineering (IV Edition) by S.S. Bhavikatti, Vikas Publishing House Pvt. Ltd., New Delhi.
6. Ferdinand P Beer and E Russel Johnson , Mechanics for Engineers (Statics & Dynamics) McGraw Hill book company, New York

Course Code: 16EE102T					**Course Name:** Basic Electronics			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	0	--	3	3	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: NIL

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand semiconductor and diode working.
CO2: Understand the application of diodes.
CO3: Understand working and application of BJT.
CO4: Understand basic concepts and applications of OPAMP.
CO5: Understand the number systems and logic circuits.
CO6: Understand communication basics.

Code/ Table/ Charts if any: NIL

UNIT I **(11 L)**

SEMICONDUCTOR DIODES AND APPLICATIONS: Introduction of Semiconductors, Electrons and Holes in an Intrinsic Semiconductors, Donor and Acceptor Impurities, P-Type and N-Type Semiconductors, Formation of a P-N Junction Diode, Biasing of P-N Junction Diode, V/I Characteristics of Diode, Diode Rectifier Circuits (Half Wave and Full Wave), Diode Rectifiers with Capacitor Filter, Zener Diode, V/I Characteristic of Zener diode, Voltage Regulators, Zener Diode as Voltage Regulator, 78XX and 79XX Ics for Voltage Regulation, Photo diodes.

UNIT II **(08 L)**

BIPOLAR JUNCTION TRANSISTOR CHARACTERISTICS: Junction Transistor, Transistor Current Components, Working of a BJT, Operating Regions, Transistor as a Switch, Transistor as an Amplifier, CB, CE and CC Configurations, Input and Output Characteristics, Transistor Biasing.

UNIT III **(08 L)**

INTRODUCTION TO OPERATIONAL AMPLIFIERS: Block Diagram and Characteristics of Ideal Op-Amp, Parameters of an Op-Amp, Concept of Feedback, Inverting and Non- Inverting Amplifier, Differential Amplifier, Virtual Ground, Adder, Subtractor, Comparator, Integrator and Differentiator, Zero Crossing Detector, Voltage Follower.

UNIT IV **(12 L)**

DIGITAL ELECTRONICS: Number systems (Decimal, Binary, Octal and Hexadecimal), One's and two's complements, Binary codes (weighted and non-weighted codes), Boolean algebraic theorems and simplification of Boolean expressions, Logic gates, Implementation of Boolean expressions using logic gates, Standard and canonical forms of Boolean expression, POS and SOP forms, Simplification of Boolean expressions using K-map, Basics of Flip-flops and its applications.

INTRODUCTION TO COMMUNICATION SYSTEMS: Elements of Communication Systems, Concept of Modulation and Demodulation, Basics of Analog and Digital Communication

Lecture: 39 Hrs
Tutorial: 00 Hrs
Approximate Total: 39 Hrs

Texts and References

1. Boylestad and Nashlesky, "Electronic Devices and Circuit Theory", PHI
2. R. A. Gaikwad, "Operational Amplfier and Linear Integrated Circuits", PHI

3. Albert Malvino and David J. Bates, “Electronic Principles”, Tata McGraw Hill
4. Morris Mano, “Digital Design”, PHI
5. G. Kennedy and B. Davis, “Electronic Communication Systems”, Tata McGraw Hill
6. V. K. Mehta, “Principles of Electronics”, S. Chand Publishers
7. N. N. Bhargava, S. C. Gupta, and D. C. Kulshreshtha, “Basic Electronics And Linear Circuits”, McGraw Hill Education (India)

Course Code: 16SC102T					**Course Name:** Physics (Theory)			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	0	--	3	3	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Nil

Course Outcomes (COs):

CO1: Vector and its Physical concept explanation and electricity and magnetism concepts.
CO2: Waves and oscillation physical concept understanding.
CO3: Interference, diffraction and polarization understanding.
CO4: Modern Physics and Laser understanding.

Code/ Table/ Charts if any: NIL

UNIT I **(13 L)**

Vector concepts & applications in Physics: Introduction to vector algebra, Physical concepts in vector fields and Scalar fields with examples, Physical and mathematical concepts of gradient, divergence and curl, Green's theorem, Gauss theorem, applications in gravitation and electrostatics. Stokes' theorem and its applications.

Electrostatics and Electrodynamics: Gauss's law in dielectric medium, Equation of continuity, Biot Savart law – Ampere's law – magnetization and magnetic intensity, Faraday's law of induction – generalization of Ampere's law, displacement current, Maxwell's equations, wave equation for electromagnetic radiation, electromagnetic wave propagation in free space and isotropic dielectric medium, Poynting theorem & Poynting vector.

UNIT II **(07 L)**

Waves and oscillations: Types of waves, Simple harmonic motion, Damped simple harmonic motion, types of damping, Forced oscillation, resonance, , Energy Transport in Wave motion.

Acoustics & Ultrasonic: Introduction to Sound, Sabine's reverberation theory, Acoustical defects and their remedies, Doppler Effect. Ultrasonic waves, methods of their generation and detection, properties and application of ultrasonic waves.

UNIT III **(08 L)**

Optics:

Interference: Types of interferences, Thin film interference, Anti-reflecting films; wedge shape films; Newton's rings and its applications,. **Diffraction:** Diffraction of light waves, Fraunhofer diffraction at a single slit, Two slit Fraunhofer Diffraction Pattern, N- Slit Fraunhofer Diffraction Pattern, diffraction grating, resolving power, Rayleigh Criterion, Fresnel diffraction (Introduction). **Polarization:** Polarization of light, production of polarized light, types of polarization and their representation, Malus's law, polarizer and analyser, Double refraction, Interference of Polarized light: Quarter wave plates and Half wave plates

UNIT IV **(12 L)**

Laser & Fibre Optics: Concepts of maser and laser, Interaction of radiation of matter-quantum mechanical view, Einstein coefficients spontaneous and stimulated emission, principles involves in laser, Meta stable state, Population inversion, three and four level laser system, and optical amplification and optical resonator, characteristics of laser, Ruby, He-Ne and semiconductor lasers, Application of lasers, Optical Fiber, physical structure and basic theory, modes in optical fibers, step index and graded index fibers, losses in optical fibers, applications of optical fibers in communication.

Nuclear Science and Engineering: Basics of Nuclear Physics, activation analysis, Q –Value, Carbon dating,

fission and fusion; principle, effect of nuclear radiation on materials, radiation protection and environment.

Lecture: 40 Hrs
Tutorial: 00 Hrs
Approximate Total : 40 Hrs

Texts and References

1. Resnick, Halliday and Krane, *Physics part I and II*, 5th Edition John Wiely (2002).
2. A. Ghatak, *Optics,* 3rd edition, Tata McGraw Hill (2005).
3. Kittel C., Knight W.O. and Ruderman M.A., *Mechanics - Berkeley Physics Course, Vol. 1*, Tata McGraw-Hill.
4. Purcell E.M. *Electricity and Magnetism - Berkeley Physics Course, Vol.2,* TataMcGraw-Hill.
5. Crawford F.S. - *Waves and Oscillations, Berkeley Physics Course, Vol. 3*,McGraw-Hill.
6. Feyman R.P., Leighton R.B. and Sands M. *The Feyman Lectures on Physics, Vol. 1.,* Narosa Publication
7. Feyman R.P., Leighton R.B. and Sands M. *The Feyman Lectures on Physics, Vol. 2*. Narosa Publication
8. Griffith D.J.H*., Introduction to Electrodynamics* - Prentice Hall, India.
9. M. N. Avadhanulu, *A text book of engineering Physics*, S. Chand & Company, Ltd.
10. Brij Lal, N. Subrahmanyam, *Heat and Thermodynamics,* S. Chand & Company, Ltd.

Course Code: 16HS108T				**Course Name:** Environmental Studies				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	0	--	3	3	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Nil

Course Outcomes (COs):

CO1: To get the Bird's eye view of Environment, its multidisciplinary and functioning.

CO2: To understand about the different types of pollutions and their effects on human beings, plants, materials and the entire environment.

CO3: To understand about the various environment pollution control strategies

Code/ Table/ Charts if any: NIL

UNIT I **(08L)**

Bird's Eye view to Environment: Environmental Studies – Its importance and Multidisciplinary nature; Ecosystem and its various types, factors affecting the functioning of an ecosystem; Biodiversity – its importance, threats and conservation; Natural Resources – Forest, Water, Mineral, Energy, Minerals, Food; Review of State of India's Environment.

UNIT II **(10L)**

Multi-scale Environmental Pollution (Global, Regional and Local): Concept of Clean Environment, Introduction to various environmental standards – air, water, soil, noise, heat. Causes and Effects of Air Pollution, Water Pollution, Soil Pollution, Solid Waste (organic and Inorganic) Pollution, Hazardous Waste Pollution, Marine Pollution, E-Waste, Noise Pollution, Thermal Pollution, Radioactive Pollution; Pollution across Indian cities – case studies; Introduction to man-made disasters like floods, heat waves, landslides, etc.

UNIT III **(12L)**

Environmental Pollution Control Strategies: Multi-approaches (role of research, technology, policy, planning & implementation, legislation & judiciary, incentives & business) for reducing various types of pollution; Case studies of Pollution control strategies; Review of the Central and State Government's policies and mechanisms for managing various natural resources and controlling the various types of pollutions (including Swacch Bharat Abhiyan), Global Initiatives for environmental management; Rainwater Harvesting Systems, Indian Culture and Traditional Wisdom for managing environment. Visits to relevant sites of Environmental conservation and systems.

UNIT IV **(09L)**

Social Issues and the Environment: Concept of sustainability and Sustainable Development, Environmental Sustainability Index, Environmental Ethics, Public awareness and people's participation (bottlenecks and solutions), Consumerism and Waste products, Introduction to Carbon Footprint & Water Footprint, Green Buildings, Green Business (profitability in managing environment).

Lecture:39 Hrs
Tutorial: 00 Hrs
Approximate Total :39 Hrs

Texts and References

1. Bharucha Erach,2005. Textbook for Environmental Studies, UGC New Delhi: Universities Press. ISBN-10: 8173715408.
2. Bharucha Erach, 2003. The Biodiversity of India, Ahmedabad: Mapin Publishing Pvt. Ltd.
3. Clark, R. S., Marine Pollution, Clanderson Press Oxford.
4. Daniel B. Botkin & Edwards A. Keller, Environmental Science, Wiley INDIA edition.
5. Hawkins R. E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay.
6. Miller T. G. Jr., 2006. Environmental Science, Clengage Learning, India
7. Odum E. P. 1971. Fundamentals of Ecology, W. B. Saunders Co, USA.
8. Survey of the Environment, The Hindu
9. Down to Earth, Centre for Science and Environment
10. Wagner K. D., 1998. Environmental Management, W. B. Saunders Co, USA.
1. Gilbert Masters and Wendell P. Ela, 2012. Introduction to Environmental Engineering and Science, PHI Learning Pvt Ltd, New Delhi.
2. Annual State of India's Environment 2016 and 2015, Down to Earth, Centre for Science and Environment, New Delhi.
3. Climate Actions – Increase Your Handprint and Decrease Your Footprint, Centre for Environment Education, Ahmedabad, 2015.
4. Alexandare Rojey, 2009. Energy and Climate, Wiley Publications, Great Bratain.
5. Trivedi R.K., Handbook of Environmental Laws, Rules and Guidelines, Compliances and Standards, Vol I & II
6. Environmental Studies by R. Rajagopalan, Oxford University Press.
7. John Barrows and Lisa Iannucci, 2009. The complete idiot's guide to Green Building and Remodelling, Alpha Publishing, Penguin Group, USA.
8. Water Harvesting Manual, Centre for Science and Environment, New Delhi.
9. Making Water Everybody's Business, Centre for Science and Environment, New Delhi

Course Code: 16SC102P				**Course Name:** Physics Lab.			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	2	1	2	**Continuous Evaluation**	**End Semester**	50
					25	25	

Prerequisites: Nil

Course Outcomes (COs):

CO1: To study the Hall Effect.
CO2: To study the Interference through Newton's ring experiment.
CO3: To study the Fiber optics communication through Laser.
CO4: To Study the diffraction using LASER.
CO5: To study the snell's law using ultrasonic frequency

List of Experiments

1. Study of Interference using Michelson’s Interferometer.
2. Introduction to Oscilloscope.
3. Study of Interference using Newton’s Ring experiment.
4. Experiment to determine volumetric coefficient of expansion of liquids.
5. Experiment to determine thermal conductivity of different solid bodies.
6. Experiment with solar collector.
7. Measurement of vapor pressure.
8. Experimental to determine linear thermal expansion coefficient of solid bodies.
9. Experiment on reflection of Ultrasonic waves.
10. Experiment to determine heat capacities.
11. Experiment to determine critical temperature.
12. Study of effect of electric force.
13. Experiments with hot air engine.
14. Experiments with heat pump.
15. Study of conducting electricity by means of electrolysis.
16. Measurement of viscosity.
17. Determining Plank’s constant and Inverse square law.
18. Experiments on diffraction with He-Ne Laser Kit.
19. Study of Hall Effect.
20. Determining semiconductor energy band gap using four probe method.
21. Experiment to study forced oscillations.
22. Study of charging and discharging of capacitive plates.
23. Study of Bio-Savart’s Law
24. Study of Kerr Effect.
25. Experiments on spectroscopy.
26. Experiments on Fiber Optics.
27. Study of Photoconductivity.
28. Study of Interference using ultrasonic Interferometer.
29. Determining e/m by Thomson’s method.
30. Study of Polarization of light using LASER.
31. Millikan’s oil drop experiment.
32. Study of Holography.

Course Code: 16MA106P				**Course Name:** Computer Programing				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**			**Total**
--	--	2	1	2		**Lab. Work**	**Lab. Exam**	50
						25	25	

Prerequisites: NIL

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand the basics of input output operations, data types.
CO2: Understand the use of conditional operators.
CO3: Understand the use of Looping Structures.
CO4: Understand the basics and application of Array.
CO5: Understand pointers.
CO6: Understand structures.

Code/ Table/ Charts if any: NIL

UNIT I

Write Algorithm/Draw Flowchart/ Write C++ Programs for Simple Programs

UNIT II

Write Algorithm/Draw Flowchart/ Write C++ Programs Using IF Condition

UNIT III

Write Algorithm/Draw Flowchart/ Write C++ Programs Using Loop

UNIT IV

Write Algorithm/Draw Flowchart/ Write C++ Programs Using Array

Course Code: 16ME101T				**Course Name:** Engineering Graphics				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
1	0	--	1	1	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Nil

Course Outcomes (CO's):

CO1: Understand the basic fundamentals of engineering graphics and representation of various ideas through concept of drawings.

CO2: Comprehend the theory of projection and develop the skills of visualization for solid geometries.

CO3: Understand the basic principles of orthographic projection and use it to represent the views on reference planes.

CO4: To apply their technical communication skill for 3-dimensional geometries in the form of communicative drawings using isometric projection.

Code/ Table/ Charts if any: NIL

UNIT I **(3 L)**

Introduction to Engineering Graphics, Drawing instruments and accessories, lettering, lines and dimensioning. BIS - SP46. Use of plane scales and Representative Fraction, Free hand sketching.

Engineering Curves: Classification of Engineering Curves, Construction of Conics, Cycloidal Curves, Involutes and Spirals.

Projections of Points & Lines: Introduction to principal planes of projections, Projections of the points located in same quadrant and different quadrants, Projections of line with its inclination to one reference plane and with two reference planes. True length of the line and its inclination with the reference planes.

UNIT II **(3 L)**

Projections of Solids & Section of Solids: Classification of solids. Projections of solids like Cylinder, Cone, Pyramid and Prism with its inclination to one reference plane and with two reference planes.

Development of Lateral Surfaces: Concept of development of the different surfaces. Parallel Line Development and Radial Line Development.

UNIT III **(3 L)**

Orthographic Projections: Principle of projection, Principal planes of projection, Projections from the pictorial view of the object on the principal planes for View from Front, View from Top and View from Side using first angle projection method and third angle projection method, Full Sectional View.

UNIT IV **(4 L)**

Isometric Projections and Isometric View or Drawing: Isometric Scale, Conversion of orthographic views into isometric projection, isometric view or drawing.

Lecture: 13 Hrs

Tutorial: 00 Hrs

Approximate Total : 13 Hrs

Texts and References

1. N. D. Bhatt and V. M. Panchal "Engineering Drawing",Charotar Publishing House, Anand
2. K. Venugopal, "Engineering Drawing & Graphics", New Age International (P) Ltd.
3. D. A. Jolhe, "Engineering Drawing with an Introduction to AutoCAD", Tata McGraw-Hill Publishing Co. Ltd., New Delhi
4. Bethune, J. D., "Engineering Graphics with Autocad", Prentice Hall
5. Agrawal, B. and Agrawal , C. M., "Engineering Drawing", Tata McGraw Hill Publishers
6. John, K. C., Engineering Graphics, Prentice Hall India Publishers
7. Kirstie Plantenberg, Engineering Graphics Essentials with AutoCAD 2016 Instruction, 4th Ed., SDC Publications
8. Kulkarni, D. M., Rastogi, A. P. and Sarkar, A. K., "Engineering Graphics with AutoCAD", PHI 2009
9. Luzadder, W. J. and Duff, J. M., "Fundamentals of Engineering Drawing", PHI 1993
10. Parthasarathy, N. S., and Murali, V., "Engineering Drawing", Oxford University Press

Course Code: 16ME101P				**Course Name:** Engineering Graphics (Practical)			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	2	1	2	**Continuous Evaluation**	**End Semester**	50
					25	25	

Prerequisites: Nil

Course Outcomes (CO's):

CO1: Understand the basic fundamentals of engineering graphics and representation of various ideas through concept of drawings.

CO2: Comprehend the theory of projection and develop the skills of visualization for solid geometries.

CO3: Understand the basic principles of orthographic projection and use it to represent the views on reference planes.

CO4: To apply their technical communication skill for 3-dimensional geometries in the form of communicative drawings using isometric projection.

Code/ Table/ Charts if any: NIL

List of Drawing Sheets:

1. Engineering curves
2. Projection of Planes
3. Projections of Solids
4. Inter section of solids
5. Development of surfaces of solids
6. Orthographic projections
7. Isometric projections
8. Practice with various CAD tools (2D and 3D drawing)

Course Structure of B. Tech. in Mechanical Engineering, w.e.f. Academic Year: 2016-17

COURSE STRUCTURE FOR B.TECH. FIRST YEAR (Mechanical Engineering)

SEMESTER II (Subjects)			**B.TECH. FIRST YEAR (Mechanical Engineering)**											
Sr. No.	**Course Code**	**Course Name**	**Teaching Scheme**					**Exam Scheme**						
			L	**T**	**P**	**C**	**Hrs/wk**	**Theory**			**Practical**		**Total Marks**
								CE	**MS**	**ES**	**CE**	**ES**	
1	16MA103T	MATHEMATICS - II	3	1	0	4	4	25	25	50	-	-	100
2	16SC101T	CHEMISTRY (Theory)	3	0	0	3	3	25	25	50	-	-	100
3	16SC101P	CHEMISTRY Lab.	0	0	2	1	2	-	-	-	25	25	50
4	16ME106T	ELEMENT OF MECHANICAL ENGG.	3	0	0	3	3	25	25	50	-	-	100
5	16EE106T	ELEMENTS OF ELECTRICAL ENGG.	3	0	0	3	3	25	25	50	-	-	100
6	16HS109T	PROFESSIONAL ETHICS AND HUMAN VALUES	1	0	0	1	1	25	25	50	-	-	100
7	16HS103T	COMMUNICATION SKILLS (Theory)	1	0	0	1	1	25	25	50	-	-	100
8	16ME104P	WORKSHOP PRACTICE	0	0	2	1	2	-	-	-	25	25	50
9	16HS103P	COMMUNICATION SKILLS (Practical)	0	0	2	1	2	-	-	-	25	25	50
10	NO101/ NS101	NCC/NSS				1 1							
		Total	**14**	**1**	**6**	**20**	**21**						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Course Code: 16MA103T				**Course Name:** Mathematics – II				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	1	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Mathematics – I

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Solve engineering problems using the principles of solution of differential equations.
CO2: Understand analytic function of a complex variable and able to apply Cauchy integral theorem and residue theorem to solve contour integrations.
CO3: To solve partial differential equations.
CO4: Apply Laplace transform and its inverse to solve initial value and other related problems.

Code/ Table/ Charts if any: NIL

UNIT I **(10L, 4T)**

Complex Analysis: Complex numbers, Function of a Complex variable, Analytic function, Cauchy-Riemann equations, Conformal mapping and its type, Some standard & special conformal mappings, Definition of a Complex line integral, Cauchy's integral theorem, Cauchy's Integral formula, Residue theorem, Calculation of residues, Evaluation of real definite integrals.

UNIT II **(10L, 3T)**

Ordinary differential equation: Differential equations of first order and higher degree, Linear. Independence and dependence of functions. Higher order differential equations with constant, coefficient, Rules for finding C.F. and P.I., Method of variation of parameter, and method of undermined coefficients, Cauchy and Legendre's linear equations, Linear differential equations of second order with variable coefficients; Simultaneous linear equations with constant coefficients. Various applications of higher order differential equations in solution of engineering problems, Orthogonal trajectories.

UNIT III **(10L,3T)**

Partial Differential Equations: Formation of P.D.E, Equations solvable by direct integration, Linear and non-linear equations of first order, Lagrange's equations. Homogeneous and non-homogeneous linear P.D.E. with constant coefficients. Rules for finding C.F. & P.I.

UNIT IV **(09L, 3T)**

Laplace transforms: Piecewise continuous functions and exponential order functions, Definition, Existence and Properties of Laplace transform, unit step function and Heavyside function, Inverse laplace transform, laplace transform of derivative, Convolution theorem, Applications for solving differential equations

Lecture: 39 Hrs
Tutorial: 13 Hrs
Approximate Total : 52 Hrs

Texts and References

1. Complex variables and applications (7thEdition), R.V.Churchill and J.W.Brown, McGraw-Hill (2003) 2. Complex analysis, J.M.Howie, Springer-Verlag (2004)
2. Higher Engineering Mathematics, R. K. Jain & S. R. K. Iyernagar.
3. E.Kreyszig, Advanced engineering mathematics (8^{th} Ed.), John Wiley (1999)
4. W.E.Boyce and R. DiPrima, Elementary Differential Equations (8^{th} Ed.) John Wiley (2005)
5. Ordinary and Partial Differential Equations by M.D. Raisinghania, 8^{th} edition, S. Chand Publication (2010)
6. Introduction to partial differential Equations, K Sankara Rao,PHI Learning pvt ltd.

Course Code: 16SC101T				**Course Name:** Chemistry (Theory)				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	0	--	3	3	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: NIL

Course Outcomes:

On completion of the course, students will be able to

CO1: Understand the hardness of water, different types of hardness and their removal techniques.
CO2: Understand types of fuel, types of fuel, calorific values and new age energy devices.
CO3: Understand the concept of corrosion, their types and control.
CO4: Understand the concept of lubrication and choice of lubricants for various industrial application.
CO5: Understand the properties and applications of advanced materials such as polymers, nanomaterials.
CO6: Understanding the working principles and applications of various analytical techniques.

Code/ Table/ Charts if any: NIL

UNIT I **(10 L)**

Water and its Treatment: Introduction, sources of water Impurities in water, hard and soft water, Degree of hardness, Types of hardness, Scale and sludge formation in boiler, Priming and Foaming, Softening of water.

UNIT II **(12 L)**

Corrosion and its Control: Introduction, Theories of corrosion, Types of corrosion, Protection of metals from corrosion – organic and inorganic materials, Inhibitors, Cathodic protection.

Chemistry of Fuels: Origin, Classification and properties of Solid, Liquid, Gaseous Fules, Proximate and Ultimate analysis, Petroleum- Distillation and Uses, Calorific Value, Determination of Calorific Value of solid and liquid fuels, Fuel Cell and Fuel Cell technology

UNIT III **(12 L)**

Cements: Introduction, Manufacturing of Portland cement, chemical composition of cement, Properties and application of different types of cement, Setting and hardening of cement, Heat of hydration, Environmental impact of cement manufacturing.

Green Chemistry: Principles of Green Chemistry, Acid rain, Greenhouse effect, Depletion of Ozone layer, Green chemical technology

UNIT IV **(10 L)**

Polymers: Classification, Types of polymerization reactions, Preparation of some commercially important polymers, Resins- Phenol formaldehyde Resins, Urea formaldehyde resin, Epoxy resins. Some aspects of supramolecular chemistry

Lecture: 44 Hrs
Tutorial: 00 Hrs
Approximate Total : 44 Hrs

Texts and References

1. Jain and Jain, Engineering Chemistry, Dhanpat Rai Publication
2. James G. Speight, The Chemistry and Technology of Petroleum, CRC Press, New York.
3. Vasily Simanzhenkov & Raphael Idem, Crude Oil Chemistry, Marcel Dekker, New York.
4. James G. Speight, Fuel Science and Technology Hand Book, Marcel Dekker, New York.
5. M.A. Famin, T.A. Al-Sahhaf, A.S. Elkilani, Fundamental of Petroleum Refining, , Elsevier
6. S. N. Banerjee, An introduction to science of corrosion and its inhibition, Oxonian Press, 1985
7. Mars Guy Fontana , *Corrosion* Engineering, 3/E, Tata McGraw-Hill Education

Course Code: 16SC101P				**Course Name:** Chemistry Lab.			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	2	1	2	**Continuous Evaluation**	**End Semester**	50
					25	25	

Prerequisites: Nil

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Perform experiments to determine constituents such as Ca, Mg, Fe, Cl, Cu, in samples.
CO2: Learning and handling of electro analytical instruments such as pH meter, Conductivity meter.
CO3: Preparation of industrially important organic polymeric compounds and understanding of reaction.

Code/ Table/ Charts if any: NIL

List of Experiments:

1. To determine the strength of given solution of ferrous ammonium sulphate by titrating against standard N/40 K2Cr2O7 using potassium ferricyanide as an external indicator
2. To determine the strength of given copper sulphate solution by titrating against N/20 sodium thiosulphate (hypo) solution
3. To prepare phenol formaldehyde resin (Bakelite)
4. To prepare p-nitro acetanilide from acetanilide
5. To determine the total, permanent and temporary hardness of given water by complexometric titration using standard 0.01M EDTA solution
6. To determine the strength of given HCl solution using a standard NaOH solution by performing a pH-metric titration
7. To determine the strength of given HCl solution using a standard NaOH solution by performing a conductometric titration
8. To determine the strength of given ascorbic acid by titrating against standard N/10 iodine solution
9. To study the kinetics of decomposition of sodium thiosulphate by a mineral acid
10. Determination of Chloride in the given water sample by Mohr Method
11. To determine the smoke point of the given oil sample.
12. To determine the viscosity of sucrose solutions of different concentrations by Ostwald viscometer, and thereby concentration of an unknown solution.
13. To evaluate the saponification value of given oil sample.
14. To determine the acid value of given oil samples.
15. To Prepare Soap by Hot Process.
16. To determine the viscosity of the given petroleum products and to study the variation of viscosity with respect to temperature and concentration.

Course Code: 16ME106T					**Course Name:** Elements of Mechanical Engineering			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	0	--	3	3	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: NIL

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand the basic fundamentals and terminologies applied in thermodynamics.
CO2: Analyze and solve closed system and control volume related energy conservation problems with ideal gas and pure substances.
CO3: Understand and analyze internal combustion engine cycles, pumps and compressors.
CO4: Understand the classification, construction and working and applications of power transmission systems and boilers.

Code/ Table/ Charts if any: NIL

UNIT I **(13 L)**

Introduction to Thermodynamics: Definition and its applications. Systems and control volumes, thermodynamic properties, state and equilibrium processes and cycles, temperature and Zeroth law of thermodynamics. Forms of Energy, energy transfer by work and heat, law of conservation of energy (First law of thermodynamics)

Properties of Pure substances: Definition, examples and phases; Phase change processes, Property diagrams and tables, ideal gas equation of state

UNIT II **(13 L)**

Closed system analysis: Concept of moving boundary work, energy balance. Specific heats, internal energy and Enthalpy-expressions for ideal gas, liquids and gases

Control volume analysis: Conservation of mass, flow work, energy analysis of steady flow systems and applications

Introduction to II law of Thermodynamics: Limitations of First Law, Thermal Energy reservoirs, heat engines, Refrigerators and Heat pumps, Kelvin Plank and Clausius statement and their equivalence.

UNIT III **(13 L)**

Internal Combustion Engines: Introduction, classification and brief description of I.C. engines mechanism, 4-Stroke and 2-Stroke petrol, gas and diesel engines, Otto, Diesel and dual cycles and their air standard efficiencies and mean effective pressures.

Pump and compressors: Classification of pumps and compressors, working principle, Theory of single stage reciprocating air compressor, effect of clearance, volumetric efficiency, concept of multistage compression.

UNIT IV **(13 L)**

Power transmission systems: Belts, gears, rope, couplings, clutches, brakes, and bearings

Boilers: Classification, study of various types of boilers.

Lecture: 52 Hrs
Tutorial: 00 Hrs
Approximate Total : 52 Hrs

Texts and References

1. Yunus A. Cengel& Bole, Thermodynamics- An Engineering Approach by Tata Mcgraw Hill, New Delhi
2. P. K. Nag, Engineering Thermodynamics, Tata Mcgraw Hill, New Delhi
3. R.K.Rajput , Engineering Thermodynamics, EVSS Thermo Laxmi Publications
4. Rayner Joel, Engineering Thermodynamics, ELBS Longman.
5. R.Yadav , Fundamentals of Engineering Thermodynamics by, Central Publishing House, Allahabad
6. B L Singhal and R. Singhal, Elements of Mechanical Engineering, Tech-Max Publications, Pune.

Course Code: 16EE106T				**Course Name:** Elements of Electrical Engineering				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	0	--	3	3	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Nil

Course Outcomes:
Course Outcomes (COs):

On completion of the course, students will be able to
CO1: Get the basic knowledge of Electrical Engineering.
CO2: Understand the concept of various quantities of Electrical Engineering.
CO3: Understand the Interrelation between Mechanical and Electrical branch.
CO4: Get the idea of types of power sources and equipment are available in the market.
CO5: Get the idea about protection and safety issues of the equipment.

Code/ Table/ Charts if any: NIL

UNIT I **(10 L)**

GENERAL: Concepts of E.M.F., potential difference and current, resistance, effect of temperature on resistance, resistance temperature coefficient, and insulation resistance. S.I. units of work, power and energy. Conversion of energy from one form to another in electrical, mechanical and thermal systems, batteries and cells, their types, primary cells and secondary cells, Lead Acid, Ni-Cd and Ni-MH batteries, current capacity and cell ratings, charging methods and maintenance procedure.
D.C. CIRCUITS: Classification of electrical networks, Ohm's law, Kirchhoff's law and their applications for network solutions. Simplifications of networks using series and parallel combinations and star-delta conversions.

UNIT II **(10 L)**

ELECTROMAGNETISM: Magnetic effect of an electric current, cross and dot conventions, right hand thumb rule and cork screw rule, nature of magnetic field of long straight conductor and toroid. Concept of M.M.F., flux, flux density, reluctance, permeability and field strength, their units and relationships. Simple series and parallel magnetic circuits, analogy of electrical and magnetic circuit, force on current carrying conductors placed in magnetic field, Fleming's left hand rule. Faradays laws of electromagnetic induction, statically and dynamically induced E.M.F., self and mutual inductance, coefficient of couplings. Energy stored in magnetic field. Charging and discharging of inductor and time constant.
ELECTROSTATICS: Electrostatics field, electric flux density, electric field strength, absolute permittivity, relative permittivity, capacitance and capacitor, composite dielectric capacitors, capacitors in series and parallel, energy stored in capacitors, charging and discharging of capacitors and time constant.
AC FUNDAMENTALS: Sinusoidal voltages and currents, their mathematical and graphical representation, concept of instantaneous, peak (maximum), average and R.M.S. values, frequency, cycle, period, peak factor and form factor, phase difference, lagging, leading and in phase quantities and phasor representation. Rectangular and polar representation of phasors.

UNIT III **(9 L)**

SINGLE PHASE A.C. CIRCUITS: Study of A.C. circuits consisting of pure resistance, pure inductance, pure capacitance and corresponding voltage-current phasor diagrams and waveforms. Development of concept of reactance, study of series R-L, R-C, R-L-C circuit and resonance, study of parallel R-L, R-C and R-L-C circuit, concept of impedance , admittance, conductance and suceptance in case of above combinations and relevant voltage-current phasor diagrams, concept of active, reactive and apparent power and power factor.

POLYPHASE A.C. CIRCUITS: Concept of three-phase supply and phase sequence. Voltages, currents and power relations in three phase balanced star-connected loads and delta-connected loads along with phasor diagrams.

SINGLE PHASE TRANSFORMERS: Construction, principle of working, E.M.F. equation, voltage and current ratios. Losses, definition of regulation and efficiency, determination of these by direct loading method. Autotransformers and dimmer stats.

UNIT IV **(13 L)**

Electrical Wiring: Connectors and switches, systems of wiring, domestic wiring installation, sub circuits in domestic wiring, simple control circuit in domestic installation, industrial electrification.

ILLUMINATION: Types of lamps, fixtures and reflectors, illumination schemes for domestic, industrial and commercial premises, Lumen requirements for different categories.

SAFETY and PROTECTION: Safety, electric shock, first aid for electric shock and other hazards, safety rules, use of multi-meters, grounding, importance of grounding, equipment grounding for safety, circuit protection devices, fuses, MCB, ELCB and relays.

Lecture: 39 Hrs
Tutorial: 00 Hrs
Approximate Total : 39 Hrs

Texts and References

1. B. L. Theraja, “Electrical Technology”, Vol.1, S.Chand Publication, New Delhi
2. V. N. Mittal, “Basic Electrical Engineering”, TMH Publication, New Delhi
3. Surjitsingh, “Electrical Estimating and Costing”, DhanpatRaiand Co.
4. V. K. Mehta, “Basic ElectricalEngineering”, S.Chandand Company Ltd., New Delhi
5. Edward Hughes, “Electrical Technology”, Seventh Edition, Pearson Education
6. H. Cotton, “Elements of Electrical Technology”, C.B.S. Publications
7. John Omalley Shawn, “Basic Circuits Analysis”, McGraw Hill
8. Del. Toro, “Principles of Electrical Engineering”, Prentice Hall of India

Course Code: 16HS109T				**Course Name:** Professional Ethics and Human Values				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
1	0	--	1	1	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: NIL

Code/ Table/ Charts if any: NIL

Basic Syllabus:

1. Defining the ethical question (Morality and the Tragedy of Commons)
2. Religion and morality. (Plato "The Euthphyro problem")
3. Utilitarianism vs Individualism (Bentham: Classical Hedonism)
4. Deontology (Immanuel Kant: The foundations of Ethics)
5. What's the Right thing to do? (Michael Sandel Lecture 1 and 2)
6. Academic Dishonesty (Oxford Murders directed by Alex De la Iglesia)
7. Professional Ethics: Choosing the best over the Good as engineers. (Some Case studies)

Note: Primary readings are indicated within brackets. These must be considered essential reading material. Two reference reading material are also included for the benefit of the student/teacher.

UNIT I **(01 L)**

The moral question is a subjective and relative question. This introductory unit deals with the problem of managing the personal within the collective definitions of moral.

UNIT II **(01 L)**

Is what ismorally good commanded by God because it is morally good, or is it morally good because it is commanded by God?" Ever since Plato's original discussion, this question has presented a problem for some theists, though others have thought it a false dilemma, and it continues to be an object of theological and philosophical discussion today.

UNIT III **(02 L)**

Utilitarianism is defined as the science of utility. Most modern amenities and engineering products are based on a utilitarian rational. However, the central problem with this approach to ethical life is that it fails to take into considerations of Justice. For example, racism was justified as a utilitarian principle. Individualism questions the greatest benefit to greatest number theory. This unit will open up the thinking of students to various ways in which they can imagine their role in society as professionals. A question they should ask of themselves is "Do I want to be the best, best engineer/student/individual or do I want to be the best good engineer/student/individual?"

UNIT IV **(02 L)**

At the end of this essential reading which prescribes a duty bound system of ethics, students are likely to ponder over the means/end problem. Kantian ethics is deeply opposed to a consequentialist ethics. In some ways all rationale is consequentialist in nature.

UNIT V **(02 L)**

This unit lays bare the Rawlsian difference between the "Good thing" and the "Right thing. Sandel in his Harvard lectures uses contemporary issues to drive home the point that making ethical choices can never be an individual choice. His book and video lectures should pave way for engaging discussions in the class.

UNIT VI **(02 L)**

This movie focused unit will raise an important debate surrounding the question of universal logic. The close relation between mathematics and philosophy is explored in the backdrop of the troubling question: Is there

an absolute truth?

UNIT VII **(02 L)**

This is a case study focused lecture.Two popular ethical questions involving the engineering community in Indian society are the use of nuclear energy and construction of large scale dams. Both of these technologies and utilitarian in nature but have been met with widespread conflict. Through these case studies, a debate on public good" can be initiated.

Lecture: 12 Hrs
Tutorial: 00 Hrs
Approximate Total : 12 Hrs

Texts and References

1. Louis P. Pojman, ed. Moral Philosophy: A Reader. 3rd ed. Indianapolis: Hackett Publishing, 2003. ISBN 0-87220-661-0
2. MacIntyre, Alisdair, After Virtue: A study in Moral Theory. Second edition: Cambridge Publications, 1991. 0-268-00594-X

Course Code: 16HS103T				**Course Name:** Communication Skills (Theory)				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
1	0	--	1	1	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: NIL

Course Outcomes (COs):

CO1: Referring to many external sources for reading helps students in having a comprehensive understanding of different fields.
CO2: It takes more than professional skills to be a successful professional and a few components help in imparting a new dimension to students' perception.
CO3: Problem solving assignments promote critical thinking to offer a solution.
CO4: Theoretical topics give an insight into the foundation and requirements of communication for students to become adept at life skills.
CO5: Versatile assignments help students look into the various aspects of profession.

Code/ Table/ Charts if any: NIL

UNIT I **(3 L)**

Communication Skills:

Process, Types and Levels of Communication. Technical communication and General Communication. Factors to be considered in technical communication.
Verbal and Non-Verbal communication (Kinesics): Components of non-verbal communication. Barriers to effective communication. Communication across culture.

UNIT II **(3 L)**

Listening Skills: Types of Listening. Barriers in Effective Listening. Tips for effective listening. Barriers to effective communication

UNIT III **(2 L)**

Interview:
Introduction. General preparation for an interview. Types of questions generally asked in interview. Types of interviews. Importance of non-verbal aspects in an interview.

UNIT IV **(6 L)**

Letter Writing, Technical Proposals and Job Applications: Business Letters, Structures and Types of Business Letters, Letters of Inquiry, Complaint, Regret and Adjustment.
Definition of technical proposal, Purpose, Types, characteristics, Structure, Style and Appearance. Essential Parts of Application. Cover Letter and the Resume. Types of Resume. Chronological Resume, Functional Resume.

Lecture: 14 Hrs
Tutorial: 00 Hrs
Approximate Total : 14 Hrs

Texts and References

1. Meenakshi Raman & Sharma, Technical Communication Principles and Practice by Oxford University Press, New Delhi.
2. Basic Communication Skills for Technology, Andrea J. Rutherford (Pearson Education)
3. Communication Skills for Engineers, Sunita Mishra, C. Murali Krishna (Pearson Education)
4. Business Communication Strategies. Matthukutty M. Monipally (Tata-McGraw-Hills)

Course Code: 16ME104P					**Course Name:** Workshop Practices		
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	2	1	2	**Continuous Evaluation**	**End Semester**	50
					25	25	

Prerequisites: Nil

Course Outcomes (COs):

CO1: To develop and enhance the machining skills in students**.**

CO2: To develop a skills in dignity of labor, precision, safety at work place, team working and development of right attitude.

CO3: To create and develop an ability to design and model different prototypes in carpentry.

CO4: To create and develop ability to design and model different basic prototypes in trade of fitting.

CO5: To create and develop ability to design and model different basic prototypes in trade of tin smithy.

Metrology

Semi-Precision tools: Rules and scales, try square. Inside/Outside Calipers, Depth gages etc. Precision Tools: Micrometers, Vernier calipers, Bevel Protractor, Dial indicator, Gage blocks, Surface plates etc.

Carpentry Shop

Timber, Seasoning and Preservation, Plywood and Ply boards, Carpentry Tools, Engineering applications. Different Joints

Bench work and Fitting

Introduction to the familiarization with tools and their uses, Hammers, Hacksaws, choice of blades & sawing techniques, Files with their classification; According to their longitudinal shape & cross section, classification based on cuts; teeth; length of the file, Care of files and hand tool safety rules Vices & their classification, Other hand tools; scribers, chisels, scrapers, center, punch, surface gauge, Universal cribbing block, Trammel, Screw drivers, Drills, Spanners, Pliers, Taps, Dies, Reamers, Screw drivers etc, Fitting Processes : Marking, Chipping, Sawing, Filing, Scrapping, Drilling, Internal Threading (or Trapping), External Threading (or Dieing), Reaming, welding, soldering, brazing

Tin Smithy – Surface development

Shearing and Bending of sheets, Making simple products by Tin Smithy practice.

List of Experiments:

1. Introduction to Workshop and safety.
2. Experiment on measurement of linear, angular and curved dimensions of the object.
3. Fitting job: Detailed drawing of work piece, use of fitting tools and job preparation.
4. Hands on experience on welding, brazing and soldering.
5. Carpentry job: Detailed drawing of work piece, use of carpentry tools and job preparation.
6. Sheet metal job: Detailed drawing of work piece, use of sheet metal working tools and job preparation.
7. Plumbing job: Internal/External threading, piping network using Tees, Elbows, Reducer, Bends etc.

Course Code: 16HS103P		**Course Name:** Communication Skills Lab.					
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	2	1	2	**Lab. Work**	**Lab. Exam**	**50**
					25	25	

Course Outcomes (COs):

CO1: Confidence to listen, speak, read and write in English.
CO2: Being able to produce something new with the help of inputs.
CO3: Learning to critically analyze.
CO4: Preparing reports with the help of collected data.
CO5: Having a multi-dimensional/disciplinary perspective and approach.

Practical Sessions

1. **Effective Presentation Strategies:** Defining purpose, Analysis of Audience, Organising Contents, Preparing an Outline of the Presentation, Visual Aids, Nuances of Delivery, Body Language and Effective Presentation.
2. **Group Discussion:** Introduction, GD as a part of selection Process, Guidelines, Role Functions and Practice of GD with current topics.
3. **Creative Writing Task:** Developing /completing a story, developing/ completing a poem.
4. **Learning English from songs:** Listening to the selected songs and exercise of grammar based on those songs will be given to students.
5. **Listening to BBC and Voice of America:** Special English Lessons. Etymology of many words as well as current colloquial expressions and their meanings. Audio clips with text are both BBC and VOA—reputed resources for English
6. **Article Writing:** Reading and analyzing a selected article. Writing an article on a given topic.

COURSE STRUCTURE FOR B.TECH. SECOND YEAR (Mechanical Engineering)

SEMESTER III (Subjects)			B.TECH. SECOND YEAR (Mechanical Engineering)											
Sr. No.	Course Code	Course Name	Teaching Scheme					Exam Scheme						
								Theory			Practical		Total Marks
			L	T	P	C	Hrs/wk	CE	MS	ES	CE	ES	
1	16MA201T	Maths – III	3	1	0	4	4	25	25	50	-	-	100
2	16MI203T	Strength of Material	4	0	0	4	4	25	25	50	-	-	100
3	17EE212T	Electrical Technology and Control Systems	4	0	0	4	4	25	25	50	-	-	100
4	16MI205T	Mechanical Measurements & Metrology	4	0	0	4	4	25	25	50	-	-	100
5	16MI201T	Thermodynamics and Fluid Flow	4	0	0	4	4	-	-	-	25	25	50
6	16MI251P	Thermodynamics, Fluid Flow and Strength of Material Lab.	0	0	3	1.5	3	25	25	50			100
7	17EE212P	Electrical Technology and Control Lab.	0	0	3	1.5	3	-	-	-	25	25	50
8	16TP110	Civic and Social Services Internship (CSSI)	0	0	0	3	0						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Course Code: 16MA201T				Course Name: Maths-III				
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Week	Theory			Total
3	1	--	4	4	Continuous evaluation	Mid Semester	End Semester	100
					25	25	50	

Prerequisites: Mathematics – I & II

Course Outcomes (COs):

CO1: Enable students to formulate and solve the system of algebraic equations using matrix methods.
CO2: Enable students to understand the matrix system using vector calculus.
CO3: Enable students to use of Fourier series, special functions in solution of ode.
CO4: Enable students to formulate and solve the partial differential equation using variable separable methods

Code/ Table/ Charts if any: NIL

UNIT I **(8L, 3 T)**

Systems of linear equations: Matrices , Matrix Operations, Special matrices, Elementary Matrices, Elementary transformation, Rank, Introduction to systems of Linear Equations, Conditions for consistency of the system, Solution by Gauss and Gauss Jordan Elimination Method, Solving system of equation using inverse of a Matrix and Cramer's rule.

UNIT II **(13L, 4T)**

Vector spaces: Euclidean n – space, Linear Transformations from Rn to Rm; Properties Linear Transformations from R^n to R^m, Matrices of General Linear Transformations, Similarity; Isomorphisim, Vector space and Subspaces, Linear dependence and Independence; Basis Dimension, Row space; null space; column space and rank of a matrix, Rank and Nullity, Dimension Theorem, Inner product spaces, Eigen values and Eigen vectors, Inner products , Angle and Orthogonality in Inner Product Spaces, Orthonormal Bases; Gram-Schmidt process; Least squares approximation, Orthogonal Matrices, Eigen values and Eigen vectors, Diagonalization.

UNIT III **(13L, 4T)**

Fourier Series: Periodic functions, Euler's formulae, Dirichlet's conditions, expansion of even and odd functions, half range Fourier series, Perseval's formula, complex form of Fourier series.
Special Functions: Power series method to solve the equation, Frobenius method for solution near regular singular points, Legendre's equation, Legendre polynomials, Rodrigue's formula, Bessel's equation and orthogonality.

UNIT IV **(5L, 2T)**

Partial Differential Equations and its Applications: Classification of partial differential equations, solutions of one dimensional wave equation, one dimensional unsteady heat flow equation in Cartesian and polar coordinates by variable separable method with reference to Fourier trigonometric series and by Laplace transform technique.

Lecture: 39 Hrs
Tutorial: 13 Hrs
Approximate Total : 52 Hrs

Texts and References

1. Higher Engineering Mathematics, R. K. Jain & S. R. K. Iyernagar.
2. E.Kreyszig, Advanced engineering mathematics (8^{th} Ed.), John Wiley (1999)
1. 3 Ordinary and Partial Differential Equations by M.D. Raisinghania, 8^{th} edition, S. Chand Publication (2010)
3. H.Anton, Elementary linear algebra with applications (8^{th} ed.), John Wiley (1995)
4. G.Strang, Linear algebra and its applications (4rh Ed.), Thomson (2006)

Course Code: 16MI203T				**Course Name:** Strength of Material				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
4	0	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Elements of Civil Engineering & Mechanics

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand fundamental concepts of mechanics of deformable solids including static equilibrium, geometry of deformation.

CO2: Develop an understanding of the concepts of stress and strain and their use in the analysis and design of machine members and structures

CO3: Understand and determine the stresses acting on the beam

CO4: Determine the failure conditions of beam ,shafts, columns and other components

CO5: Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight

CO6: Build the necessary theoretical background for further structural analysis and design courses

Code/ Table/ Charts if any: NIL

UNIT I **(12L)**

SIMPLE STRESSES AND STRAINS: Elasticity and plasticity, Types of stresses and strains, Hooke's law, stress, strain diagram for mild steel, Working stress, Factor of safety, Lateral strain, Poisson's ratio and volumetric strain, Elastic moduli and the relationship between them, Bars of varying section, composite bars, Temperature stresses.

STRAIN ENERGY: Resilience, Gradual, sudden, impact and shock loadings, simple applications.

SHEAR FORCE AND BENDING MOMENT: Definition of beam, Types of beams, Concept of shear force and bending moment, S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l., uniformly varying loads and combination of these loads, Point of contra flexure, Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT II **(12L)**

FLEXURAL STRESSES: Theory of simple bending, Assumptions, Derivation of bending equation, Neutral axis, Determination bending stresses, section modulus of rectangular and circular sections (Solid and Hollow), T, I, Angle, Channel sections, Design of simple beam sections.

SHEAR STRESSES: Derivation of formula, Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T angle sections

UNIT III **(15L)**

DEFLECTION OF BEAMS: Bending into a circular arc, slope, deflection and radius of curvature, Differential equation for the elastic line of a beam, Double integration and Macaulay's methods, Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, - U.D.L. Uniformly varying load.-Mohr's theorems, Moment area method, application to simple cases including overhanging beams.

PRINCIPAL STRESSES AND STRAINS: Stresses on an inclined section of a Bar under axial loading, compound stresses: normal and tangential stresses on an inclined plane for biaxial stresses. Two perpendicular normal stresses accompanied by a state of simple shear, Mohr's circle stresses- Principle stresses and strains- analytical and graphical solutions- various theories of failures like maximum principle stress theory, maximum principle strain theory, max. shear stress theory, max. strain energy theory- max . shear strain energy theory.

UNIT IV **(13L)**

TORSION: Torque, Derivation and use of torque equation, Shear stress diagram for solid and hollow circular shafts, Comparison between solid and hollow shaft with regard to their strength and weight, Power

transmitted by shaft, Concept of mean and maximum torque.

COLUMNS & STRUTS: Buckling and Stability, Columns with Pinned ends, Columns with other support conditions, Limitations of Euler's Formula, Rankine's Formula, Columns with eccentric Axial Loads, Secant formula.

SELF-STUDY: The self- study contents will be declared at the commencement of the semester. Use of programming software for open end problem using industrial data will be looked out.

Lecture: 52 Hrs
Tutorial: 00 Hrs
Approximate Total : 52 Hrs

Texts and References book(s):

1. Mechanics of Materials by James M Gere, Cengage publication
2. Introduction to textbook of Strength of Material by U.C. Jindal, Galgotia.
3. S.Ramamrutham, Strength of Materials, Dhanpat Rai.
4. Mechanics of Materials by Beer and Johnston. Tata Mc Graw hill.
5. Mechanics of Materials by R. C. Hibbeler. Prentice Hall, Pearson, India.
6. Strength of Materials by S. S. Ratan. Tata Mc Graw hill.
7. Strength of materials by R.K.Rajput, S.Chand & Co, New Delhi.

Course Code: 17EE212T					**Course Name:** Electrical Technology and Control Systems			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
4	0	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Elements of Electrical Engineering

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand the fundamentals of basic electrical machines like dc machines, transformers, induction motors and synchronous machines.

CO2: Understand the construction, working principle, operation, characteristics, control and applications of various electrical machines like dc machines, transformers, induction motors and synchronous machines.

CO3: Apply the knowledge on open and closed loop control system, basic components of control systems, sensors, PID controllers and programmable logic controllers (PLCs).

CO4: Evaluate the performance parameters of stationary and rotating electrical machines and improving the ability to analyze the performance.

CO5: Understand the methods to analyze the stability of systems from transfer function forms.

CO6: Understand the concept of state variable analysis

Code/ Table/ Charts if any: NIL

UNIT I **(14L)**

SINGLE PHASE TRANSFORMER: Construction, working principle, Types, EMF equation, KVA rating, transformer on No-load and Transformer on Load, approximate equivalent circuit, voltage regulation and efficiency of transformer, condition for maximum efficiency.

THREE PHASE TRANSFORMER: Construction of three phase transformer, Types of transformer connections (star/star, star/delta, delta/star, and delta/delta) and applications based on connections. Introduction of power and distribution transformers.

D. C. Machines: Construction, working principle of D.C. generator, EMF equation of D C generator, Working principle of D.C. motor. Types of D. C. motors, back EMF, torque equation for D.C. motor, characteristics of D. C. motors (series, shunt and compound), starters of D.C. shunt and series motor, methods for speed control of D.C shunt and series motors, Industrial applications.

UNIT II **(14L)**

THREE PHASE INDUCTION MOTOR: Constructional feature, working principle of three phase induction motors, types; torque equation, torque slip characteristics; power stages; efficiency; types of starters; methods of speed control and Industrial applications. SINGLE PHASE INDUCTION MOTOR: Types, construction, working principle, types of single phase Induction motors, applications. Specifications of induction motors.

SYNCHRONOUS GENERATOR: Constructional features (Salient and non- salient),working principle, EMF equation, synchronous speed of an alternator, concept of synchronous reactance and impedance, phasor diagram of loaded alternator, voltage regulation of alternator by direct loading method and synchronous impedance method. Specifications of synchronous generator.

UNIT III **(16L)**

Introduction to Control Systems: Open loop and closed loop control systems, Examples, Meaning & need of automation, types of automation, fixed, programmable and integration. Concepts of transfer function, Mathematical modeling of physical systems with applications, time response analysis and specifications.

State space analysis: Concept of state, state space and state equations, state transition matrix, controllability and observability. Stability analysis: Introduction to stability, Absolute and relative stability, Routh Hurwitz criterion, Stability using root locus.

UNIT IV **(12L)**

Measurement and sensors, component of automation, analog, open and closed loop control, servo system, analysis and response, control configuration, sensors characteristics, two position control, PID controls. Logic control and PLCs: logic control, elements, programmable logic controllers, applications, architecture, operation, programming of PLCs with applications.

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 56 Hrs
Tutorial: 00 Hrs
Approximate Total : 56 Hrs

Texts and References

1 B. L. Theraja, "Electrical Technology", S. Chand Publication Co Ltd.
2 Ashfaq Husain, "Fundamentals of Electrical Engineering", Dhanpat Rai and Co.
3 D P Kothari and I J Nagrath, "Electrical machines Tata McGraw Hill"
4 Nagartah I. J., Gopal M., Control system engineering, New Age International
5 Nise Norman, Control systems engineering, Fifth Edition, John Wiley and sons.
6 E. A. Parr, Programmable Controllers- An Engineer's Guide, Newnes.

Course Code: 16MI205T					**Course Name:** Mechanical Measurements & Metrology			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
4	0	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: NIL

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand the fundamentals of measuring systems and roles of different standard and Transducers.
CO2: Study different Concepts of tolerances and analyze the force, pressure and torque measuring systems for mechanical measurements along with surface roughness.
CO3: Analyze the strain, speed and temperature measurement systems with respect to mechanical application.
CO4: Apply the concepts of Linear and angular metrology and to study the functioning of different comparators.
CO5: Understand the metrological features of screw threads and gear systems.
CO6: Study the Nano-metrology concepts and understand the principles of quality assurance and control.

Code/ Table/ Charts if any: NIL

UNIT I **(15L)**

Fundamentals of measurement systems: Principal of measurements, metrology: introduction and types, methods of measurements, basic terminology of measurements: accuracy, precision, errors in measurements, repeatability, reproducibility, sensitivity, range and span, hysteresis, dead zone, drift, backlash, dynamic characteristics in measurements, uncertainty analysis.
Standard of measurement: Roles of standards in measurement, material standards, types of standard, subdivision of standards, calibrations.
Transducers for Measurement: Introduction, Transfer Efficiency, Classification of Transducers, Quality Attributes for Transducers, Intermediate Modifying Devices, Advantages of Electrical Intermediate, Electrical Intermediate Modifying Devices, Terminating Devices

UNIT II **(15L)**

Limits, Fits, Tolerance and Limit gauging: Principle of Interchangeability, selective assembly, Tolerances, allowance, Maximum and Minimum Metal Conditions, Fits, System of Limits and Fits, Hole basis and shaft basis systems, Design of Limit gauging: Taylor's Principle, Wear allowance in limit gauge, Plain Plug Gauges, Snap Gauges.
Measurements of Force, Torque, and Pressure: Measurement of Force: platform balance, load cell, proving ring; Measurement of Torque: dynamometer; Pressure Measurement Scales, Method of Pressure Measurement, Ring Balance, Inverted Bell Manometer, Elastic Transducers, Electrical Pressure Transducer, Dead-weight Pressure Gauge, Measurement of Vacuum, High Pressure Measurement.
Measurements of Strain, Speed, and Temperature: Measurement of Strain, Strain Gauge Material, Backing or Carrier Materials, Adhesives, Protective Coatings, Bonding of Gauges, Gauge Factor, Theory of Strain Gauges, Methods of Strain Measurement, Strain Gauge Bridge Arrangement, Temperature Compensation in Strain Gauges

UNIT III **(15L)**

Linear and Angular metrology: Linear measurements instruments: verniers and micrometers; Angle measurement instruments: bevel protector, sine bar and centre, clinometers, collimator; Calibrations of the instruments, slip gauges.
Comparators: Need for comparators, characteristics of comparators, classifications: mechanical, optical, mechanical-optical, electrical, and pneumatic.

Measurement of surface roughness and texture: Significance of surface finish, terminology of surface texture, influencing factors for surface finish, symbolic representation of surface finish, surface roughness measurement techniques.

Metrology of Screw threads and Gears: Specifications of screw threads and gears, terminology: threads and gear, measurement of external and internal threads, measurement and checking of spur gear.

UNIT IV **(09L)**

Inspection and quality control: Introduction to Inspection and Quality Control, Specifying Limits of Variability, Dimensions and Tolerances, Selection of Gauging Equipment, Gauge Control, Quality Control and Quality Assurance, Statistical Quality Control, Total Quality Management, Six Sigma, Quality Standards.

Nanometrology: Introduction, types of nanomaterial, applications of nanotechnology, techniques of nanometrology: transmission electron microscope, scanning electron microscope, atomic force microscope, X-ray diffraction systems.

Miscellaneous Metrology: Precision Instrumentation Based on Laser Principles, Coordinate Measuring Machines, Machine Tool Metrology, Automated Inspection, Machine Vision.

Self-study: The self- study contents will be declared at the commencement of semester. Use of programming software for open end problem using industrial data will be looked out.

Lecture: 60 Hrs
Tutorial: 00 Hrs
Approximate Total : 60 Hrs

Texts and References

1. 1. N.V. Raghavendra and L. Krishnamurthy Engineering metrology and measurements, Oxford publication.
2. Anand K Bewoor and Vijay A Kulkarni , Metrology and measurement, Mc Graw Hill publisher.
3. D S Kumar Mechanical Measurements and Control, Metropolian publisher.
4. R K Jain , Engineering Metrology, Khanna Publisher.
5. A K Sawhney, Mechanical Measurement and Instrumentation, Dhanpat Rai Publication.
6. M. Mahajn, Text book of Metrology, Dhanpat Rai Publication.

Course Code: 16MI201T				**Course Name:** Thermodynamics and Fluid Flow				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
4	0	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: Elements of Mechanical Engineering

Course Outcomes (CO's): On completion of the course, students will be able to

CO1: Apply thermodynamics laws for open and closed systems to **analyze** various thermodynamics processes.
CO2: Understand the concept of exergy and energy analysis of systems and the thermodynamics relations
CO3: Understand the thermodynamics properties and **analyze** the processes on T-v diagram.
CO4: Study different types of air standard cycles and **apply** the first and second law of thermodynamics in the analysis of Rankine power cycle.
CO5: Understand the properties of fluids, principles of buoyancy, stability conditions and **apply** principles of fluid statics and dynamics

Code/ Table/ Charts if any: NIL

UNIT I **(11L, 04 T)**

Review of the basics of Thermodynamics: Review of Zeroth and First Law of Thermodynamics, Second Law of Thermodynamics (law of degradation of energy), Concept of Reversibility & reversible cycle. Entropy as a property, Clausius inequality, principle of increase of Entropy and its numerical problems

Fuels and Combustion: Combustion theory, Combustion Equations Theoretical, excess air and equivalence ratio. Analysis of products of combustion Calorific value – HCV & LCV., Enthalpy of formation and enthalpy of combustion, first law analysis of reacting systems, adiabatic flame temperature, entropy change of reacting systems, second law analysis of reacting systems

UNIT II **(11L, 04T)**

Availability: Available and unavailable energy, concept of availability, availability of heat source at constant temperature and variable temperature (Numerical) Availability of non-flow and steady flow systems, Helmholtz and Gibbs function, irreversibility and second law efficiency

Thermodynamic Relations: Different relationship for systems of constant composition, Helmholz and Gibb's function, variable specific heat, Joule-Kelvin coefficient, Clausius- Clapeyron equation Ideal Gas mixtures: Composition of a gas mixtures, P-V-T behaviour of ideal gas mixtures, properties of ideal gas mixtures, psychometrics of gas-vapor mixtures

UNIT III **(11L, 04T)**

Properties of Steam and Vapor Processes: Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-V, T-S and Mollier diagram for steam, Dryness fraction and its determination, Study of steam calorimeters (Separating, Throttling and combined) Non-flow and Steady flow vapour processes, Change of properties, Work and heat transfer

Vapour Power Cycles: Carnot cycle, Rankine cycle, Comparison of Carnot cycle and Rankine cycle, Efficiency of Rankine cycle , Relative efficiency, Effect of superheat, boiler and condenser pressure on performance of Rankine cycle. Reheat & Regenerative cycle (no numerical, for reheat & regenerative)

Gas power cycles: Introduction to Carnot cycle, Otto cycle, Diesel cycle, Dual cycle, Brayton cycle, Ericssion Cycle, Stirling cycle

UNIT IV **(12L, 03T)**

Introduction to Fluid Flow: Introduction to Continuum, Force, Stress, Strain, Solids vs. Fluids, Types of fluids, Fluid Properties, Newton's law of viscosity, Stokes' theorem, Compressibility and 38odell pressure, Fundamental Concepts: Fluid flow definition (Eulerian vs. Langrangian), System vs. Control Volume, Reynolds' transport theorem

Fluid Statics: Hydrostatic law, Pascal's law, Pressure at a point, Total Pressure, Centre of pressure, Pressure on a plane(Horizontal, Vertical, Inclined) & Curved surfaces, Archimedes Principle , Buoyancy and stability of floating and submerged bodies, Meta-centric height

Fluid Dynamics: Introduction to Navier-Stokes'equation, Euler's equation of motion along a stream line, Bernoulli's equation, Application of Bernoulli's equation to Pitot tube, Venturi meter, Orifices, Orifice meter, Triangular Notch & Rectangular Notch

Flow Through Pipes: Total energy line, Hydraulic grade line, Energy losses through pipe, Darcy-Weisbach equation, Moody diagram, Minor losses in pipes, pipes in series and parallel, Siphons, Transmission of power, Turbulent Flow, Velocity Distribution

Compressible fluid flow: Ideal gas relations, Mach number, speed of sound. Isentropic flow of ideal gas

Use of programming software for numerical problems.

Self-study: The self- study contents will be declared at the commencement of semester. Use of programming software for open end problem using industrial data will be looked out.

Lecture: 45 Hrs
Tutorial: 15 Hrs
Approximate Total : 60 Hrs

Texts and References

1. Yunus A Cengel & Bole, Thermodynamics- An Engineering Approach, Tata Mcgraw Hill, New Delhi
2. P. K. Nag, Engineering Thermodynamics, Tata Mcgraw Hill, New Delhi
3. R Joel , Engineering Thermodynamics, ELBS Longman.
4. R.Yadav , Fundamentals of Engineering Thermodynamics by, Central Publishing House, Allahabad
5. S. Gupta, Fluid Mechanics and Hydraulic Machines, Pearson Publishers.
6. Cengel and Cimbala, Fluid Mechanics, Tata-McGraw Hill Publishers.
7. F. White, Fluid Mechanics, Tata-McGraw Hill publishers.
8. R. Fox and A. McDonald, Fluid Mechanics, John Wiley Publishers.
9. J. Douglas, J. Gasiorek, J. Swaffield, and L. Jack, Fluid Mechanics, Pearson Publishers.
10. C. Ojha, P. Bernstein and P. Chandramouli, Fluid Mechanics and Machinery, OxfordUniversity Press.

Course Code: 16MI251P			**Course Name:** Thermodynamics, Fluid Flow and Strength of Material Lab				
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	3	1.5	3	**Continuous Evaluation**	**End Semester**	50
					25	25	

Prerequisites: Elements of Mechanical Engineering

Course Outcomes:

On completion of the course, the students will be able;

CO1: Verify the principles of thermodynamics and fluid flow.

CO2: Understand basic concept of thermodynamics, fluid flow and its application to industries including pipe flow.

CO2: Identification, formulation and solution of engineering problems exist in mechanical element under damage

CO3: Understanding of failure behavior of structural element and impact of usage of material in various application

List of Experiments:

Thermodynamics

1. Introduction to reciprocating air compressor.
2. Performance test on Reciprocating air compressor.
3. To calculate the calorific value of a liquid fuel by bomb calorimeter.
4. To study the working of single cylinder diesel engine and analyze by Engineering Equation Solver (EES).
5. Load test on four stroke single cylinder diesel engine.
6. Heat balance test on four stroke single cylinder diesel engine.
7. Exergy analysis of a operating power plant.
8. Exergy analysis of single cylinder four stroke diesel engine.
9. Exergy analysis of reciprocating air compressor.

Fluid Mechanics

10. To determine the meta-centric height of a floating body.
11. To verify the Bernoulli's Theorem.

Strength of Materials

12. To study the Universal testing machine and perform the tensile test and compression test
13. To study the torsion testing machine and perform the torsion test.
14. To study the shear testing machine and perform the shear test.
15. To study the Brinell hardness testing machine & perform the Brinell hardness test.
16. To study the Rockwell hardness testing machine & perform the Rockwell hardness test.
17. To study the Vickers hardness testing machine & perform the Vickers hardness test.
18. To study the Impact testing machine and perform the Impact tests (Izod & Charpy).

Course Code: 17EE212P				**Course Name:** Electrical Technology and Control Lab			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	**-**	**3**	**1.5**	**3**	**Continuous Evaluation**	**End Semester**	**50**
					25	25	

Prerequisites: Elements of Electrical Engineering

Course Outcomes (COs):

CO1: To get hands on experience in the area of Electrical Machines and Control system
CO2: To understand basic concept of Electrical Machines and its application to industries including motors, generators and transformers.
CO3: To impart the knowledge on control of Electrical machines and understanding the performance characteristics, starting and speed control of motors.
CO4: To impart the knowledge on various sensors, PID control and PLCs.

List of Experiments:

Electrical Technology:

1. To understand the construction and operation of DC machine.
2. Polarity and Voltage ratio Test on Single Phase Transformer.
3. Load Test on Single Phase Transformer.
4. O.C. and S.C. Test on single Phase Transformer.
5. Parallel operation of Single Phase Transformers.
6. To perform load test on three phase transformer to find out efficiency and regulation.
7. To obtain the efficiency and load characteristics of a DC shunt motor by Direct load test.
8. Speed Control Methods of D C shunt motors.
9. To understand the construction and operation of Induction machine.
10. To determine the performance characteristics of 3-phase squirrel cage induction motor by direct loading.
11. Load test on single phase induction motor.

Control Systems:

12. Introduction to MATLAB.
13. To study various sensors/transducers.
14. Implementation of PID control.
15. Experiment on programmable PLCs.
16. Computation of time constant of physical systems.
17. Open loop step response for single board heating system.
18. Stability analysis using root locus by MATLAB.

COURSE STRUCTURE FOR B.TECH. SECOND YEAR (Mechanical Engineering)

SEMESTER IV (Subjects)			B.TECH. SECOND YEAR (Mechanical Engineering)										
Sr. No.	Course Code	Course Name	Teaching Scheme					Exam Scheme					
								Theory			Practical		Total Marks
			L	T	P	C	Hrs/wk	CE	MS	ES	CE	ES	
1	16MA202T	Numerical Methods	3	0	0	3	3	25	25	50	-	-	100
2	16MI205T	Manufacturing Process I	4	0	0	4	4	25	25	50	-	-	100
3	16MI206T	Fluid Mechanics and Fluid Machinery	3	1	0	4	4	25	25	50	-	-	100
4	16MI207T	Engineering Metallurgy	3	1	0	4	4	25	25	50	-	-	100
5	17MI204 T	Design and Kinematics of Machines	3	1	0	4	4	-	-	-	25	25	50
6	17MI210P	MMM and Metallurgy Lab	0	0	3	1.5	3	25	25	50			100
7	17MI211 P	Fluid Mechanics and Fluid Machinery Lab	0	0	3	1.5	3	-	-	-	25	25	50

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Course Code: 16MA202T				**Course Name:** Numerical Methods				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	0	--	3	3	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: NIL

Course Outcomes (COs):

CO1: Enable students to formulate and solve the algebraic and transcendental equations using numerical methods.
CO2: Enable students to solve the differential equations using numerical methods.
CO3: Enable to solve theoretical problems using probability.
CO4: Enable to measure statistical parameter of theoretical problems using probability.

Code/ Table/ Charts if any: NIL

UNIT I **(10L)**

Numerical Solution of System of linear equations & non-linear equations: Solution of transcendental and non-linear equations by Bisection, RegularFalsi, Newton's Raphson and Secant method. Solution of a system of linear simultaneous equations by LU Decomposition, Cholesky Decomposition, Jacobi and Gauss Seidel methods. Concept of Ill conditioned system.

UNIT II **(14L)**

Interpolation and Numerical Integration: Introduction of Finite differences, Operators, Newton Gregory Forward Interpolation Formula, Newton Gregory Backward Interpolation Formula, Gauss's Forward and Backward Interpolation Formula, Stirling's Central Difference Formula, Lagrange's Interpolation Formula for unevenly spaced data, Inverse Interpolation, Divided Differences, Properties of Divided Differences, Newton's Divided Difference Formula, Relation between Divided Differences and Ordinary Differences. Formulae for Derivatives, Newton-Cotes's Quadrature Formula, Trapezoidal rule, Simpson's one-third rule, Simpson's Three-Eighth rule, Weddle's rule, Romberg's method, Double Integration. Numerical solution of first order ordinary differential equation by Taylor series method, Picard's method, Euler's method, Modified Euler's method and Runge-Kutta (4^{th} order only)method. Multi step methods: Adams-Moulton method and Milne's method.

UNIT III **(06L)**

Probability: Various approaches of probability-classical, frequency (statistical), subjective and axiomatic. Theorems on probability, conditional probability, Independence, Baye's Theorem.
Random variable-discrete and continuous. Distribution function and their properties, probability mass and density functions.

UNIT IV **(08L)**

Statistics: Mathematical Expectation, Moment Generating Function and its properties. Probability distributions: Bernoulli, Binomial, Negative Binomial, Poisson and Normal Distributions. Theory of least squares and curve fitting. Correlation-Simple, Multiple and Partial, Regression lines and Regression coefficients.

Lecture:38 Hrs
Tutorial:00 Hrs
Approximate Total :38 Hrs

Texts and References:

1. B.S. Grewal, Numerical Methods in Engineering and Science with Programs in C & C++,Khanna Publishers(2010).
2. S.S. Sastry, Introductory Methods for Numerical Analysis,4thEd., Prentice Hall of India (2009).
3. M.K. Jain, S.R.K. Iyenger and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 5thEd., New Age International (2007).
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics,S. Chand Publisher (2007).
5. R.K. Jain & S.R.K. Iyenger, Advanced Engineering Mathematics,3rdEd., Narosa (2002).

Course Code: 16MI205T				**Course Name:** Manufacturing Process-I				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
4	0	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites: NIL

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand the concept of manufacturing Process & fundamentals of casting process.
CO2: Study various bulk forming process such as forging, extrusion, rolling, drawing and sheet metal forming.
CO3: Apply the knowledge of manufacturing systems on welding processes and its sub disciplines.
CO4: Evaluate the performance of advanced forming process and its application.

Code/ Table/ Charts if any: NIL

UNIT I **(15 L)**

Introduction to manufacturing, classification of manufacturing processes, manufacturing challenges, selection of manufacturing process.

Casting: Introduction to casting, types of foundries, steps in making of casting, pattern, materials and allowances of pattern, making of patterns, types of moulding sand, ingredients of moulding sand and its properties, gating system, gating ratio, pressurized and un-pressurized gating, function of riser and its design. Introduction to cores, types of cores and making of cores. Solidification of casting, controlling of solidification direction, chaplets. Melting, types of crucibles and operation of cupola. Casting of metals and plastics, sand casting, permanent casting, investment casting, die casting, centrifugal casting, continuous casting, CO_2 casting and evaporative pattern casting. Casting defects and their consequences, shrinkage defects, porosity defects and metallurgical defects, remedies of defects.

UNIT II **(15 L)**

Classification of forming processes, bulk forming operations, sheet metal operations, basic metal working concepts and plasticity, cold and hot working, formability.

Forging: Fundamentals, principle, tools, dies, classifications of forging. Drop forging, roll forging, rotary forging. Forging defects.

Rolling: Fundamentals, theory of rolling, types of rolling mills and products, forces in rolling and power requirements.

Extrusion: Extrusion and its characteristics, classifications, hot and cold extrusion, forward and backward extrusion, impact extrusion, hydrostatic extrusion.

Drawing: Drawing of wires, bars and tubes. Drawing forces and power.

Sheet metal forming: Bending, drawing, deep drawing, spring back effect, roll forming, stamping, spinning, peen forming, explosive forming, sheet metal forming and magnetic – pulse forming.

UNIT III **(15 L)**

Welding and cutting: Introduction to welding, soldering and brazing. Classification of welding, welding energy sources and their characteristics, gas welding, ARC welding, fluxes and coatings, MIG welding, TIG welding, resistance spot welding, thermit welding, plasma welding, induction welding, explosive welding, forge welding, frictional stir welding, laser welding, electron beam welding, plasma welding, types of weld joints, weldability and welding of various metals and alloys, metallurgical characteristics of welded joints, heat affected zones in welding and weldability. Welding defects, causes and remedies of defects, destructive and non-destructive testing of welds. Introduction to tailor welded blanks. Introduction to cutting, classification of cutting, gas cutting and plasma cutting.

UNIT IV **(15 L)**

Introduction to high energy rate forming processes (HERFP), various methods of HERSP, under water explosions, under water spark discharge, pneumatic mechanical means, internal combustion of gas mixtures, rapid force magnetic fields.

Powder forming: Introduction to powder forming, powder forming techniques, applications and classifications.

Processing of plastics: Introduction to plastic manufacturing, types of plastics, properties, applications and their processing methods and equipment. Injection moulding, blow moulding, extrusion moulding, vacuum forming, compression moulding, rotational moulding, thermo forming.

Non-Conventional Manufacturing Processes: Introduction to non-conventional manufacturing processes, classifications, applications, rapid prototyping (RP), steps involved in rapid prototyping, liquid based RP, powder based RP, solid wire RP, applications of lasers in RP, recent advances in manufacturing.

Self-study: The self- study contents will be declared at the commencement of semester. Use of programming software for open end problem using industrial data will be looked out.

Lecture: 60 Hrs
Tutorial: 00 Hrs
Approximate Total : 60 Hrs

Texts and References Books:

1. P.N.Rao, Manufacturing & Technology: Foundry Forming and Welding, Tata McGraw Hill Publications.
2. Serope Kalpakjian, Manufacturing engineering and Technology, Wesley Publishing Co.
3. Lindberg R.A, Processes and Materials of Manufacture, Prentice Hall of India (P) Ltd.
4. Roy A Lindberg, Process and Materials of Manufacturing, Pearson Edu.
5. Serope Kalpakjian & Steuen. R. Sechmid, Manufacturing Technology, Pearson Education Asia.
6. Taylor H.F Flemings M.C & Wulff J., Foundry Engineering, Wiley Eastern Limited.
7. Chee Kai Chua, Kah Fai Leong, Chu Sing Lim, Rapid prototyping: Principles and applications, World scientific publications.

Course Code: 16MI206T					**Course Name:** Fluid Mechanics and Fluid Machinery			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	1	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites:

1. Elements of mechanical engineering (UME 106)
2. Thermodynamics and Fluid Flow (UMI 201)

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Evaluate transport properties of fluid and its behavior under various conditions of internal and external flows.

CO2: Apply conservation principles of mass, linear momentum, and energy **to determine** flow rates, pressure changes, minor and major head losses for viscous flows through circular pipes and between flat plates.

CO3: Design simple pipe systems to deliver fluids under specified conditions.

CO4: Apply principles of dimensional analysis and similitude to simple problems and use dimensionless parameters.

CO5: Understand working principles of fluid machines (pumps, compressors and turbines), operating characteristics and the factors affecting their performance.

CO6: Apply principles of fluid mechanics to examine the performance of fluid machines, design and selection of fluid machinery such as pumps, compressors and turbines

Code/ Table/ Charts if any: NIL

UNIT I **(9L, 3 T)**

Fluid Kinematics: Types of flow (steady vs. unsteady, uniform vs. non-uniform, laminar vs. turbulent, One, Two and Three dimensional, compressible vs. incompressible, rotational vs. Irrotational), Stream lines, path lines, streak lines, velocity components, convective, local and total acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates

Fluid Dynamics: Introduction to Navier-Stokes'equation, Euler's equation of motion along a stream line, Bernoulli's equation, Application of Bernoulli's equation to Pitot tube, Venturi meter, Orifices, Orifice meter.

Dimensional Analysis: Dimensions of physical quantities, dimensional homogeneity, Buckingham pi Theorem, important dimensionless numbers, Model analysis (Reynolds, Froude and Mach)

UNIT II **(8L, 2T)**

Laminar Flow: Definition, relation between pressure and shear stresses, laminar flow through round pipe, fixed parallel plates.

Boundary Layer Theory: Development of Boundary Layer on a flat plate, Laminar and Turbulent Boundary Layers, Laminar sub layer, Separation of Boundary Layer and Methods of Controlling, Flow around Immersed Bodies, Lift and Drag, Classification of Drag, Flow around circular cylinder and Aerofoil, Development of lift on Aerofoil.

UNIT III **(12L, 4T)**

Introduction: Definition and classification of turbo machines; Principles of operation; Energy transfer in turbo machines.

Impact of Free Jet: Impulse – momentum principle; Impact of jet on different types of flat and Curved plates fixed and moving single and series of plates held normal or inclined; derivation of efficiency condition for maximum efficiency and value of maximum efficiency.

Hydraulic Turbine: General Lay out and essential components of hydro power plant, Classification of turbines.

Pelton Wheel Turbines: Major component parts; construction; operation and governing mechanism of a Pelton wheel; effective head; available head; work done and efficiency of a Pelton wheel; design aspects; Performance Characteristics; governing of impulse turbines.
Francis Turbines: Major Component parts; construction and operation of a Francis turbine; governing mechanism; work done by the turbine runner; working proportions and design parameters; slow, medium and fast runners; inward/outward flow reaction turbines; Performance Characteristics.
Propeller and Kaplan turbines: Major Component parts; construction and operation of a Propeller; Kaplan turbine; differences between the Francis and Kaplan turbines; draft tube – its function and different forms; Performance Characteristics; Governing of reaction turbine.

UNIT IV **(16L, 6T)**

Reciprocating air compressor: review of single stage compressor, multi stage compression, work of compression volumetric efficiency.

Rotary compressor: centrifugal and axial flow compressor, positive displacement compressor, velocity diagram, Analysis, Design and construction features. Compressor characteristics, surging and choking.

Pumps: Working principles; classification of pumps. Centrifugal Pumps: Roto-dynamics pumps; construction and working; velocity vector diagrams and work done; mano-metric efficiency; vane shape; pump losses; minimum starting speed; design considerations; multi-stage pumps. Similarity relations and specific speed; net positive suction head; cavitation and maximum suction lift; performance characteristics. Reciprocating Pumps: Construction and operational details; work and power input; volumetric efficiency and slip; separation; air vessels and their utility; characteristic curves; centrifugal V/S reciprocating pumps.

Miscellaneous hydraulic machines: Hydraulic accumulator, Hydraulic intensifier, Hydraulic lift, Hydraulic ram, Hydraulic coupling.

Use of programming software for numerical problems.

Self-study: The self- study contents will be declared at the commencement of semester. Use of programming software for open end problem using industrial data will be looked out.

Lecture: 45 Hrs
Tutorial: 15 Hrs
Approximate Total : 60 Hrs

Texts and References Books:

1. 1.EJ Shaughnessy, IM Katz, JP Schaffer, Fluid Mechanics, Oxford Press
2. F. White, Fluid Mechanics, Tata-McGraw Hill publishers
3. Cengel and Cimbala, Fluid Mechanics, Tata-McGraw Hill Publishers.
4. R. Fox and A. McDonald, Fluid Mechanics, John Wiley Publishers.
5. S.K Som and Gautam Biswas, Introduction to fluid mechanics and fluid machine.
6. PK Kundu, IM Cohen, Fluid Mechanics, Academic press
7. Shepherd, D. G., Principles of Turbo machinery, Macmillan,
8. S. L. Dixon, Fluid Mechanics, Thermodynamics of Turbomachinery, Pergamon Press Ltd.
9. G. Ingram, Basic Concepts in Turbomachinery, Grant Ingram &Ventus Publishing
10. R. K. Turton, Principles of Turbomachinery, Chapman & Hill
11. Cherkassky, V. M., Fans and Compressors, Pumps , Mir Publishers
12. Sayers, A.T., Hydraulic and Compressible Flow Turbo machines, McGraw Hill
13. V. and Manohar Prasad, An Introduction to Energy Conversion Vol.III: Turbo machinery, Wiley
14. Eastern
15. Vasandani, V.P., Hydraulic Machines: Theory and Design, Khanna Publishers
16. Wright,T., Fluid Machinery: Performance, Analysis and Design, CRC Press

Course Code: 16MI207T				**Course Name:** Engineering Metallurgy				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	1	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	**100**
					25	25	50	

Prerequisites: NIL

Course Outcomes (COs):
On completion of the course, students will be able to

CO 1: Understand the sub disciplines of metallurgy, its application and structure property correlation.
CO2: Develop fundamental understanding of Mechanical, Metallurgical and NDT testing.
CO3: Familiarization with Iron- Carbon, TTT, CCT diagrams and Heat treatment.
CO4: Understand the Metallurgy of Ferrous and Nonferrous materials.
CO5: Knowledge of Powder Metallurgy, surface hardening and fractography.
CO6: ASTM Standards and its relevance.

Code/ Table/ Charts if any: ASTM standards for mechanical testing.

UNIT I **(11L, 4 T)**

Structure Property Relation: Engineering metals and alloys, Elastic and plastic deformation, deformation in a single crystal and polycrystalline metal, Critical resolved shear stress, plastic deformation mechanisms-slip and twin, effect of defects on deformation mechanism, work hardening, fracture in metals , changes in properties due to deformation, re-crystallization, cold working and hard working.
Testing of metals: concept of stress and strain, strength, elasticity, plasticity, stiffness, resilience, toughness, malleability, ductility, and brittleness.
Destructive Tests: Tension Test- Engineering and True stress-strain curves, their conversion relationships, evaluation of properties.

UNIT II **(11L, 4T)**

Numericals based on tension test, engineering stress – strain diagram for ductile and brittle materials, compression test. Hardness test – Brinell, Poldi, Vickers, Rockwell, Rockwell superficial. Micro hardness tests. Impact tests – Charpy and izod, fatigue and creep test, Erichsen cupping test, concept of fracture toughness testing. Introduction to Non Destructive Testing, visual inspection, dye penetration test, ultra sonic test.
Ferrous metals and Designation: Wrought and cast components, allotropy of iron, iron-carbon diagram, plain carbon steels, limitations of plain carbon steel, and advantages of alloy steels. Effect of alloying elements on mechanical properties of steel, alloy steels, tool steels, stainless steels, cast irons. Designation of steels and cast iron.

UNIT III **(11L, 4T)**

Heat Treatment: Effect of non- equilibrium cooling on microstructure and properties of steel, TTT diagram for 0.8% carbon steel only, Isothermal treatments, continuous cooling transformation curves, critical cooling rate & heat treatments like annealing, normalizing, hardening and tempering. Hardenability of steels, jominey end quench test, surface hardening treatment scarburizing. Nitriding, carbonitriding, tufftride, sursulf, induction hardening and flame hardening.
Introduction to powder metallurgy & applications: Non- ferrous metals and alloys- Copper and its alloys, Aluminium and its alloys, babbits.
Introduction to advanced Materials: Types and properties of composite materials, high temperature materials & cryogenic materials. Glass and Rubber.

UNIT IV **(12L, 3T)**

Numericals based on engineering stress vs. engineering strain curve, true stress vs. true strain curve, impact energy vs. temperature curve, stress amplitude vs. number of cycles in fatigue test, calculation of fatigue life and strength. Evaluating number of phases, composition of phase and amount of phases for the given

condition using lever rule. Determination of ASTM grain size number, recent advances in engineering metallurgy.
ASTM standards for mechanical testing, study of few important standards.

Self-study: The self- study contents will be declared at the commencement of semester. Use of programming software for open end problem using industrial data will be looked out.

Lecture: 45 Hrs
Tutorial: 15 Hrs
Approximate Total : 60 Hrs

Texts and References Books:

1. R.A. Higgins, Engineering Metallurgy, Viva Books Pvt Ltd.
2. R.A.Higgins, Properties of Engineering Materials Viva Books Pvt Ltd.
3. DrV.D.Kodgire, Material science and metallurgy for Engineers.
4. Donald Raskeland, The Science and Engineering of materials, Thomson Brooks.
5. R.E. Reed-Hill, Physical Metallurgy Principles, Cengage Learning.
6. F.C. Compbell, Elements of Metallurgy and Engineering Alloys, ASM International, Ohio.
7. R .E. Smallman, A.H.W. Nagan Physical Metallurgy and Advanced Materials, Elsevier.
8. William D Callister, Jr., Materials Science and Engineering, Wiley India (P) Ltd.
9. D.A. Porter and K.E. Easterling, Phase Transformations in Metals and Alloys, Second edition.

Course Code: 17MI204T				**Course Name:** Design and Kinematics of Machines				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	**1**	**--**	**4**	**4**	**Continuous evaluation**	**Mid Semester**	**End Semester**	**100**
					25	25	50	

Prerequisites:

1. Mathematics I, II and III
2. Strength of material

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Design a system, component, or process to meet desired needs within realistic constraints.

CO2: Understand the fundamentals of the theory of kinematics and dynamics of machines.

CO3:Apply techniques for **analyzing and design** of motion of machines and their components

CO4: Design and interpret various components namely rivets, joints, welded joints for their safe use.

CO5: Design and interpret of shaft, couplings, springs, keys, levers for their safe use.

CO6: Understand and implement various design and failure criterion as per the industry standards.

Code/ Table/ Charts if any: NIL

UNIT I **(11L, 4 T)**

Introduction to machine design, design procedure, Selection of materials, Properties and coding of various materials, factors of safety, Types of stresses, principle stress, Residual stresses, hertz contact stress.

Design against static loading: Design of Cotter joint, Knuckle joint**,** Permanent vs temporary joints, Advantages and disadvantages of permanent joints.

Riveted Joint: Terminology of a riveted joint, types of rivets and riveted joints, Materials for rivets, Stresses in rivets and design of a riveted joint, Joint Efficiency, Eccentrically loaded riveted joint.

Welded Joint: Types of welded joints, Weld Materials, Stresses in welded joints and design of welded joints, Welded joint subjected to eccentric loading.

UNIT II **(11L, 4T)**

Design of Shafts: Shaft Material, Design of solid and hollow shafts for strength and rigidity, Design of shafts for combined bending and axial loads

Design of Shaft Couplings: Types of couplings, Rigid vs. flexible couplings, Design of flange coupling, Design of keys

Design of Power Screws: Types of power screw threads, design of screw with different types of threads used in practice, Design of nuts, Design of clamp, Screw jack, toggle jack, design of coupler, Design of Levers: Design of lever for safety valve, design of bell crank lever, design of rocker arm for exhaust valves.

Design of Mechanical Springs: Types of springs, Materials for Springs, Stresses, deflection and buckling of helical springs, Helical Springs of non-circular cross-sections, Helical Tension spring, Energy storage capacity, Helical torsion springs, Co-axial springs,leaf springs

UNIT III **(11L, 4T)**

Fundamentals of Kinematics and Mechanisms: Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom (Mobility), inversions of simple mechanisms, Grashoff's law, Steering gear mechanisms, Hook's joint.

Cams: Introduction, Types of cams, Types of followers, Definitions, Follower displacement diagrams, High speed cams, Motions of follower, Layouts of cam profiles, Cams with specified contours, Analysis of cams.

UNIT IV **(12L, 3T)**

Velocity and Acceleration Analysis of Simple Mechanisms by relative velocity method and instantaneous centre method, Coriolis component of acceleration, Klein's construction

Introduction to Synthesis of Linkages: Steps in synthesis process: Type, number and dimensional synthesis. Tasks of Kinematic synthesis: Path, function and motion generation (Body guidance). Precision Positions, Chebyshev spacing, Mechanical and structural errors, Branch defect and order defect, Crank Rocker mechanisms.

Graphical synthesis: Two and three position synthesis using relative pole method and inversion method for single slidercrank and four bar mechanism, Three position motion synthesis of four bar Mechanism.

Analytical synthesis: Derivation of Freudenstein's equation, Three-position function generation using Freudenstein's equation.

Self-study: The self- study contents will be declared at the commencement of semester. Use of programming software for open end problem using industrial data will be looked out.

Lecture: 45 Hrs
Tutorial: 15 Hrs
Approximate Total : 60 Hrs

Texts and Reference Books:

1. V. Bhandari, Machine Design, Tata-McGraw Hill Publishers.
2. C. Sharma and K. Purohit, Design of Machine Elements, PHI Publishers.
3. J. Shigley, C. Mischke, R. Budynas, Mechanical Engineering Design, Tata-McGraw Hill Publishers.
4. S. S. Ratan, "Theory of Machines", Tata Mc Graw-Hill publications, New Delhi
5. Ghosh Amitabha, "Theory of Mechanisms and Machines", East West Press
6. U. Jindal, Machine Design, Pearson Publishers.
7. N. Pandya and C. Shah, Machine Design, Charotar Publishers.
8. R. Juvinall, K. Marshek, Fundamental of Machine Component Design, John Wiley and Sons Publishers.
9. R. Norton, Machine Design: An Integrated Approach, Pearson Education Publishers.
10. Rao J.S. and Dukkipati R.V, "Mechanisms and theory Machines theory", Wiley Eastern Ltd.
11. Shigley J.E and Uicker J.J, "Theory of Machines and Mechanisms,", Oxford University Press
12. S. Kazimi, Solid Mechanics, Tata-McGraw Hill Publishers.

Course Code: 17MI210P				**Course Name:** Mechanical Measurement, Metrology and Metallurgy Lab.			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	3	1.5	3	**Continuous Evaluation**	**End Semester**	**50**
					25	25	

Prerequisites: NIL

Course Outcomes (COs)

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

CO 1 Understand the practical significance of metallography technique**.**
CO 2 Observe the wear behaviour of metal and alloy.
CO 3 Illustration of super plastic behaviour using Hot tensile testing for different materials
CO 4 Analyse the measuring capacity/ allowance and precision of different measuring instruments.
CO 5 Evaluate the different components with the help of various Gauges.
CO 6 Analyse and evaluate the defects and discontinuity in metals and alloys using NDT.

List of Experiments:

Mechanical Measurements & Metrology:

1. To measure the various dimensions of the given work piece by various measuring Instruments.
2. Introduction to generalized measurement system and Terminology.
3. To study the working of following instruments and Analysis of environmental parameters at different locations.
4. Feature recognition using optical method, selection and counting.
5. To study and calibrate the precision measuring instruments like Vernier caliper, Micrometer, and Dial gauge.
6. To get acquainted with sine bar.
7. Surface analysis of various manufacturing processes.
8. To measure the fundamental dimensions of a gear using contour (profile) projector.
9. To study different types of the comparators.
10. To demonstrate different types of Limit Gauges.

Metallurgy:

11. To determine the macro hardness of the steel and aluminum samples using Macro Vickers hardness test
12. To determine the micro hardness of the steel and aluminum samples using Knoop and Vickers hardness tests.
13. Study the variation in micro and macro hardness of the welded steel samples using Vickers hardness test.
14. To develop and observe the microstructure of the steel/welded samples under optical microscope.
15. Study the application and use of image analysis software in Engineering Metallurgy.
16. To develop and observe the microstructure of different nonferrous materials- Aluminum and Copper.
17. Experiments based on NDT.
18. Guided bend test for the determination of soundness and ductility of welds in ferrous and non ferrous materials.
19. Estimation of ASTM grain size number.

Course Code: 17MI211P				Course Name: Fluid Mechanics and Fluid Machinery Lab			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	3	1.5	3	**Continuous Evaluation**	**End Semester**	50
					25	25	

Prerequisites: Thermodynamics and fluid flow (UMI 206)

Course Outcomes (COs):

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

CO1: Apply Bernoulli's theorem **and evaluate** the coefficient of discharge of flow measuring devices.
CO2: Identify flow patterns and flow types for internal flow.
CO3: Evaluate, compare and contrast experimental results of major and minor losses for fluid flow systems with theoretical trends, and to attribute observed discrepancies to either measurement error.
CO4: Use and apply engineering systems needed to set-up and run fluid machines in controlled laboratory environments.
CO5: Evaluate performance of hydraulic turbines and **analyze** effect of variation of various performance parameters with load and speed.
CO6: Evaluate performance of pumps and compressor and **analyze** effect of variation of various performance parameters with load and speed.

List of Experiments:

Fluid Mechanics

1. Discharge coefficient of Venturimeter
2. Discharge coefficient of Orificemeter
3. Calibration of rotameter
4. Reynolds apparatus
5. Verification of Bernoulli's principle
6. Friction in circular pipe
7. Studies on Pitot tube

Fluid Machinery

8. Impact of Jet
9. Experiment on Performance Characteristics of Pelton Wheel Turbine
10. Experiment on Performance Characteristics of Francis Turbine
11. Experiment on Performance Characteristics of Kaplan Turbine
12. Experiment on performance characteristics of centrifugal pump
13. Experiment on performance characteristics of reciprocating pump
14. Experiment on performance characteristics of axial flow fan

COURSE STRUCTURE FOR B.TECH. THIRD YEAR (Mechanical Engineering)

SEMESTER V (Subjects)			B.TECH. third YEAR (Mechanical Engineering)											
Sr. No.	Course Code	Course Name	Teaching Scheme					Exam Scheme						
			L	T	P	C	Hrs/wk	Theory			Practical		Total Marks
								CE	MS	ES	CE	ES	
1	18ME302T	Production Operation Management	3	1	0	4	4	25	25	50	-	-	100
2	18ME301T	Manufacturing Process II	3	1	0	4	4	25	25	50	-	-	100
3	18ME306T	Heat and Mass Transfer	3	1	0	4	4	25	25	50	-	-	100
4	18ME304T	Dynamics of Machine	3	1	0	4	4	25	25	50	-	-	100
5	18ME303T	Dept. Elective – I (Non-Conventional Energy Sources)	3	0	0	3	3	25	25	50	-	-	100
6	18ME301P	Manufacturing process and Production Technology Lab.	0	0	3	1.5	3	-	-	-	25	25	50
7	18ME304P	Kinematics and Dynamics of Machine Lab.	0	0	3	1.5	3	-	-	-	25	25	50
8	TP210	Industrial Orientation	-	-	-	3							

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Course Code: 18MI302T					**Course Name:** Production Operation Management			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	**1**	**--**	**4**	**4**	**Continuous evaluation**	**Mid Semester**	**End Semester**	**100**
					25	25	50	

Prerequisites:

1. Manufacturing Processes I (UMI205)
2. Manufacturing Processes II

Course Outcomes (COs)

CO1: Understand significance of management of production operations.
CO2: Comprehend the importance of various techniques of forecasting.
CO3: Apply principles of Inventory management and develop understanding on the concept of optimum ordering quantity.
CO4: Develop skills of material requirement planning and project management.
CO5: Evaluate various waiting line models, analysis of various queues and measuring queue performance.
CO6: Apply theory of operations and strategies

Code/ Table/ Charts if any: NIL

UNIT I **(12L, 3T)**

Operations Management: Introduction, Operations Management and Strategy, Tools for Implementation of Operations, Industry Best Practices.

Demand management and forecasting: Introduction, The Strategic Importance of Forecasting, Benefits, Cost implications and Decision making using forecasting, Classification of Forecasting Process, Methods of Forecasting, components of demand Forecasting and Product Life Cycle, Selection of the Forecasting Method, Qualitative Methods of Forecasting: Market research, historical analogy, Delphi method and other methods, Quantitative Methods, web-based forecasting: collaborative planning, forecasting and replenishments. Associative Models of Forecasting, Accuracy of Forecasting, case studies in fore casting.

Inventory management: definition of inventory, purposes of inventory, independent vs dependent demand, inventory costs, fixed order quantity models and fixed time period models, ABC inventory planning, inventory accuracy and cycle, the basic EOQ model, EOQ with gradual replenishment, price break models, reorder point, safety stock, the Newsboy problem, inventory control and supply chain management, case studies in inventory control.

Material Requirements Planning (MRP): Components and structure of MRP (demand for products, bill of materials, inventory records, MRP computer program). MRP logic, lot sizing in MRP systems (LFL, EOQ, POQ, LTC, LUC, etc.), case studies on MRP, introduction to ERP.

UNIT II **(12L, 3T)**

Operations Scheduling: Introduction, Purpose of Operations Scheduling, Factors Considered while Scheduling, Scheduling Activity under Production Planning and Control, Scheduling Strategies, Scheduling Guidelines, Approaches to Scheduling, Scheduling Methodology [Quantitative], Scheduling in Services, Sequencing methods (SPT, EDD, Moore's method, Johnson's method, etc.), case studies in operation scheduling.

Project management: Project control charts, Gantt charts, Critical Path Method, Activity on arrow /Activity on node networks, concept of slack, the critical path, probabilistic time estimates, and project crashing. Case studies in project management.

Service Processes: the queuing system, customer arrival, distribution of arrivals, Waiting line models, various types of queues M/M/1. M/D/1, M/G/1, M/M/S and their corresponding derivations to measure various quantities such as length of queue, length of system, average waiting time in queue and in system, probability of waiting in line, measures of queue performance, management of waiting lines, computer simulation of waiting lines. Case studies in waiting line models.

UNIT III **(12L, 3T)**

Facility planning: Introduction, objectives of the layout, types of layouts, the facility location problem, factors influencing facility location, facility location models, process layouts, layout methods, computerized algorithms for facility layout, product layouts, fixed position layouts, cellular layouts, layout of service facilities, case studies in facility planning.

Quality Management: Introduction, quality specification, quality cost, quality management systems, concepts of total quality management (TQM), quality tools, process capability, concept of six sigma, quality tools, statistical quality control, control charts (X and R charts, p-chart, np-chart, c chart), acceptance sampling, AQL, LTPD, OC curves. Six-sigma quality, six-sigma methodology, process control procedures, case studies in quality management.

Lean manufacturing: Lean logic, lean implementation requirements, lean layout and design flow, lean applications for line flow, lean services, case studies in lean manufacturing, Just-in-time (JIT), characteristics of JIT, implementation of JIT, the Toyota Production System: elimination of waste and respect for people, push vs. pull systems, use of Kanban, case studies on pull vs push systems.

UNIT IV **(12L, 3T)**

Introduction to Work Study, Work of F.W. Taylor; Frank and Lillian Gilbreth and others; definition of productivity; means of increasing productivity; definition of work study; productivity and work study;human factors in the application of work study. Motion Study, definition, aims; procedure for method study; selection of jobs; recording techniques; micro-motion study; Therbligs; cyclograph and chronocyclograph; principles of motion economy; design of work place layout; analysis in the form of a chart; operation chart; flow process chart; flow diagram; string diagram; man-machine chart; two hand chart; simo chart. Introduction to work measurement, definition, uses, procedure;

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 48 Hrs
Tutorial: 12 Hrs
Approximate Total : 60 Hrs

Texts and Reference Books:

1. Chase, R. B., Ravi Shankar, Jacobs, F. R. and Aquilano, N. J., Operations and Supply Management, Tata McGraw Hill.
2. Buffa, E. S. and Sarin, R., Modern, Production and Operations Management, John Wiley.
3. Russell, R. S. and Taylor, B. W., Operations Management along the Supply Chain, Wiley India.
4. Heizer J., Render, B. and Rajashekhar, J., Operations Management, Pearson Education.
5. Jacobs, F. R., Chase, R. B., & Aquilano, N. J. (2004). Operations management for competitive advantage. Boston: Mc-Graw Hill.
6. Martand Telsang, Industrial engineering and production management.
7. R. Panneerselvam, Production and operations management, PHI learning.
8. N. G. Nair, Production and operations management, Tata McGraw hill publishing company.

Course Code: 18MI301T					**Course Name:** Manufacturing Process II			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	1	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites:

1. Manufacturing Processes I (UMI205)
2. Engineering Metallurgy (UMI202)

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand secondary different machining processes.
CO2: Apply different machine tools and machining processes.
CO3: Remember fundamental knowledge and principles of material removal.
CO4: Analyze the importance of metal cutting parameters for different metal cutting operations

Code/ Table/ Charts if any: NIL

UNIT I **(12L, 3 T)**

Introduction and machine tool drives: Need of machining – classification of machining – machining requirements. Introduction to machine tools – functional principles – machine tool power drives – role and forms of kinematic structure in machine tools – methods of changing speed and feed in machine tools – design of speed gear box of machine tools – classification of machine tools.

Single point cutting tool: Working and auxiliary motions – introduction to single point cutting tool – tool geometry of single point cutting tool – concept of rake and clearance angles – different systems of tool geometry – importance of chips – mechanism of chip formation – mechanics of machining – use of chip breakers – orthogonal and oblique cutting. Purpose of cutting fluids – essential properties of cutting fluids – types of cutting fluids and their application – machinability – failure, life and materials of cutting tools.

UNIT II **(12L, 3T)**

Lathe: Kinematic system – principle of working – cutting speed, feed and depth of cut – material removal rate, cutting power, specific energy and machining time. Tool and job holders in lathes – various lathe operations – accessories – classification and specification of lathe machines.

Shaping, slotting, planning and broaching machines: Kinematic systems – principle of working – classifications, specification and operations performed – machining time calculation. Failure of single point cutting tools – tool life.

Drilling and boring machines: Kinematic system – principle of working – classifications – specifications – operations performed – twist drill – deep hole drilling machines. Boring machines and classifications.

UNIT III **(12L, 3T)**

Milling machine: Kinematic system – principle of working – classifications – specifications – operations performed – accessories – milling cutter – classifications of cutters. Introduction to indexing – methods of indexing – gear cutting methods.

Grinding: Introduction – differences between machining and grinding – basic principles, methods and applications of grinding – grinding requirements – grinding wheels – mechanism of grinding – classifications of grinding machines – specifications – different bonds and abrasives – selection of grinding wheel – faults in grinding – truing and dressing. Super abrasive wheels and their bonds.

Super finishing: Purpose and order of super finishing – micro and super finishing methods – characteristics and applications – lapping – honing – super finishing – burnishing – polishing – magnetic float polishing – magnetic field assisted polishing – electro polishing.

UNIT IV **(12L, 3T)**

Jigs and Fixtures: Introduction – purpose of using fixtures and jigs in machine shops-considerations while designing fixtures and jigs – principles and methods of design of fixtures and jigs (design for locating, design for supporting and design for clamping the blank in jig and fixture), functions and design aspects of bushes used in jigs (factors to be considered while designing for jig bushing and types of bushes used in jigs), design of jigs and fixtures for specific machining requirements – economic viability analysis prior to use of a fixture or jig – planning prior to design and construction of a fixture or jig - methods of mounting blanks and cutting tools in machine tools – general methods of mounting blanks and cutting tools in different machine tools. Economy and eco-friendliness in machining. Automation of machine tools – recent advances in conventional machine tools.

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 48 Hrs
Tutorial: 12 Hrs
Approximate Total : 60 Hrs

Texts and Reference Books:

1. A. B. Chattopadhyay, Machining and Machine Tools, John Wiley & Sons publisher.
2. Geoffrey Boothroyd, Fundamentals of Metal Machining and Machine Tools, CRC press.
3. R.K. Jain and S.C. Gupta, Production Technology.
4. Production Technology, H.M.T. (Hindustan Machine Tools), McGraw hill publications.
5. C.Elanchezhian and M. Vijayan, Machine Tools, Anuradha Agencies Publishers.
6. B S Raghuwanshi, Workshop Technology – Vol II.
7. R. K. Singhal, M. Singhal and R. Singhal, Fundamentals of machining and machine tools.
8. B. L. Juneja, G. S. Sekhon, N. Seth, Fundamentals of Metal cutting and Machine tools, New age international publishers.
9. P. C. Sharma, A text book of Produciton Technology, S Chand

Course Code: 18MI306T					**Course Name:** Heat and Mass Transfer			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	1	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites:

1. Thermodynamics and Fluid Flow (16MI201T)
2. Fluid Mechanics and Machinery (16MI206T)

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Comprehend various modes of heat transfer such as conduction, conduction and radiation and **apply** principles of heat transfer to basic engineering systems.
CO2: Analyze and Solve problems involving steady and unsteady heat conduction.
CO3: Evaluate convection heat transfer problems for a variety of flow conditions using appropriate empirical or theoretical equations for heat transfer coefficients.
CO4: Design and Analyze performance of heat exchangers using LMTD and NTU methods.
CO5: Evaluate radiative heat exchange between two or more surfaces of different geometries.
COE6: Understand the basic principles of mass transfer.

Code/ Table/ Charts if any: NIL

UNIT I **(15L, 5T)**

Introduction: Various modes of heat transfer; Fourier's law of heat conduction; effect of temperature on thermal conductivity of various kinds of materials, gases and liquids; thermal diffusivity. Applications of the heat transfer.

Heat Conduction: Introduction and industrial applications of heat conductions. Derivation of generalized three dimensional heat conduction equation in the Cartesian, cylindrical and spherical co-ordinates; One dimensional steady state solutions (with and without heat generation); Boundary conditions; Composite walls, hollow and composite cylinders, spheres; electrical analogy; overall heat transfer coefficient; and critical radius of insulation. Variable thermal conductivity. Transient heat conduction – lumped heat system analysis; approximate analytical and graphical solutions; Transient heat conduction in semi-infinite solids and multidimensional systems. Heat transfer through extended surfaces; fin performance parameters.

UNIT II **(15L, 5T)**

Heat Convection: Introduction and industrial applications of heat 59odelling59. Classification, physical mechanism and dimensional analysis applied to forced and free convection; Thermal and hydrodynamic boundary layers; Differential convection equations and solutions for flat plate; Analogies between momentum and heat transfer; local and average het transfer coefficients and dimensionless numbers; laminar and turbulent heat flow correlations for external flow.

Internal forced convection: concept of average velocity and temperature; entrance region; General thermal analysis for laminar flow in a tube; heat transfer correlations.

Free convection: Equation of motion and the Grashof number; natural convection over surfaces and inside enclosures; combined natural and forced convection.

Boiling and Condensation: Boiling regimes and the boiling curve; flow boiling; Film and drop wise condensation; correlations.

UNIT III **(7L, 2T)**

Thermal Radiation: Introduction and industrial applications of thermal radiation heat transfer, Concept of radiation, absorptivity, reflectivity & transmissivity, black, white and grey surfaces, emissive power & emissivity. Laws of radiation – Planck, Stefan – Boltzman, Wein's displacement, Kirchoff. Intensity of radiation & solid angle, Lambert's cosine law, shape factor. Radiation heat exchange between black bodies, geometric

configuration factor, heat exchange between non-black bodies- infinite parallel planes and infinite long concentric cylinders, radiation shield, heat exchange between enclosed grey surfaces, electrical analogy to simple problems and non-luminous gas radiation.

UNIT IV **(08L, 3T)**

Heat Exchangers: Introduction and industrial applications of heat exchangers. Different types of heat exchangers, heat exchange performance analysis, LMTD for parallel & counter flow heat exchanger, overall heat transfer coefficient, fouling, correction factor for multi-pass arrangement, effectiveness and number of transfer unit for parallel and counter flow heat exchanger, design of industrial heat exchanger. **TEMA standards**.

Introduction to Mass Transfer: Fick's law; Analogy between heat and mass transfer; Mass diffusion: mass and molar basis; Diffusion through a stationary and moving medium; mass convection and analogies.

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 45 Hrs
Tutorial: 15 Hrs
Approximate Total : 60 Hrs

Texts and Reference Books:

1. Yunus A. Cengel and Afshin J. Ghajar, Heat and Mass Transfer, McGraw Hill Education (India) Private Limited.
2. F. P. Incropera and D. P. DeWitt, Introduction to Heat Transfer, Wiley and Sons, New York
3. J. P. Holman, Heat Transfer, Tata McGraw Hill Book Company
4. F. White, Heat and Mass Transfer, McGill Hill
5. P. S. Ghoshdastidar , Heat Transfer, Oxford University Press, New Delhi
6. S. P. Sukhatme, A Textbook of Heat Transfer, S. P., Universities Press, Hyderabad
7. C. P, Kothandaraman, Fundamentals of Heat and Mass Transfer, New Age International Publishers
8. R. C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age International Publishers, New Delhi

Course Code: 18MI304T					**Course Name:** Dynamics of Machine			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	1	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites:

1. Design and Kinematics of Machines
2. Engineering Mechanics

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Analyze the effect of static and dynamic forces on the mechanism.
CO2: Understand the application of gears, gear trains and gyroscope.
CO3: Analyze the balancing of rotating masses.
CO4: Analyze the unbalanced force in a reciprocating masses.
CO5: Understand the tribological behavior of materials and behavior under lubricated conditions.

Code/ Table/ Charts if any: NIL

UNIT I **(12L, 4T)**

Static Force Analysis: Static equilibrium, equilibrium for two force and three force members, torque, Force convention, Free body diagrams, Superposition, Virtual work, Friction in mechanisms.
Dynamic Force Analysis: D'Alemberts Principle, Dynamic analysis of four link, slider crank, Velocity and acceleration of automobile components, Turning moment, Dynamically equivalent system, determination of Inertia forces in connecting rods, engines. Turning Moment Diagrams, Fluctuation of energy, Flywheels.

UNIT II **(12L, 4T)**

Gears: Laws of gearing, gears terminology, tooth form, standard interchangeable tooth profile, minimum number of teeth on pinion in contact with a gear, interference and under cutting, bevel, helical and spiral gears.
Gear Trains: Simple, compound, reverted and epicyclic gear trains, analytical and tabular methods, torques in epicyclic train, differential gear box, gear boxes-sliding and constant mesh gear box for automobiles.
Gyroscope: Angular velocity, angular acceleration, gyroscopic torque, gyroscopic effect on naval ships and aeroplanes, stability of an automobile, two-wheel vehicle, rigid disc at an angle fixed to a rotating shaft.

UNIT III **(11L, 3T)**

Brakes and Dynamometers: Introduction, General description and study of operation principle.
Balancing: Balancing of rotating masses Single and multiple single and different planes.
Balancing of Reciprocating Masses: Primary and secondary balancing of reciprocating masses. Analytical and graphical methods. Unbalanced forces and couples examination of "V", multi cylinder in line and radial engines for primary and secondary balancing.

UNIT IV **(11L, 3T)**

Vibration : Introduction and basic terminology, types of vibration, causes of vibrations (single and multi-degree), effects of vibrations, displacement, velocity and acceleration calculation, Free vibration without damping and with damping, logarithmic decrement, types of damping, forced vibration, forced damped vibration, resonance, Vibration isolation and transmissibility, Whirling of shaft, Torsional system, Time domain and Frequency domain signal interpretation and applications.

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 46 Hrs
Tutorial: 14 Hrs
Approximate Total : 60 Hrs

Texts and Reference Books:

1. S. S. Ratan Theory of Machines , Tata Mc Graw-Hill publications, New Delhi
2. Ghosh Amitabha, Theory of Mechanisms and Machines , East West Press
3. Rao J.S. and Dukkipati R.V, Mechanisms and Machines Theory, Wiley Eastern Ltd.
4. Rao S.S., Mechanical Vibrations, Pearson publications.
5. Shigley J.E and Uicker J.J, Theory of Mechanisms and Machines, Oxford University Press

Course Code: 18ME303T					**Course Name:** Dept. Elective-I (Non-Conventional Energy Sources)			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	0	--	3	3	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites:

1. Elements of Mechanical Engineering (UME 106)
2. Thermodynamics and Fluid Flow (16MI 201T)
3. Heat and Mass Transfer

Course Outcomes (COs):

On completion of the course, students will be able to

1. **Understand** the terms of earth-sun geometry and **analyze** the availability of solar radiation at various locations.
2. **Find** the ways to use solar energy for various applications like heating, cooling, water distillation and electricity and **evaluate** their performance.
3. **Interpret** and **classify** the ways to harness the energy from Biomass.
4. **Understand** and **analyze** the Wind and wave energy conversion.
5. **Summarize** the ways to harness energy from other nonconventional energy sources like geothermal, ocean, MHD etc.

Code/ Table/ Charts if any: NIL

UNIT I **(10 L)**

Introduction: Man and Energy, World production and reserve of conventional energy sources, Indian production and reserves, Energy alternatives.

Solar radiation and measurement: Origin, nature and availability of solar radiation, estimation of solar radiation, Effects of receiving surface location and orientation, heat transfer considerations relevant to solar energy.

Solar energy collectors: Characteristics of materials and surfaces used in solar energy absorption, Devices for thermal collection and storage, Design consideration and performance of different types of solar collectors.

UNIT II **(10 L)**

Solar energy storage: Energy storage devices such as water storage systems, packed Bed storage systems, phase change storage systems.

Solar Energy Application: Systems for space heating, solar water pumps, solar pond, solar thermal power plants, solar distillation, solar refrigeration and air conditioning, solar PV systems.

UNIT III **(10 L)**

Wind energy: Nature, power, forces, conversion and estimation. Components of wind energy system, types, design considerations, performance calculations.

Energy from biomass: Generation, conversion technologies and utilization of biogas, design of biogas plants and gasifiers.

Geothermal Energy Systems.

Ocean Energy Systems.

UNIT IV **(09 L)**

Hydroelectric Power Plant: Principles of working, lay out, Site selection classification and arrangement of hydro-electric plants, Run off size of plant and choice of units, Operation and maintenance, hydro systems, interconnected systems.

Energy Management: Role of the unconventional energy, sources in power planning. Introduction to energy conservation and audit

Environmental Impact: Different pollutants due to thermal power plants and their effects of human health,

Environmental control of different pollutant such as particulate matter, Oxides of sulphur, nitrogen, global warming & greenhouse effect, thermal pollution, Noise pollution.

Self-study: The self- study contents will be declared at the commencement of semester. Use of programming software for open end problem using industrial data will be looked out.

Lecture: 39 Hrs
Tutorial: 00 Hrs
Approximate Total : 39 Hrs

Texts and Reference Books:

1. Bansal Keemann, Meliss, Renewable energy sources and conversion technology, Tata McGraw Hill.
2. Kothari D.P., Renewable energy resources and emerging technologies, Prentice Hall of India Pvt. Ltd.
3. Rai G.D, Non-Conventional energy Sources, Khanna Publishers.
4. Desai Ashok V., Nonconventional Energy, , New Age International Publishers Ltd.
5. S.P. Sukhatme, " Solar Energy", Tata-McGraw hill, New Delhi.
6. Duffie J. A. & Beckman W.A., Solar engineering of thermal processes, Wiley- international Publication

Course Code: 18ME301P				**Course Name:** Manufacturing process and Production Technology Lab.			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	3	1.5	3	**Continuous Evaluation**	**End Semester**	50
					25	25	

Prerequisites:

1. Manufacturing Processes I
2. Engineering Metallurgy

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Understand the different welding process, their compatibility and limitations.

CO2: Apply the fundamentals and principles of metal cutting to practical applications using lathes, milling, shaper, planar, drilling, grinding machines.

CO3: Analyze the effect of manufacturing processes on change in properties of work piece.

List of Experiments:

1. Shielded metal arc welding
2. Gas metal arc welding
3. Gas tungsten arc welding,
4. Gas welding, Gas cutting,
5. Plasma cutting
6. Resistance welding spot, projection, butt welding,
7. Soldering and Brazing.
8. Injection molding of plastics
9. Development of macro and microstructure of welded joints.
10. Introduction to foundry/ forming industry/plastic industry.
11. Friction Welding
12. Friction Stir Welding
13. Prepare a Job on Lathe Machine.
14. Prepare a Job on Milling Machine.
15. Prepare a Job on Drilling Machine.
16. Prepare a Job on Grinding Machine.
17. Prepare a Job on Shaping Machine.
18. Total productive maintenance of different machines like drilling, milling, grinding, shaping
19. Effect of operating variables
20. Study of specification of machines through different catalogs.

Course Code: 18ME304P				**Course Name:** Kinematics and Dynamics of Machine Lab			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	3	1.5	3	**Continuous Evaluation**	**End Semester**	50
					25	25	

Prerequisites:

1. Engineering Mechanics
2. Engineering Graphics

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Analyze the behavior of bodies undergoing vibrations, both theoretically as well as practically.

CO2: Apply the principles of force and couple balance to statically and dynamically balance an unbalanced rotating system.

CO3: Calculate and interpret forces and torques in various mechanisms.

CO4: Compare and assess the dynamic behavior of various mechanisms.

CO5: Determine and interpret displacement, velocity and acceleration characteristics of various mechanisms.

Leaning Objectives:

1. To analyze the behavior of bodies undergoing vibrations, both theoretically as well as practically.
2. To statically and dynamically balance an unbalanced rotating system.
3. To calculate Gyroscopic Torques in a Gyroscope apparatus.
4. To compare the behavior of various configurations of Governors.
5. To analyze and interpret data across all practical.
6. To determine and interpret displacement, velocity and acceleration of various mechanisms.

List of Experiments:

1. To study and determine the characteristics of governors.
2. To determine the Gyroscopic couple and its effect on a rotating disc.
3. To demonstrate the effect of static and dynamic unbalance in a system and to completely balance the system.
4. To study undamped free vibrations (longitudinal) of a spring mass system.
5. To determine the natural frequency of single rotor and two rotor system.
6. To find the damping coefficient of a system undergoing torsional oscillations.
7. To demonstrate whirling of shafts and Jump phenomena in Cam follower system.
8. To plot the characteristics of Forced Damped Vibrations for the given system.
9. To determine velocity and acceleration in various mechanism by relative velocity method.
10. To determine velocity in various mechanism by I- centre method and klien's construction
11. To draw cam profile for different follower motion.
12. Synthesis the four bar mechanism for the given motion by Freudenstein's equation, Chebyshev's spacing and body guidance.

COURSE STRUCTURE FOR B.TECH. THIRD YEAR (Mechanical Engineering)

SEMESTER VI (Subjects)			B.TECH. Third YEAR (Mechanical Engineering)											
Sr. No.	Course Code	Course Name	Teaching Scheme					Exam Scheme						
			L	T	P	C	Hrs/wk	Theory			Practical		Total Marks
								CE	MS	ES	CE	ES	
1	18ME 313T	Machine Design – I	3	1	0	4	4	25	25	50	-	-	100
2	18ME309T	Refrigeration and Air-Conditioning	3	1	0	4	4	25	25	50	-	-	100
3	18ME315T	Computer Aided Design	3	1	0	4	4	25	25	50	-	-	100
4	18ME310T	Robotics	3	0	0	3	3	-	-	-	25	25	50
5	18ME311T	Dept. Elective II (Advance Manufacturing Process)	3	1	0	4	4	25	25	50	-	-	100
6	18ME316P	Heat-Mass Transfer and NCES Lab.	0	0	3	1.5	3	25	25	50			100
7	18ME315P	Computer Aided Design Lab.	0	0	3	1.5	3	-	-	-	25	25	50

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Course Code: 18ME313T				**Course Name: Machine Design – I**				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	1	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites:

1. Mathematics (16MA101)
2. Strength of Materials (16MI203T)
3. Design of Machine Element and Kinematics of Machines with Industrial Drafting (17MI204T)

Course Outcomes (Cos):

On completion of the course, students will be able to

CO1: To develop an ability to design and **analyze** components based on its strength and applications.
CO2: To **understand** the concept of failure related to static and dynamic loading conditions of mechanical components.
CO3: To design and **analyze** pressure vessels for various applications.
CO4: To design and **evaluate** various type of power transmission systems.
CO5: To **understand** the fundamentals of theory and design of various IC engine components.
CO6: To utilize design data book and **understand** its utility for designing various mechanical components.

Leaning Objectives:

1. To develop an ability to design a system and its component based on its strength and application.
2. To understand the fundamentals of the theory to design power transmission drives, IC engine parts and different failure criteria.
3. To learn the use of design data book for designing different mechanical machine components.

Code/ Table/ Charts if any: NIL

UNIT I **(12L, 3T)**

Design based on deflection and stiffness: Tension, compression and torsion based design, deflection in members, statistically indeterminate design problems, design of compression members, design for eccentric loading, design for shock and impact loading.
Failure resulting from static load: Stress concentration, theories of failure for ductile and brittle material, contact stress
Failure resulting from variable load: strain –life relationship, stress-life relationship, endurance limit, fatigue strength, notch sensitivity, torsional fatigue, fluctuating stress characterization, Goodman's line, Soderberg's line, Modified Goodman's line, surface fatigue strength, Design factor in fatigue.

UNIT II **(12L, 3T)**

Design of Pressure Vessels: Types and applications of pressure vessels, Design of thin and thick cylindrical and spherical shells, Compounding of cylinders, Design of interference joints – press / shrink fitted assemblies, Design of cylinder covers, Cover plates, pipes and pipe flanges for pipe joints.

UNIT III **(12L, 3T)**

Design of Power Transmission Systems: Introduction and applications of power transmission systems. Types of power transmission devices, advantages and disadvantages, components of belt drive, mechanism of belt drive, Belt Materials, Types of belts and pulleys and their selection, Stresses in belts, Transmission efficiencies, Design/selection of flat belt drive, design/selection of V-belt drive, Design of Chain drives and wire ropes

UNIT IV **(12L, 3T)**

Design of Engine Parts: Components of I.C. engine, materials for engine components, working conditions, Forces and stresses acting on various engine components, Design of cylinder and cylinder liner, Design of piston, Design of Connecting Rod, Design of crank shafts, Design of crank pins.

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 48 Hrs
Tutorial: 12 Hrs
Approximate Total : 60 Hrs

Texts and Reference Books:

1. C. Sharma and K. Purohit, Design of Machine Elements, PHI Publishers.
2. U. Jindal, Machine Design, Pearson Publishers.
3. N. Pandya and C. Shah, Machine Design, Charotar Publishers.
4. J. Shigley, C. Mischke, R. Budynas, Mechanical Engineering Design, Tata-McGraw Hill Publishers.
5. R. Juvinall, K. Marshek, Fundamental of Machine Component Design, John Wiley and Sons Publishers.
6. R. Norton, Machine Design: An Integrated Approach, Pearson Education Publishers.
7. V. Bhandari, Machine Design, Tata-McGraw Hill Publishers.
8. S. Kazimi, Solid Mechanics, Tata-McGraw Hill Publishers.

Course Code: 18ME309T					**Course Name:** Refrigeration and Air- Conditioning			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	**1**	**--**	**4**	**4**	**Continuous evaluation**	**Mid Semester**	**End Semester**	**100**
					25	25	50	

Prerequisites:

1. Thermodynamics and Fluid Flow (16MI201T)
2. Fluid Mechanics and Machinery (16MI206T)
3. Heat and Mass Transfer

Course Outcomes (Cos)

On completion of the course, students will be able to

CO1: Understand the working principles, importance and applications of refrigeration and air-conditioning technology

CO2: Apply the fundamentals of thermodynamics, heat transfer and hydraulic machines to analyze the refrigeration systems

CO3: Analyze generalized psychrometrics of moist air and apply to HVAC processes to analyze air-conditioning systems

CO4: Design thermal comfort conditions with respect to temperature, humidity, activities and its impact on human comfort, productivity, and health

CO5: Evaluate cooling/heating load calculations

CO6: Perform duct deign, and air distribution system for different air-conditioning applications

Code/ Table/ Charts if any: NIL

UNIT I **(12L, 4T)**

Introduction: Introduction to Refrigeration; Necessity and applications; Ideal refrigeration cycles; air-refrigeration, Bell-Coleman cycle, open and dense air systems, Simple air refrigeration system, Boot strap air refrigeration system, Regenerative air refrigeration system, and Reduced air refrigeration system.

Vapour Compression Refrigeration: Working principle and essential components of the plant, simple vapour compression refrigeration cycle **–** COP, Representation of cycle on T-S and p-h charts – effects of sub cooling and super heating – cycle analysis – Actual cycle, Influence of various parameters on system performance – necessity of multi-staging, multistage compression system, and their analysis, multi-evaporator system and their analysis, necessity and working of cascading system. Working of expansion valves like capillary tube, automatic, and thermostatic expansion valve

UNIT II **(11L, 3T)**

Refrigerants: Desirable properties of refrigeration's; classification of refrigerants; ozone depletion global warming, secondary refrigerants, future industrial refrigerants, recent development.

Vapour Absorption Refrigeration: 71odell absorption system working principles; description and working of NH_3- water system and LiBr –water; three fluid absorption system and its salient features; steam jet refrigeration system – working principle, basic components and analysis; principle and operation of vortex tube.

UNIT III **(12L, 4T)**

Psychometric & Human Comfort: Psychometric – Composition of air and its effect on human comfort; psychometric terms – specific humidity, relative humidity percentage humidity and absolute humidity; temperatures – dry bulb, wet bulb and dew point; Psychometric processes: different types of psychometric processes sensible heating and cooling process, Latent heating and cooling process, heating with humidification, cooling with dehumidification, adiabatic cooling; air washer process; contact and bypass factor; apparatus dew pint; condition line; sensible heat factor; calculation of ADP with the help of the chart; Requirement of human comfort.

UNIT IV **(11L, 3T)**

Air Conditioning: comfort air-conditioning; summer and winter air-conditioning; concept of effective temperature, comfort chart; requirements of industrial air-conditioning, air-conditioning load calculations. Refrigeration and air-conditioning control, air handling, air distribution and duct design.

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 46 Hrs
Tutorial: 14 Hrs
Approximate Total : 60 Hrs

Texts and Reference Books:

1. C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill
2. R.J. Dossat, Principal of refrigeration, John Willey
3. W.F. Stoker, Refrigeration and Air-conditioning, McGraw-Hill
4. Abdul Ameen, Refrigeration and Air Conditioning, Prentice Hall of India Ltd.
5. P. N. Ananthanarayan, Basic Refrigeration and Air Conditioning, Tata McGraw Hill
6. Wilbert F. Stoecker and Jerold W. Jones, Refrigeration and Air Conditioning, Tata McGraw Hill
7. Richard Charles Jordan, Gayle B. Priester, Refrigeration and Air Conditioning, Prentice hall of India Ltd.

Course Code: 18ME315T					**Course Name:** Computer Aided Design			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	**1**	**--**	**4**	**4**	**Continuous evaluation**	**Mid Semester**	**End Semester**	**100**
					25	25	50	

Prerequisites:

1. Engineering Graphics
2. Design and Kinematics of Machines
3. Machine Design-I

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Build an understanding of the fundamental concepts related to Computer Aided Design that includes the need of CAD in computer aided processes that are used in various engineering applications
CO2: Define various standards of CAD including the algorithms for generating simple geometric entities namely line, circle and ellipse.

CO3: Construct various geometric modelling entities required for 2D and 3D affine transformations.
CO4: Analyze geometric modelling entities namely plane curves like line, circle, parabola, hyperbola along with the space curves like Hermite, Bezier and B-spline curves and solid modelling.
CO5: Develop the fundamentals required to finite element methods as applied in finite element method.
CO6: Define the programming concepts to design mechanical components using commercial packages.

Code/ Table/ Charts if any: NIL

UNIT I **(8L, 2T)**

CAD Fundamentals: Introduction, Reasons for implementing a CAD system, Computer aided process application, benefits, CAD software's, Elements of programming, CAD programming, Need and scope of computer aided design.
Computer Graphics: Scan conversion; Bresenham's Algorithm for line, circle and ellipse. Standards for graphics programming, features of GKS, other graphics standards, PHIGS, IGES, PDES. Standards in CAD.

UNIT II **(12L, 3T)**

Geometric Transformations: Geometric transformations- 2D and 3D translation, scaling, rotation, shear and reflection, homogeneous transformations.

UNIT III **(15L, 4T)**

Plane & Space Curves: Types of mathematical representation of curves, parametric representation of line, circle, ellipse, parabola, hyperbola. Wire frame models, wire frame entities, parametric representation of synthetic curves: Hermit cubic splines, Bezier curves, B-splines, constructive solid geometry.

UNIT IV **(12L, 4T)**

Finite Element Method: Introduction, FEM procedure, Discretization of the Domain, Interpolation Models, Higher Order and Isoparametric Elements, Derivation of Element Matrices and Vectors, Assembly of Element Matrices and Vectors and Derivation of System Equations, Numerical Solution of Finite Element Equations, Basic Equations and Solution Procedure, Analysis of Trusses, Beams.
Computer Programming: Use of computer programming in design of machine elements, development of computer program using Matlab for machine components like shaft, spring, gears, bearing etc., plotting graphs using programming language, generalized programming, optimization in design.

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 47 Hrs
Tutorial: 13 Hrs

Approximate Total : 60 Hrs

Texts and Reference Books:

1. Mathematical elements for computer graphics by David F Rogers and J. Adams, 2nd Edition, Tata McGraw-Hill, New Delhi
2. Computer Aided Engineering & Design by Jim Browne, New Age International Publications,
3. CAD/CAM: Computer Aided design and Manufacturing by Mikell Groover and Zimmer, Pearson Education
4. CAD/CAM Theory & Practice by Ibrahim Zeid, 2nd Edition, Tata Mc Graw Hill, New Delhi
5. Computer Graphics & design by P. Radhakrishnan, C.P. Kothanadaraman, New Age publication
6. Finite Element Analysis by Chendraupatla, EEE Publication.
7. The Finite Element Method in Engineering by S. S. Rao, 5th Edition, Butterworth–Heinemann Publications
8. Computer Graphics by Donald Hearn, 2nd Edition, Pearson
9. Finite Element Procedures by K. J. Bathe 2nd Edition, Prentice Hall Publications
10. An Introduction to Finite Element Methods, MC Graw Hill Publishers, 3rd Edition
11. Curves and Surfaces for Computer Graphics, David Salomon, Springer

Course Code: 18ME310T					**Course Name:** Robotics			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	**0**	**--**	**3**	**3**	**Continuous evaluation**	**Mid Semester**	**End Semester**	**100**
					25	25	50	

Prerequisites:

1. Design and Kinematics of Machines
2. Dynamics of Machine

Course Outcomes (Cos):

On completion of the course, students will be able to

CO1: Outline the capabilities and constructional features of an Industrial Manipulator.
CO2: Develop Kinematic and Dynamic Model for an Industrial Manipulator for successful function and trajectory manipulation.
CO3: Explain the function of various subcomponents of a industrial manipulator for successful function.
CO4: Understand the importance of allied technologies for successful function of a manipulator.
CO5: Understand the suitability of Robots in industrial applications and newer technologies associated with them.

Code/ Table/ Charts if any: NIL

UNIT I **(10 L)**

Introduction: Classification of robots, basic robot components, robot anatomy, manipulator end effectors, controller, power unit, sensing devices, specification of robot systems, accuracy precision and repeatability, work envelop, gripper actuators and gripper design.
Co-ordinate Systems: local frame and global frame, representation, transformations, wrist analysis

UNIT II **(12 L)**

Kinematics and Dynamics: Parameters of robot link, formulation of D-H matrix, Analysis of different types of robots with different degrees of freedom, kinematic chains, inverse kinematics, Dynamic analysis

UNIT III **(09 L)**

Motion planning: Different trajectories and its analysis, motion planning, trajectory planning and control
Robotic sensing devices: Position, velocity and acceleration sensors, proximity and range sensors, touch and slip sensors, tactile sensors, force sensors and torque sensors.

UNIT IV **(09 L)**

Robotic vision system: imaging components, picture coding, object recognition, training and vision systems, review of existing vision systems.
Robotics programming: Methods of robot programming, types of programming, robotics programming languages, artificial intelligence.
Robot applications and Economic analysis of robotics

UNIT IV **(05 L)**

Industry 4.0: Technologies involved, Implementation and Potential
Non-Industrial Robots: Technologies involved with Domestic Robots, Humanoids, Nature Exploration Robot and other futuristic design.

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 45 Hrs
Tutorial: 00 Hrs
Approximate Total : 45 Hrs

Texts and Reference Books:

1. Fundamentals of Robotics Analysis and control : Robert J. Schiling
2. Introduction to Robotics: Mechanics and Control, 3E: John J. Craig, Pearson
3. Robotics and Control: R K Mittal and I J Nagrath, Tata McGraw-Hill Education Private Limited
4. Industrial robotics : Groover, Weiss Nagel and Odrey, Mc Graw Hill
5. Robotics engineering: Klafter, Chmielwski and Nagirn, Prentice Hall.
6. Robotics for engineering: Yorem Korem, Mc Graw Hill.
7. Robotics: Control, Sensing Vision and Intelligence: K.S. Fu, R.C.Gonzalez, C.S.g Lee, McGraw Hill

Course Code: 18ME311T					**Course Name:** Dept. Elective II (Advance Manufacturing Process)			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	**0**	**--**	**3**	**3**	**Continuous evaluation**	**Mid Semester**	**End Semester**	**100**
					25	25	50	

Prerequisites:

1. Manufacturing process-I (16MI205T)
2. Manufacturing Processes-II

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: U**nderstand** Mechanical abrasion processes.

CO2: Understand principles and applications of Thermal and electrochemical processes

CO3: Analyze the relation between the process parameters and mechanical properties.

CO4: Understand the principles and applications of advanced welding processes

Code/ Table/ Charts if any: NIL

UNIT I **(10 L)**

Advanced material removal processes (Mechanical):

- Need for advanced material removal processes, Classification of advanced machining / material Removal processes, considerations in process selection and applications.
- Ultrasonic Machining Process (USM) – Mechanism of material removal, advantages, disadvantages, applications, ultrasonic Machine and its process Parameters, Modeling of MRR in USM, economic considerations, applications and limitations.
- Abrasive Flow Machining- Principle, AFM technology, advantages, disadvantages, applications, Mechanism and process parameters in AFM, recent developments in AFM technology (Ultrasonic flow polishing, Orbital AFM, Magneto abrasive flow machining, Centrifugal force assisted AFM)
- Abrasive jet machining (AJM) – Principle, advantages, disadvantages, applications, Components and process parameters, modeling of MRR in AJM for brittle material
- Water jet and abrasive Water Jet Machining (AWJM) – Process principles, equipment, parameters, process capabilities, advantages, applications, modeling of mixing process, modeling of MRR in WJM & AWJM
- Magnetic abrasive finishing – Introduction, Machining system, material removal process, application
- Other recent material removal processes with mechanical energy domain of material removal.

UNIT II **(12L)**

Advanced material removal processes (Thermal, Electrochemical and Chemical):

- Electrical Discharge Machining (EDM) – EDM principle, Mechanism of material removal in EDM, selection of tool electrode and dielectric fluids, advantages, types of EDM processes – (Die sink EDM, wire cut EDM, Powder mixed EDM), overcut, ovality, taper ratio, taper angle in EDM, modeling of MRR in EDM, Micro-EDM (Introduction)
- Laser Beam Machining (LBM) – Principle of Laser, solid state lasers, gas state lasers, Attributes of laser beam, Classification of laser beams, Types of laser, Mechanism of Material Removal / Cutting using laser beam, advantages, disadvantages, applications, Process parameters, modeling of MRR in LBM
- Electron beam machining (EBM) – Basic equipment, removal mechanism, advantages, disadvantages, applications
- Electrochemical Machining (ECM) – Mechanism of Material Removal in ECM, advantages, disadvantages, applications, The Subsystems of Electro-Chemical Machining, ECM process parameters, MRR of alloy in ECM, Dynamics of ECM (no feed condition and with feed condition). Surface finish and accuracy in ECM, economic aspects of ECM.
- Chemical machining: Important steps in chemical machining, etchants in chemical machining,

important applications,

- Combined machining processes – Electrochemical-Assisted Processes (Electrochemical grinding, Electrochemical Honing, Electrochemical deburring, Electrochemical Super-finishing, Ultrasonic-Assisted Electrochemical Machining), Thermal-Assisted Processes – (Abrasive Electro-discharge Grinding, EDM with Ultrasonic Assistance)
- Electrostream drilling and other advanced non-conventional machining processes under thermal, electro-chemical and chemical energy domain.

UNIT III **(10L)**

- Cold metal transfer welding – Working principle, CMT pulse, Advanced CMT, application
- Pulse arc welding – Pulse gas tungsten arc welding and pulse gas metal arc welding (P-GMAW)
- Ultrasonic welding – Introduction of different types of ultrasonic welding (Ultrasonic seam welding, ultrasonic torsion welding, Ring welding, line welding), application
- Electron Beam Welding – EBW Equipment, process parameters, process capabilities, advantages, limitation, application
- Hybrid welding processes – Hybrid Laser Arc Welding, TIG-MIG hybrid welding, hybrid friction stir welding

UNIT IV **(07L)**

- Microwave Processing of Materials – The electromagnetic spectrum, Conventional and microwave heating, Polarization and Conduction, Unique benefits and distinctive features of Microwave Processing, Microwave Applications, New Trends (Sintering using microwaves, Microwave Joining of non-metallic materials, Microwave coating and cladding).
- Advances in casting processes – Evaporative Pattern Casting (Process Description, Process variables), Hybrid Evaporative Pattern Casting Process (Process Description, Process variables), Vacuum Sealed Molding Process (Sequence of Producing V-Process Molds), Ceramic Shell Investment Casting Process (CSIC)

Self-study: The self- study contents will be declared at the commencement of semester.

Lecture: 39 Hrs
Tutorial: 00 Hrs
Approximate Total : 39 Hrs

Texts and Reference Books:

1. Hassan El-Hofy, Advanced machining processes, Non-traditional and hybrid machining processes, Tata Mcgraw Hill.
2. Mehta K. (2017) Advanced Joining and Welding Techniques: An Overview. In: Gupta K. (eds) Advanced Manufacturing Technologies. Materials Forming, Machining and Tribology. Springer publisher.
3. V. K. Jain, Advanced Machining Processes, Allied Publishers Mumbai.
4. Serope Kalpakjian, Manufacturing Processes for Engineering Materials, Pearson India
5. Nontraditional Manufacturing Processes By GaryF. Benedict

Course Code: 18ME316P				**Course Name:** Heat Transfer and Non-Conventional Energy Sources Lab.			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	**-**	**3**	**1.5**	**3**	**Continuous Evaluation**	**End Semester**	**50**
					25	25	

Prerequisites:

1. Thermodynamics and Fluid Flow
2. Fluid mechanics and Machinery

Course Outcomes (COs):

On completion of the course, students will be able to

1. **Understand** and **evaluate** different modes of heat transfer.
2. **Understand** and **analyze** emissivity and conductivity of different materials.
3. **Examine** the performance of heat exchangers.
4. **Measure** the solar radiation and effective sunshine hours.
5. **Demonstrate** the ways to use solar energy for various applications like heating, cooling, water distillation and electricity and **evaluate** their performance.
6. **Interpret** and **classify** the ways to harness the energy from Biomass, Wind and other nonconventional energy sources like geothermal, ocean, MHD etc.

List of Experiments:

Non-Conventional Energy Sources

1. Solar radiation and its measurement
2. Performance characteristic of solar flat plate collector
3. Performance characteristic of solar cooker
4. Performance evaluation of solar still
5. Study and demonstration of evacuated tube solar collector technology
6. Performance characteristic of parabolic trough collector
7. Performance evaluation of Solar PV
8. Study of various types of wind power plant
9. Study of various types of bio gas plant
10. Case study on power conservation aspects
11. Feasibility study of ocean power plant
12. Walk through industrial/institute energy audit.

Heat Transfer

13. To identify the thermal Conductivity of Metal Rod
14. To identify the thermal Conductivity of Insulating Powder
15. To identify the convective heat transfer of air in natural convection mode
16. To identify the convective heat transfer of air in force convection mode
17. To identify the effect of orientation in natural convection heat transfer
18. To find out the performance parameter of concentric tube heat exchanger
19. To verify the Stefan Boltzmann constant
20. To identify the emissivity of a test material

Course Code: 18ME315P				**Course Name: Computer Aided Design Lab.**			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total**
-	-	3	1.5	3	**Continuous Evaluation**	**End Semester**	50
					25	25	

Prerequisites:

1. Strength of Materials
2. C Programing Concepts

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Model the mechanical components using the advanced modelling software.
CO2: Apply the concepts of geometric transformations and solve the problems in both 2D and 3D.
CO3: Develop the MatLab code for the generic problems for the line and circle algorithms using various basic commands.
CO4: Analyze the real time engineering problems and estimate the physical quantities.

List of Experiments:

Drafting and Modeling using CREO:

1. Modeling, Drafting using Creo/Solidworks.
2. Advanced modeling using Creo/Solidworks.
3. Assembly modeling using Creo/Solidaworks.
4. Exercise problems on generation of views, BOM, GDNT etc in Creo/Solidworks.
5. Assembly drawing/modeling vice-a-versa using Creo/Solidworks. (Exercises: Cotter Joint, Knuckle Joint, Flange coupling, universal coupling, Oldham coupling, engine parts-stuffing box, connecting rod, Screw Jack, Eccentric etc)

Mathematical Modeling using MATLAB:

1. Exercise problems on basic Matlab commands: *If-else, switch*, *for, while, Plot*.
2. Generation of line using DDA and Bresenham's Algorithms.
3. Generation of circle using Mid-Point algorithm.
4. Perform a 2D translation like Scaling, Reflection and Rotation about the coordinate axes.
5. Perform 3D Rotation not commutative.
6. Exercise problems on generation of Hermite, Bezier and B-Spline Curves

Finite Element Analysis using ANSYS:

1. Introduction to ANSYS Mechanical APDL Finite Element Analysis.
2. FEA of Structural and Thermal problems.
3. Exercise and assignment problems of FEA on 1D, 2D Structural and Thermal problems.

COURSE STRUCTURE FOR B.TECH. FINAL YEAR (Mechanical Engineering)

SEMESTER VII (Subjects)			B.TECH. FINAL YEAR (Mechanical Engineering)											
Sr. No.	Course Code	Course Name	Teaching Scheme					Exam Scheme						
								Theory			Practical		Total Marks
			L	T	P	C	Hrs/wk	IA	MS	ES	Lab. Work	Practical/ Viva	
1	19ME401T	Machine Design - II	4	0	0	4	4	25	25	50	-	-	100
2	19ME402T	Internal Combustion Engine	4	0	0	4	4	25	25	50	-	-	100
3	19MEXXXT	Dept. Elective-III	3	0	0	3	3	25	25	50	-	-	100
4	19MEXXXT	Dept. Elective -IV	3	0	0	3	3	25	25	50	-	-	100
5	18ME403T	Discipline based/ Generic (*Optimization Techniques*)	3	0	0	3	3	25	25	50	-	-	100
6	19ME410T	Refrigeration, Air Conditioning and Internal Combustion Engine Lab	0	0	3	1.5	3	-	-	-	25	25	50
7	19ME401P	Machine Design Lab	0	0	3	1.5	3	-	-	-	25	25	50
8		Seminar	-	-	3	-	-						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Department Elective – III & IV: ME 411- Experimental Stress Analysis, 18ME406T- Science and Technology of Welding, ME 414- Computation Fluid Dynamics and Heat Transfer, 19ME408T - Rapid Product Development, ME-431/IE-403- Planning of Facilities and Materials Handling Systems, 19ME407T- Vibration Engineering Design, ME-429- Design for Manufacturing, ME 415- Fuels Combustion and Pollution, Automotive Design, ME 413- Lubrication, ME 428- Micro- & Nano-Manufacturing, 19ME409T- Cryogenics

Department Elective – V: Machine Learning Applications in Design and Manufacturing, Heat Exchangers design, ME427- Automobile Engineering, ME 417- Solar Photovoltaic Fundamental: Technologies & Application, ME-432/IE-308- Procurement and Material management, ME 422- Flexible Manufacturing Systems, ME 416- Advances in Measurement Techniques

Course code: 19ME401T					**Course name:** Machine Design-II					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
4	0	--	4	4	25	50	25	--	--	100

Prerequisites (if any): Strength of Materials, Machine Design-1

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Design and **analyze** bearings that are used in various engineering and commercial applications.
CO2: Design and **analyze** gears that are used in various engineering and commercial applications.
CO3: Demonstrate the concept of materials handling systems in industries,
CO4: Design various components namely rope, crane hook, sheaves for their safe use.
CO5: Design gear box after understanding the concepts of various types of gear drives.
CO6: Interpret and **adapt** the various design and failure criterion as per the industry standards.

UNIT I **20**

Design of Bearings: Types, materials and selection of bearings, Working conditions for the bearings, Hydrodynamic lubrication theory for journal bearings, Design factors (minimum film thickness, flow variable, heat balance etc.) for journal bearings, Design procedure for journal bearings, Design of bearings (bearing materials, bearing housings, bearing shells etc.), Design of thrust (pivot and collar) bearings, Ball and roller bearings, Load and life rating of bearings

UNIT II **18**

Design of Gear Drives: Gear terminology, Kinematics of gear drive, Standard system of gear tooth, Gear materials, Design of Spur, helical and bevel gears (Tooth proportions, Force analysis, Dynamic loading of gear tooth, Heat Treatment and Wear Resistance, Gear Construction and stress concentration), Design of worm gear set

UNIT III **08**

Design of Gear boxes:

Geometric progression- standard step ratio, vehicle motion resistance, sliding mesh gear box, constant mesh gear box, synchromesh gearbox, Epicyclic gear box, multi speed gear box.

UNIT IV **14**

Design of material handling equipment:

Introduction of material handling equipment, classification and their selection. Concept of material handling system design, design of hooks, sheaves, drums, grab buckets and cranes.

Lecture: 60 Hrs
Tutorial: 00 Hrs
Approximate Total : 60 Hrs

Texts and References

1. C. Sharma and K. Purohit, Design of Machine Elements, PHI Publishers.
2. U. Jindal, Machine Design, Pearson Publishers.
3. N. Pandya and C. Shah, Machine Design, Charotar Publishers.
4. J. Shigley, C. Mischke, R. Budynas, Mechanical Engineering Design, Tata-McGraw Hill Publishers.
5. Dr. Sadhu Singh, Machine design, khanna publishers.
6. R. Juvinall, K. Marshek, Fundamental of Machine Component Design, John Wiley and Sons Publishers.
7. R. Norton, Machine Design: An Integrated Approach, Pearson Education Publishers.
8. V. Bhandari, Machine Design, Tata-McGraw Hill Publishers.
9. S. Kazimi, Solid Mechanics, Tata-McGraw Hill Publishers.

Course code: 19ME402T					**Course name:** Internal Combustion Engine			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	1	--	4	4	**Continuous evaluation**	**Mid Semester**	**End Semester**	100
					25	25	50	

Prerequisites:

1. Thermodynamics
2. Heat and mass transfer.
3. Fluid mechanics and machineries

Course Outcomes:

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

CO1: Classify, compare and elaborate various systems and components in an internal combustion engine.
CO2: Apply energy, mass and heat transfer principle to an internal combustion engine
CO3: Examine conditions of the IC engine and Analyze to determine losses for the engine and heat balance sheets.
CO4: Estimate the work output and efficiencies from Pressure- volume and temperature- entropy graphs and evaluate the performance of the engine
CO5: Compare, predict and estimate the improvements to the IC engine within the given time frame

UNIT I **(08 L , 6T)**

Introduction: Engine classifications, basic engine components and terminology, working principles of engines, four-stroke (4S) and two-stroke (2S) SI and CI engines, comparison of 4S and 2S SI and CI engines, application of IC engines, engine performance parameters. Air-standard cycles: Carnot cycle, Stirling cycle, Ericsson cycle, Otto cycle, Diesel cycle, Dual cycle, Atkinson cycle, comparison of the Otto, Diesel and Dual cycles. Fuel-air cycles: Fuel-air cycles and their significance, variable specific heats, dissociation, comparison of air-standard and fuel-air cycles, effect of compression ratio & fuel-air ratio, valve-timing diagrams

UNIT II **(12 L, 2T)**

Actual cycles: comparison of air-standard and actual cycles. Fuels for IC engines: solid, liquid, gaseous fuels, rating of fuels, alternate fuels. Fuel systems for SI engines: Carburetion, principle of carburetion, types of carburettors, Solex carburettor, Carter carburettor, S.U. carburettor, petrol injection. Fuel systems for CI engines: Mechanical injection systems, electronic injection systems, ignition. Combustion and Combustion Chambers: Combustion in SI engines, abnormal combustion and knock in SI engines, combustion chambers for SI engines, Combustion in CI engines, knocking in CI engines, combustion chambers for CI engines, abnormal combustion in SI and CI engines

UNIT III **(10 L , 2T)**

Lubrication: Lubrication of engine components, lubrication systems, properties of lubricants, additives for lubricants. Heat transfer and cooling: theory of engine heat transfer, parameters affecting engine heat transfer, engine cooling systems, liquid-cooled systems, air-cooled systems. Engine emissions and control: products of combustion in IC engines, control of

pollutants from IC engines, emission standards for IC engines

UNIT IV **(10 L, 6T)**

Supercharging and turbo-charging, Two-stroke engines, Alternative engines. Performance and Testing: performance parameters, speed measurements, fuel consumption, brake power, friction power, indicator diagram measurements, heat balance sheet, performance comparison of SI and CI engines Alternative fuels for IC engines.

Self-study: The self- study contents will be declared at the commencement of semester. Use of programming software for open end problem using industrial data will be looked out.

Lecture: 40 Hrs
Tutorial: 16 Hrs
Approximate Total : 56 Hrs

Text and references:

11. V. Ganesan, *Internal Combustion Engines*, 3rd edition, The Tata McGraw-Hill publications
12. H. N. Gupta, *Fundamentals of Internal Combustion Engines*, Prentice Hall India pvt. Ltd.
13. J. B. Heywood, *Internal Combustion Engine Fundamentals*, The Tata McGraw-Hill publications
14. M.L. Mathur and R.P. Sharma, *A COURSE IN INTERNAL COMBUSTION ENGINES*, Dhanpar Rai Publications.
15. Colin R. Ferguson and Allan T. Kirkpatrick, *Internal Combustion Engines Applied Thermo sciences,* 2nd edition, John Wiley & Sons.

Course code: 18ME403T				**Course name:** Optimization Techniques				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	**-**	**--**	**3**	**3**	**Internal evaluation**	**Mid Semester**	**End Semester**	**100**
					25	**25**	**50**	

Course Outcomes (COs):

CO1: To understand and formulate optimization problems
CO2: To adapted optimization techniques for the solution of problems
CO3: To understand the different constraints handling techniques
CO4: To understand the difference between various optimization techniques

UNIT I (**09L)**

Introduction: Objective function, constraints, design variables, feasible and infeasible solutions, classification of optimization problems, applications. Graphical Method: different cases - Feasible and infeasible solutions, redundant constraints, unbound solutions, unique solution.

UNIT II (**12L)**

Linear Programming: Problem formulation, simplex method, transportation and assignment problems, PERT and CPM

UNIT III (**9L)**

Unconstrained Optimization Techniques: elimination methods, interpolation methods, direct and indirect search methods

UNIT IV (**9L)**

Classical Optimization techniques: single variable, multivariable optimization techniques, Random Search Methods, Methods of Feasible Directions.

Lecture: 39 Hrs
Tutorial: 00 Hrs
Approximate Total : 39 Hrs

Text and reverences:

1. S S Rao, Engineering Optimization, New Age International
2. K Deb, Optimization for Engineering Design: Algorithms & Examples, Prentice-Hall of India
3. C Pearce, E Hunt , Optimization: Structure and Applications, Springer
4. A. Ravindran, G. Reklaitis, K. M. Ragsdell, Engineering Optimization: Methods And Applications, Wiley
5. F Hillier, G Lieberman, Introduction to Operation Research, Mc Graw Hill
6. H Taha, Operation Research –, Pearson Education.
7. A Verma, Operation Research, S.K. Kataria and Sons.
8. V Kapoor, Operation Research, Sultan Chand & Sons

Course code: 19ME410T				**Course name:** Refrigeration, Air-conditioning and Internal Combustion Engine Lab			
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs /Week**	**Practical**		**Total Marks**
-	-	3	1.5	3	**Lab work**	**Lab exam/Viva**	50
					25	25	

Course Outcomes (COs):

On completion of the course, students will be able to

CO1: Recognize and **understand** the function of different components of refrigeration and air-conditioning system.
CO2: Evaluate the performance of refrigerating system and **analyze** the effect of operating parameters (evaporator and condenser) on its performance.
CO3: Recognize Psychometric processes, **Evaluate** performance of Air Conditioning system and **analyze** the effects of operating parameters on its performance
CO4: Recognize and **understand** various parts and systems of petrol and diesel engines.
CO5: Evaluate performance of petrol and diesel engines and **analyze** effect of variation of various performance parameters with load and speed.
CO6: Use and **apply** engineering systems needed to set-up and run engines in controlled laboratory environments.

List of experiments: Refrigeration and Air Conditioning

1. Performance on Vapor Compression Refrigeration system
2. Performance on vapour absorption refrigeration system
3. Performance on heat pump system
4. Performance to obtained different psychometric process of air
5. Performance on air washer
6. Performance on air-conditioning unit
7. Performance on cascade refrigeration system
8. Performance on Vortex tube
9. Cooling load calculation for given application

List of experiments: Internal Combustion Engine

1. Performance test on 4Stroke-4Cylinder SI engine
2. Performance test on single-cylinder 4Stroke CI engine
3. Study of Turbochargers and Superchargers

Course Code: 19ME401P					Course Name: Machine Design –II Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Lab. Work	Lab. Exam/Viva	
--	--	3	1.5	3	25	25	50

Course Outcomes (COs):

On completion of course, students will be able to

CO1: Define problem and **solve** mathematical equations.
CO2: **Design** and develop Matlab code.
CO3: Conduct FEA analysis and **understand** the results.
CO4: Compare, **analyze** and interpret the findings obtain through Matlab and FEA.

Part A:

List of Design Problems: Manual design, Computer program and solid model using Creo

1. Design exercise for Spur/Helical gears
2. Design exercise for Bevel/Worm gears
3. Design exercise for Bearings
4. Design exercise for Gear boxes
5. Design exercise for Material Handling equipment
6. Design exercise for various other machine elements lie chain drive, pulley drive, belt drives, rope design etc.

Part B: Major Design

Consist of:

Identifying five industry which manufactures part given in major design
Visit of any one industry identified
Manual Design of the major design
Preparation of the Computer program for the design (for parametric analysis and optimization)
Preparation of the solid model, detail and assembly drawings using software
Analysis of the parts using FEA software
Preparation of the report

COURSE STRUCTURE FOR B.TECH. FINAL YEAR (Mechanical Engineering)

SEMESTER VIII (Subjects)			B.TECH. FINAL YEAR (Mechanical Engineering)											
Sr. No.	Course Code	Course Name	Teaching Scheme					Exam Scheme						
								Theory			Practical		Total Marks
			L	T	P	C	Hrs/wk	IA	MS	ES	Lab. Work	Practical/ Viva	
Major In-house Project with three courses														
1		CAM	4	0	0	4	4	25	25	50	-	-	100
2		Thermal Engineering and Power Plant	3	0	0	3	3	25	25	50	-	-	100
3		Project Management / Department Elective-V	3	0	0	3	3	25	25	50	-	-	100
6		Major Project				12	12	-	-	-			
		Seminar											
Comprehensive Project with Two courses														
8		Thermal Engineering and Power Plant	3	0	0	3	3	25	25	50	-	-	100
		Project Management / Department Elective-V	3	0	0	3	3	25	25	50	-	-	100
		Comprehensive Project				16							
		Seminar				3							

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Department Elective – V: Machine Learning Applications in Design and Manufacturing, Heat Exchangers design, ME427- Automobile Engineering, ME 417- Solar Photovoltaic Fundamental: Technologies & Application, ME-432/IE-308- Procurement and Material management, ME 422- Flexible Manufacturing Systems, ME 416- Advances in Measurement Techniques

Course Code:					Course Name: Computer Aided Manufacturing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	-	4	4	25	25	50	--	--	100

Prerequisite Courses:

Course Outcomes (COs):

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

CO1: Understand the need and basics of Computer Aided Manufacturing
CO2: Analyze basics and advancement in NC and CNC for automatic manufacturing.
CO3: Understand and write tool path for CNC programming for Lath and milling machine
CO4: Apply the role of group technology and Flexible manufacturing system in automation.
CO5: Understand role of computer aided production management in industries

UNIT I **13**

Introduction: Introduction to CAM, Concepts & scope of CAM, Nature & type of manufacturing system, Evolution, Benefits of CAM,

Constructional details, of CNC machines:

Basis and need of CNC machines: NC, CNC and DNC systems. Machine structures, slide ways, motion transmission elements, Chip removal and safety considerations, Automatic tool changers and multiple pallet systems, Sensors and feedback devices in CNC machines, Constructional details of CNC turning center, Classification of CNC control systems, Applications of CNC machines in manufacturing, advantages of CNC machine.

UNIT II **13**

CNC part programming: Axis identification and coordinate systems, structure of CNC part program, Programming formats, NC programming codes.

Programming for 2 axis control systems: Manual part programming for a turning center, programming using tool nose radius compensation, do loop, sub routines and fixed cycles, Programming for CNC wire-cut machines.

Programming for 3 axis control system: Manual part programming for CNC machining center programming using tool radius compensation tool offsets, do loop, subroutines and fixed cycles.

COMPUTER AIDED CNC PART PROGRAMMING: Using APT language CAD/CAM Aided CNC part programming.

Tooling for CNC machines: Tooling requirements of CNC machine, preset and qualified tools, work and tool holding devices in CNC machines.

UNIT III **13**

FMS:

Introduction & Component of FMS, Needs of FMS, general FMS consideration, Objectives, Types of FMS, advantages of FMS, Automated material movement (AGVS, RGV etc.) & AS/RS, Cellular & Flexible manufacturing, Cutting tools and tool management, Tool supply system, Tool Monitoring System, Flexibility, FMS scheduling, sequencing, FMS lay out and essentials, Flexible Fixturing,

Automatic Identification And Data Capture: Overview of Automatic Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies

Automated Production Lines: Fundamentals of Automated Production Lines, Applications of Automated Production Lines, Analysis of Transfer Lines

UNIT IV **13**

Group Technology and Cellular Manufacturing:

Introduction, part families, part classification and coding, machining cells, benefits of group Technology, production flow analysis, Cellular Manufacturing

Computer Aided Production management:

Introduction, PPC fundamentals, Problems with traditional PPC, use of computer in PPC such as CAPP, MRPI, MRPII, CAGC etc.

Approximate Total : 52 Hrs

Texts and References

1. Computer Aided Manufacturing by Tien Chien Chang, Pearson Education
2. Automation, Production Systems and Computer Integrated Manufacturing by by Groover, Pearson Education
3. CNC Programming - Principles and Applications, Mike Mattson, Cengage Publication.
4. CNC programming – Dr. S.K.Sinha – Golgotia publications.
5. Flexible Manufacturing Cells and System -William. W. Luggen Prentice Hall, England Cliffs, New jersy
6. P.Radhakrishnan, " Computer Numerical Control ", New Central Book Agency.
7. Computer integrated manufacturing -S. Kant Vajpayee – Prentice Hall of India.
8. Computer Aided Manufacturing- Rao, Tewari, Kundra, McGraw Hill.
9. CAD/CAM, Principles and Applications –P N Rao, McGraw Hill.
10. CAD/CAM, Introduction, -Ibrahim Zeid, Tata McGraw Hill.
11. CAD/CAM, Groovers and Zimmers, Pearson

Course code:					**Course name:** Thermal Engineering and Power Plant			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Total**
3	--	--	3	3	**MS**	**ES**	**IA**	**100**
					25	50	25	

Prerequisites (if any): Thermodynamics, Fluid Mechanics, Fluid Machines

Course Outcomes (COs):

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

CO 1: Classify, compare and elaborate various gas turbines systems, Jet propulsion system, steam nozzles and steam turbines.

CO 2: Derive the mathematical model to obtain flow equations, efficiency and work output for various conditions in an gas turbine, nozzle and steam turbine

CO 3: Examine & compare various improvement enhancing systems like regeneration, re-heating, inter-cooling, velocity and pressure compounding etc. to suggest the best suited system based on the industry requirement.

CO 4: Estimate the work output and efficiencies of gas turbines, nozzles and steam turbines for all working conditions.

UNIT I **(10T)**

Steam generator: steam generator classification, critical and super critical boilers, fluidized bed boilers.

Steam Nozzles: Types of nozzles, velocity and heat drop, condition for maximum discharge, Effect of Friction and nozzle efficiency, Physical concept of critical pressure, General relationship between area, velocity and pressure, super saturated flow, Effect of variation of back pressure. Isentropic flow through nozzle and diffusers, Introduction to shock waves.

UNIT II **(12T)**

Steam Turbine: Layout and working of steam turbine power plant. Principle of operation and Types of steam turbines, classification of steam turbines; Velocity diagrams and compounding of turbines. Impulse Turbine: Velocity diagrams, forces on blade and work done on the turbine blades, diagram efficiency, stage efficiency, Axial thrust, multi staging, most economical ratio of blade angles, Reheat factor, Internal Efficiency, Effects of finite stages. Impulse-Reaction Turbine: Velocity diagrams, forces on blade and work done by blade; degree of reaction, Impulse reaction turbine with similar blade section and half degree reaction, height of impulse-reaction blading, Effects of varying heat drop, blade sections and losses in turbine.

UNIT III **(12T)**

Gas Turbines: Layout and working of Gas turbine power plant. Simple open and close cycle gas turbine, efficiency and specific output of simple cycle, effects of – regeneration, re-heating and inter-cooling on efficiency and work output, effect of operating variables on thermal efficiency, air rate, work ratio; water injection, Advantages and disadvantages of gas turbine, gas turbine components, performance and application of gas turbine**.**

Jet Propulsion: Introduction to jet propulsion, advantages and disadvantages of jet propulsion – turbojet engine with and without after burner, turboprop, ram jet, pulse jet, rocket engines – operation, solid and liquid propellants.

UNIT IV **(06T)**

Hydro electric station: Principles of working, applications, site selection classification and arrangement of hydro-electric plants Diesel power plant: General layout, diesel plant operation and efficiency. Nuclear power plant: Principles of nuclear energy, classification of reactors, basic components, Working, Safety measures

Lecture: 40 Hrs
Tutorial: 00 Hrs
Approximate Total : 40 Hrs

Text and reverences:

1. Gas Turbines, Cohen & Rogers, Pearson Prentice Hall
2. Fundamentals of Gas Dynamics By Robert D. Zucker and Oscar Biblarz, John Wiley & Sons,
3. Fundamentals of Gas Dynamics by Robert P. Benedict, John Wiley & Sons, Inc.
4. Steam & Gas turbines, R. Yadav, Central publishing House, Allahabad.
5. P.K. Nag, Power Plant Engineering, Tata McGraw Hill.

Course code: 18ME410				**Course name:** Project Management				
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs./ Week**	**Theory**			**Total**
3	**0**	**--**	**0**	**3**	**Continuous evaluation**	**Mid Semester**	**End Semester**	**100**
					25	**25**	**50**	

Prerequisites:
Knowledge of subject Production operation management and industrial economics along with knowledge of basic manufacturing processes such as casting, metal forming and welding

Course Outcomes (COs):
On completion of the course, students will be able to,

CO1: Understand the concepts of project management, its different aspects and specifications.
CO2: Analyze the project performance with different tools.
CO3: Understand the concepts of project scheduling and ascertain different quality tools.
CO4: Understand the project monitoring and control tools and techniques.
CO5: Understand the project closure traits and its different tools.

UNIT I **(9 Hours)**

Introduction to Project Management: Justifying Project Management, Projects – Definitions, The Project Management Triangle – Scope, Time and Cost, What is Project Management, Projects & Operations, The Project Life Cycle, Project Stakeholders, Project Management Process Groups, Project Management Knowledge Areas

Specification of a Project: The Project Charter, The Project Scope Document, Work Breakdown Structures, Project Contracts – Scope, Delivery, Costs and Risks

UNIT II **(09 Hours)**

Project Planning and Scheduling: Project Network Representations, Activity Parameter Estimation – Time, Cost and Resources, Project Time Schedule, Gantt Charts, CPM and PERT, Activity and Project Crashing, Resources Scheduling.

UNIT III **(12 hours)**

Project Execution Management: Quality Specifications, Quality Control Tools, Resources Procurement and Allocation, Systems and Processes, Communications and Documentation, Managing Teams, Resources Demobilization, Project Simulation and Risk Assessment, use of IT tools.

UNIT IV **(09 Hours)**

Project Monitoring and Control: Project Work Measurement, Performance Measurement, Earned Value Management, Estimate Revision.

Project Closure and Review: Performance Evaluation – Scope, Time and Cost, Performance of Teams, Lessons Learnt, Project Closure Report.

Integrated Examples/Cases

Self-study: The self- study contents will be declared at the commencement of semester.

Approximate Total: 39 Hrs.

Texts and References

1. *PMBOK*® Guide, 4th Edition
2. Mantel Jr., Samuel J., Jack R. Meredith, Scott M. Shafer, Margaret M. Sutton with M. R. Gopalan

(2006) *Project Management Core Text Book*, First Indian Edition, Wiley, New Delhi.
3. Meredith, Jack R., and Samuel J. Mantel, Jr. (2010) *Project Management: A Managerial Approach*, 7/e, Wiley, New Delhi.
4. Maylor, Harvey (2003) Project *Management*, 3/e, Pearson, New Delhi.
5. Pinto, Jeffrey K. (2009) *Project Management: Achieving Competitive Advantage and MS Project*, 1/e, Pearson, New Delhi.
6. Gray, Clifford and Erik Larson (2005) Project *Management: The Managerial Process*, 3/e, Tata McGraw-Hill, New Delhi.
7. Nicholas, John M. (2008) *Project Management for Business, Engineering and Technology: Principles and Practice*, 3/e, Elsevier, New Delhi.