UNIVERSITY DEPARTMENTS,
RAJASTHAN TECHNICAL UNIVERSITY, KOTA

MTL203: Mathematics for Mechanical Engineering

Credit: 4 **Max. Marks: 150 (IA:50, ETE:100)**

3L+1T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	HOURS
1.	**Numerical Analysis:** Interpolation, difference operators- forward, backward, central, shift and average operators, Newton's forward and backward interpolation formulae, Gauss's forward and backward interpolation formulae, Stirling's formula, Lagrange interpolation formula for unequal intervals. Inverse interpolation. Numerical differentiation by Newton's, Gauss's and Stirling's formula. Numerical integration: Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule. Numerical solution of ODE of first order: Picard's method, Euler's method, Modified Euler's method, Runge-Kutta forth order method, Milne's Method. Numerical solutions of simultaneous and higher order ODE: Runge-Kutta forth order method	**20**
2.	**Statistics & Probability Theory**: Curve Fitting: Fitting of a straight line, second degree parabola, power curve and exponential curves. Correlation and Regression: Karl Pearson's coefficient of correlation, rank correlation, repeated ranks. Line of regression, regression coefficients, properties of regression coefficients. Basic concepts of probability, conditional probability, Baye's theorem. Random variable and distributions: Discrete and continuous random variables, Moments, Expectation, Moment generating function, Binomial, Poisson, Discrete Uniform, Normal and Exponential distributions	**20**
	Total Hours	**40**

TEXT BOOKS:

1. Advanced Engineering Mathematics, Jain and Iyengar, Narosa Publications.

REFERENCE:

1. Advanced Engineering Mathematics, Irvin Kreyszig, Wiley, India.
2. Advanced Engineering Mathematics, M. Greenberg, Pearson Education, India.
3. Engineering Mathematics for semesters III and IV, C.B. Gupta, Mc Graw Hill Education, India.
4. Advanced Engineering Mathematics, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited.
5. Advanced Engineering Mathematics, O'neil, Cengage Learning, India.
6. Higher Engineering Mathematics, B. V. Ramana, Mc Graw Hill Education, India.
7. Numerical Methods for Scientific & Engineering Computation, Jain and Iyengar, Jain, New Age International Publication, India.
8. Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Lerning, India.
9. Numerical Methods for Engineers, Chapra, Mc Graw Hill Education, India.
10. Introduction to Probability and Statistics, Seymour Lipschutz and John J. Schiller, Mc Graw Hill Education, India.

11. Fundamentals of mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons., India.
12. Probability and Statistics, Murray Spiegel, John Schiller, R. Alu Srinivasan, McGraw Hill Education, India.

Course Outcome: The student will be able to:	
CO1	Demonstrate understanding of the basic concepts of numerical methods and mathematical statistics.
CO2	Apply and derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation and integration.
CO3	Demonstrate understanding and implementation of numerical solution applied to the classes of problems including ordinary differential equations.
CO4	Use various mathematical and statistical techniques required to solve engineering practical problems.

CO-PO Mapping (3-Strong, 2- Moderate and 1- Weak):

Title of Course: Mathematics for Mechanical Engineering (MTL203)												
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2	3	2										
CO3	2	3										
CO4	3	2	1		1							1

MEL130: ENGINEERING THERMODYNAMICS

B.Tech. (Mechanical) 3rd semester

3L+0T

Unit	Contents	Contact hours
I	**Basic Concepts and definitions of Thermodynamics**: System, Surroundings, Property, Energy, Thermodynamic Equilibrium, Process, work and modes of work.	2
	Zeroth and First Law of Thermodynamics: Zeroth of Thermodynamics, Temperature scale, First law of thermodynamics, First law analysis of some elementary processes. Steady and unsteady flow energy equations.	5
II	**Second Law of Thermodynamics:** Heat engine, Heat pump and refrigerator, Second law of thermodynamics, Equivalence of the Kelvin-Plank and Clausius statements. Reversible and Irreversible Processes, Carnot engine, Efficiency of a Carnot engine, Carnot principle, thermodynamic temperature scale, Clausis Inequality.	4
	Entropy: Entropy, Calculation of Entropy change, Principle of entropy increase. Temperature-Entropy diagram, Second law analysis of a control volume.	3
	Availability: Available energy, Loss in available energy, Availability Function, Irreversibility.	3
III	**Thermodynamic Properties of Fluids:** Pure substance, Concept of Phase, Graphical representation of p-v-T data, Properties of steam. Steam tables, Mollier chart	4
	Ideal Gas and Real Gas: Ideal gas, Real gas, Internal energy, enthalpy and specific heats of an ideal gas, equations of state, Dalton's law of partial pressures, Gibbs Dalton law, Thermodynamic properties of gas mixtures.	4
IV	**Thermodynamic Relations:** Thermodynamic variables, Independent and dependent variables, Maxwell's thermodynamic relations, Thermodynamic relations involving entropy, Thermodynamic relations involving enthalpy and internal energy, Joule-Thomson coefficient, Clapeyron equation.	4
	Power Cycles: Otto cycle, Diesel cycle, Dual cycle, Brayton cycle and Ericsson cycle.	5
V	Vapour power cycle: Rankine cycle, effect of operating conditions on its efficiency, properties of ideal working fluid in vapour power cycle	3
	Reheat cycle, regenerative cycle, bleeding extraction cycle, feed water heating co-generation cycle.	3
	TOTAL	40

TEXT BOOK		
1	Nag P.K., Engineering Thermodynamics, Tata Mc-Graw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Chattopadhyay P., Engg Thermodynamics, Oxford University Press.	**2011**
2	Van G.J. Wylen and Sonntag R.E., Fundamental of Thermodynamics, J Wiley	**2003**
3	Cengel Y.A. and. Boles M.A, Thermodynamics-An Engg. Approach, TMH	**2011**
4	Jones J.B.&.Dugan R.E, Engineering Thermodynamics, PHI	**1996**
5	Rao Y.V.C., An Introduction to Thermodynamics, Wiley Eastern Ltd.	**1993**
6	Moran M.J and H.N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley and Sons	**1996**
7	Rogers, Gorden., Engineering Thermodynamics, Pearson Education	**1996**
8	Kroos & Potter, Thermodynamics for Engineers, Cengage learning	**2015**
9	Mishra, Engineering Thermodynamics, Cengage learning.	**2015**

Course outcome

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

CO1: Apply concepts of TD and Zeroth Law in solving numerical problems with relevant units.

CO2: Analyze and evaluate different forms work, heat and other properties by applying 1st Law of TD

CO3: Evaluate COP, EER, Efficiency, temperature and entropy by applying second law of TD and its corollaries.

CO4: : Illustrate problem solving procedure related to pure substances, ideal and real gases using PT, PV, TH diagrams

CO5: Correlate various thermodynamic variables in thermodynamic relations.

CO6: Evaluate vapour and gas power cycles, its components and summarize performance on the basis of different parameters

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1									1
CO2	3	3	2	2								2
CO3	3	3	2	2			2					2
CO4	3	3	1									
CO5	3	3	1									
CO6	3	3	2	3			2					2
Average	**3.0**	**3.0**	**1.5**	**2.3**			**2.0**					**1.8**

MEL110 INDUSTRIAL MANAGEMENT

B.Tech. (Mechanical) 3th semester **3L+0T**

CO1: **Learn** the basic concepts of industrial engineering.

CO2: G**ain understanding of procedure of work study, forms of business, financial aspect like time value of money, financial statement and depreciation.**

CO3: **Apply** the tool and techniques of work study, financial analysis for improvement of productivity.

Course outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
CO1	2	3	2	2	-	-	-	-	-	-	-	-
CO2	2	3	2	2	-	-	-	-	-	-	-	-
CO3	2	3	2	2	-	-	-	-	-	-	-	-

Unit	Contents	Contact Hours
I	Concept and definition of Industrial Engineering, Historical development of IE, Role of Industrial Engineer, Applications of IE. Concept of Productivity, Work Study and Productivity,	3
	Techniques of work study, basic procedure, approach to method study, method study charts and diagrams, principles of motion economy,	4
II	Work measurement; basic procedure, techniques: Stop watch time study, rating, determination of standard time	4
	Evolution of Management Theory, scientific management, Contributions of Taylor, Fayol, Mayo to scientific management, Levels of Management, Administration and Management, fundamental functions of management, Decision making.	4
III	Business Forms and Organization: Forms of Business: Single proprietorship, partnership, joint stock company, co-operative society, State undertakings, Joint Stock Companies: Organization: meaning, Types of organization; Line, Functional, Line Staff organization and line Staff Committee organization, span of control.	5
	Finance & Financial Statements: Introduction, Needs of Finance, Kinds of Capital, Sources of fixed capital, Shares. Borrow capital, surplus profits.	3
IV	Sources of working capital and its management, Profit & Loss Statement, Balance Sheet, Financial ratios: Liquidity ratio, Profits investment ratio, equity ratio, inventory ratio.	5
	Time value of money: Simple and compound interest, Time value equivalence, Compound interest factors, Cash flow diagrams, Calculation of time –value equivalences. Present worth comparisons, Comparisons of assets with equal, unequal life, comparison of deferred investments,	4
	Time value of money II: Future worth comparison, payback period comparison. Rate of return, internal rate of return, comparison of IRR with other methods	3
V	Depreciation: Causes, Basic methods of computing depreciation charges; Straight line, Sinking fund, Declining Balance and Sum of year's digits method.	3
	Breakeven analysis: Basic concepts, Linear Breakeven analysis for single product, Breakeven charts.	2
	TOTAL	**40**

TEXT BOOK		
1	Motion and Time Study and Measurement of Work, Ralph, M Barnes , John Wiley and Sons.	2001
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Introduction to Work Study, George Kanawaty, ILO.	2002
2	Prasad, L.M., Principles and practice of Management, Sultan Chand	2015
3	Sushil Kumar Basu, K. C. Sahu, N. K. Datta, Works Organisation & Management, Oxford & IBH.	2002
4	Dexter S. Kimball, Principles of Industrial Organization, Read Books.	2009
5	Leon Pratt Alford, Henry Russell Beatty, Principles of Industrial Management, Revised Edition, Ronald Press Co.	2001
6	Essentials of Industrial Management, McGraw-Hill Industrial organization and management series, Lawrence L. Bethel, McGraw-Hill.	2003
7	Riggs, J.L., Bedworth, D.J., Randhawa, S.U., Engineering Economics, Tata McGraw-Hill.	2006
8	Raju, Industrial Engg and Management, Cengage learning	2015

MEL120:MECHANICS OF SOLIDS

B.Tech. (Mechanical) 3rd semester
3L+0T

Unit	Details	Hours
I	Stress and Strain: Elementary definition of stress and strain, stress-strain relationship, elastic, plastic and visco-elastic behavior of common materials in tension and compression test, stress-strain curves, Hooke's law, Poisson's ratio, elastic constants and their relations for an isotropic Hookean material.	4
	Tension, compression, shearing stress and strain, thermal stresses, composite bars, equations of static equilibrium, concept of free body diagram. Strain energy due to axial loading.	5
II	Members Subjected to Flexural Loads: Theory of simple bending, bending moment and shear force diagrams for different types of static loading and support conditions on beams.	5
	Bending stresses, section modulus and transverse shear stress distribution in circular, hollow circular, I, Box, T, angle sections etc. Strain energy due to bending	4
III	Principal Planes, Stresses and Strains: Members subjected to combined axial, bending and torsional loads, maximum normal and shear stresses, concept of equivalent bending and equivalent twisting moments, Mohr's circle of stress and strain.	6
IV	Torsion: Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity. Strain energy due to torsional loads.	4
	Stability of Equilibrium: Instability and elastic stability, long and short columns, ideal strut, Euler's formula for crippling load for columns of different ends, concept of equivalent length, eccentric loading, Rankine formulae and other empirical relations.	4
V	Transverse Deflection of Beams: Relation between deflection, bending moment, shear force and load, transverse deflection of beams and shaft under static loading, area moment method, direct integration method.	5
	Thin-walled Pressure Vessels: Stresses in cylindrical and spherical vessels	3

TEXT BOOKS& OTHER REFERENCES BOOKS

Text Books	
1.	Surendra Singh, "Strength of Materials", M/s S K Kataria & Sons, 2013
2.	Rattan S.S., "Strength of Materails", Mc Graw Hill Education (India) Pvt Ltd., Third Edition, 2017
Suggested / Reference Books	
1.	Timoshenko, S.P., and Gere, J.M., "Mechanics of Materials", 2nd Ed., CBS Publishers
2.	Crandall, S.H., Dahl, N.C., and Lardner, T.J., "An Introduction to the Mechanics of Solids", Tata McGraw-Hill
3.	Pytel and Kiusalaas, "Mechanics of Materials" Cengage Learning
4.	Popov, E.P., Nagarajan, S., and Lu, Z. A., "Mechanics of Materials", 2nd Ed., Prentice-Hall of India

Websites References	
1.	https://nptel.ac.in/courses/112/102/112102284/ (NPTEL course on Solid Mechanics, IITD)
2.	https://ocw.mit.edu/courses/mechanical-engineering/2-001-mechanics-materials-i-fall-2006/download-course-materials/ (MIT open course ware on Mechanics & Materials)
3.	https://nptel.ac.in/courses/112/106/112106141/ (NPTEL course on Strength of Materials IIT Madras)

Course Outcomes:

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

CO1: Understand the fundamental concept of stress and strain, and the relationship between both in order to solve problems on principle of superposition, compound bars, and thermal stresses.
CO2: Apply the theory of simple bending to seek solution related to the pure and non-uniform bending of beams.
CO3: Analyze the members/structure subjected to combined loading and identify the principle planes/stress/strain.
CO4: Evaluate the torsional stress for various cases of shaft and determine buckling load for column of different end conditions.

CO5: Apply different methods to evaluate deflection of beam and carry out stress analysis of thin pressure vessels.

MEL111 : MATERIAL SCIENCE & MANUFACTURING PROCESSES

B.Tech. (Mechanical) 3rd semester

4L+0T

Unit	Contents	Contact Hours
	MATERIAL SCIENCE	
I	Crystal structure – BCC, FCC and HCP, unit cell, crystallographic planes and directions, miller indices. Crystal imperfections, point, line, surface and volume defects. Frank Reed source of dislocation, Elastic & plastic modes of deformation, Bauschinger's effect, slip & twinning, strain hardening, Cold/hot working: recovery, re-crystallization and grain growth.	**6**
II	Classification of Engineering Materials: Solidification of metals and of some typical alloys, mechanism of crystallization (I) nuclear formation (ii) crystal growth, general principles of phase transformation in alloys, phase rule and equilibrium diagrams, equilibrium diagram of binary system having complete mutual solubility in liquid state and limited solubility in solid state, binary isomorphous alloy system, Hume-Rothery rule , binary system with limited solid solubility of terminal phase and in which solubility decreases with temperature and also alloy with a peritectic transformation, equilibrium diagram of a system whose components are subject to allotropic change.	**6**
	Iron carbon equilibrium diagram, phase transformation in the iron carbon diagram, eutectic, peritectic, eutectoid and peritectoid reactions and microstructures.	**3**
III	Isothermal transformation diagrams – cooling curves superimposed on Isothermal Transformation diagram, critical cooling rate. (i) Formation of Austenite from Pearlite (ii) Transformation of Austenite into Pearlite. Full annealing, stress relief, spheroidizing – normalizing, hardening and tempering of steel. Hardenability, Jominey end quench test – Austempering, martempering. Case hardening, carburising, nitriding, cyaniding, carbo nitriding. Flame and Induction hardening. Classification of steels & cast iron, constitution and properties. BIS standards. Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels – HSLA steel.	**9**
	SUB-TOTAL	**24**

TEXT BOOK		
1	Material Science and Engineering An Introduction, William D.Callister, John Wiley and Sons.	**2003**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Material Science, Raghvan V., Prentice Hall India	**2012**
2	Principles of Material Science and Engineering, William F.Smith, Tata McGraw-Hill Publications.	**2008**
3	Engineering Physical Metallurgy, Lakhtin Y., Mir Publisher.	
4	Introduction to Engineering materials Tata McGraw-Hill Publications.	**2011**
6	Material Science and Engineering properties, Gilmore, Cengage Learning	**2015**

Unit	Contents	Contact hours
	Manufacturing processes	

I	General Classification and Introduction to Manufacturing processes. **Foundry Technology**: Casting materials, Patterns: types, material and pattern allowances. Moulding sands; composition, properties and testing; Grain fineness; moisture content, clay content and permeability test. Core & core prints; Gating system. Principles and method of floor mould casting, centrifugal casting, investment casting; Casting defects; types, causes & remedy	**7**
II	**Forming Processes**: Classification; Hot working and cold working; principle, advantages, disadvantages and applications.	
	Forging: Classification, drop forging and press forging methods and use;	
	Rolling: Process & applications of hot rolling and cold rolling;	
	Extrusion; Principles, operations and applications. Principle of Shearing; Parting, notching, trimming, nibbling, blanking and piercing,	**8**
	Drawing: Principles of drawing and deep drawing.	
III	**Metal Joining Processes**: classification of welding process, Principle, characteristics and applications of Welding, Brazing, soldering and gas welding, TIG and MIG welding; Resistance welding; Spot welding; Seam welding;	
	Welding defects; Types, causes, effects & remedy. Electrodes and Electrode Coatings	**6**
IV	**Powder Metallurgy**: Properties and manufacturing of Powder, mechanical compacting of powders & sintering, advantage & applications of Powder metallurgy.	**4**
	SUB-TOTAL	**25**
	TOTAL	**49**

TEXT BOOK		
1	Rao.P.N., Manufacturing Technology, Vol. 1,2 and 3, Tata McGraw Hill	**2013**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Ghosh, A., & Mallik, A. K. 1986. Manufacturing Science: Ellis Horwood.	
2	Schey, Introduction to Manufacturing Processes, Tata McGraw Hill	**1999**
3	Kalpakjian, S., Schmid, S.,Manufacturing processes for engg materials, Pearson Education.	**2000**
4	Campbell, J. S. Principles of manufacturing materials & processes: TMH	**2008**
5	Heine, R.., Loper, C.R., and Rosenthal, P.C., "Principles of Metal casting", TMH	**1999**
6	Groover, M.P., Fundamentals of Modern Manufacturing: Materials, , PHI	**1976**
7	Kalpakjian, S. & Schmid S.R, Manufacturing Engg & Tech, Addison Wesley	**2007**
8	Little, R.L., Welding and welding technology Tata McGraw-Hill Education	**2000**

Course Outcomes:

CO1: explain principles, materials and methods of foundry technology & Forming processes.

CO2: explain principles, materials and methods of metal joining.

CO3: differentiate powder metallurgy process, its application from other processes.

CO4: Explain and memorize concept of crystal structure, crystal defects and their effect on the properties of the different type of materials. Analysis of plastic deformation and related concepts.

CO5: Discuss analyze and draw the various types of Equilibrium diagrams. Evaluate the composition of various microstructures using Lever rule. Analysis of Iron carbon equilibrium diagram.

CO6: Illustrate the concept of heat treatment and explain the effect on properties of the material.Understanding the classification of steel. Compare and describe the properties of steel, and the effect of alloying elements onsteels.

CO-PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1								
CO2	3	2	2	1								
CO3	3	2	2	1								
CO4	3	2	1									1
CO5	3	3	2	2								
CO6	3	3	2	1								

MEP112: PRODUCTION PRACTICE-I

B.Tech. (Mechanical) 3rd Semester

0L+0T+3P

SN	***NAME OF EXPERIMENT***
	Machine Shop
1	*To study lathe machine construction and various parts including attachments, lathe tools cutting speed, feed and depth of cut.*
2	*To perform step turning, knurling and chamfering on lathe machine as per drawing.*
3	*To perform taper turning* *(a) by tailstock offset method as per drawing* *(b) Using compound rest.*
4	*To prepare the job by eccentric turning on lathe machine.*
5	*To study shaper machine, its mechanism and calculate quick return ratio. To prepare a job on shaper from given mild steel rod.*
	Foundry Shop
6	*To prepare mould of a given pattern requiring core and to cast it in aluminium.*
7	*To perform moisture test and clay content test.*
8	*Strength Test (compressive, Tensile, Shear Transverse etc. in green and dry conditions) and Hardness Test (Mould and Core).*
9	*To perform permeability test*
10	*A.F.S. Sieve analysis test.*
	Welding Shop
11	*Hands-on practice on spot welding.*
12	*Hands-on practice on submerged arc welding*
13	*Hands-on practice on metal inert gas welding (MIG) and tungsten inert gas welding (TIG).*

Course Outcomes:

CO1: To learn parametric aspects of machining, working principle and machining process.
CO2: Learn and practice the machining operation and tools used in machining.
CO3: Understand and perform sand mould testing methods.
CO4: Learn and perform the spot, submerged arc, MIG, TIG welding operations.
CO5: Learn to operate the machine used in mechanical engineering workshop.

CO-PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2			1						
CO2	3	3										
CO3	3	3				1						
CO4	3	3	2			2						
CO5	3	3	3			1						

MEP120:MECHANICAL ENGINEERING DRAWING AND CAD LAB

0L+0T+2P

SN	CONTENTS
	Assembly drawing with sectioning and bill of materials of the following: Lathe tail stock, shaper tool head, machine vice etc (1 drawing sheet of any assembly) Detailed part drawings from assembly drawing indicating fits, tolerances and surface finish symbols by referring BIS codes: Check-valve, Junction Valve, Journal bearing etc (1 drawing sheet for parts drawing of any assembly) Free hand sketches of simple mechanical systems. Computer Aided Drafting: Introduction to different features of the CAD Software (AutoCAD/ProE/ Creo/Solidworks etc). At least one drawing problem related to a. 2-D Drafting. b. 3-D Modeling. c. 3-D Advanced Modeling. d. Assembly modeling. e. Feature Modification and Manipulation f. Detailing. g. Surface Modeling

TEXT BOOK	
1	Laxminarayan and M.L. Mathur,Machine Drawing ,Jain Brothers
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Gill P S, Machine Drawing, Kataria & Sons
2	Basudeb Bhattacharya, Machine Drawing, Oxford University Press
3	Junnarkar N D, Machine Drawing, Pearson Education,
4	Goutam Pohit and Goutam Ghosh, Machine Drawing with AutoCAD, Pearson Education
5	Ostrowsky, O., Engineering Drawing with CAD Applications, ELBS
6	Siddeshswar N., P Kannaiah, VVS Shastry, Machine Drawing,TMH

Course outcome

At the end of the course, the student will be able to
CO1: Construct assembly drawing of mechanical systems with bill of materials.
CO2: Interpret assembly drawings and prepare part drawings indicating fits, tolerances, surface finish.
CO3: Produce freehand sketches of mechanical systems and its parts.
CO4: Develop 2-D and 3-D models on CAD software.

MEP111: MATERIAL SCIENCE LAB.

B.Tech. (Mechanical) 3rd Semester

0L+0T+2P

SN	NAME OF EXPERIMENT
1	(a) Study of various crystals structures through models BCC, FCC, HCP, tetrahedral and octahedral voids. (b) Material identification of, say, 50 common items kept in a box.
2	Specimen preparation for metallographic examination /micro structural examination-cutting, grinding, polishing, etching.
3	Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.)
4	Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after.
5	Study of Microstructure and hardness of steel at different rates of cooling. Microstructure examination of white cast iron.
6	To perform Tensile/Compressive/Shear/torsion test on a given material and to determine its various mechanical properties under tensile/compression/Shear/torsional loading
7	To determine Rockwell/ Vickers/Brinell hardness of a given material
8	To perform Impact test on a given material and to determine its resilience.
9	To study and perform Fatigue test on a given material and to determine fatigue strength of the material
10	To perform Bending test and to determine the Young's Modulus of Elasticity via deflection of beam.
11	Creep testing on creep testing machine.

REFERENCE BOOKS		
SN	Name of Authors /Books /Publisher	Year of Pub.
1	Vander Voort, Metallography: Principles and Practice, McGraw-Hill,	1984
2	Prabhudev K.H., Handbook of Heat Treatment of Steels, TMH	2000
3	Suryanarayanan, A.V.K. "Testing of Metalic materials" TMH	1993
4	Abbaschian, Physical metallurgy principles, Cengage Learning	

CO1: Understand the basic concepts of material science, to learn about different types of crystal system.
CO2: Analyse different mechanism of plastic deformation.
CO3: Analyse the effect of heat treatment on properties of steel.
CO4: In depth knowledge and comparison of properties of different materials.

COURSE OUTCOME	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3	3	-	-	-	-	-	-	-	-
C02	3	3	3	2	-	-	-	-	-	-	-	-
C03	3	3	2	2	-	-	-	-	-	-	-	-
C04	3	3	2	2	-	-	-	-	-	-	-	-

MEP211: INDUSTRIAL ENGINEERING LAB-I.

B.Tech. (ME) 3rd Semester
0L+0T+2P

SN	SESSIONAL WORK	CONTACT HOURS
1	Case study on X bar charts and process capability analysis	
2	PChart: (a)Verify the Binomial Distribution of the number of defective balls by treating the balls with a red colour to be defective. (b) Plot a P-chart by taking a sample of n=20 and establish control limits	
3	To plot C-chart using given experimental setup	
4	Operating Characteristics Curve: (a) Plot the operating characteristics curve for single sampling attribute plan for n = 20 ; c = 1 , 2 , 3 Designate the red ball to defective. (b) Compare the actual O.C. curve with theoretical O.C. curve using approximation for the nature of distribution	
5	Distribution Verification: (a) Verification of Normal Distribution. (b) To find the distribution of numbered cardboard chips by random drawing one at a time with replacement. Make 25 subgroups in size 5 and 10 find the type of distribution of sample average in each case. Comment on your observations	
6	Verification of Poisson distribution	
7	Central Limit Theorem: (a) To show that a sample means for a normal universe follow a normal distribution (b) To show that the sample means for a non normal universe also follow a normal Distribution.	
8	Solve problems using available Statistical Process Control software in lab	

CO1: Learn the statistical basics of control charts and sampling.
CO2: Construct the control charts, OC curves and evaluate the process performances.
CO3: Apply the SQC methods to problems using SPC software.

Course Outcomes	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	3	3	-	3	-	-	-	-	-	-	-	-
CO2.	3	2	-	3	-	-	-	-	-	-	-	-
CO3.	3	3	-	3	2	-	-	-	-	-	-	2

MEL210: METAL CUTTING AND METAL WORKING PROCESSES

B.Tech. (Mechanical) 4th semester

3L+0T

Unit	Contents	Contact Hours
I	Classification of metal removal process and machines: Geometry of single point cutting tool and tool angles, tool nomenclature in ASA, ORS. Concept of orthogonal and oblique cutting.	6
	Type of chips, Mechanics of metal cutting; interrelationships between cutting force, shear angle, strain and strain rate. Thermal aspects of machining and measurement of chip tool interface temperature.	6
II	Concept of machinability, machinability index, factors affecting machinability, Different mechanism of tool wear. Types of tool wear (crater, flank etc), Concept of tool life.	4
	Taylor's tool life equation. Introduction to economics of machining. Cutting fluids: Types, properties, selection and application methods	4
III	Nature of Plastic Deformation, Rolling, Forging, extrusion, wire Drawing, Rod and Tube Drawing	8
IV	Sheet Metal Working: Press Tool Operations, Shearing action, shearing operations, drawing, spinning, bending, stretch forming, Embossing and coining, blanking and piercing.	8
V	High Velocity Forming Methods: Definition; Hydraulic forming, Explosive forming, Electro-hydraulic forming, Magnetic pulse forming.	4
	Total	**40**

TEXT BOOK		
1	Rao.P.N., Manufacturing Technology, Vol. 1,2 and 3, Tata McGraw Hill	**2013**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Lal G.K., Introduction to Machining Science, New Age international Pub.	**2007**
2	Ghosh, A., &Mallik, A. K. 1986. Manufacturing Science: East West Press	**1999**
3	Schey, Introduction to Manufacturing Processes, Tata McGraw Hill	**2000**
4	Kalpakjian, S., &Schmid, S. R., Manufacturing processes for engineering materials, Pearson Education.	**2008**
5	Pandey & Singh, Production Engineering Science, Standard Publishers	**1999**
6	Stephenson, D. A., &Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis.	**2006**
7	Karl H.Heller, All About Machine Tools, Wiley Eastern Ltd., New Delhi	**1972**
8	Kalpakjian, S. &Schmid S.R, Manufacturing Engineering and Technology, Addison Wesley Pub. Co.	**2000**
9	Sen, G. C., & Bhattacharyya, A. Principles of Machine Tools: New Central Book Agency	**1988**
10	Bhattacharyya A, Theory & Practice of Metal Cutting, New Central Book	**2006**
11	Shan, H.S., Manufacturing Process, Pearson Education.	**2012**
12	Boothroyd, G., & Knight, W. A. Fundamentals of machining and machine tools: Taylor and Francis.	**2006**
13	Milton C. Shaw, Metal Cutting Principles, CBS Publishers.	**2005**

CO1: Acquires the fundamental knowledge and principles in material removal processes.
CO2: Demonstrate the fundamentals of machining, finishing, SPM processes and machine tools.
CO3: Evaluate the importance of input and output metal cutting parameters.
CO4: Learn about tool materials, cutting fluid and tool wear mode / mechanism.
CO5: Understand and analyse about high velocity forming methods.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	3	-	-	-	-	-	-	-	-
C02	3	3	3	2	-	-	-	-	-	-	-	-
C03	3	2	3	2	-	-	-	-	-	-	-	-
C04	3	3	3	3	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	-	-	-	-

MEL230 : I.C. ENGINES

B.Tech. (Mechanical) 4th Semester
3L+0T

Unit	Contents	Contact Hours
I	**History of IC engines**: Nomenclature, Classification & Comparison, SI & CI, 4stroke- 2 stroke, First Law analysis, Energy Balance. Fuel-air cycles, Actual cycles..	4
	Testing & Performance: Performance parameters, Measurement of operating parameters e.g. speed, fuel & air consumption, Powers, IHP, BHP, FHP, Efficiencies Thermal, Mechanical, Volumetric, Emission Measurement, Indian & International standards of Testing, Emission.	4
II	**Fuel & Combustion:** Combustion in CI & SI engines, Ignition Limits, Stages of combustion, Combustion parameters. Delay period and Ignition Lag, Turbulence and Swirl, Effects of engine variables on combustion parameters, abnormal combustion in CI & SI engines, Detonation & knocking, Theories of detonation, Control of abnormal combustion, Combustion chamber design principles, Types of combustion chamber.	4
	Fuel: Conventional Petroleum, structure, Refining Fuels for SI & CI engines, Knock rating, Additives, Fuels for Turbine & Jet Propulsion.	2
	Alternative Fuels: Methanol, Ethanol, Comparison with gasoline, Manufacturing, Engine performance with pure Methanol, Ethanol & blends, Alcohols with diesel engine, Vegetable oils, Bio gas.	2
III	**Engine Systems & Components:** Fuel System (SI Engine), Carburetion & Injection, process & parameters, properties of A/F mixture, Requirements of A/F ratios as per different operating conditions, Carburettors, types, Aircraft carburettor, comparison of carburetion & injection, F/A ratio calculations.	3
	CI engine: Mixture requirements & constraints, Method of injection, Injection systems, CRDI etc. system components, pumps injectors.	2
	Ignition system: Conventional & Modern ignition systems Magneto v/s Battery, CB point v/s Electronic ignition, Fuel Ignition Energy requirements. Spark advance, centrifugal, vacuum Firing order, spark plugs.	3
IV	**Engine Friction & Lubrication :** Determination of friction, Lubrication principles, Types of lubrication, Places of lubrication Bearings and piston rings etc., Functions of Lubrication, Properties, Rating and Classification of lubricating oil, Additives, Lubrication systems. Engine Cooling: Requirements of cooling, Areas of heat flow, High temperature regions of combustion chamber. Heat Balance, Cooling Systems, Air, Water Cooling, Cooling system components.	5
	Supercharging: Objectives, Thermodynamic cycle & performance of super charged SI & CI engines, Methods of super charging, Limitations, Two stroke engines: Comparison of 4s & 2s engines construction & valve lining scavenging. Process parameters, systems, supercharging of 2 stroke engines.	
V	**Dual & Multi fuel engines:** Principle, fuels, Combustion, performance Advantages, Modification in fuel system.	4
	Special Engines: Working principles of Rotary, Stratified charge, Free piston, Variable compression ratio engines.	4
		40

TEXT BOOK		
1	Mathur & Sharma, Internal Combustion Engines, Dhanpat Rai & Sons	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub. year**
1	Gupta H.N., Fundamentals of Internal Combustion Engines, PHI, India	
2	F.Edward Obert, Internal Combustion Engines, Harper and Raw Publisher.	
3	John B. Heyword, Internal Combustion Engines Fundamentals, McGraw Hill	
4	Lichty, Internal Combustion Engines, McGraw Hill.	
5	Gill, Smith, Ziurs, Fundamentals of Internal Combustion Engine, Oxford & IBH	
6	Rogowsky, IC Engines, International Book Co.	
7	Ganeshan, V., Internal Combustion Engine, Tata Mc Graw Hill.	
8	R. Yadav, I.C Engine, Central Publishing House, Allahabad	

CO1: Understand engineering involved in using engines, various testing and performance parameters.
CO2: Learn about characterstics and concept supercharging.
CO3: Examine various fuel supply systems and various ignition systems.
CO4: Apply principles of engine friction and different lubrication methods.
CO5: Analyse multi fuel engines, special engines.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
CO1	2	3	2	2	-	-	-	-	-	-	-	-
CO2	2	3	2	2		-	-	-	-	-	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-
CO4	2	2	2	2	-	-	-	-	-	-	-	-
CO5	2	3	3	3	-	-	-	-	-	-	-	-

MEL231: FLUID MECHANICS & MACHINES

B.Tech. (Mechanical) 4th Semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Fluid Properties**: Definition of a fluid, Viscosity-dynamic and kinematic, Surface Tension.	**3**
	Fluid Statics: Basic equation of fluid statics, Manometers, Force on plane areas and curved surfaces, center of pressure, Buoyant force, Stability of floating and submerged bodies.	**5**
II	**Fluid flow concepts and Basic control volume equations**: General control equation, conservation of mass, energy equation and its application, Momentum equation and its applications	**4**
	Basic governing differential equation: Reynolds transport equation, continuity equation, momentum equation, energy equation, Bernoulli's equation.	**4**
III	**Viscous flow:** Laminar flow through pipe and between parallel plate.	**4**
	Turbulent flow: Relation, Prandle mixing length, Losses in open and closed conduit	**4**
IV	Measurements:Pressure, velocity, flow measurement-orifices, venturimenter, orificemeter, nozzle meter, notches and weirs.	**3**
	Flow through pipe: Major and minor Losses in pipe, Hydraulic and energy gradient line, Network of pipes-series and parallel.	**5**
V	**Hydraulic Turbines:** Classification of hydraulic turbines, work done and efficiencies of Pelton, Francis and Kaplan turbines, Draft tube, Specific speed and unit quantities	**5**
	Hydraulic systems: Hydraulic press, Hydraulic accumulator, Hydraulic Intensifier, Hydraulic Ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque convertor Gear pump.	**3**
	TOTAL	**40**

TEXT BOOK		
1	Yunus A. Cengel and Cimbala, Fluid Mechanics, Tata McGrawHill,	**2006**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Streeter V.L., K.W. Bedford and E.B.Wylie , Fluid Mechanics , Tata McGraw Hill	**2010**
2	Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, John Wiley & Sons.	**2009**
3	Potter, Mechanics of Fluids, Cengage Learning.	**2012**
4	Frank M. White, Fluid Mechanics, Tata McGraw Hill.	**2003**
5	John F. Douglas, Fluid Mechanics, Pearson Education.	**2007**
6	Munson, B. R., Young, D. F., & Okiishi, T. H. Fundamentals of Fluid Mechanics, Wiley	
7	Som, S. K., & Biswas, G. Introduction to fluid mechanics and fluid machines, Tata McGraw Hill.	**2010**
8	K.Subramaanya, Hydraulic Machines, McGrawhill,	**2013**
9	Modi and Seth, Fluid Mechanics and Hydraulic Machinery, Standard Book House	**1991**

Course outcome

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

CO1: Identify and calculate the key fluid properties used in the analysis of fluid behavior. Describe and apply the principles of pressure, pressure measurement, fluid statics, buoyancy and floatation.

CO2: Apply and deduce the concept of basic governing differential equation of conservation of mass, energy and momentum alongwith their application

CO3: Describe and analyze viscous and turbulent flow.

CO4: Understand and apply the principle of Bernoulliβ€™s equation for fluid flow measurement and to identify the major and minor energy losses that is involved in a fluid flow and their accountability.

CO5: Study and analysis of hydraulic turbines, Hydraulic press, Hydraulic accumulator, Hydraulic Intensifier, Hydraulic Ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque convertor Gear pump.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	3	3	2								1
CO2	3	3	3	2								1
CO3	3	3	3	2								1
CO4	3	3	2	2			2					1
CO5	3	3	2	2			2					1
Average	**3.0**		**3.0**	**2.6**	**2.0**	**2.0**	**1.0**					

MEL220: DESIGN OF MACHINE ELEMENTS – I

B.Tech. (Mechanical) 4th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Materials**: Mechanical Properties and IS coding of various materials, Selection of material from properties and economic aspects.	**3**
	Manufacturing Considerations in Design: Standardization, Interchangeability, limits, fits tolerances and surface roughness, BIS codes, Design consideration for cast, forged and machined parts. Design for assembly.	**4**
II	**Design for Strength**: Modes of failure, Strength and Stiffness considerations, Allowable stresses, factor of safety, Stress concentration: causes and mitigation, fatigue failures.	**4**
	Design of Members subjected to direct stress: pin, cotter and keyed joints.	**5**
III	**Design of Members in Bending**: Beams, levers and laminated springs. **Design for stiffness of beam:** Use of maximum deflection formula for various end conditions for beam design with practical examples.	**7**
IV	**Design of Members in Torsion** **Shaft and Keys:** Design for strength, rigidity. Solid and hollow shafts. Shafts under combined loading. Sunk keys.	**5**
	Couplings*:* Design of muff coupling, flanged couplings: rigid and flexible	**3**
V	**Design of Threaded fasteners**: Bolt of uniform strength, Preloading of bolts: Effect of initial tension and applied loads, Eccentric loading	**4**
	Power screws like lead screw, screw jack	**3**
	Design of members which are curved like crane hook, body of C-clamp, machine frame etc.	**2**
	TOTAL	**40**

TEXT BOOK		
1	Bhandari, V. B., Introduction to Machine Design, McGraw Hill Education (India)	**2013**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Bahl and Goel, Mechanical Machine Design, Standard Publishers Distributors	**2002**
2	Shigley, Joseph E., Mechanical Engineering Design, McGraw Hill Education (India)	**2002**
3	Sharma and Aggarwal, Machine Design, S.K.Kataria and Sons, Delhi.	**1997**
4	Sharma and Purohit, Design of Machine Elements, Prentice Hall India.	**2002**
5	Jindal U C, Machine Design, Pearson Education India	**2010**

Course outcome
At the end of the course, the student will be able to
CO1: Describe various design criteria and explain material and failure theories.
CO2: Determine the sizes of the parts of cotter and knuckle joints considering various modes of failure.
CO3: Design the bending members like Lever and laminated spring based on strength and stiffness consideration.
CO4: Design the shaft and shaft - coupling under torsional loading.
CO5: Select the bolt size for different loading conditions and analyze the power screw & curved beams for computing the size.

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CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1								
CO2	2	3	3	1								
CO3	2	3	3	1								
CO4	2	3	3	1								
CO5	2	3	3	1								
Average	**2.2**	**2.8**	**2.8**	**1.0**								

MEP210 : PRODUCTION PRACTICE-II

B.Tech. (Mechanical) 4th semester

0L+0T +3P

Unit	Name Of Experiment
1	To study of single point cutting tool geometry and to grind the tool as per given tool geometry.
2	To study the milling machine, milling cutters, indexing heads and indexing methods and to prepare a gear on milling machine.
3	To machine a hexagonal /octagonal nut using indexing head on milling machine.
4	To cut BSW/Metric internal threads on lathe machine.
5	a) To cut multi-start Square/Metric threads on lathe machine.
	b) Boring using a boring bar in a centre lathe.
6	Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing.
7	Demonstration on milling machine for generation of plane surfaces and use of end milling cutters.
8	Grinding of milling cutters and drills.
9	Exercise on cylindrical and surface grinders to machine surfaces as per drawing.
10	Cylindrical grinding using grinding attachment in a centre lathe

CO1: To know the practical aspects of machining, working principle and machining process.
CO2: Learn and practice the machining operation and tools used in machining.
CO3: Understand the foundry techniques.
CO4: Learn and perform the gas, arc, spot, welding operations.
CO5: Learn to operate the machine used in manufacturing.
CO6: To know the basic concept of production technology

Course Outcomes	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	3	2	2	3	-	-	-	-	-	-	-	-
CO2.	3	3	-	3	-	-	-	-	-	-	-	-
CO3.	3	3	3	3	-	-	-	-	-	-	-	-

MEP220: MACHINE DESIGN SESSIONAL-I

B.Tech. (Mechanical) 4th Semester
0L+0T+2P

Sn	Sessional Work	Contact Hours
1	Material selection and relevant BIS nomenclature	
2	Selecting fit and assigning tolerances	
3	Examples of Production considerations	
4	Problems on:	
	(a) Knuckle & Cotter joints	
	(b) Torque: shafts and shaft couplings	
	(c) Design of screw fastening and power screw	
	(d) Bending: Beams, Levers and laminated springs.	
	(e) Combined stresses: Shafts, brackets, eccentric loading of bolts.	

Important Note: It is mandatory for every student to undertake a group activity. A group shall consist of maximum five students. The group is required to carry out a survey of applications of the machine components. Also it is required to prepare a report including various aspects like materials, load, manufacturing process etc and make presentation. Final evaluation shall include 20% weight age to mini project.

TEXT BOOK		
1	Bhandari, V. B., Introduction to Machine Design, McGraw Hill Education (India)	**2013**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Bahl and Goel, Mechanical Machine Design, Standard Publishers Distributors	**2002**
2	Shigley, Joseph E., Mechanical Engineering Design, McGraw Hill Education (India)	**2002**
3	Sharma and Aggarwal, Machine Design, S.K.Kataria and Sons, Delhi.	**1997**
4	Sharma and Purohit, Design of Machine Elements, Prentice Hall India.	**2002**
5	Jindal U C, Machine Design, Pearson Education India	**2010**

Course outcome

At the end of the course, the student will be able to
CO1: Select the material to be used for an application based on its properties and understand its BIS nomenclature
CO2: Make use of manufacturing considerations in designing a part and select a suitable fit for mating of two parts
CO3: Determine the sizes of the parts of cotter and knuckle joints considering various modes of failure.
CO4: Design the shaft under combined loading and shaft - coupling under torsional loading.
CO5: Design the bending members like Lever based on strength and stiffness consideration and bolted connections under different load condition.
CO6: Apply concepts of design to practical applications.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2								
CO2	2	2	3	2								
CO3	3	3	2	2								
CO4	3	3	2	2								
CO5	3	2	2	2								
CO6	2	3	3	3		2.0			3			2
Average	**2.8**	**2.6**	**2.2**	**2.0**		**2.0**			**3.0**			**2.0**

MEP 230 : THERMAL ENGINEERING LAB-I

B.Tech. (Mechanical) 4th semester

0L+0T +2P

Unit	Name Of Experiment
1	Study of working of four stroke petrol engine and four stroke diesel engine with the help of cut section models
2	Study of working of two stroke petrol and two stroke diesel engine with the help of cut section models.
3	To draw valve timing diagram for a single cylinder diesel engine.
4	Study of various types of boilers.
5	Study of various types of mountings and accessories.
6	Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.
7	Study of braking system with specific reference to types of braking system, master cylinder, brake shoes.
8	Study of transmission system including clutches, gear box assembly and differential.
9	Study of fuel supply system of a petrol engine (fuel pump and simple carburetor)
10	Study of fuel supply system of a Diesel engine (fuel pump and fuel injector)
11	Study of Ignition systems of an IC Engine (Battery and Magneto ignition system) and Electronic ignition system.
12	Study of Lubrication system of an IC Engine (mist, splash and pressure lubrication)
13	Study of cooling systems of an IC Engine (air cooling and water cooling)

MEP231 : FLUID MECHANICS LAB

B.Tech. (Mechanical) 4th Semester

0L+0T+2P

SN	NAME OF EXPERIMENT
1	Determination of Meta-centric height of a given body.
2	Determination of Cd, Cv & Cc for given orifice.
3	Calibration of contracted Rectangular Notch and / Triangular Notch and determination of flow rate.
4	Determination of velocity of water by Pitot tube.
5	Verification of Bernoulli's theorem.
6	Calibration and flow rate determination using Venturimeter & Orifice meter and Nozzle meter
7	Determination of head loss in given length of pipe.
8	Determination of the Reynold's number for laminar, turbulent and transient flow in pipe.
9	Determination of Coefficient for minor losses in pipes.
10	To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
11	To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness.

Course outcome

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

CO1: to plot various performance curves of the machine elements

CO2: to perform different balancing operations

CO3: to determine the various operating parameters of oscillating machines

CO4: to study the gear operated systems

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	P(
CO1	3	3	1	3								
CO2	3	3	1	2								
CO3	3	3	1	3								
CO4	3	1	1	2								
Average	**3.0**	**2.5**	**1.0**	**2.5**								

MEL330 : HEAT TRANSFER

B.Tech. (Mechanical) 5th Semester
3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** Heat transfer processes, conduction and radiation. Fourier's law of heat conduction, thermal conductivity, thermal conductivity of solids, liquids and gases, effect of temperature on thermal conductivity. Newton's law of cooling, definition of overall heat transfer coefficient. General parameters influence the value of heat transfer coefficient.	4
	Conduction: General 3-Dimensoinal conduction equation in Cartesian, cylindrical and spherical coordinates; different kinds of boundary conditions; nature of differential equations; one dimensional heat conduction with and without heat generation; electrical analogy; heat conduction through composite walls; critical thickness of insulation	3
II	**Heat transfer from extended surfaces:** Governing differential equation of fin, fin efficiency and effectiveness for different boundary conditions.	3
	Unsteady state heat conduction for slab, cylinder and sphere, Heisler chart.	2
	Convection: Review of Navier Stokes and energy equation, hydrodynamic and thermal boundary layers; laminar boundary layer equations; forced convection appropriate non dimensional members; effect of Prandtl number; empirical relations for flow over a flat plate and flow through pipes.	4
III	**Natural convection:** Dimensional analysis, Grashoff number, boundary layers in external flows (flow over a flat plate only), boundary layer equations and their solutions, heat transfer correlations.	4
	Heat transfer with change of phase: Nature of vaporization phenomena; different regimes of boiling heat transfer; correlations for saturated liquid vaporization; condensation on flat plates; correlation of experimental results, drop wise condensation.	4
IV	**Heat exchanger:** Types of heat exchangers, arithmetic and logarithmic mean temperature differences, heat transfer coefficient for parallel, counter and cross flow type heat exchanger; effectiveness of heat exchanger, N.T.U. method, fouling factor. Constructional and manufacturing aspects of Heat Exchangers.	8
V	**Thermal Radiation:** Plank distribution law, Krichoff's law; radiation properties, diffuse radiations; Lambert's law. Radiation intensity, heat exchange between two black bodies heat exchanger between gray bodies. Shape factor; electrical analogy; reradiating surfaces heat transfer in presence of reradiating surfaces.	8
		40

TEXT BOOK

1	J.P. Halman, Heat Transfer, Mc Graw Hill

REFERENCE BOOKS

	Name of Authors /Books /Publisher	Year of Pub.
1	Incropera and Dewitt, Fundamental of Heat and Mass transfer, John Wiley	**2007**
2	Cengel, Heat and Mass transfer, Mc Graw Hill	**2011**
3	M.Thirumaleshwar, Fundamental of Heat and Mass Transfer, Pearson Education	**2006**
4	Ozisik, Heat and Mass Transfer, Mc Graw Hill	**2009**
5	Rolle, Heat and Mass Transfer, Cengage learning	**2016**

CO1: Understand the modes of heat transfer.
CO2: Evaluate the performance factors to select the process and product of heat transfer.
CO3: Optimize the heat exchangers.
CO4: Demonstrate and examine the existing correlations.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	2	-	-	-	-	-	-	-	-
C02	3	3	3	3	-	-	-	-	-	-	-	-
C03	3	3	3	2	-	-	-	-	-	-	-	-
C04	2	3	3	2	-	-	-	-	-	-	-	-

MEL221: THEORY OF MACHINES		
B.Tech. (Mechanical) 5th semester		
3L+0T		
UNIT	**CONTENTS**	**CONTACT HOURS**
I	**Introduction to mechanism:** Basic concept of machines, links, kinematic pair, kinematic chain and mechanism. Inversions of kinematic chains: four bar chain mechanisms, quick return mechanisms, inversions of double slider crank mechanisms. Types of cam and followers.	**5**
	Velocity and acceleration in mechanism: Velocity and acceleration polygons, relative velocity and instantaneous centre method	**4**
II	**Friction devices:** Types and laws of friction. Pivots and collars.	**4**
	Clutches: Single and multi-plate clutches. **Brakes:** Band, block and band and block brakes.	**4**
III	**Gears:** Laws of gearing, gears terminology; tooth forms; length of path of contact, arc of contact, contact ratio, interference, undercutting and minimum number of teeth on pinion. Rack and pinion, Spur, helical, basic introduction of bevel, worm and worm gears,.	**8**
IV	**Gear Trains:** Simple, compound and epicyclic gear trains.	**3**
	Gyroscope: Principles of gyroscopic couple, effect of gyroscopic couple and centrifugal force on vehicles taking a turn, stabilization of ship.	**4**
V	**Balancing:** Balancing of rotating masses in same and different planes, balancing of reciprocating masses, single cylinder engine, multi-cylinder inline engines, V-engines.	**8**
	TOTAL	**40**

TEXT BOOK		
1	Rattan, S.S., "Theory of Machines", 2nd Ed., Tata McGraw Hill	2006
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Bevan, T., "Theory of Machines", Pearson Education.	2013
2	Uicker, J.J., Pennocle, G.R, and Shigley, J.E, "Theory of Machines and Mechanisms", 3rd Ed., Oxford University Press.	2009
3	Ambekar , A. G., "Mechanism And Machine Theory", Prentice-hall Of India	2007
4	Ghosh, A., "Theory of Mechanisms and Machines", Affiliated East West Press.	
5	Singh, S., "Theory of Machines", Pearson Education	2013
6	Stanisic., "Mechanisms and Machines-Kinematics, Dynamics & Synthesis", Cengageleasrning	2014

COURSE OUTCOME

Course Name	Course Outcome	Details
THEORY OF MACHINES	CO1	Learn the basic concept of machine and different mechanism & sketch velocity and acceleration diagrams.
	CO2	Apply the concept of friction in brakes and clutches.
	CO3	Identify appropriate gear and gear train for particular applications.
	CO4	Explain the gyroscopic effect.
	CO5	Solve problems of balancing of rotating and reciprocating masses.

CO-PO MAPPING

	Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
THEORY OF MACHINES	CO1	2	3	2	2								
	CO2	3	3	2	1								
	CO3	2	3	2	1								
	CO4	3	3	2	1								
	CO5	2	3	3	2								
	Average	2.4	3	2.2	1.4								

MEL212 : MECHATRONICS AND MEMS

B.Tech. (Mechanical) 5th semester

3L+0T

Unit	CONTENTS	Contact Hours
	Overview of Mechatronics: Historical perspective, Definition, Applications, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Systems Engineering, Verification Vs Validation, Benefits of mechatronics in manufacturing	2
	Electrical and Electronic Systems: Electrical circuits and Kirchhoff's laws, Network Theorems and AC circuit Analysis, Transformers, Analog Devices, Signal Conditioning, Digital Electronics, Data Acquisition systems.	3
II	**Modeling, Analysis and Control of Physical Systems:** Basics of System Modeling: LTI and LTV systems, Need for modeling, Types of modeling, Steps in modeling, Building blocks of models, Modelling of one and two degrees of freedom systems, Modeling of Electro-mechanical systems, Mechanical Systems, Fluid systems, Thermal systems; Dynamic Responses, System Transfer Functions, State Space Analysis and System Properties, Stability Analysis using Root Locus Method, Stability Analysis using Bode Plots, PID Controllers (with and without Time Delay)	3
III	**Sensors and Actuators**: Static characteristics of sensors and actuators, Position, Displacement and Proximity Sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors, Actuators: Electrical Actuators (Solenoids, Relays, Diodes, Thyristors, Triacs, BJT, FET, DC motor, Servo motor, BLDC motor, AC motor, Stepper motors), Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.	4
IV	**Microprocessors, Microcontrollers and Programmable Logic Controllers** Logic Concepts and Design, System Interfaces, Communication and Computer Networks, Fault Analysis in Mechatronic Systems, Synchronous and Asynchronous Sequential Systems, Architecture, Microcontrollers, Programmable Logic Controllers (PLCs): Architecture, Number Systems Basics of PLC Programming, Logics, Timers and Counters, Application on real time industrial automation systems.	5
V	**Micro-Electro Mechanical Systems (MEMS)** History, Effect of scaling, Fabrication techniques: Oxidation, Sputter disposition, CVD, Lithography, Etching, Wafer bonding, LIGA, DRIE, Applications: Lab on chip	5
	Case Studies: Design of pick and place robot, Car engine management system, Automated manufacturing system, Automatic camera, Automatic parking system, Safety devices and systems.	3
	TOTAL	**40**

TEXT BOOK		**Ed.**
1	W.Bolton,Mechatronics,Electroniccontrolsystemsinmechanicalandelectricalengineering,PearsonEducation,5/e,2011.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub Year .**
2	JamesJAllen,MicroElectroMechanicalSystemsDesign,CRCPress.	2013
3	DavidG.AlcaiatoreandMichelB.Histand,IntroductiontoMechatronicsandMeasuringSystems,Mc.GrawHillInt.Edition,3/e,	2006
4	CraigK.C.andStolfi,F.R.,IntroductiontoMechatronicSystemDesignwithApplications,IEEEEducationalActivitiesDepartment,.	1994
5	RobertH.Bishop.TheMechatronicsHandbook, CRCPress,2/e	2007

Course outcome

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

CO1: Discuss overview of mechatronics and MEMS with their applications.

CO2: Classify different sensors and actuators .

CO3: Construct control on mechatronics system.

CO4: Apply signal conditioning and discuss data acquisition system.

CO5: Develop various mechatronics system .

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO1	PSO2
CO1	3	3	2	2	1	1		1						
CO2	3	2	1	1										
CO3	3	2	2	2										
CO4	3	2	2	2										
CO5	3	3	3	3	2		1		1			1		
Average	**3.0**	**2.4**	**2.0**	**2.0**	**1.5**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**				

MEL320: DESIGN OF MACHINE ELEMENTS- II		
B.Tech. (Mechanical) 5th Semester		
3L+0T		
UNIT	**CONTENTS**	**CONTACT HOURS**
I	**Fatigue Considerations in Design:** Variable load, loading pattern, endurance stresses, Influence of size, surface finish, notch sensitivity and stress concentration.	**3**
	Goodman line, Soderberg line, Design of machine members subjected to combined, steady and alternating stresses.	**3**
	Design for finite life, Design of Shafts under Variable Stresses, Bolts subjected to variable stresses.	**2**
II	**Design of IC Engine components:** Piston, Cylinder, Connecting Rod and Crank Shaft.	**8**
III	Design of helical compression, tension, torsional springs, springs under variable stresses.	**8**
IV	**Design of gear teeth:** Lewis and Buckingham equations, wear and dynamic load considerations.	**4**
	Design and force analysis of spur, helical, bevel and worm gears, Bearing reactions due to gear tooth forces.	**4**
V	**Design of Sliding and Journal Bearing:** Methods of lubrication, hydrodynamic, hydrostatic, boundary etc. Minimum film thickness and thermal equilibrium.	**4**
	Selection of anti-friction bearings for different loads and load cycles, Mounting of the bearings, Method of lubrication.	**4**
	TOTAL	**40**

TEXT BOOK		
1	Design of Machine Elements, Bhandari V.B, 3rd Ed., Tata McGraw-Hill, New Delhi	2010
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Machine Design, Sharma and Aggarwal, Kataria and Sons, Delhi.	**1997**
2	Mechanical Engg Design, Shigley, Mischke, Budynas and Nisbett, Tata McGraw-Hill	**2002**
3	PSG Design Data Book, P.S.G. College of Technology, Coimbatore.	**1966**
4	A Text Book of Machine Design, Karwa A., Laxmi Publication.	**2002**
5	Machine Design, Hall, Holwenko and Laughlin, Schaum's Outlines Series, Tata McGraw Hill.	

Course outcome

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

CO1: Predict the failure of machine component under fatigue loading conditions and design the components for finite and infinite life.

CO2: Analyse and design IC Engine components.
CO3: Identify appropriate spring for particular applications and design it.
CO4: Assess and evaluate the forces on gear teeth of spur , helical worm gears and calculate gear size.
CO5: Evaluate the performance of journal bearings and manipulate the parameters according to operating conditions. Select the suitable rolling contact bearing for different load conditions.

CO-PO Mapping

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	3	1								
CO2	2	3	3	1								
CO3	2	3	3	1								
CO4	2	3	2	1								
CO5	2	3	3	1								
Average	**2.0**	**3.0**	**2.8**	**1.0**								

MEP330: HEAT TRANSFER LAB.

B.Tech. (Mechanical) 5th Semester

0L+0T+3P

SN	NAME OF EXPERIMENT
1	To Determine Thermal Conductivity of Insulating Powders.
2	To Determine Thermal Conductivity of a Good Conductor of Heat (Metal Rod).
3	To determine the transfer Rate and Temperature Distribution for a Pin Fin.
4	To Measure the Emissivity of the Test plate Surface.
5	To Determine Stefan Boltzmann Constant of Radiation Heat Transfer.
6	To Determine the Surface Heat Transfer Coefficient For Heated Vertical Cylinder in Natural Convection.
7	Determination of Heat Transfer Coefficient in Drop Wise and Film Wise condensation.
8	To Determine Critical Heat Flux in Saturated Pool Boiling.
9	To Study and Compare LMTD and Effectiveness in Parallel and Counter Flow Heat Exchangers.
10	To Find the Heat transfer Coefficient in Forced Convection in a tube.
11	To study the rates of heat transfer for different materials and geometries
12	To understand the importance and validity of engineering assumptions through the lumped heat capacity method.

CO1: Analyze basic principles of heat transfer for various heat transfer applications.
CO2: Evaluate and optimize the heat transfer systems.
CO3: Evaluate the performance of different heat exchangers.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3	3	-	-	-	-	-	-	-	-
C02	3	3	3	3	-	-	-	-	-	-	-	-
C03	3	3	3	3	-	-	-	-	-	-	-	-

MEP320: MACHINE DESIGN SESSIONAL –II

B.Tech. (Mechanical) 5th Semester
0L+0T+3P

SN	SESSIONAL WORK
	Problems on:
1. 1	Fatigue loading.
2. 2	I C Engine components.
3. 4	Helical compression, tension and torsional springs design.
4. 6	Gear Design.
5. 7	Sliding contact bearing design.
6. 8	Anti-friction bearing selection

Note: Use of Design data book is permitted in the examination.

Important Note: It is mandatory for every student to undertake a Mini project. Mini project shall be a group activity. A group shall consist of maximum five students. Final evaluation shall include 30% weight age to mini project.
Suggestive topics: Develop a computer code to implement the design procedure of a machine component, Design of a mechanical system (assembly of components) using various BIS codes/data book, CAD model of a mechanical system assembly etc.

Course outcome
At the end of the course, the student will be able to
CO1: Apply the design criterion of fatigue loading in designing machine components for both finite and infinite life.
CO2: Determine the size of different I C Engine under the given condition.
CO3: Design helical springs for different applications.
CO4: Determine the size of spur, helical and worm gears under the operating condition.
CO5: Evaluate the performance of journal bearings & manipulate the parameters according to operating conditions and select suitable anti-friction bearing for the given situation.
CO6: Apply concepts of design to practical applications.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								
CO2	3	3	3	3								
CO3	3	3	3	2								
CO4	3	3	3	2								
CO5	3	3	3	2								
CO6	3	3	3	2		2			3			2
Average	**3.0**	**3.0**	**3.0**	**2.4**		**2.0**			**3.0**			**2.0**

MEP221: THEORY OF MACHINES LAB

B.Tech. (Mechanical) 5th Semester
0L+0T+2P

SN	NAME OF EXPERIMENT
1	To verify the torque relation for gyroscope.
2	To plot force vs. radius and lift vs. speed curves for governors.
3	To plot pressure distribution curves on a journal bearing.
4	To perform wheel balancing.
5	To perform static and dynamic balancing on balancing set up.
6	To determine mass moment of inertia of a flywheel.
7	Study of a lathe gear box.
8	Study of a sliding mesh automobile gear box.
9	Study of a planetary gear box.
10	To determine co-efficient of friction using two roller oscillating arrangement.
11	Study of various cam-follower arrangements.To plot displacement v/s angle of rotation curve for various cams
12	Perform study of the following using Virtual Lab http://www.vlab.co.in/ a) Position, velocity and acceleration analysis of Grashof four bar mechanism b) Position, velocity and acceleration analysis of Slider Crank mechanism

Course outcome
At the end of the course, the student will be able to
CO1: Plot various performance curves of the machine elements
CO2: Perform different balancing operations
CO3: Determine the various operating parameters of oscillating machines
CO4: Study the gear operated systems

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3								
CO2	3	3	1	2								
CO3	3	3	1	3								
CO4	3	1	1	2								
Average	**3.0**	**2.5**	**1.0**	**2.5**								

MEP212: MECHATRONICS AND MEMS LAB.

B.Tech. (Mechanical) 5th Semester **Max. Marks: 50**

SN	NAME OF EXPERIMENT
1	**UsingTransducersKit :-** • CharacteristicsofLVDT • Principle&CharacteristicsofStrainGauge • CharacteristicsofSummingAmplifier • CharacteristicsofReflective OptoTransducer
2	**MobileRobot** • Programfor OperatingBuzzerBeep • ProgramforOperatingMotion control • Programfor OperatingDirectioncontrol • Programfor OperatingWhitelinefollowerfor thegiven arena
3	**PLC PROGRAMMING** • LadderprogrammingonLogicgates,Timers&counters • LadderProgramming fordigital &Analogysensors • Ladderprogramming forTrafficLightcontrol,Water level control andLift controlModules
4	**MATLABProgramming** • Sampleprogrammeson Matlab • Simulation and analysisofPIDcontrollerusingSIMULINK

CO1	Measure load, displacement and temperature using analogue and digital sensors.
CO2	Develop programs for control of traffic lights, water level ,lift sand conveyor belts.
CO3	Simulate and analyse PID controllers for a physical system using MATLAB.
CO4	Develop pneumatic and hydraulic circuits using available software

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	-	-	-	-	-	-	-	-
CO2	2	-	3	1	3	-	-	-	-	-	-	-
CO3	2	-	3	1	3	-	-	-	-	-	-	2
CO4	2	-	3	3	3	-	-	-	-	-	-	2

MEL315 : NON DESTRUCTIVE TESTING

B.Tech. (ME) 5th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction**: An Overview, Factors influencing the Reliability of NDE, Defects in materials, Defects in composites. NDT methods used for evaluation of materials and composites.	3
	Visual Inspection: Basic Principle and Applications.	2
	Liquid Penetrant Testing: Principle, Procedure and Test Parameters, Materials, Limitations and Applications.	3
II	**Radiographic Inspection:** Principles of X – ray radiography, equipment, Absorption, Scattering, X-ray film processing, General radiographic procedures, Reading and Interpretation of Radiographs, Industrial radiographic practice, Limitations and Applications, Welding defects detection. Gamma ray radiography.	8
III	**Ultrasonic Testing:** Principle of wave propagation, Ultrasonic equipment, Variables affecting an ultrasound test, Basic methods: Pulse Echo and Through Transmission, Types of scanning.	5
	Applications of UT: Testing of products, Welding Inspection, Tube Inspection, Thickness Measurement, Elastic Constant Determination, Ultrasonic testing of composites.	3
IV	**Magnetic Particle Inspection:** Methods of generating magnetic field, Demagnetization of materials, Magnetic particle test: Principle, Test Equipment and Procedure, Interpretation and evaluation.	5
	Introduction to Accostic Emission Testing and Thermography.	3
V	**Eddy Current Testing:** Principle of eddy current, Factors affecting eddy currents, Test system and test arrangement, Standardization and calibration, Application and effectiveness.	5
	Comparison and Selection of NDT Methods, Codes and Standards	3
	TOTAL	40

TEXT BOOK		
1	Baldev Raj, T. Jay Kumar, M. Thavasimuthu,Practical Non-Destructive Testing, Narosa.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Loius Cartz, Non Destructive Testing, ASM International	1995
2	J PRASAD, C G K NAIR, NDT & Evaluation Of Materials, TMH	2008
3	R. Halmshaw, Introduction to the Non-Destructive Testing of Welded Joints,	1997
4	American Metals Society, Non-Destructive Examination and Quality Control, Metals Hand Book, Vol.17, 9th Ed.	1989

MEL334 : AUTOMOBILE ENGINEERING

B.Tech. (Mechanical) 5th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Frame & Body:** Layout of chassis, types of chassis frames and bodies, their constructional features and materials.	3
	Clutches: single plate, multi-plate, cone clutch, semi centrifugal, electromagnetic, vacuum and hydraulic clutches. Fluid coupling. **Brakes:** Classification and function; Mechanical, hydraulic, vacuum air and self engineering brakes; Brake shoes and lining materials.	5
II	**Gear Boxes**: Sliding mesh, constant mesh, synchromesh and epicyclic gear boxes, Automatic transmission system; Hydraulic torque converter	4
	Drives: Overdrive, Propeller shaft, Universal joints, Differential; Rear axle drives. Hotchkiss and torque tube drives; Rear axle types; Front wheel and All wheel drive.	4
III	**Wheels and Tyres**:Tyre types, Tyre construction; Tyre inflation pressure, Tyre wear and their causes; Re-treading of the tyre,	2
	Steering system: steering gear boxes, Steering linkages, Steering mechanism, Under and Over steering. Steering Geometry, Effect of camber, caster, king pin inclination, toe in and toe out; Power steering; Integral and linkage types	3
	Suspension system: objective and requirements, Suspension spring, front and rear suspension systems, Independent suspension system Shock absorbers.	3
IV	**Automotive Electrical System:** Battery construction, Charging and testing, battery types, Starting and Battery Charging System: Starter motor construction, types of drive, Alternator construction, regulation and rectification.	4
	Ignition System: Magneto and coil ignition systems, System components and requirements, Automotive lighting: Wiring systems Electrical instruments; head lamp, electric horn, fuel level indicator.	4
V	**Automotive Air Conditioning:** Introduction, Loads, Air conditioning system Components, Refrigerants, Fault Diagnosis.	4
	Automotive Safety: Safety requirements, Safety Devices, Air bags, belts, radio ranging, NVS (Night Vision System) GPS (Global Positioning System)	4
	TOTAL	**40**

TEXT BOOK		
1	RP SHARMA,A Course in Automobile Engineering,Dhanpat Rai & Sons	
2	P S Gill,A Text book of Automobile Engineering,KATSON Books VOL 1&2	2010
3	Kirpal Singh,Automobile Engineering, Standard	2003
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	R K Rajpoot,A Text book of Automobile Engineering,Laxmi Publications	2007
2	Jornsen Reimpell, Helmut Stoll,The Automotive Chassis: Engineering Principles,Jurgen Betzler (P) Ltd,	2001

MEL331: REFRIGERATION AND AIR CONDITIONING

B.Tech. (Mechanical) 6th Semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** Refrigeration and second law of Thermodynamics, Refrigeration effect and unit of Refrigeration, Heat pump, reversed Carnot cycle. **Vapour Compression Refrigeration System:** Analysis of simple vapour compression Refrigeration cycle by p-h and T-S diagram. Effect of operating conditions	5
	Multiple Evaporator and compressor system: Application, air compressor system, Individual compressor, compound compression, cascade system. Application, air compressor systems, individual compressor, compound compression, cascade system.	3
II	**Gas Cycle Refrigeration:** Limitation of Carnot cycle with gas, reversed Brayton cycle, Brayton cycle with regenerative heat exchanger.	4
	Air cycle for air craft: Necessity of cooling of air craft, Basic cycle, boot strap, regenerative type air craft refrigeration cycle.	4
III	**Other refrigeration systems** (description only): Vapour absorption refrigeration system, Electrolux refrigerator, Lithium Bromide - Water system, Water vapour refrigeration system, Vortex tube refrigeration system, thermo electric refrigeration system.	4
	Refrigerants: Classification, Nomenclature, selection of Refrigerants, global warming potential of CFC Refrigerants. Refrigeration Equipments: Compressor, condenser, evaporator, expansion devices, types & working.	4
IV	**Psychrometry:** Psychrometric properties, psychometric relations, pyschrormetric charts, psychrometric processes, cooling coils, By-pass factor, Apparatus Dew point temperature and air washers.	5
	Human Comfort: Mechanism of body heat losses, factors affecting human comfort, effective temperature, comfort chart.	3
V	**Cooling load calculations:** Internal heat gain, system heat gain, RSHF, ERSHF, GSHF, cooling load estimation, heating load estimation, psychrometric calculation for cooling.	5
	Selection of air conditioning: Apparatus for cooling and dehumidification, Air conditioning system, year round air conditioning.	3
	TOTAL	**40**

TEXT BOOK		
1	Arora, C.P., Refrigeration and Air Conditioning, Tata McGraw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Stoecker W.F., "Refrigeration & Air Conditioning" McGraw Hill Publication.	**2000**
2	Andrew D. Althouse., "Modern Refrigeration & Air Conditioning" GoodHeart-Willcox Co.	**2002**
3	Jorden & Priester, Refrigeration & Air Conditioning, Prentice Hall of India.	**2003**
4	Roy J. Dossat, Principal of Refrigeration, Pearson Education, New Delhi.	**2014**
5	Edward G. Pita, Air Conditioning Principles and Systems, Pearson Education, New Delhi.	**2003**
6	Jain V.K., Refrigeration & Air Conditioning, Tata McGraw Hill New Delhi.	2004

CO1: Understand the concepts of refrigeration and air conditioning.
CO2: Evaluate & select the refrigerants for any process and product.
CO3: Determine the comfort cooling and heating conditions.
CO4: Analyse and compute the air conditioning system

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	2	-	-	-	-	-	-	-	-
C02	3	2	3	2	-	-	-	-	-	-	-	-
C03	3	3	3	2	-	-	-	-	-	-	-	-
C04	3	3	3	2	-	-	-	-	-	-	-	-

MEL222: VIBRATION ENGINEERING

B.Tech. (Mechanical) 6th semester

3L+1T

Unit	CONTENTS	Contact Hours
I	**Introduction to Sound:** Frequency dependent human response to sound, Sound pressure dependent human response, Relationship among sound power, sound intensity and sound pressure level.	2
	Introduction to Noise: Auditory and Non auditory effects of Noise, Major sources of the noise, Industrial noise sources, Industrial noise control strategies.	3
	Introduction to Vibration: Importance and scope of vibrations, terminology and classification, Concept of Degrees of freedom, Harmonic motion, vectorial representation, complex number representation, addition.	3
II	**Undamped Single Degree of Freedom System:** Derivation of equation of motion for one dimensional longitudinal, transverse and torsional vibrations without damping using Newton's second law, D' Alembert's principle and Principle of conservation of energy, Compound pendulum and centre of percussion.	3
	Damped vibrations of single degree of freedom systems: Viscous damping, under-damped, critically damped and over-damped systems, Logarithmic decrement.	3
	Vibration characteristics of Coulomb damped system and Vibration characteristics of Hysteretic damped systems.	2
III	**Forced Vibrations of Single Degree of Freedom Systems:** Forced vibration with constant harmonic excitation, Steady state and transient parts, Frequency response curves and phase angle plot, Forced vibration due to excitation of support.	4
	Vibration Isolation and Transmissibility: Force transmissibility, Motion transmissibility, Forced vibration with rotating and reciprocating unbalance, Materials used in vibration isolation.	4
IV	**System with Two Degrees of Freedom:** principle mode of vibration, Mode shapes, Undamped forced vibrations of two degrees of freedom system with harmonic excitation, Vibration Absorber, Undamped dynamic vibration absorber and centrifugal pendulum absorber	5
	Critical Speed of Shaft: Critical speed of a light shaft without damping, critical speed of shaft having multiple discs, secondary critical speed.	3
V	**Many Degrees of Freedom Systems (Exact analysis)**: Equation of Motion, The matrix method, Eigen Values and Eigen Vectors, Method of influence Coefficients and Maxwell's reciprocal theorem. Torsional vibrations of multi rotor system, vibrations of geared system, Generalized coordinates and coordinate coupling **Many Degrees of Freedom Systems (approximate methods**): Rayleigh's, Dunkerley's, Stodola's and Holzer's methods	5
	Vibrations of continuous systems: Transverse vibration of a string, Longitudinal vibration of a bar, Torsional vibration of a shaft.	3
	TOTAL	**40**

TEXT BOOK

1	Rao S.S., "Mechanical Vibrations", Pearson Education, 2nd Indian reprint.	2004

REFERENCE BOOKS

SN	Name of Authors /Books /Publisher	Publ
1	Ambekar A.G., "Mechanical Vibrations and Noise Engineering", PHl	2006
2	Kelly, S.G., "Mechanical Vibrations, Theory and Applications, CengageLrg	2013
3	Thomson, W.T., and Dahleh, M.D., Padmanabhan, C., "Theory of Vibrations with Applications", Pearson Education.	2014
4	Meirovitch, L., "Elements of Vibration Analysis", Tata McGraw-Hill	2006

5	Tongue, B.H., "Principles of Vibration", Oxford Publication	2007

Course outcome

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

CO1: Get familiarized with terminology and classification of vibration; and basic concepts of sound and noise thus will be able to identify major noise sources and develop their control strategies.

CO2: Derive the equation of motion for one dimensional longitudinal, transverse and torsional vibration with and without damping and will be able to differentiate between various sources of damping and their characteristics.

CO3: Model the forced vibrations of single degree of freedom system and get grasp over the vibration isolation and transmissibility in various practical situations.

CO4: Learn higher concepts of vibrations related to two degree of freedom system including Mode shapes, vibration absorbers and critical speed of shafts.

CO5: Analyze the many degrees of freedom system using exact and approximate methods; and also derive and solve the governing equation of vibrations of various continuous systems such as string, bar and shafts.

CO-PO Mapping

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1			1						
CO2	3	2	1									
CO3	3	3	2									
CO4	3	3	2	1								
CO5	3	3	3	1	1							
Average	**3.0**	**2.6**	**1.8**	**1.0**	**1.0**	**1.0**						

MEL211: QUALITY MANAGEMENT

Credit: 3	**Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P	**End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**Introduction to Quality Management**: Quality – Concept, Different Definitions and Dimensions, Inspection, Quality Control, Quality Assurance and Quality Management, Quality as Wining Strategy, Views of different Quality Gurus, Quality Cost.	06
3	**Process Quality Improvement:** Introduction to process quality, Graphical and statistical techniques for process Quality Improvement, Graphical tools for data representation, 7QC tools, Sampling, sampling distribution, and hypothesis Testing, Regression, control charts, process capability analysis, Measurement system analysis, Analysis of Variance(ANOVA), Design and analysis of experiment (DOE), Acceptance sampling pan, TQM	9
4	**Leadership,** Lean and JIT Q Quality Philosophy, Benchmarking, Process failure mode and effect analysis (PFMEA), Service Quality, Six sigma for process Improvement, ISO 9001, ISO 14000 and QS 9000, Quality audit, Quality Circles.	9
5	**Product Quality Improvement:** Quality Function Deployment, Robust Design and Taguchi Method	08
6	**Design Failure** Mode and Effect Analysis, Product Reliability Analysis, Six sigma in product development	07
	Total	40

TEXT BOOK		
1	Introduction to Statistical Quality Control, Douglas C. Montgomery, 2nd Edition, Wiley.	1991
2	Fundamentals of Quality Control and Improvement, Amitava Mitra, 2nd Edition, Prentice Hall	1998
3	Quality Planning and Analysis, J.M.Juran and F.M. Gryna, McGraw Hill	
4	Quality Control, Dale H. Besterfield, 8th Edition, Pearson/Prentice Hall	2008

5	Statistical Quality Control, E. L. Grant and Richard S. Leavenworth, Tata McGraw-Hill	2000
6	Design and Analysis of Experiments, 5th Edition, Douglas C. Montgomery, Wiley-India	2007

MEL332: TURBOMACHINES

B.Tech. (Mechanical) 6th Semester

3L+0T

UNIT	CONTENTS	Contact Hours
I	**Basic Concepts of Turbo Machines:** Definition & classification of Turbo machine, Basic laws and governing equations: continuity equation, steady flow energy equation(1st law of thermodynamics),2nd law of thermodynamics applied to turbo machines, Newton's 2nd law of motion applied to turbomachines - Euler's pump equation and Euler's turbine equation	4
	Dimensional analysis applied to hydraulic machines, power coefficient, flow coefficient, head coefficient, non dimensional specific speed, Range of specific speeds for various turbo machines, Dimensional analysis applied to compressible flow machines, pressure ratio as a Function of temperature ratio, mass flow rate parameter and speed parameter	4
II	**Centrifugal Compressors and Fans:** Components and description, velocity iagrams, slip factor, energy transfer, power input factor, stage pressure rise and loading coefficient, pressure coefficient, degree of reaction, Centrifugal compressor characteristic, surging, rotating Stall and Choking	3
III	**Axial Flow Compressors and Fans:** Basic constructional features, Advantages of axial flow compressors, working principle, velocity triangle, elementary theory, stage work, work done factor, stage loading, degree of reaction; vortex theory, simple design calculations, introduction to blade design, cascade test, compressibility effects, operating characteristics	3
	Reciprocating Compressors: Basic constructional features, working principle, work done calculation, single and double acting compressors	2
IV	**Centrifugal Pumps:** Main parts, work done and velocity triangles, slip and slip factor, pump losses and efficiencies, minimum starting speed, net positive suction head, performance curve.	3
V	**Axial Flow Pumps:** Description, velocity triangles, work done on the fluid, energy transfer, axial pump characteristics, cavitation.	3
	Reciprocating Pumps: Classification, component and working, single acting and double acting, discharge, work done and power required, coefficient of discharge, indicator diagram, slip, effect of friction and acceleration, theory of air vessels.	2
	TOTAL	40

TEXT BOOK		
1	Gas turbines, V. Ganesan, Tata McGraw-Hill	2011
2	Subramanya, K., Hydraulic Machine, Tata McGraw Hill	2013
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	Pub. Year
1	Principle of Turbo Machinery, Turton R.K., Springer Publication	1994
2	Fundamentals of Turbo Machinery, William W., John Wiley and Sons.	2008
3	Turbo Machinery Basic Theory and Application, Logan E.J.	1981
4	Principles of Turbo Machinery, Shepherd Dennis G., Mac Millan Pub, N.York.	1956
5	TurboMachines, A Valan Arasu, Vikas Publishing House Pvt. Ltd.	2009
7	Gas turbine theory, Cohen and Saravanamutto, Pearson Educational Pub.	2009
8	Hydraulic Machine: Turbines and Pumps, Nazarov N.T., Springer New York.	2003
9	Gas Turbine Theory, Cohen and Roger, Pearson Education.	
10	Hydraulic Machinery, Jagdish Lal, Metropolitan Books.	

CO 1	Learn the basic laws and governing equation of hydraulic machines.
CO 2	Analyse the flow phenomenon and characteristics of components.
CO 3	Demonstrate and examine the operating aspects of different hydraulic machines.
CO 4	Apply and evaluate the performance parameters of various components of machine.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3									
C02	3	2	2	-	-	-	-	-	-	-	-	-
C03	3	3	3	-	-	-	-	-	-	-	-	-
C04	3	3	2	-	-	-	-	-	-	-	-	-

MEP311: PRODUCTION ENGINEERING LAB.

B.Tech. (Mechanical) 6th Semester

0L+0T+2P

SN	NAME OF EXPERIMENT	CONTACT HOURS
1	Study of various measuring tools like dial gauge, micrometer, vernier caliper and telescopic gauges.	
2	Measurement of angle and width of a V-groove by using bevel protector..	
3	(a) To measure a gap by using slip gauges (b) To compare & access the method of small-bore measurement with the aid of spheres.	
4	Measurement of angle by using sine bar.	
5	(a) Measurement of gear tooth thickness by using gear tooth vernier caliper. (b) To check accuracy of gear profile with the help of profile projector.	
6	To determine the effective diameter of external thread by using three-wire method.	
7	To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat.	
8	To check the accuracy of a ground, machined and lapped surface - (a) Flat surface (b) Cylindrical surface.	
9	Find out Chip reduction co-efficient (reciprocal of chip thickness ratio) during single point turning.	
10	Forces measurements during orthogonal turning.	
11	Torque and Thrust measurement during drilling.	
12	Forces measurement during plain milling operation.	
13	Measurement of Chip tool Interface temperature during turning using thermocouple technique.	

CO1: To understand the science of measurement using measuring instrument.
CO2: To learn the modern measuring tools used in industry / shop floor.
CO3: Practice and apply measuring tool to measure angles, gap, forces, thrust and torque.
CO4: Understand and analyse about surface finishing of product.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	-
CO2	3	3	2	2	3	-	-	-	-	-	-	-
CO3	3	3	3	2	1	-	-	-	-	-	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-

MEP331: THERMAL ENGINEERING LAB-II

B.Tech. (Mechanical) 6th Semester

0L+0T+3P

SN	LABORATORY WORK/NAME OF EXPERIMENT
1	To perform constant speed load test on a single cylinder diesel engine and to plot performance curves: indicated thermal efficiency, brake thermal efficiency, mechanical efficiency Vs. Brake power, and heat balance sheet.
2	To estimate the Indicated Power, Friction Power and Mechanical Efficiency of a multi-cylinder Petrol Engine. (Morse Test)
3	Analysis of engine exhaust gases using Orsat apparatus / gas analyzer.
4	To study refrigeration cycle, determination of coefficient of performance of cycle and tonnage capacity of refrigeration unit.
5	To determine the COP and tonnage capacity of a Mechanical heat pump.
6	To study various controls used in Refrigeration and Air conditioning system.
7	Determination of dryness fraction of steam.
8	Study and Performance of Simple Steam Turbine
9	Performance characteristics of Pelton wheel turbine.
10	Performance characteristics of Francis turbine.
11	Performance characteristics of Kaplan turbine.
12	Performance characteristics of variable speed centrifugal pump.
13	Performance characteristics of rated speed centrifugal pump.

CO 1	To perform and evaluate the efficiencies of thermal systems
CO 2	To estimate the various performance parameters of system
CO 3	To study the performance of different rotating and reciprocating systems
CO 4	To determine the operating characteristics of thermal systems.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	2	3	-	2	-	-	-	-	-	-	-	-
C02	2	3	-	2	-	-	-	-	-	-	-	-
C03	3	1	-	-	-	-	-	-	-	-	-	-
C04	3	2	-	2	-	-	-	-	-	-	-	-

MEP222: VIBRATIONS AND MAINTENANCE ENGINEERING LAB

B.Tech. (Mechanical) 6th Semester

0L+0T+2P

SN	NAME OF EXPERIMENT
1	To verify relation $T = 2\pi\sqrt{(l/g)}$ for a simple pendulum.
2	To determine radius of gyration of compound pendulum.
3	To determine the radius of gyration of given bar by using bifilar suspension.
4	To determine natural frequency of a spring mass system.
5	Equivalent spring mass system.
6	To determine natural frequency of free torsional vibrations of single rotor system. i. Horizontal rotor ii. Vertical rotor
7	To verify the Dunkerley's rule.
8	Performing the experiment to find out damping co-efficient in case of free damped torsional vibration
9	To conduct experiment of trifler suspension.
10	Harmonic excitation of cantilever beam using electro-dynamic shaker and determination of resonant frequencies.
11	Study of Vibration measuring instruments.
12	Perform study of the following using Virtual Lab http://www.vlab.co.in/
13	Forced Vibration of a Cantilever Beam with a Lumped Mass at Free End: To calculate the natural freq and damping ratio for forced vibration of a single DOF cantilever beam system, experimentally; and compare the results with theoretical values.
14	Harmonically Excited Forced Vibration of a Single DOF System: To analyze the forced vibration response of a single DOF system at diff damping ratio and frequency ratio.
15	Perform study of the following using Virtual Lab http://www.vlab.co.in/
16	Forced Vibration of a Cantilever Beam with a Lumped Mass at Free End: To calculate the natural freq and damping ratio for forced vibration of a single DOF cantilever beam system, experimentally; and compare the results with theoretical values.
17	Harmonically Excited Forced Vibration of a Single DOF System: To analyze the forced vibration response of a single DOF system at diff damping ratio and frequency ratio.

Course outcome
At the end of the course, the student will be able to
CO1: Model different vibratory systems for undamped free vibration studies
CO2: Identify the importance of vibration in mechanical design of machine parts that operates in damped vibratory conditions.
CO3: Analyze multi degree of freedom system using Dunkerley's rule
CO4: Identify resonant frequencies of cantilever beam harmonically excited using electro-dynamic shaker
CO5: Examine different parameters using Vibration Measuring Instruments for different applications

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2					1			
CO2	3	3	2	2					1			
CO3	3	3	2	2					1			
CO4	3	3	2	2		2			2			
CO5	3	3	2	2					2			2
Average	**3.0**	**3.0**	**2.0**	**2.0**		**2.0**			**1.4**			**2.0**

MEP211: QUALITY MANAGEMENT LAB

B.Tech. (ME) 6th Semester
0L+0T+2P

SN	NAME OF EXPERIMENT
1	Case study on X bar charts and process capability analysis
2	PChart: (a)Verify the Binomial Distribution of the number of defective balls by treating the balls with a red colour to be defective. (b) Plot a P-chart by taking a sample of n=20 and establish control limits
3	To plot C-chart using given experimental setup
4	Operating Characteristics Curve: (a) Plot the operating characteristics curve for single sampling attribute plan for n = 20 ; c = 1 , 2 , 3 Designate the red ball to defective. (b) Compare the actual O.C. curve with theoretical O.C. curve using approximation for the nature of distribution
5	Distribution Verification: (a) Verification of Normal Distribution. (b) To find the distribution of numbered cardboard chips by random drawing one at a time with replacement. Make 25 subgroups in size 5 and 10 find the type of distribution of sample average in each case. Comment on your observations
6	Verification of Poisson distribution
7	Central Limit Theorem: (a) To show that a sample means for a normal universe follow a normal distribution. (b) To show that the sample means for a non normal universe also follow a normal Distribution.

MEL312: SUPPLY AND OPERATIONS MANAGEMENT

B.Tech. (Mechanical) 6th semester **Max. Marks: 150**

4L+0T **Exam Hours: 3**

Unit	Contents	Contact Hours
I	Introduction to operations management (OM), the scope of OM; Historical evolution of OM; Trends in business; the management process. Operations Strategy, Competitiveness and Productivity	3
	Demand Forecasting: components of forecasting demand, Approaches to forecasting: forecasts based on judgment and opinion, Time series data. Associative forecasting techniques, Accuracy and control of forecasts, Selection of forecasting technique.	4
II	Product and Service design, Process selection, Process types, Product and process matrix, Process analysis.	3
	Capacity Planning: Defining and measuring capacity, determinants of effective capacity, capacity strategy, steps in capacity planning process, determining capacity requirements, Capacity alternatives, Evaluation of alternatives; Cost Volume analysis.	2
III	Facility Location: Need for location decisions, factors affecting location, qualitative and quantitative techniques of location. Facilities layout: Product, Process, Fixed position, combination and cellular layouts; line balancing. Material Handling	4
	Planning levels: long range, Intermediate range and Short range planning, Aggregate planning: Objective, Strategies, and techniques of aggregate planning. Master scheduling; Bill of materials, MRP; inputs processing and outputs, and overview of MRPII , use of MRP to assist in planning capacity requirements, Introduction to ERP	4
IV	Techniques of production control in job shop production, batch production and mass production systems. sequencing: priority rules, sequencing jobs through two work centers, scheduling services	4
	Introduction to Just-in-time (JIT) and Lean Operations: JIT production, JIT scheduling, synchronous production, Lean operations system	4
V	Supply Chain Management (SCM): Need of SCM, Bullwhip effect, Elements of SCM, Logistics steps in creating effective supply chain, Purchasing and supplied management.	3
	Project Management: Nature of projects, project life cycle, Work breakdown structure, PERT and CPM, Time-Cost trade-offs: Crashing. Resource allocation, leveling	5
	TOTAL	40

TEXT BOOK		
1	Stevenson, Operations Management, Tata McGraw Hill.	2009
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Roberta S. Russell, Bernard W. Taylor, Operations Management, John Wiley	2010
2	Joseph S. Martinich, Production And Operations Management, John Wiley	2008
3	S.N. Chary, Production and Operations Management, Tata McGraw Hill	2009
4	Norman Gaither, Greg Frazier, Operations Management, Thomson Learning	2002

CO1: **Describe** the basic concepts of operations management and production systems
CO2: **Analyse** and **solve** the problems of production planning, scheduling & control.
CO3: **Understand** the concepts of MRP, JIT and SCM.
CO4: **Solve** the problems using project management & reliability.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	1	1	2									
C02	1	3	3	3								
C03	1	3	3	3	2	-	-	-	-	-	-	-
C04	1	1	2	3	1	-	-	-	-	-	-	-

MEL313: CNC MACHINES AND PROGRAMMING

B.Tech. (P&IE) 6th semester
4L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Introduction: Definition of NC, Applications of NC, Historical Developments in Automation, Classification of NC Systems, Comparison of NC and Conventional Machines, Advantages of NC	**8**
II	NC Hardware: Architecture of NC Systems, Design Considerations, Mechanical Elements, Structure, Guideways and Slides, Guideway Elements, Transmission Systems, Spindle Unit, Coolant system, Lubrication System, Tool and work Changing Mechanisms, Electrical Elements, Drives, Sensors, Control Loops, Computing Elements/ Firmware, Interpolators	**8**
III	NC Software: Introduction, Manual Part Programming, Computer-Assisted Part Programming, Language Based , Geometric Modeling Based, Automatic Part Program Generation,	**4**
IV	CAPP Systems, 5 Axis Programming, Post-Processing, Programming Robots and CMMs	**4**
	NC Simulation, Kinematic simulation, Volumetric simulation, Applications of Volumetric NC Simulation, Verification	**4**
V	Advanced Topics:, Adaptive Control, Off-line adaptive control, Various optimization criteria, Hardware Based AC, Software Based AC, Tooling and Instruments for NC Special, Rapid Product Development, CAM, FMS, CIM	**4**
	TOTAL	**32**

TEXT BOOK		
1	Krar S. and Gill A., CNC: Technology and Programming, McGraw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	
1	Koren Y., Computer Control of Manufacturing Systems, Tata McGraw Hill.	
2	Michael Fitzpatrick, Machining and CNC Technology, McGraw Hill Education	
3	Jones B.L.,Introduction to Computer Numerical Control, John Wiley & Sons.	
4	Kral I.H., , Numerical Control Programming in APT, Prentice-Hall	
5	Chang C.H. and Melkanoff M.A., ,NC Machine Programming and Software Design, Prentice-Hall	

Course outcome

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

CO1: Implementation and Examine applications and advantages of CNC machines and technology.

CO2: Recognize about the CNC machine tool Structure.

CO3: Knowledge of basic programming codes and calculation of CNC Machining Parameters.

CO4: Preparation of CNC program for CNC Lathe & Milling

CO5: Demonstrate and verify NC softwareβ€™s, Sensors, NC modeling & Simulation and

Robotics.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO1	PSO2
CO1	3	1												
CO2	3	1		2						2				
CO3	3	3	2	3						2				
CO4	3	3	3	3						2				
CO5	3	3	3	3						2				
Average	**3.0**	**2.2**	**2.7**	**2.8**						**2.0**				

MEL321: COMPUTER AIDED DESIGN AND GRAPHICS		
B.Tech. (Mechanical) 6th semester		
4L+0T		
UNIT	**CONTENTS**	**CONTACT HOURS**
I	**Overview of Computer Graphics:** Picture representation, Coordinate Systems, Raster Scan Display, DDA for line generation and Bresenham's algorithm for line and circle generation; Graphics standards: GKS, IGES, STEP, DXF..	**5**
	Parametric representation of plane curves: line, circle, ellipse, parabola and hyperbola.	**5**
II	**Parametric representation of Space Curves:** Cubic spline curve, Bezier Curve and B Spline Curves. Blending of Curves.	**6**
	Parametric representation of Surfaces: HermiteBicubic surfaces, Bezier surfaces and B-spline surfaces.	**5**
III	**Solid Representation:** B-rep. and CSG. Comparison between three types of models.	**9**
IV	**Two and Three Dimensional Transformation of Geometric Models:** Translation, Scaling Reflection, Rotation and Shearing, Homogeneous Representation, Combined Transformation.	**4**
	Projection of Geometric models: Parallel and Perspective Projection.	**6**
V	**Clipping:** Point clipping, Line clipping, Cohen- Sutherland algorithm etc., Viewing transformation.	**4**
	Hidden line and surface removal: Techniques and Algorithms. Coloring and Shading.	**6**
	TOTAL	**50**

TEXT BOOK		
1	Zeid and Sivasubramanian,CAD/CAM: Theory and Practice, Tata McGraw Hill	
2	Rogers and Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Rao P.N., CAD / CAM Principles and Applications, McGraw Hill.	**2004**
2	Pao Y.C., Elements of Computer Aided Design and Manufacturing, John Wiley and Sons.	**1984**
3	Alavala C.R., CAD/CAM: Concepts and Applications, Prentice Hall of India.	**2008**
4	Xiang and Plastock, Computer Graphics, Schaum's Outlines, Tata McGraw Hill.	**2007**

Course outcome

At the end of the course, the student will be able to
CO1: Explain various aspects of picture representation on the display device and model the plane curves

in parametric representation.
CO2: Develop different geometries from the curve and surface entities using parametric representation.
CO3: Develop solid models using B-rep and CSG.
CO4: Apply geometric transformation and projection on geometric models to get the desired display.
CO5: Make use of algorithms for clipping and hidden line/surface removal.

CO-PO Mapping

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	1	2							
CO2	3	3	3	1	2							2
CO3	3	3	3	1	2							2
CO4	3	2	3	1	2							
CO5	3	2	3	1	2							
Average	**3.0**	**2.4**	**3.0**	**1.0**	**2.0**							**2.0**

MEL333: STEAM ENGINEERING AND POWER GENERATION

B.Tech. (Mechanical) 6th Semester **Max. Marks: 150**

3L+1T **Exam Hours: 3**

Unit	Contents	Contact hours
I	**Steam generators:** Classification of Boilers, water and fire tube boilers, High pressure boilers, Advantages of high pr. Boilers, Natural and forced circulation boilers, Water wall.	4
	Steam drum internal, steam super heaters, Economizers, air preheater, induced, forced and balanced draught boilers, Fluidized bed boilers	4
II	Definition and type of nozzle and diffuser equation of continuity, sonic velocity, mach no. and stagnation properties, the steady flow energy equation for nozzles, momentum energy equation for flow through steam nozzles nozzle efficiency, effect of friction, nozzle for uniform pressure drop, throat pressure for maximum discharge or chock flow, critical pressure ratio, design of nozzle and diffuser.	8
III	**Steam Turbines:** Principle and working of steam turbines, type of turbines, compounding for pressure and velocity. Overview and difference of various type of turbine, different types of governing of turbines.	3
	Impulse turbine: The effect of blade friction on velocity diagram. Force, work and power, Blade or diagram efficiency, Gross stage efficiency, steam speed to blade, speed ratio for optimum performance, turbine performance at various loads	5
IV	**Impulse reaction turbine:** Velocity diagram and work done, degree of reaction, Parson turbine, blade efficiency, gross stage efficiency comparison of enthalpy drop in various stages, size of blades in impulse reaction turbines for various stages of impulse reaction and impulse turbine.	5
	Regenerative Feed Heating Cycles: Introduction, Ideal regenerative feed heating cycle, Regenerative heating cycles and their representation on T-s and h-s Diagram, Representation of actual process on T s andh s Diagram Regenerative cycles, types of feed heating arrangements, Optimum feed water temperature and saving in Heat Rate. direct contact and surface heaters.	4
V	**Reheating of steam**: Practical reheating and Non- reheating cycles, advantage and disadvantages of reheating, reheat regenerative cycle, regenerative water extraction cycles.	4
	Process heat and by product power cycle, pass out turbine, Binary vapour cycle. Condensers.	3
		40

TEXT BOOK		
1	Steam, Gas Turbine and Power Plant Engineering, Yadav R., CPH Allahabad	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	A Practical Guide to Steam Turbine, Heinz P. Bloch, McGraw Hill Publication	**1995**
2	Steam Turbines: Design Application and Rerating, Heinz P. Bloch, McGraw Hill	**1996**
3	Steam Turbine: Theory and Design, Shlykhin P., University press of Pacific.	**2006**
4	Steam Turbine: Theory and Construction, Wilde and Salter, Merchant Books.	**2007**
5	Power Plant Engineering, Nag P.K., Tata McGraw-Hill, New Delhi.	**1992**
6	Thermal Science & Engineering, Kumar D.S., S.K.Kataria & Sons	**2006**
7	Engineering Thermodynamics, Nag P.K., Tata McGraw-Hill, New Delhi	**1998**
8	Fundamentals of Classical Thermodynamics, G J Van Wylen, Willey Eastern	**1959**
9	Engineering Thermodynamics, Cengel & Boles, Tata McGraw-Hill, New Delhi.	**2006**
10	Engineering Thermodynamics, Chottopadhyay P., Oxford University Press.	**2009**

CO1: Learn about the economics of power plants.
CO2: Learn about site selection and the working cycles of different power plants.
CO3: Learn how to analyze and compare the performance of various power plants.
CO4: Students learns and apply general theories of renewable energy to improve power generation.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	-	-	-	-	-	-	-	-	-
C02	3	3	2	-	-			-	-	-	-	
C03	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-

2	Steam Turbines: Design Application and Rerating, Heinz P. Bloch, McGraw Hill	**1996**
3	Steam Turbine: Theory and Design, Shlykhin P., University press of Pacific.	**2006**
4	Steam Turbine: Theory and Construction, Wilde and Salter, Merchant Books.	**2007**
5	Power Plant Engineering, Nag P.K., Tata McGraw-Hill, New Delhi.	**1992**
6	Thermal Science & Engineering, Kumar D.S., S.K.Kataria & Sons	**2006**
7	Engineering Thermodynamics, Nag P.K., Tata McGraw-Hill, New Delhi	**1998**
8	Fundamentals of Classical Thermodynamics, G J Van Wylen, Willey Eastern	**1959**
9	Engineering Thermodynamics, Cengel & Boles, Tata McGraw-Hill, New Delhi.	**2006**
10	Engineering Thermodynamics, Chottopadhyay P., Oxford University Press.	**2009**

CO1: Learn about the economics of power plants.
CO2: Learn about site selection and the working cycles of different power plants.
CO3: Learn how to analyze and compare the performance of various power plants.
CO4: Students learns and apply general theories of renewable energy to improve power generation.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	-	-	-	-	-	-	-	-	-
C02	3	3	2	-	-	-	-	-	-	-	-	-
C03	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-

MEL310 : COMPUTER INTEGRATED MANUFACTURING SYSTEMS

B.Tech. (Mechanical) 7th semester **Max. Marks: 150**

3L+0T **Exam Hours: 3**

Unit	CONTENTS	Contact hours
I	**Introduction to CIM:** Overview of Production Systems, the product cycle, Automation in Production Systems, computer's role in manufacturing, sources and types of data used in manufacturing. The Beginning of CAM: Historical Background,	2
	Numerical Control (NC): Basic components of an NC system, coordinate system and motions control systems. Computer Numerical Control (CNC): features of CNC, machine control unit, CNC software. Direct Numerical Control and Distributed Numerical Control. Applications, advantages and disadvantages of NC. Adaptive control of machining system.	3
II	NC Part programming: Manual and computer assisted part programming, Part programming with APT. NC part programming using CAD/CAM software. NC cutter path verification.	8
III	Computer Aided Process Planning: Traditional Process Planning, Retrieval process planning system, Generative Process Planning, Machinability data systems, computer generated time standards.	4
	Group Technology: Introduction, part families, part classification and coding, coding system and machining cells.	4
IV	Computer Aided Production Management Systems: Introduction to computer aided PPC, Introduction to computer aided inventory management, manufacturing resource planning (MRPII), computer process monitoring and shop floor control, computer process control.	6
	Computer Aided Quality Control; Computer in quality control, contact inspection methods, Non contact inspection methods, optical and non optical computer aided testing.	2
V	Computer Aided Material Handling; Computer control on material handling, conveying, picking. Ware house control, computerized material handling for automated inspection and assembly.	
	Computer Integrated Manufacturing Systems: Introduction, types special manufacturing systems, flexible manufacturing systems (FMS).	5
	Collaborative Engineering; Introduction, Faster Design throughput, Web based design, Changing design approaches, extended enterprises, concurrent engineering, Agile and lean manufacturing.	3
	TOTAL	**40**

TEXT BOOK		
1	Mikell P. Groover, , Automation, Production Systems, and Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall,	2008
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	James A. Rehg and Henry W. Kraebber, 2005, Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall,	
2	Nanua Singh, 1996, Systems Approach to Computer-Integrated Design and Manufacturing, John Willey & Sons.	
3	Computer Aided Manufacturing, Chang, Wysk &Wang, Pearson Edu.	
4	CAD/CAM: Principles and Applications, P.N. Rao, McGraw Hill	
5	Computer Control of Manufacturing Systems,Y. Koren, McGraw Hill	
6	Computer aided Manufacturing, Rao, Tiwari and Kundra, TMH.	
7	Computer Numerical Control: Machining and Turning Centres, Quesada and Jeyepoovan, PearsonEducation	

CO1	Understand the effect of manufacturing automation strategies and derive production metrics.
CO2	Analyze automated flow lines and assembly systems, and balance the line.
CO3	Demonstrate automated material handling and storage systems for a typical production system
CO4	Develop CNC programs to manufacture industrial components.
CO5	Explain CAPP systems for rotational and prismatic parts.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	-	1	2	-	-	-	-	-	-
CO2	3	3	1	1	2	-	-	-	-	-	-
CO3	2	2	3	2	2	-	-	-	-	-	-
CO4	2	2	3	2	2						
CO5	2	2	2	3	3	-	-	-	-	-	-

MEL311: OPERATIONS RESEARCH

B.Tech. (Mechanical) 7th semester
3L+0T

Unit	Contents	Contact hours
I	**Overview of Operations Research**	1
	Linear Programming: Applications and model formulation, Graphical method, Simplex method, duality and Sensitivity analysis.	4
	Transportation Model and Assignment Model including travelling salesman problem.	4
II	**Integer Linear Programming:** Enumeration and cutting Plane solution concept, Gomory's all integer cutting plane method, Branch and Bound Algorithms, applications of zero-one integer programming.	5
	Replacement Models: Capital equipment replacement with time, group replacement of items subjected to total failure.	3
III	**Queuing Theory**: Analysis of the following queues with Poisson pattern of arrival and exponentially distributed service times, Single channel queue with infinite customer population, Multichannel queue with infinite customer population,	3
	Competitive Situations and Solutions: Game theory, two person zero sum game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy, approximate solution, and simplified analysis for other competitive situations. Application of linear programming	4
IV	Theory of Decision making: Decision making under certainty, risk and uncertainty. Decision trees.	5
	Deterministic Inventory control models: functional role of inventory, inventory costs, model building, Single item inventory control model without shortages, with shortage and quantity discount. Inventory control model with uncertain demand, service level, safety stock, P and Q systems, two bin system. Single period model. Selective Inventory control techniques.	4
V	**Probabilistic Inventory control models:** Instantaneous demand without setup cost and with setup cost, Continuous demand without setup cost	4
	Simulation: Need of simulation, advantages and disadvantages of simulation method of simulation. Generation of Random numbers, Generation of Normal Random numbers. Use of random numbers for system simulation. , Monte Carlo simulation, simulation language ARENA, Application of simulation for solving queuing Inventory Maintenance, Scheduling and other industrial problems	4
	TOTAL	40

TEXT BOOK		
1	Operations Research, Ravindran, Phillips and Solberg, Wiley India.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Introduction to Operations Research, Hillier F.S. and Lieberman G.J., CBS Publishers.	
2	Operations Research, Taha H.A., Pearson Education	
3	Linear Programming and Network Flows, Bazaraa, Jarvis and Sherali, Wiley India.	
4	Principles of Operations Research, Wagner H.M., Prentice Hall of India.	
5	Operations Research, Gupta and Heera, S. Chand Publications.	

CO1: Discuss the concepts of operations research modelling approaches by formulating and solving engineering and managerial situations as LPP

CO2: Evaluate engineering and managerial situations as Transportation and Assignment problems.

CO3: Explain game and queuing theories.

CO4: Illustrate decision theory and estimate inventory management policy

CO5: Simulate and analyze engineering and managerial problems.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	3	2	1	1							
CO2	3	3	3	3	2							
CO3	3	3	3	2	2							
CO4	3	3	3	1	2							
CO5	3	3	3	3	3							
		Average		**3.0**		**3.0**	**2.8**	**2.0**	**2.0**			

MEP321: Programming with MATLAB and FEM	
B.Tech. (Mechanical) 7th Semester	

SN	LABORATORY WORK/NAME OF EXPERIMENT
1	Laboratory work for the solution of solid mechanics problems, heat transfer problems, and free vibration problems **by using FE packages such as NASTRAN/ANSYS/SIMULIA/ABAQUS**
2	Introduction of GUI of the software in the above mentioned areas realistic problems.
3	Analysis of beams and frames (bending and torsion problems)
4	Plane stress and plane strain analysis problems
5	Problems leading to analysis of axisymmetric solids
6	Problems leading to analysis of three dimensional solids (a) Heat transfer problems (b) Modal analysis problem
7	One Dimensional problems of Finite Element Method Note: (These exercises may be performed by any of the following Advanced CAD Software such as Pro E /Unigraphics/ AotoCAD Inventor)
	Laboratory work for the solution of solid mechanics problems, heat transfer problems, and free vibration problemsby writing own code for finite element analysis using **MATLAB for:**
1	Plane stress and plane strain analysis problems
2	Modal Analysis problem
3	Numerical Analysis Problems

Course outcome
At the end of the course, the student will be able to
CO1: Analyze beams and frames using commercial FEM software
CO2: Analyze plane stress, plane strain and axisymmetric structural problems using FEM software
CO3: Solve multi-dimensional heat transfer and modal analysis problems using FEM software
CO4: Develop code using MATLAB for Plane stress and plane strain analysis problems using finite element method.
CO5: Simulate and analyze Modal Analysis problem by coding on MATLAB.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3				2			2
CO2	3	3	2	2	3				2			2
CO3	3	3	2	2	3				2			2
CO4	3	3	2	2	3				2			2
CO5	3	3	2	2	3				2			2
Average	**3.0**	**3.0**	**2.0**	**2.0**	**3.0**				**2.0**			**2.0**

MEP310: CIMS Lab(CAM, IE & SIMULATION Practicals)

B.Tech. (ME) 7th Semester

SN	NAME OF EXPERIMENT
1	To prepare part programming for plain turning operation.
2	To prepare part program for turning operations using turning cycle.
3	To prepare part program for threading operation.
4	Toprepare part program for gear cutting using mill cycle.
5	To prepare part program for multiple drilling in X and Z axis using drilling cycle.
	Case Study on the following:
1	Work Methods Design
2	Process Control Charts
3	Materials Management
4	Capacity Planning
	Simulation experiments
1	Generate Pseudo Random No. using different Techniques
2	Develop an Analytical Model for a given physical system
3	Develop a Monte Carlo Simulation Model for a given physical system
4	Find a area of an irregular 2-D shape using Monte-Carlo Simulation
5	Find the effectiveness of simulation on a physical Stochastic System
6	Develop an algorithm for a selected Simulated Study and write the program in a high level language.
7	Modeling of manufacturing system using simulation software such as ARENA

MEL213 : MANAGEMENT INFORMATION SYSTEM

B.Tech. (Mech) 7th semester
4L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Organisation & Types, Decision Making, Data & information, Characteristics & Classification of information,	3
	Cost & value of information, Various channels of information & MIS.	2
II	Foundation of Information System : Introduction to Information System in Business Fundamentals of Information System, Solving Business Problems with Information System,	4
	Concept of Balanced MIS, Effectiveness & Efficiency Criteria. Tool and Techniques of MIS- dataflow diagram, flow chart etc.	4
III	Business application of information technology, electronic commerce, Internet, Intranet, Extranet & Enterprise Solutions, Information System for Business Operations,	5
	Information system for managerial Decision Support, Information System for Strategic Advantage	5
IV	Managing Information Technology, Enterprise & Global Management, Security & Ethical Challenges, Planning & Implementing Change..	4
	Reports: Various types of MIS reports, GUI & Other Presentation tools	4
V	Advanced concepts in information system: Enterprise Resource Planning: introduction, various modules like Human Resources, Finance, Accounting, Production & Logistics.	5
	Supply Chain Management, CRM, Procurement Management System Object Oriented modeling case studies.	4
	TOTAL	**40**

TEXT BOOK		
1	Information systems for Modern Management, G.R.Murdick, Prentice Hall of India	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Management Information systems, S.Sadagopan, Prentice Hall of India	
2	Management Information Systems, Effy Oz, Cengage Learning	
3	Management Information Systems, James A O Brien, Irwin McGraw Hill	
4	Management Information Systems, Laudon and Laudon, Prentice Hall of India	

MEL314: NON CONVENTIONAL MACHINING METHODS

B.Tech. (Mechanical) 7th semester **Max. Marks: 150**
4L+0T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Introduction and classification of advanced machining process, consideration in process selection, difference between traditional and non-traditional process, Hybrid process.	3
	Abrasive finishing processes: AFM, MAF (for Plain and cylindrical surfaces).	4
II	**Mechanical advanced machining process**: Introduction, Mechanics of metal removal, process principle, Advantages, disadvantages and applications of AJM,USM,WJC.	6
III	**Thermo electric advanced machining process**: Introduction, Principle, process parameters,advantages, disadvantages and applications about EDM, EDG,	4
	LBM, PAM, EBM	6
IV	**Electrochemical and chemical advanced machining process**: ECM, ECG, ESD, Chemical machining,	5
	Anode shape prediction and tool design for ECM process. Tool (cathode) design for ECM Process.	3
	TOTAL	36

TEXT BOOK		
1	Modern Machining Process, Pandey and Shan, Tata McGraw Hill	1980
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Advance Machining Process, Jain V.K., Allied Publishers Ltd.	2002
2	Non Traditional Manufacturing Process, Gary F. Bevedict, Marcel Dekker Inc New York.	1987
3	Non-Conventional Machining Process, Mishra P.K., Narosa Publishing House	2006
4	Non-Conventional Machining Process, J.A. McGeough	1988
5	Nano and Micromachining, J. Paulo Davim, and Mark J. Jackson, Wiley-ISTE	2008

MEL322: FINITE ELEMENT METHODS

B.Tech. (Mechanical) 7th semester **Max. Marks: 150**

4L+0T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Introduction to FEM, Applications and Advantages of FEM, Gauss elimination method, Uniqueness of solution, Banded symmetric matrix and bandwidth.	4
	Direct stiffness method: Two-force member element, Local stiffness matrix, Assembly, Global stiffness matrix, imposition of Boundary conditions, Properties of stiffness matrix	5
II	One-dimensional Finite Element Analysis: Basics of structural mechanics, stress and strain tensor, constitutive relation, Principle of minimum Potential Energy, General steps of FEM, Discretization, Derivation of finite elements equations using potential energy approach for linear and quadratic 1-D bar element,	5
	Shape functions and their properties, Assembly, Boundary conditions, Computation of stress and strain.	5
III	Two Dimensional Finite Element Analysis: Finite element formulation using three nodded triangular (CST) element, Plane stress, Plane strain and Axisymmetric problems.	4
	Shape functions, node numbering and connectivity, Assembly, Boundary conditions, Isoparametric formulation of 1-D bar elements and 4-node quadrilateral element.	4
	Numerical integration using gauss quadrature formula, computation of stress and strain.	3
IV	Finite Element Formulation from Governing Differential Equation: Method of Weighted Residuals-Galerkin method.	4
	Application to one dimensional heat conduction problems and fluid flow. Introduction to variational formulation (Ritz Method.)	6
V	Shape functions of higher order elements: Family of triangular and quadrilateral elements. Lagrangian and serendipity element, compatibility, element continuity, Convergence of solution: p and h methods of refinement, Aspect ratio and element shape,	6
	Structural Dynamics: Concept of element mass matrix, Natural frequencies of one-dimensional bar.	4
	TOTAL	**50**

TEXT BOOK		
1	SeshuP.,"Text Book of Finite Element Analysis", Prentice Hall India	**2003**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Dixit, U. S., "Finite Element Methods for Engineers" Cengage Learning	**2003**
2	Finite Element Procedure in Engineering Analysis, Bathe K.J., Prentice Hall India.	**2001**
3	An Introduction to the Finite Element Method, Reddy J.N., Tata McGraw-Hill, New Delhi	**1993**
4	Concepts & Applications of Finite Element Analysis, Cook and Plesha, Willey India New Delhi.	**2007**
5	Introduction to Finite Elements in Engineering, Chandupatla and Belegundu,	**1999**

Course outcome
At the end of the course, the student will be able to
CO1: Apply direct stiffness method for structural analysis and explain the concept of global stiffness matrix and boundary conditions.
CO2: Formulate and solve one dimensional structural problem using linear and quadratic elements and explain concept of shape function & its properties.
CO3: Formulate and solve plane stress and plane strain problems using CST elements
CO4: Formulate and solve one dimensional heat transfer problems
CO5: Develop shape functions for higher order elements and explain the concept of convergence & refinement

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							
CO2	3	3	2	2	2							3
CO3	3	3	2	2	2							3
CO4	3	3	2	2	2							3
CO5	3	2	2	1	2							
Average	**3.0**	**2.8**	**2.0**	**1.8**	**1.8**							**3.0**

MEL316: OPTIMIZATION TECHNIQUES

B.Tech. (ME) 7th Semester **4L+0T**

Teaching Scheme: 4 hrs/week;

End Term Exam Maximum Marks: 100; Exam Hrs: 3

Course Outcomes:

At the end of this course:

- Students will know the principles of optimization.
- Students will have knowledge of algorithms for design optimization.
- Students will be able to formulate an optimization problem.
- Students should be able to find the optimum solution of their problems using optimization techniques.

Syllabus Contents:

Unit 1: Introduction to Optimization: Classification and formulation of optimization problem.

Unit 2: Classical Optimization Methods: Single variable optimization, Multivariable optimization with no constraints, Multivariable optimization with equality constraints: Solution by Direct Substitution, Solution by the Method of Constrained Variation, & Solution by the Method of Lagrange Multipliers. Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Conditions, Constraint Qualification.

Unit 3: One-Dimensional Minimization Methods: Unimodal Function, Elimination Methods: Unrestricted Search (Search with Fixed Step Size, Search with Accelerated Step Size), Exhaustive Search, Dichotomous Search, Interval Halving Method, Fibonacci Method, Golden Section Method.

Unit 4: Unconstrained Optimization Techniques: Indirect search (Descent) methods-Gradient of a Function, Steepest Descent (Cauchy) Method, Conjugate Gradient (Fletcher–Reeves) Method, & Newton's Method.

Unit 5: Constrained Optimization Techniques: Indirect Methods-Basic Approach of the Penalty Function Method, Interior Penalty Function Method, Exterior Penalty Function Method, Checking the Convergence of Constrained Optimization Problems: Testing the Kuhn–Tucker Conditions.

Unit 6: Modern Method of Optimization: Neural-Network Based Optimization.

Suggested Readings:

1. S. S. Rao, "Engineering Optimization: Theory and Practice".
2. J. S. Arora, "Introduction to Optimum Design".
3. R. Saravanan, "Manufacturing Optimization through Intelligent Techniques".

MEL411:INTERNET OF THINGS AND MACHINE LEARNING

B.Tech. (ME) 7th Semester

Course Learning Objectives:

1. Impart necessary and practical knowledge of components of Internet of Things
2. Develop skills required to build real-life IoT based projects.
3. Introduce to the basic concepts and techniques of Machine Learning.
4. Develop skills of using recent machine learning software for solving practical problems.

UNIT	CONTENTS	CONTACT HOURS
	Introduction to IoT and Machine Learning	**1**
I	**IoT:** What is IoT, how does it work? Difference between Embedded device and IoT device, Properties of IoT device, IoT Ecosystem, IoT Decision Framework, IoT Solution Architecture Models, Major IoT Boards in Market **Setting Up Raspberry/Arduino to Create Solutions:** Explore Raspberry Pi, Setting up Raspberry Pi, Showing working of Raspberry Pi using SSH Client and Team Viewer, Understand Sensing actions, Understand Actuators and MEMS	5
II	**Communication Protocols used in IoT:** Types of wireless communication, Major wireless Short- range communication devices, properties, comparison of these devices (Bluetooth, WIFI, ZigBee, 6LoWPAN) Major wireless Long-range communication devices, properties, comparison of these devices (Cellular IoT, LPWAN) **IoT Applications:** Industrial Internet 4.0, Applications such as: Smart home, wearables, smart city, smart grid, connected car, connected health(digital health, telehealth, telemedicine), smart retail	6
III	**Sensors:** Applications of various sensors: Google Maps, Waze, Whats App, Ola Positioning sensors: encoders and accelerometers, Image sensors: cameras, Global positioning sensors: GPS, GLONASS, IRNSS, Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer, Magnetometer, Proximity Sensor, Gyroscope Calibration, noise modeling and characterization and-noise	4

	filtering and sensor data processing. Privacy & Security	
IV	**Basics of Machine Learning:**Applications of Machine Learning, processes involved in Machine Learning, Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Real life examples of Machine Learning.	6
V	**Supervised Learning:**Classification and Regression: K-Nearest Neighbour, Linear Regression, Logistic Regression, Support Vector Machine (SVM), Evaluation Measures: SSE, MME, R2,confusionmatrix,precision,recall,F- Score, ROC-Curve. **Unsupervised Learning:** Introduction to clustering, Types of Clustering: Hierarchical- Agglomerative Clustering and Divisive clustering; Partitioned Clustering- K-means clustering, Principal Component Analysis, ICA.	6

Text Books:

1 CunoPfister, Getting Started with the Internet of Things, OReillyMedia 2011
2 Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing 2015
3 Tom Mitchell, Machine Learning, McGraw Hill, 2017

Reference Books:

4 Vijay Madisetti and Arshdeep Bahga, Internet of Things (AHands-on Approach), 1st Edition, VPT 2014
5 Francis daCosta, Rethinking the Internet of Things: A ScalableApproach to Connecting Everything, 1stEdition, Apress Publications 2013
6 Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2011
7 T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2 editions, 2008

MOOCs on this course are available at:

1 Introductionto Internetof Things- https://www.edx.org/course/introduction-to-the-internet-of-things-iot
2 IoTProgrammingandBigData-https://www.edx.org/course/iot-programming-big-data-curtinx-iot4x
3 Data Science: Machine Learning - https://www.edx.org/course/data-science-machine-learning

4 MachineLearning- https://www.coursera.org/learn/machine-learning

Course Outcomes:

Students will be able to

1. Understand internet of Things and its hardware and software components Interface I/O devices, sensors & communication modules
2. Remotely monitor data and control devices
3. Develop real life IoT based projects
4. Recognize the characteristics of machine learning that make it useful to real-world problems.
5. Understand the basic underlying concepts for supervised, semi-supervised, and unsupervised learning.
6. Effectively use machine learning toolboxes.

MEL426: COMPOSITE MATERIALS TECHNOLOGIES

B.Tech. (ME) 7th Semester

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction of Composites:** Definition, Classification, Metal matrix, Polymer matrix and Ceramic matrix composites, Types of fibres and matrix materials and their properties, Lamina and Laminate:Particulate Composites.	5
	Advantages and applications: Advantages and applications of composites in present world	3
II	**Manufacturing and Fabrication of Composites:** Hand lay-up technique; Autoclave moulding; Pressure bag and vacuum bag moulding; Pultrusion; Resin-transfer moulding; Injection moulding; Prepregs	4
	Elastic Behaviour of Composite Lamina-Micromechanics: Volume fraction, weight fraction, density of composites; Longitudinal elastic properties, transverse elastic properties, in-plane shear modulus, Poisson's ratio, Halpin-Tsai equations	5
III	**Elastic behaviour of unidirectional Lamina:** Stress-Strain relationsfor a thin lamina, general anisotropic materials, orthotropic material, transversely isotropic material, isotropic material.	8
IV	**Introduction to multi-directional Laminates:** Laminate orientation code, symmetric and balanced laminate; cross-ply, angle-ply and quasi isotropic laminates;	3
	Special Types of Composites: Short fibre composites; Sandwich structure composites; Honeycomb structure composites.	4
V	**Mechanical Testing of Composites:** Tensile testing; Compressive testing; Intra-laminar shear testing; Fracture testing; Fatigue testing	4
	Failure and Maintenance of Composites: Introduction to failure modes in laminates; Damage to laminate structures; Inspection Methodology, Quality control, case studies	4
	Total	40

TEXT BOOKS:-

1. "Analysis and Performance of Fiber Composites", B. D. Agarwal & L. J. Broutman, John Wiley & Sons

2. "Engineering Mechanics of Composite Materials", I.M. Daniel & O. Ishaai, Oxford University Press

REFERENCE BOOKS:-

1. “Mechanics and Analysis of Composite Materials”, V.V. Vasiliev& E.V. Morozov, Elsevier Science Ltd.

2. “Mechanics of Composite Materials”, R.M. Jones, Technomic Publication

3. “Composite Material: Science and Engineering”, Krishnan K. Chawle. Springer

4. “An Introduction to metal matrix composites”, T. W. Clyne& P.J. Withers, Cambridge University Press

Course outcome
At the end of the course, the student will be able to
CO1: Identify the role of matrices and reinforcements used in practical composite structures.
CO2: Develop understanding of different methods of manufacturing and micro-mechanical model to estimate the lamina properties
CO3: Ability to analyze problems on macro mechanical behavior of composites
CO4: Understand application of laminate to different composite structures
CO5: Perform characterization of composites and study of composite failure and its maintenance.

CO-PO Mapping

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2								
CO2	2	3	2	2								3
CO3	2	3	2	2								3
CO4	2	2	2	2								3
CO5	2	3	2	2								
Average	**2.0**	**2.6**	**2.0**	**2.0**								**3.0**

MEL430 : RENEWABLE ENERGY SYSTEMS

B.Tech. (Mechanical) 7th semester
4L+0T

Unit	CONTENTS	Contact Hours
I	Global and National scenarios, Form and characteristics of renewable energy sources. **Solar Energy:** Solar radiation, its measurements and prediction, Solar thermal collectors, flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers, conversion of heat energy in to mechanical energy, solar thermal power generation systems.	**2**
	Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication, **Photovoltaic applications:** battery charger, domestic lighting, street lighting, water pumping, power generation schemes	**3**
II	**Wind Energy:** Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS- classification, characteristics, applications.	**3**
III	**Ocean Energy:** Ocean energy resources, ocean energy routes, Principles of ocean thermal energy conversion systems, ocean thermal power plants, Principles of ocean wave energy conversion and tidal energy conversion.	**4**
IV	**Other Sources:** Nuclear fission and fusion, Geothermal energy- Origin, types of geothermal energy sites, site selection, geothermal power plants, Magneto-hydro-dynamic (MHD) energy conversion, Formation of biomass, photosynthesis, Biomass resources and their classification, Chemical constituents and physicochemical characteristics of biomass, Biomass conversion processes.	**5**
V	**Fuel Cells:** Thermodynamics and electrochemical principles, Basic design, types, applications. **Hydrogen Energy:** Economics of hydrogen, Production methods.	**5**
	TOTAL	**40**

TEXT BOOK		**Ed.**
1	Power Generation through Renewable Source of Energy, Rai and Ram Prasad, Tata McGraw-Hill, New Delhi.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub Year .**
2	Renewable Energy Sources and Conversion Technology, Bansal, Kleemann and Meliss, TMH	2013
3	Solar Energy: Fundamental and Applications, H. P. Garg J Prakash, TataMcGraw-Hill	2006
4	Solar Energy: Principles of Thermal Collection and Storage, S P Sukhatme, TMH	1994

CO 1	To understand the various renewable systems
CO 2	To learn the various sources of renewable energy
CO 3	To examine the operating conditions of systems
CO 4	To explore the systems and apply for various purposes

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	1	-	-	-	-	-	-	-	-
C02	3	2	1	2	-	-	-	-	-	-	-	-
C03	3	3	2	1	-	-	-	-	-	-	-	-
C04	3	3	1	2	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	-	-	-	-

MEL410: SIMULATION MODELING AND ANALYSIS

B.Tech. (Mech) 8th semester **Max. Marks: 100**
3L+0T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Physical modeling :** Concept of system and environment, continuous and discrete system, linear and nonlinear system, stochastic activities, static and dynamic models, principles used in modeling, Basic simulation modeling,	4
	Role of simulation in model evaluation and studies, Advantages and Disadvantages of simulation. Modeling of Systems, iconic analog. Mathematical Modeling	3
II	**Computer system simulation:** Technique of simulation, Monte Carlo method, experimental nature of simulation, numerical computation techniques, continuous system models, analog and hybrid simulation, feedback systems	4
	Buildings simulation models of waiting line system, Job shop, material handling and flexible manufacturing systems	4
III	**Probability concepts in simulation:** Stochastic variables, discrete and continuous probability functions mainly Normal, lognormal, Weibull, exponential, Uniform, Poisson, Binomial, Triangular, Erlang etc.	4
	Random Numbers: Properties, Generations methods, Tests for Random number- Frequency test, Runs test, Autocorrelation test. **Random Variate Generation:** Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and log normal Distributions, convolution methods- Erlang distribution, Acceptance Rejection Technique	5
IV	**Input Modelling**: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis.	4
	Verification and validation: Design of simulation experiments, validation of experimental models, testing and analysis.	3
V	**Output Analysis – Types of Simulations with Respect to Output Analysis,** Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations.	4
	Selection of Simulation Software, Simulation packages, Trend in Simulation. Do modeling using ARENA software which is freely available. Some more s**uggested simulation packages are** Promodel, Quest, Witness, Extend, Simio etc. Students can learn any one of them.	5
	TOTAL	40

TEXT BOOK		
1	Simulation Modeling and Analysis, Law A.M., McGraw Hill.	

REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Discrete-Event System Simulation, Banks and Carsan, Prentice Hall of India	
2	Simulation Modeling and Analysis with ARENA, Altiok and Melamed, Academic Press	
3	Simulation with ARENA, Keltan, Sadowski and Turrock, McGraw Hill	
4	Simulation Modeling and ARENA, Rossetti and Taha, John Wiley and Sons	
5	Narsingh Deo, Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition, 2004, ISBN : 0-87692-028-8.	

MEL427: PRODUCT DEVELOPMENT AND LAUNCHING

B.Tech. (Mechanical) 8th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Importance of New Product:** Definition-importance-Development Process, Importance of new product for growth of enterprise, Definition of product and new product,	2
	Responsibility for new product development, Demands on product development team, Classification of products from new product development point of view- Need based/Market pull products, Tech. push, Platform based, Process based and customized products,	3
	New product development process and organization, Generic product development process for Market Pull Products, Modification of this process for other types of products.	3
II	**Need Analysis:** Problem Formulation Establishing economic existence of need, Need Identification and Analysis, Engineering Statement of Problem, Establishing Target Specification.	8
III	**Generation of Alternatives and Concept Selection:** Concept generation- a creative process, Creativity, Road Elects to creative thinking-Fear of criticism and Psychological set,	4
	Tools of creativity like brain storming, Analogy, Inversion etc., Creative thinking Process, Concept feasibility and Concept Selection, Establishing Engineering Specification of Products.	4
IV	**Preliminary and Detailed Design:** Design Review Preliminary design-Identification of subsystems, Subsystem specifications, Compatibility, Detailed design of subsystems, component design,	6
	Preparation of assembly drawings, Review of product design from point of view of Manufacturing, Ergonomics and aesthetics.	2
V	**Management of New Product:** Development and Launch New Product Management's Challenges, Maintaining focus, Promotion of Right Culture, Management of Creativity, Top Management attention, Design Team Staffing and Organization, Setting key mile stone, Identification of Risk Areas, Project Execution and Evaluation Product Launch Strategies,	8
	TOTAL	**40**

TEXT BOOK		
1	Product Design and Manufacturing, Chitale and Gupta. McGraw Hill.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Product Design and Development, Ulrich and Eppinger, McGraw Hill	**2003**
2	Project Management in New Product Development, Barkley B.T., Tata McGraw Hill.	**2008**
3	Product Management, Anandan C., McGraw Hill.	**2009**
4	Engineering Design Methods, Cross, Nigel, John Wiley and Sons.	**1995**
5	Product Design and Manufacture, Lindbeck, J.R., Prentice Hall of India.	**1995**

Course outcome

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

CO1: Explain the process of product development.

CO2: Analyse the need for a product and its economic existence.

CO3: Select a concept or product through feasibility study of different identified

solution.

CO4: Prepare the specifications and detailed design of components considering manufacturing aspects ,ergonomics and aesthetics.

CO5: Define new product management and launch strategies.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	1	1	3	2	1	2	2		1			
CO2	1	2	3	2	1	2	2		1	1		
CO3	1	3	3	2	2	2	2		1	1		
CO4	2	3	3	2	1	2	1		1			
CO5	2	1	1	1	1	2			2		3	
Average	**1.4**	**2.0**	**2.6**	**1.8**	**1.2**	**2.0**	**1.8**		**1.2**	**1.0**	**3.0**	

OPEN CATEGORY COURSES

MEL215: INDUSTRIAL SAFETY

B.Tech. (ME) 4th semester
3L+0T

Teaching Scheme: 3 hrs/week;
End Term Exam Maximum Marks: 100; Exam Hrs: 3

Course Outcomes:

At the end of this course:

- Students will demonstrate knowledge of Industrial Safety.
- Students will demonstrate understanding for maintenance engineering, corrosion, fault tracing, and periodic & preventive maintenance.

Syllabus Contents:

Unit 1: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of Factories Act-1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety colour codes. Fire prevention and fire-fighting, equipment and methods.

Unit 2: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit 3: Wear & Corrosion and their prevention: Wear-types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit 4: Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit 5: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Suggested Readings:

1. Lindley R. Higgins and Lester Coridon Morrow, "Maintenance Engineering Handbook".
2. H. P. Garg, "Industrial Maintenance".

MEL216 : TOTAL QUALITY MANAGEMENT

B.Tech. (ME) 4th semester
3L+0T

Unit	Contents	Contact Hours
I	Introduction to TQM: Definition, Basic approach, Guru's of TQM, TQM framework, benefits.	2
	Leadership: Characteristics of Quality Leadership, Leadership Concepts, The 7 Habits of Highly Effective People, The Deming Philosophy, The Role of TQM LeadersStrategic Planning Communications, Decision Making.	3
	Customer Satisfaction: Introduction, Customer Perception of Quality, Service Quality, Translating Needs into Requirements, Customer Retention.	3
II	Continuous Process Improvement: Introduction, Process, The Juran Trilogy, Improvement Strategies, Types of Problems PDSA Cycle, Problem-Solving Method, DMAIC, Kaizen, Reengineering, six sigma.	3
	Supplier Partnership: Principles of Customer/Supplier Relationship Partnering, Sourcing Supplier, Selection ,Supplier Certification Supplier Rating, Relationship Development.	2
	Performance Measures: Basic Concepts, Strategy, performance measure presentation, Cost of Quality, Malcolm Baldrige and Rajiv Gandhi National Quality Award, Balanced Score Card	3
III	Lean Enterprise: Historical Review, Lean Fundamentals, Value Stream Map, Implementing Lean, Benefits.	3
	Six Sigma: Historical Review, Statistical Aspects, Improvement Methodology, Organizational Structure Benefits.	3
	Benchmarking: Benchmarking Defined, Reasons to Benchmark, Process, deciding what to benchmark, Pitfalls and Criticisms.	2
IV	Quality Management Systems: Benefits of ISO Registration, ISO Series of Standards, ISO 9001 Requirements, Implementation, Documentation,	2
	Environmental Management Systems: ISO 14000 Series Standards,Concepts of ISO 14001, ISO 14001, Requirements, Benefits, Integrating QMS and EMS. Other EMS Systems,	2
	Quality Function Deployment: The QFD Team, QFD Process.	2
	Total Productive Maintenance: The Plan, Learning the New Philosophy, Promoting the Philosophy, Training, Improvement Needs, Goal,	2
V	Management Tools: Forced Field Analysis, Nominal Group Technique, Affinity Diagram, Interrelationship Digraph, Tree Diagram, Matrix Diagram, Process Decision Program Chart, Activity Network Diagram	2
	Experimental Design: Introduction, Basic Statistics, Hypothesis, t Test F Test. One Factor at a Time Orthogonal Design, Point and Interval Estimate, Two Factors Full Factorials. Fractional Factorials.	3
	Taguchi's Quality Engineering: Introduction, Loss Function, Orthogonal Arrays, Signal-to-Noise Ratio, Parameter Design,	3
	TOTAL	**40**

TEXT BOOK		
1	D. H. Besterfield, G. H Besterfield, Hemant Urdhwareshe, Total Quality Management: Revised Third Edition, Pearson Higher Education	2013
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year Pub.**
1	Total Quality Management: text with cases, John S Oakland, Butterworth-Heinemann	2003
2	Total Quality Management for Engineers, Zaire, M., Wood Head Publishing	1991
3	Total Quality Control, Feigenbaum. Armand V., McGraw Hill	1991
4	The Management and Control of Quality,(5th Edition), James R.Evans and William M.Lidsay, South-Western (Thomson Learning)	2002

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

MEL336: SOLAR ENGINEERING

B.Tech. (Mechanical) 5th semester
3L+0T

SN	Contents	Hours
1	Energy Scenario, Physics of propagation of solar radiation from the sun to earth, Sun-Earth Geometry, Extra-Terrestrial and Terrestrial Radiation, Solar energy measuring instruments, Estimation of total radiation.	8
2	Fundamentals of solar PV cells, principles and performance analysis, modules, arrays, theoretical maximum power generation from PV cells.	8
3	Solar flat plate collectors: Construction, performance analysis, estimation of losses, collector efficiency and collector heat removal factor, testing procedures Solar Air Heaters: Performance analysis of Conventional Air heater, testing procedures	8
4	Concentrating collectors: Flat plate collector with booster mirror, cylindrical parabolic collectors, compound parabolic collector, paraboloid dish collector, central receiver collector, etc.	8
5	Thermal Energy Storage (sensible, latent and thermochemical), Solar pond, Solar dryer. Applications: Solar Refrigeration, Passive architecture, solar distillation, and emerging technologies	8

TEXT BOOK	
1	H. P. Garg and J. Prakash, Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 1997
REF ERENCE BOOK	
SN	
1	S. P. Sukhatme and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill, 2006
2	J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley, 2006.

CO 1 Predict and measure the solar radiation.

CO 2 Discuss the construction, working and applications of solar PV System. Design the solar PV based power plant.

CO 3 Analyze the flat plate collector, selection of tubes, reflector and coating. Compare different types of Solar concentrating collectors systems.

CO 4 Compare, analyze and select solar still, solar cooling and refrigeration for specific application.

COs	PO1	PO2	PO 3
CO 1	-	-	1
CO 2	-	-	2
CO 3	-	-	2
CO 4	-	-	2

MEL214:RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS

B.Tech. (Mechanical) 5th semester
3L+0T

Course learning objectives:

1. Give an overview of the research methodology and explain the technique of defining a research problem
2. Explain the functions of the literature review in research.
3. Explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
4. Explain various research designs and their characteristics.
5. Explain the details of sampling designs, and also different methods of data collections.
6. Explore the art of interpretation and the art of writing research reports.
7. Learn various forms of the intellectual property, its relevance and business impact in the changing global business environment.
8. Discuss leading International Instruments concerning Intellectual Property Rights.

UNIT	CONTENTS	CONTACT HOURS
	Introduction to Research Methodology and IPR	**1**
I	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	5
II	Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	5
III	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	6
IV	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases.Geographical Indications.	5
V	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc.Traditional knowledge Case Studies, IPR and IITs.	6

Text Book:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”
2. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016

Reference Books:

3. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
4. Mayall, “Industrial Design”, McGraw Hill, 1992.
5. Niebel, “Product Design”, McGraw Hill, 1974.
6. Asimov, “Introduction to Design”, Prentice Hall, 1962.
7. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

Course Outcomes:

Students will be able to:

1. Discuss research methodology and the technique of defining a research problem
2. Explain the functions of the literature review in research, carrying out a literature search,
3. Develop theoretical and conceptual frameworks and writing a review.
4. Explain various research designs and their characteristics.
5. Explain the art of interpretation and the art of writing research reports
6. Discuss various forms of the intellectual property, its relevance and business impact in the
7. Change global business environment and leading International Instruments concerning IPR

Course outcome

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

CO1: Explain the concept of TQM and different theories of customer satisfaction.

CO2: Determine the basic concept of performance measures and different theories of continuous process improvement.

CO3: Determine the importance of lean enterprise, six sigma and bench marking system.

CO4: Evaluate the principles of quality management and how these principles can be applied within quality management systems.

CO5: Determine the management tools, experimental design and taguchi's quality engineering.

CO-PO Mapping

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO1**	**PO1**	**PO1**
	PSO1	**PSO2**										
CO1	1	1	1	1	1			2		2		
CO2	2	2	2	2	2			2		2		
CO3	2	1	1	1	1					2		
CO4	2	2	2	2	2					2		
CO5	2	1	1	1	1					2		
Average	**1.8**		**1.4**	**1.4**	**1.4**	**1.4**	**2.0**	**2.0**				

MEL317: LEAN & AGILE MANUFACTURING

B.Tech. (Mechanical) 6th semester **Max. Marks: 150**
4L+0T **Exam Hours: 3**

Course Contents/Syllabus:

	Weightage (%)
Module I: INTRODUCTION TO LEAN MANUFACTURING	**20%**
Descriptors/Topics • Objectives of lean manufacturing • Key principles and implications of lean manufacturing • Traditional Vs lean manufacturing •	
Module II : LEAN MANUFACTURING CONCEPTS	**20%**
Descriptors/Topics • Value creation and waste elimination- main kinds of waste • Pull production-different models of pull production • Continuous flow-continuous improvement. • Kaizen- worker involvement -cellular layout- administrative lean • Toyota Production System	

Module III : LEAN MANUFACTURING TOOLS AND METHODOLOGIES	**20%**
Descriptors/Topics • 5S, 5Why, A3 Report, Jidoka, Poka Yoke. Team work and team engagement • ABCXYZ method of supply management. JIT, JIS principles and Kanban. Kanban circles. • Optimization of product portfolio. DFMA (Design for Manufacturing and Assembly) • Production layout, process and logistic approach. Layout of production cell. Warehouse layout • TOC (Theory of Constraints) principle and DBR (Drum-Buffer-Rope) methods • SMED (Single Minute Exchange of Die) principles. TPM (Total Productive Maintenance) principles • Tact Time, Cycle Time, Target Cycle Time. DTD (Dock to Dock Time).	
Module IV : Agile Manufacturing	**20%**
Descriptors/Topics • Definition, business need, conceptual frame work, characteristics, generic features • CAPP for Agile Manufacturing,Aggregate capacity planning and production line design / redesign in Agile manufacturing. • Cellular manufacturing, concepts, examples • Robust design approach, Approaches to enhance agility in manufacturing • Role of QFD, Managing people in Agile organization, Approaches • Applications of multimedia to improve agility in manufacturing .	
Module V: Agile Supply Chain Management	**20%**
• Principles, IT/IS concepts in supply chain management • Enterprise integration and management in agile manufacturing, concepts • Agility, Adaptability • Strategic options in Agile manufacturing	

MEL412: RAPID PROTOTYPING

B.Tech. (ME) 6th semester
4L+0T

	CONTENTS	
UNIT I	**INTRODUCTION:** Historical development, Three Phases of Rapid Prototyping, Fundamentals of RP, Advantages of Rapid Prototyping, Classification of Rapid Prototyping Systems, Fundamental Automated Process-Subtractive, Additive, Formative, Process Chain,	
UNIT II	**LIQUID BASED RP SYSTEMS**: Stereolithography Apparatus (SLA), Polyjet, Solid Ground Curing (SGC), Solid Creation System (SCS), Solid Object Ultraviolet Laser Plotter (SOUP), Rapid Freeze Prototyping, Microfabrication, Other notable liquid-based RP systems	
UNIT III	**SOLID BASED RP SYSTEMS:** Laminated Object Manufacturing (LOM), Fused deposition modelling (FDM), Multijet Modelling System (MJM), Paper Lamination Technology (PLT), Plastic Sheet Lamination (PSL) Other notable Solid-based RP systems	
UNIT IV	**POWDER BASED RP SYSTEMS:** Selective Laser Sintering (SLS), 3D printing, Laser Engineered Net Shaping (LENS), Electron Bean Melting (EBM), Other notable powder-based RP systems	
UNIT V	**Rapid Tooling (RT)**: Introduction to RT, Indirect RT process-Silicon rubber molding, Epoxy tooling, Spray metal tooling and Investment Casting, Direct RT processes-Laminated Tooling, Powder Metallurgy based technologies, Welding based technologies, Direct pattern making (Quick Cast, Full Mold Casting)	
UNIT VI	**CAD Modelling and Data Processing for RP:** CAD model preparation, Data interfacing: formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), conversation, validity checks, repair procedures; Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magic's, Mimics, Solid View, View Expert, 3 D View, Velocity 2 , Rhino, STL View 3 Data Expert and 3 D doctor. Part orientation and support generation, Support structure design, Model Slicing algorithms and contour data organization, direct and adaptive slicing, Tool path generation	
UNIT VII	**RP Applications:** Application – Material Relationship, Application in Design , Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis etc	

TEXT BOOK		
1	C.K. Chua , K.F. Leong , C.S. Lim, Rapid Prototyping: Principles And Applications, World Scientific Publishing Co Pte Ltd	2008
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
2	Ali K. Kamrani , Emad Abouel Nasr,Rapid Prototyping: Theory And Practice (Manufacturing Systems Engineering Series) ,Springer-Verlag New York Inc	2006
3	Stucker, David W. Rosenand Ian Gibson, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, And Direct Digital Manufacturing, Springer New York.	2014
4	Neil Hopkinson , Richard Hague , Philip Dickens, Rapid Manufacturing: An Industrial Revolution For The Digital Age 1st Edition,Wiley New York;	2005
5	Chee Kai Chua, Kah Fai Leong, 3d Printing And Additive Manufacturing: Principles And Applications , Fourth Edition Of Rapid Prototyping, World Scientific Publishing Company;	, 2014

MEL413:BUSINESS ANALYTICS

B.Tech. (ME) 6th semester
4L+0T

Teaching Scheme: 4 hrs/week;

End Term Exam Maximum Marks: 100; Exam Hrs: 3

Course Outcomes:

At the end of this course:

- Students will demonstrate knowledge of data analytics.
- Students will demonstrate the ability of thinking critically in making decisions based on data and deep analytics.
- Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
- Students will demonstrate the ability to translate data into clear, actionable insights.

Syllabus Contents:

Unit 1: Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.
Unit 2: Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.
Unit 3: Organization Structures of Business analytics: Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.
Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.
Unit 4: Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.
Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.
Unit 5: Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, Value of Information, Utility and Decision Making.
Unit 6: Recent trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Suggested Readings:

1. Marc J. Schniederjans, Dara Schniederjans and Christopher M. Starkey, “Business

analytics Principles, Concepts, and Applications: What, Why, and How".
2. James R. Evans, "Business Analytics".

MEL415 : COMPUTER AIDED MANUFACTURING

B.Tech. (ME) 6th semester

4L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction to CIM:**Overview of Production Systems, the product cycle, Automation in Production Systems, computer's role in manufacturing, sources and types of data used in manufacturing. The Beginning ofCAM: Historical Background,	2
	Introduction to manufacturing System, Classification of manufacturing system, overview of classification scheme, manufacturing progress functions.	3
II	Computer Aided Process Planning (CAPP): Traditional Process Planning,Retrieval process planningsystem, Generative Process Planning, Machinability data systems, computer generated timestandards.	8
III	Group Technology (GT): Introduction, part families, part classification and coding, codingsystem and machining cells. Introduction to Product data Management System (PDM)	4
	Computer Aided Production Management Systems (CAPM): Introduction to computer aided PPC, Introduction tocomputer aided inventory management, manufacturing resource planning (MRPII), computer processmonitoring and shop floor control, and computer process control.	5
IV	Computer Aided Quality Control (CAQ); Computer in quality control, Off-Line and On-Line Quality control, Automated inspection, contact inspection methods, Non contact inspection methods: optical and non opticalcomputer aided testing. Overview of automatic identification methods.	5
	Flexible manufacturing systems (FMS). Types of FMS, Flexibility in manufacturing, FMS components, FMS applications and benefits.	4
V	Product Design and CAD/CAM in the production system: Introductory concepts Product design and CAD, CAM,CAD/CAM and CIM	4
	Collaborative Engineering; Introduction, Faster Designthroughput, Web based design, Changing design approaches, extended enterprises, concurrentengineering, Agile and lean manufacturing.	5
	TOTAL	**40**

TEXT BOOK		
1	Mikell P. Groover, , Automation, Production Systems, and Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall,	2008
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	James A. Rehg and Henry W. Kraebber, Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall,	2005
2	Nanua Singh, Systems Approach to Computer-Integrated Design and Manufacturing, John Willey & Sons.	1996
3	Computer Aided Manufacturing, Chang, Wysk and Wang, Pearson Education	2008
4	CAD/CAM: Principles and Applications, P.N. Rao, McGraw Hill	2003
5	Computer Control of Manufacturing Systems,Y. Koren, McGraw Hill	2009
6	Computer aided Manufacturing, Rao, Tiwari and Kundra, Tata McGraw Hill.	2002
7	Computer Numerical Control: Machining and Turning Centres, Quesada and Jeyepoovan, PearsonEducation	2007

Course outcome

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

CO1: Describe the elements of the CIMS

CO2: Explain computer aided process planning

CO3: Discuss and solve the problem in part coding system in GT and PDM

CO4: Explain computerised quality control

CO5: Construct the product design, CAD/CAM in production system and collaborative engineering

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	2	1		3							
CO2	3	3	2		3							
CO3	3	3	3		3							
CO4	3	3	3		3							
CO5	3	3	3	1	3	1						
Average	**3.0**	**2.8**	**2.4**	**1.0**	**3.0**	**1.0**						

MEL414: Reliability and Maintainability.

B.Tech. (P&I) 7th semester **Max. Marks: 100**
3L+1T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Reliability**: Definition, reliability function Mean failure rate, mean time to failure (MTTF), mean time between failures (MTBF), hazard rate curve. Bathtub curve, Conditional Reliability, guarantee period etc, ,	**7**
II	**Constant Failure rate model:** Exponential Reliability function, Failure Modes, CFR model, memoryless	**5**
	System reliability: Series, parallel, mixed & complex configuration; Reliability improvement.	**3**
III	**Design for reliability**- Reliability specifications and system Measurements, System Effectiveness, redundancy, Classification of Redundancy. failure mode and effect analysis(FMEA)	**4**
	Analysis of Failure data: Data collection and empirical methods, static life estimation.	**4**
IV	**Maintainability**- Analysis of Downtime, repair time distribution, stochastic point processes,	**4**
	Design for Maintainability, Maintenance requirements, Maintenance concepts and procedures, Component reliability and Maintainability.	**4**
V	**Availability:** Concept and definition, Exponential Availability model, Static life estimation.	**4**
	Reliability testing: Product testing, Reliability life testing, test time calculations, Burn in testing.	**4**
		40

TEXT BOOK		
1	Reliability & Maintainability engineering, Ebling Charles E., Mcgraw Hill	2000
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	Year of Pub.
1	Maintainability Principles and Practices, B.S. Blanchand, McGraw Hill	2003
2	Maintenance Management, A.S. Carder, McGraw Hill Book Company	2012
3	Reliability Engineering, , L.S. Srinath, Affiliated East West Press	2008
4	Reliability engineering, theory and practice, Alessandro Birolini, Springer, 2007	
5	Maintainability, Maintenance and Reliability for engineers, Balbir S. Dhillon, CRC Press, 2006	2011
6	Practical Reliability Engineering, Patrick D. T. O'Connor, David Newton, Richard and Bromley, John Wiley and Sons, 2002.	2003

MEL416: PROJECT MANAGEMENT

B.Tech. (Mechanical) 7th semester
3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	Introduction to Project Management Project management: concepts & types of projects, project organizations; Project management knowledge area. Project life cycle	8
II	Project appraisal Concept, Types of appraisal: Technical, Economic, Financial, Social appraisal of the Industrial Projects, Numerical on Economic, financial appraisals Project scope management and break down structure Project scope, creating work break down structure (WBS); responsibility matrix , Activity relationship, Sequencing, activity duration, schedule development, Resource estimation , allocation & Leveling.	7
III	Project networking: Project networking, Networking techniques, critical path methods-CPM, PERT, network analysis, Network cost models - Crashing	8
IV	Project Quality Management: Definition of -Project quality planning, quality assurance and quality control, Tools and techniques for project Quality planning, quality assurance and quality .	8
V	Project Risk management Project Risk Management: risk identification, risk quantification Measuring risk; Contingency planning; scheduling resources; reducing project duration; Project Performance analysis and closure Project performance evaluation: Concept of earned value ', Schedule & cost Variance S' curves for project completion and cost comparison;	7
	TOTAL	**40**

TEXT BOOK

1. Project Management – Clifford F Gray , Erik W Larson- Mc Grawhill.

REFERENCE BOOKS

Name of Authors /Books /Publisher

1. Project management (core text book) – Samual J. Mantel, Scott M. shafer
2. Project management & control –Singh & Narendra
3. Pert & CPM – Dr BC Punmia, KK Khendelwal- Laxmi publication
4. Project management Desai, Vasant
5. Project Management K P Sharma National publishing house Dehli
6. Project Management – M R Agrawal
7. Fundamentals of Project Management - James P Lewis, Heritage
8.Prasanna Chandra, Projects: Planning, Analysis, Financing, Implementation & Review, Tata Mc-Graw Hill, 2002
9.John M. Nicholas, Project Management for Business, Engineering and Technology, Elsevier publications, 2008.
10.Goel B.S., Production and Operations Management, Pragati Prakashan, Merrut, 21 Edition, 2009

MINOR SPECIALIZATION

IN

BUSINESS ADMINISTRATION

MEL416: PROJECT MANAGEMENT

B.Tech. (Mechanical) 4th semester
3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	Introduction to Project Management Project management: concepts & types of projects, project organizations; Project management knowledge area. Project life cycle	8
II	Project appraisal Concept, Types of appraisal: Technical, Economic, Financial, Social appraisal of the Industrial Projects, Numerical on Economic, financial appraisals Project scope management and break down structure Project scope, creating work break down structure (WBS); responsibility matrix , Activity relationship, Sequencing, activity duration, schedule development, Resource estimation , allocation & Leveling.	7
III	Project networking: Project networking, Networking techniques, critical path methods-CPM, PERT, network analysis, Network cost models - Crashing	8
IV	Project Quality Management: Definition of - Project quality planning, quality assurance and quality control, Tools and techniques for project Quality planning, quality assurance and quality .	8
V	Project Risk management Project Risk Management: risk identification, risk quantification Measuring risk; Contingency planning; scheduling resources; reducing project duration; Project Performance analysis and closure Project performance evaluation: Concept of earned value ', Schedule & cost Variance S' curves for project completion and cost comparison;	7
	TOTAL	**40**

TEXT BOOK

1. Project Management – Clifford F Gray , Erik W Larson- Mc Grawhill.

REFERENCE BOOKS

Name of Authors /Books /Publisher

1. Project management (core text book) – Samual J. Mantel, Scott M. shafer
2. Project management & control –Singh & Narendra
3. Pert & CPM – Dr BC Punmia, KK Khendelwal- Laxmi publication
4. Project management Desai, Vasant
5. Project Management K P Sharma National publishing house Dehli
6. Project Management – M R Agrawal
7. Fundamentals of Project Management - James P Lewis, Heritage
8.Prasanna Chandra, Projects: Planning, Analysis, Financing, Implementation & Review, Tata Mc-Graw Hill, 2002
9.John M. Nicholas, Project Management for Business, Engineering and Technology, Elsevier publications, 2008.
10.Goel B.S., Production and Operations Management, Pragati Prakashan, Merrut, 21 Edition, 2009

MEL417: MARKETING MANAGEMENT

3L+0T

OBJECTIVES

1. To learn various dimensions of Marketing Management, Concepts and Applications.
2. To understand analytical perspectives, management decision tools for Planning, designing & implementing marketing strategy.
3. To have right understanding of consumer motivation and expectations.

LEARNING OUTCOMES:

1. Develop strong conceptual knowledge in the functional area of marketing management.
2. Analyze consumer markets, identify market segments, targets and craft the brand positioning.

3. Apply analytical skills in developing right marketing strategies and plans.
4. Devise effective product, pricing, promotion and placing strategies after environmental scanning for creating long-term loyalty relationships.

SECTION-A

UNIT	COURSE DESCRIPTION	SESSIONS
I	Introduction: Concept and Scope of Marketing, Philosophies of Marketing Management, Elements of Marketing - Needs, Wants, Demands, Customer, Markets and Marketers; Marketing Vs. Selling, Marketing – Mix,	6
II	Marketing Environment: Marketing Environment: Internal and External, Factors Affecting Marketing Environment, Functions of Marketing Management.	6
III	Segmentation, Targeting and Positioning: The STP process, Concept of Market Segmentation, Benefits of Market Segmentation, Requisites of Effective Market Segmentation, Process of Market Segmentation, Bases for Segmenting Consumer Markets, Targeting strategies, Positioning concept and strategies.	6
IV	Consumer buying behavior: Introduction, Characteristics, Types of Buying Decision Behavior, Factors influencing Consumer Buying Behavior, Buying Decision Process, Buying Motives, Buyer Behavior Models	6
V	Pricing and Channel Decisions : Pricing Objectives Pricing:- Pricing objectives – Setting and modifying the price – Initiating price changes and responding to price changes .Distribution Channel Management, Physical Distribution and Strategies:- Distribution Mix - Managing channel - intermediaries - transport and warehousing.	6

VI	Promotion: concept and importance Promotion: Promotion Mix - Advertisement - Message - copy writing - Media strategy -sales promotion - Personal selling and publicity.	6

Section B

At Least one Case Study from each module

Questions will be case/inferences/application based

BOOKS RECOMMENDED:

1. Kotler, P. T., & Armstrong, G. (2017). Principles of Marketing, Global Edition.
2. Chernev Alexander (2019) Strategic Marketing Management - The Framework, Cerebellum Press.
3. Dr .G. Bhuvaneshwari, Dr .S. Ramachandran (2018). Marketing Management, Airwalk Publications.
4. V S Ramaswamy (2017).Marketing Management: A Strategic Decision Making Approach, McGraw Hill Education
5. Michael J Etzel, Bruce J Walker, William J Stanton, Ajay Pandit, (2017). Marketing, 14e, McGraw Hill Education.
6. David A. Aaker& Amp; Damien McLoughlin; (2017). Strategic Market Management; John Wiley & Sons (Asia) Pvt. Ltd.

MEL420: SUPPLY AND OPERATIONS MANAGEMENT

B.Tech. (Mechanical) 5th semester **Max. Marks: 150**

3L+0T **Exam Hours: 3**

Unit	Contents	Contact Hours
I	Introduction to operations management (OM), the scope of OM; Historical evolution of OM; Trends in business; the management process. Operations Strategy, Competitiveness and Productivity	3
	Demand Forecasting: components of forecasting demand, Approaches to forecasting: forecasts based on judgment and opinion, Time series data. Associative forecasting techniques, Accuracy and control of forecasts, Selection of forecasting technique.	4
II	Product and Service design, Process selection, Process types, Product and process matrix, Process analysis.	3
	Capacity Planning: Defining and measuring capacity, determinants of effective capacity, capacity strategy, steps in capacity planning process, determining capacity requirements, Capacity alternatives, Evaluation of alternatives; Cost Volume analysis.	2
III	Facility Location: Need for location decisions, factors affecting location, qualitative and quantitative techniques of location. Facilities layout: Product, Process, Fixed position, combination and cellular layouts; line balancing. Material Handling	4
	Planning levels: long range, Intermediate range and Short range planning, Aggregate planning: Objective, Strategies, and techniques of aggregate planning. Master scheduling; Bill of materials, MRP; inputs processing and outputs, and overview of MRPII , use of MRP to assist in planning capacity requirements, Introduction to ERP	4
IV	Techniques of production control in job shop production, batch production and mass production systems. sequencing: priority rules, sequencing jobs through two work centers, scheduling services	4
	Introduction to Just-in-time (JIT) and Lean Operations: JIT production, JIT scheduling, synchronous production, Lean operations system	4
V	Supply Chain Management (SCM): Need of SCM, Bullwhip effect, Elements of SCM, Logistics steps in creating effective supply chain, Purchasing and supplied management.	3
	Project Management: Nature of projects, project life cycle, Work breakdown structure, PERT and CPM, Time-Cost trade-offs: Crashing. Resource allocation, leveling	5
	TOTAL	40

TEXT BOOK		
1	Stevenson, Operations Management, Tata McGraw Hill.	2009
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Roberta S. Russell, Bernard W. Taylor, Operations Management, John Wiley	2010
2	Joseph S. Martinich, Production And Operations Management, John Wiley	2008
3	S.N. Chary, Production and Operations Management, Tata McGraw Hill	2009
4	Norman Gaither, Greg Frazier, Operations Management, Thomson Learning	2002

CO1: **Describe** the basic concepts of operations management and production systems
CO2: **Analyse** and **solve** the problems of production planning, scheduling & control.
CO3: **Understand** the concepts of MRP, JIT and SCM.
CO4: **Solve** the problems using project management & reliability.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	1	1	2									
C02	1	3	3	3								
C03	1	3	3	3	2	-	-	-	-	-	-	-
C04	1	1	2	3	1	-	-	-	-	-	-	-

MEL422: FINANCIAL MANAGEMENT

3L+0T

Objective:

The course is designed to impart knowledge of business skills in accounting and finance. The student will be able to understand the system of utilizing financial, costing, and other information to assist the management. Throughout the duration of the course students are regularly assessed through quizzes, class tests, viva, presentations, submission of assignments.

Section A

Module I: Basic concepts of Accounting: (7 Hours)

Meaning of Book-Keeping, Accounts ,Accounting and Accountancy. Accounting concepts and conventions, Accounting Equation. Users, Importance, Scope, Areas and Functions of Accounting . Role and Responsibilities of an Accounts Manager. Emerging Trends in Accounting.

Module II: Financial Statement Analysis: (6 Hours)

Financial Statement Analysis: Comparative Statement, Common Size Statement, Trend Analysis and Income Statement.

Module III: Costing (7 Hours)

Nature, Role, Scope of Cost Accounting, Concept of Cost Centers and Cost Units, Elements of cost, Classification of cost, Cost Sheet , Activity Based Costing

Module IV: Sources of Finance (6 Hours)

Long term sources and Short term sources of finance: Shares, Debentures, Term loans, Lease financing, Venture capital investing, Private equity, international resources.

Module V: Overview of Securities market: **(7 Hours)**

Concept of Savings and Investments, Parameters of Investment Decisions, Investment Avenues, An overview of Indian Financial System, Stock market in India-primary and secondary market trends.

Section B (3 Hours)

At Least one Case Study from each module

Questions will be case/inferences/application based

Recommended Books:

1 Kumar, Vijay. Accounting for Management. Tata McGraw-Hill.
2 Kaplan and Atkinson. Advanced Management Accounting, 3rd Ed., Prentice Hall.
3 Kaplan, Atkinson and Young. Management Accounting. Pearson Education.
4 Vij. Management Accounting. Macmillan Publishers India.
5 Prasanna Chandra Investment Analysis And Portfolio Management,
Tata McGraw Hill Latest Edition

6 Reilly / Brown, Investment Analysis and Behaviour, TMH Latest Edition
7 Prasanna Chandra Investment Analysis And Portfolio Management,
Tata McGraw Hill Latest Edition

MEL424: HUMAN RESOURCE MANAGEMENT

3L+0T

Objective:

The objective of this course is to help the students develop a knowledge of the dimensions of the Human resource Management and to create an understanding of the various policies and practices of human resource management.

Section A

Module I: Introduction (7 Hours)

Introduction, Meaning and significance of HRM, Scope and Concept of HRM, Functions of HRM, Role of HR department, HR environment in India.

Module II: Human Resource Planning and Job Analysis: (7 Hours)

Meaning, Significance and Process of Human Resource Planning, Meaning, Importance and Process of Job Analysis. Job Design: Job Enlargement, Job Enrichment and Job Rotation.

Module III: Recruitment and Selection (7 Hours)

Meaning and Concept, Significance, Process and Sources of Recruitment, Concept, Significance and Process of Selection, Selection Techniques: Tests and Interviews.

Module IV: Training and Development (8 Hours)

Meaning and Significance of Training and Development, Process, Training Needs Analysis, Methods of Training: On the Job and Off the Job Methods, Career planning and development.

Module V: Performance Appraisal (7 Hours)

Meaning, Importance, Objective and Process of Performance Appraisal, Traditional and Modern methods of Performance Appraisal, Potential Appraisal, Job evaluation : concept & methods**.**

Section B

At Least one Case Study from each module

Questions will be case/inferences/application based

Recommended Books:

1. Byars, L & Rue, L. Human Resource Management. McGraw Hill.
2. Aswathappa, K. Human Resource Management. Tata McGraw-Hill.
3. Dessler, Varkkey. Human Resource Management. Pearson.
4. Jyothi. Human Resource Management. Oxford University Press.
5. Mondy, R. Human Resource Management. Prentice Hall.

DEPARTMENT SPECIALIZATION

IN

DESIGN OF THERMAL SYSTEMS

MEL433: Design of Heat Exchangers

B.Tech. (Mechanical) 4th semester
3L+0T

Course Content (Syllabus):

Unit No.	Description	Hrs
1	**Introduction to Heat Exchangers:** Mechanism of heat exchange, Classification, Geometrical construction of Tubular, plat and compact heat exchanger, Applications and Selection.	**6**
2	**Basic Design Methods of Heat Exchanger:** Basic equations in design, overall heat transfer coefficient, LMTD, NTU Method for parallel and counter flow heat exchangers, multi-pass and cross flow heat exchangers, Heat exchanger design calculation- heat transfer and pressure drop calculation, Heat exchangers design methodology- rating and sizing.	**6**
3	Fouling Of Heat Exchangers: Effect of fouling, Categories of fouling, Process of Fouling, Prediction of fouling, Design of heat exchanger courseed to fouling, Operation of heat exchanger under fouling, Control of fouling	**6**
4	Shell And Tube Heat Exchanger: Basic components, TEMA and other standards, Basic design methodology –	**6**
	heat transfer and pressure drop calculation, Shell side calculation- KERN'S and Bell-Delaware Method.	
5	Compact and Plate Heat Exchanger: Plate fin and tube fin heat exchanger- application, construction and heat transfer and pressure drop calculation. Plate Heat Exchanger: Application, mechanical features, operational characteristics, flow arrangement, heat transfer and pressure drop calculation.	**6**
6	Condensers and Evaporators: Features, types, construction, working, design and operational considerations, and thermal analysis.	**6**

Recommended books:

1. Kakac, Sadik, Hongtan Liu, and Anchasa Pramuanjaroenkij. Heat exchangers: selection, rating, and thermal design. CRC press, 2012.
2. R K Shah, Fundamental of Heat Exchanger Design
3. Kays and London, Compact heat exchanger, Krieger Pub Co,., 1998
4. Hessel greaves, John E. Compact heat exchangers: selection, design and operation. Gulf Professional Publishing, 2001.
5. T. Taborek, G.F. Hewitt and N. Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980
6. Taborek, Jerry. "Industrial Heat Exchangers: A Basic Guide By G. Walker, Hemisphere Pub L. Corp. Washington Dc, 1982, $41.50, 408 Pg." AIChE Journal 29, no. 2 (1983): 349-350.
7. Fraas, Arthur P. Heat exchanger design. John Wiley & Sons, 1989.

Course outcomes: Upon successful completion of the course, students should be able to

1. have knowledge of different techniques of heat exchanger analysis and be aware of common heat exchangers with their constructions, working principles and performance parameters,
2. Understand the significance of contents of the course for the design and development of heat exchangers.
3. Apply their knowledge for thermal design of a heat exchanger such as shell and tubes, compact and plate heat exchanger,
4. Analyze an existing heat exchanger with reference to rating and sizing.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	1	1	2	-	-	-	-	-	-	-	-
C02	3	3	1	3	-	-	-	-	-	-	-	-
C03	2	3	1	3	-	-	-	-	-	-	-	-
C04	2	2	3	3	-	-	-	-	-	-	-	-

MEL434: Refrigeration System Design

B.Tech. (Mechanical) 4th semester
3L+0T

Course Content (Syllabus):

Unit No.	Description	Hrs
1	**Refrigeration Cycles**: Analysis Evolving vapour compression cycle from basic Carnot cycle - analysis of multi- pressure systems – cascade systems	6
2	**System Components and Selection:** Compressors, condensers-evaporators- expansion devices- types, performance, and their selection, condensers: estimation of heat transfer coefficient – fouling factor – friction factor – design procedures – Wilson plots – designing different types of condensers – bis standards – optimization studies – design of evaporative condensers. evaporators: design procedure – thermal stress calculations – matching of components	6
3	**Refrigerants-** Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact- ODP, GWP, TEWI Montreal/Kyoto protocols, Paris Agreement, Phase out plans, -ecofriendly Refrigerants, Natural Refrigerants	6
4	**System balancing & controls** Estimation of cooling load – system equilibrium, balancing and matching of components – cycling controls – different defrosting and capacity control methods – electronic controls in refrigerators	6
5	**Refrigeration System Components System Capacity control –** piping – Oil return – Oil separators – Different types- Refrigerant driers- strainers – Receivers – Accumulators – Low pressure receivers – Refrigerant Pumps. Cooling Tower components-Air Washers – Spray ponds. Compressor Motor protection devices – Oil equalizing in multiple evaporators –Testing of Air conditioners, Refrigerators, Visicoolers, Cold Rooms	6
6	**Tools and Project Design-** Different Types of Refrigeration Tools – Evacuation and Charging Unit – Recovery and Recycling Unit. **Project Design:** Refrigeration System Design for Cold storage for Potato etc.	6

Recommended books:

1Dossat, Roy J. Principles of refrigeration. No. 621.56 D68 1978. 1978.
2. Stoecker, Wilbert F. Refrigeration and air conditioning. Vol. 3. London: McGraw-Hill, 1958.
3. Ananthanarayanan, P. N. Basic refrigeration and air conditioning. Tata McGraw-Hill Education, 2013.
4. Goshnay W.B., Principles and Refrigeration, Cambridge, University Press, 1982.
5. Langley, Billy C., Solid state electronic controls for HVACR, Prentice-Hall 1989.

Course Outcomes: Upon successful completion of the course, students should be able to

1. have a review of refrigeration cycles and alternate refrigeration system to enhance their knowledge of refrigeration, and will be able to explain them,
2. Understand and solve the problem of component selection, refrigerant related issues and system balancing and control
3. Apply their knowledge to appraise different refrigeration system components and environmental issue caused by refrigerant.
4. Analyze a refrigeration problem to carryout necessary calculation.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	1	1	2	-	-	-	-	-	-	-	-
C02	3	3	1	3	-	-	-	-	-	-	-	-
C03	2	3	1	3	-	-	-	-	-	-	-	-
C04	2	2	3	3	-	-	-	-	-	-	-	-

MEL435: Air Conditioning System Design

B.Tech. (Mechanical) 5th semester
3L+0T

Course Content (Syllabus):

Unit No.	Description	Hrs
1	**Psychometrics:** Introduction, properties of air and water vapour mixture, psychrometric chart and its use in air-conditioning, air and human comfort.	6
2	**Design of Equipment:** Analysis of air-conditioning load, load calculation.	6
3	**Equipment selection:** Balancing, piping system, valves, receivers, oil trap, oil regenerators, driers and strainers	6
4	**Air-conditioning system:** Window type, package type, split type, central units-direct and indirect, construction details, specification and testing, evaporative cooling system.	6
5	**Air distribution:** air distribution devices-air circuits-design of supply system, noise consideration **Air-conditioning controls:** Control system of temperature, pressure, oil flow, compressor motor-protection devices.	6
6	**AC system Design for various applications:** Air-conditioning in automobiles, railway wagons, marine vessels, air craft and other commercial application.	6

Recommended books:

1.Edward Pita, Airconditioning-An Energy Approach, Pearson Press, 2002

2. Wang, Shan Kuo, and Shan K. Wang. "Handbook of air conditioning and refrigeration." (2000).

3 Carrier Air Conditioning Co., Handbook of Air Conditioning Systems design, McGraw Hill.

4. Langley, Billy C. Refrigeration and Air Conditioning Ed. 3, Engle wood Cliffs (N.J) Prentice Hall, 1995.

5. ASHRAE, Handbooks. All volumes

6. Jones, William Peter. Air conditioning engineering. Routledge, 2007.

Course Outcomes: Upon successful completion of the course, students should be able to

1. Develop knowledge and understanding of air conditioning system design,
2. Describe the fundamental of psychometrics and different air condition system
3. Analyze an air conditioning system, carryout related calculation and select appropriate components
4. Apply knowledge their knowledge to solve many real life problems of air conditioning system

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	1	1	2	-	-	-	-	-	-	-	-
C02	3	3	1	3	-	-	-	-	-	-	-	-
C03	2	3	1	3	-	-	-	-	-	-	-	-
C04	2	2	3	3	-	-	-	-	-	-	-	-

MEL437: Energy and Exergy analysis of Thermal Systems

B.Tech. (Mechanical) 6th semester
3L+0T

Course Content (Syllabus):

Unit No.	Description	Hrs
1	Basic Energy concepts: First Law and Second Law of Thermodynamics, Energy concepts for closed systems analysis, non flow analysis	**6**
2	Basic exergy concepts: classification of forms of exergy, concepts of exergy, exergy concepts for control volume, physical exergy, exergy concepts for closed systems analysis, non flow analysis	**6**
3	Elements of Plant Analysis: Control volume analysis, criterion for performance, pictorial representation of exergy balance, exergy based property diagram.	**6**
4	Exergy Analysis in Process: Expansion process, compression process, heat transfer process, mixing process, separation process, and combustion processes.	**6**
5	Energy and Exergy analysis of various Power Plants: Energy and Exergy Analysis of gas turbine, steam power plant, captive power plant, combined cycle power plant, heat exchanger.	**6**
6	Energy and Exergy analysis of refrigeration plant and Solar PV systems	**6**

Recommended books:

P.K.Nag, Engineering Thermodynamics, McGrawhill

Yunus Cengel, Michael Boles, Mehmet Kanoglu, Thermodynamics: An Engineering Approach, McGrawhill

Michael J. Moran, Fundamentals of Engineering Thermodynamics, Wiley

Ibrahim Dincer , Marc A. Rosen. Exergy: Energy, Environment and Sustainable Development, Elsevier Science,

Gopal Nath Tiwari and Neha Gupta, Photovoltaic Thermal Passive House System: Basic Principle, Modeling, Energy and Exergy Analysis, CRC Press

Various Research Paper available on internet.

Course Outcomes

1. The student can understand the concept of Energy Analysis
2. The student can understand the concept of Exergy Analysis
3. The student can identify different areas of Energy and Exergy Analysis of Thermal Systems.
4. Can find the applications of all the areas in day to day life.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	1	1	2	-	-	-	-	-	-	-	-
C02	3	3	1	3	-	-	-	-	-	-	-	-
C03	2	3	1	3	-	-	-	-	-	-	-	-
C04	2	2	3	3	-	-	-	-	-	-	-	-

MEL439: Design and Analysis of Thermal System

B.Tech. (Mechanical) 7th semester
3L+0T

Course Content (Syllabus):

Unit No.	Description	Hrs
1	**Requirement of engineering design, Other similar terms:** Analysis, Synthesis, Selection and Optimization. Characteristics of a thermal system, types and analysis. **Formulation of the Design Problem:** Conceptual Design, Steps in the Design Process, Computer-Aided Design, Material Selection	6
2	**Modelling Basics:** Importance of Modelling in Design, basic features of modelling, Types of Models- Analogue, Mathematical, Physical and Numerical. Mathematical modelling – general procedure, final model and validation.	6
3	**Modelling Techniques:** Physical modelling and dimensional analysis, Curve fitting – exact and best fit. Synthesis of Different Design Steps – Initial design, Design strategies- commonly used design approach and Iterative design procedure.	6
4	**Economic Considerations:** Calculation of interest- simple, compound, continuous compounding and effective. Worth of money as function of time. Types of payments. Bonds and stocks, Taxes and depreciations. Cost comparison and rate of return. Application to thermal system.	6
5	**Optimization- Introduction:** Need of optimization, Basic concepts- Objective function, constraints, mathematical formulation for optimization	6
6	**Methods of Optimization:** Calculus method, Search method and Geometrical programming Practical aspect of Optimal design – choice of variables, sensitivity analysis, dependence on objective function, multi-objective optimization.	6

Recommended books:

1. Jaluria, Yogesh. Design and optimization of thermal systems. CRC press, 2007.Stoecker, W.F. Design of Thermal Systems, McGraw-Hill, New York.
2. Dieter, G.E.,Engineering Design: A Materials and Processing Approach, McGraw-Hill, 2008.
3. Janna, William S. Design of Fluid Thermal Systems-SI Version. Cengage learning, 2010.
4. Rieder, W.G. and Busby, H.R. Introductory Engineering Modelling Emphasizing differential Models and Computer Simulation, Wiley, 1986.
5. Collier, Courtland A., and William Burl Ledbetter. Engineering economic and cost analysis. Harpercollins College Division, 1988.
6. Fox, R.L. Optimization Methods for Engineering Design, Addison-Wesley, 1971.
7. Rao, Singiresu S., and S. S. Rao. Engineering optimization: theory and practice. John Wiley & Sons, 2009.

DEPARTMENT SPECIALIZATION

IN

BUSINESS ADMINISTRATION

MEL416: PROJECT MANAGEMENT

B.Tech. (Mechanical) 4th semester
3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	Introduction to Project Management Project management: concepts & types of projects, project organizations; Project management knowledge area. Project life cycle	8
II	Project appraisal Concept, Types of appraisal: Technical, Economic, Financial, Social appraisal of the Industrial Projects, Numerical on Economic, financial appraisals Project scope management and break down structure Project scope, creating work break down structure (WBS); responsibility matrix , Activity relationship, Sequencing, activity duration, schedule development, Resource estimation , allocation & Leveling.	7
III	Project networking: Project networking, Networking techniques, critical path methods-CPM, PERT, network analysis, Network cost models - Crashing	8
IV	Project Quality Management: Definition of - Project quality planning, quality assurance and quality control, Tools and techniques for project Quality planning, quality assurance and quality .	8
V	Project Risk management Project Risk Management: risk identification, risk quantification Measuring risk; Contingency planning; scheduling resources; reducing project duration; Project Performance analysis and closure Project performance evaluation: Concept of earned value ', Schedule & cost Variance S' curves for project completion and cost comparison;	7
	TOTAL	**40**

TEXT BOOK

1. Project Management – Clifford F Gray , Erik W Larson- Mc Grawhill.

REFERENCE BOOKS

Name of Authors /Books /Publisher

1. Project management (core text book) – Samual J. Mantel, Scott M. shafer
2. Project management & control –Singh & Narendra
3. Pert & CPM – Dr BC Punmia, KK Khendelwal- Laxmi publication
4. Project management Desai, Vasant
5. Project Management K P Sharma National publishing house Dehli
6. Project Management – M R Agrawal
7. Fundamentals of Project Management - James P Lewis, Heritage
8.Prasanna Chandra, Projects: Planning, Analysis, Financing, Implementation & Review, Tata Mc-Graw Hill, 2002
9.John M. Nicholas, Project Management for Business, Engineering and Technology, Elsevier publications, 2008.
10.Goel B.S., Production and Operations Management, Pragati Prakashan, Merrut, 21 Edition, 2009

MEL417: MARKETING MANAGEMENT

3L+0T

OBJECTIVES

1. To learn various dimensions of Marketing Management, Concepts and Applications.
2. To understand analytical perspectives, management decision tools for Planning, designing & implementing marketing strategy.
3. To have right understanding of consumer motivation and expectations.

LEARNING OUTCOMES:

1. Develop strong conceptual knowledge in the functional area of marketing management.
2. Analyze consumer markets, identify market segments, targets and craft the brand positioning.

3. Apply analytical skills in developing right marketing strategies and plans.
4. Devise effective product, pricing, promotion and placing strategies after environmental scanning for creating long-term loyalty relationships.

SECTION-A

UNIT	COURSE DESCRIPTION	SESSIONS
I	Introduction: Concept and Scope of Marketing, Philosophies of Marketing Management, Elements of Marketing - Needs, Wants, Demands, Customer, Markets and Marketers; Marketing Vs. Selling, Marketing – Mix,	6
II	Marketing Environment: Marketing Environment: Internal and External, Factors Affecting Marketing Environment, Functions of Marketing Management.	6
III	Segmentation, Targeting and Positioning: The STP process, Concept of Market Segmentation, Benefits of Market Segmentation, Requisites of Effective Market Segmentation, Process of Market Segmentation, Bases for Segmenting Consumer Markets, Targeting strategies, Positioning concept and strategies.	6
IV	Consumer buying behavior: Introduction, Characteristics, Types of Buying Decision Behavior, Factors influencing Consumer Buying Behavior, Buying Decision Process, Buying Motives, Buyer Behavior Models	6
V	Pricing and Channel Decisions : Pricing Objectives Pricing:- Pricing objectives – Setting and modifying the price – Initiating price changes and responding to price changes .Distribution Channel Management, Physical Distribution and Strategies:- Distribution Mix - Managing channel - intermediaries - transport and warehousing.	6

VI	Promotion: concept and importance Promotion: Promotion Mix - Advertisement - Message - copy writing - Media strategy -sales promotion - Personal selling and publicity.	6

Section B

At Least one Case Study from each module

Questions will be case/inferences/application based

BOOKS RECOMMENDED:

1. Kotler, P. T., & Armstrong, G. (2017). Principles of Marketing, Global Edition.
2. Chernev Alexander (2019) Strategic Marketing Management - The Framework, Cerebellum Press.
3. Dr .G. Bhuvaneshwari, Dr .S. Ramachandran (2018). Marketing Management, Airwalk Publications.
4. V S Ramaswamy (2017).Marketing Management: A Strategic Decision Making Approach, McGraw Hill Education
5. Michael J Etzel, Bruce J Walker, William J Stanton, Ajay Pandit, (2017). Marketing, 14e, McGraw Hill Education.
6. David A. Aaker& Amp; Damien McLoughlin; (2017). Strategic Market Management; John Wiley & Sons (Asia) Pvt. Ltd.

MEL420: SUPPLY AND OPERATIONS MANAGEMENT

B.Tech. (Mechanical) 5th semester **Max. Marks: 150**

3L+0T **Exam Hours: 3**

Unit	Contents	Contact Hours
I	Introduction to operations management (OM), the scope of OM; Historical evolution of OM; Trends in business; the management process. Operations Strategy, Competitiveness and Productivity	3
	Demand Forecasting: components of forecasting demand, Approaches to forecasting: forecasts based on judgment and opinion, Time series data. Associative forecasting techniques, Accuracy and control of forecasts, Selection of forecasting technique.	4
II	Product and Service design, Process selection, Process types, Product and process matrix, Process analysis.	3
	Capacity Planning: Defining and measuring capacity, determinants of effective capacity, capacity strategy, steps in capacity planning process, determining capacity requirements, Capacity alternatives, Evaluation of alternatives; Cost Volume analysis.	2
III	Facility Location: Need for location decisions, factors affecting location, qualitative and quantitative techniques of location. Facilities layout: Product, Process, Fixed position, combination and cellular layouts; line balancing. Material Handling	4
	Planning levels: long range, Intermediate range and Short range planning, Aggregate planning: Objective, Strategies, and techniques of aggregate planning. Master scheduling; Bill of materials, MRP; inputs processing and outputs, and overview of MRPII , use of MRP to assist in planning capacity requirements, Introduction to ERP	4
IV	Techniques of production control in job shop production, batch production and mass production systems. sequencing: priority rules, sequencing jobs through two work centers, scheduling services	4
	Introduction to Just-in-time (JIT) and Lean Operations: JIT production, JIT scheduling, synchronous production, Lean operations system	4
V	Supply Chain Management (SCM): Need of SCM, Bullwhip effect, Elements of SCM, Logistics steps in creating effective supply chain, Purchasing and supplied management.	3
	Project Management: Nature of projects, project life cycle, Work breakdown structure, PERT and CPM, Time-Cost trade-offs: Crashing. Resource allocation, leveling	5
	TOTAL	40

TEXT BOOK		
1	Stevenson, Operations Management, Tata McGraw Hill.	2009
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Roberta S. Russell, Bernard W. Taylor, Operations Management, John Wiley	2010
2	Joseph S. Martinich, Production And Operations Management, John Wiley	2008
3	S.N. Chary, Production and Operations Management, Tata McGraw Hill	2009
4	Norman Gaither, Greg Frazier, Operations Management, Thomson Learning	2002

CO1: **Describe** the basic concepts of operations management and production systems
CO2: **Analyse** and **solve** the problems of production planning, scheduling & control.
CO3: **Understand** the concepts of MRP, JIT and SCM.
CO4: **Solve** the problems using project management & reliability.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	1	1	2									
C02	1	3	3	3								
C03	1	3	3	3	2	-	-	-	-	-	-	-
C04	1	1	2	3	1	-	-	-	-	-	-	-

MEL422: FINANCIAL MANAGEMENT

3L+0T

Objective:

The course is designed to impart knowledge of business skills in accounting and finance. The student will be able to understand the system of utilizing financial, costing, and other information to assist the management. Throughout the duration of the course students are regularly assessed through quizzes, class tests, viva, presentations, submission of assignments.

Section A

Module I: Basic concepts of Accounting: (7 Hours)

Meaning of Book-Keeping, Accounts ,Accounting and Accountancy. Accounting concepts and conventions, Accounting Equation. Users, Importance, Scope, Areas and Functions of Accounting . Role and Responsibilities of an Accounts Manager. Emerging Trends in Accounting.

Module II: Financial Statement Analysis: (6 Hours)

Financial Statement Analysis: Comparative Statement, Common Size Statement, Trend Analysis and Income Statement.

Module III: Costing (7 Hours)

Nature, Role, Scope of Cost Accounting, Concept of Cost Centers and Cost Units, Elements of cost, Classification of cost, Cost Sheet , Activity Based Costing

Module IV: Sources of Finance (6 Hours)

Long term sources and Short term sources of finance: Shares, Debentures, Term loans, Lease financing, Venture capital investing, Private equity, international resources.

Module V: Overview of Securities market: **(7 Hours)**

Concept of Savings and Investments, Parameters of Investment Decisions, Investment Avenues, An overview of Indian Financial System, Stock market in India-primary and secondary market trends.

Section B (3 Hours)

At Least one Case Study from each module

Questions will be case/inferences/application based

Recommended Books:

1 Kumar, Vijay. Accounting for Management. Tata McGraw-Hill.
2 Kaplan and Atkinson. Advanced Management Accounting, 3rd Ed., Prentice Hall.
3 Kaplan, Atkinson and Young. Management Accounting. Pearson Education.
4 Vij. Management Accounting. Macmillan Publishers India.
5 Prasanna Chandra Investment Analysis And Portfolio Management,
Tata McGraw Hill Latest Edition

6 Reilly / Brown, Investment Analysis and Behaviour, TMH Latest Edition
7 Prasanna Chandra Investment Analysis And Portfolio Management,
Tata McGraw Hill Latest Edition

MEL424: HUMAN RESOURCE MANAGEMENT

3L+0T

Objective:

The objective of this course is to help the students develop a knowledge of the dimensions of the Human resource Management and to create an understanding of the various policies and practices of human resource management.

Section A

Module I: Introduction (7 Hours)

Introduction, Meaning and significance of HRM, Scope and Concept of HRM, Functions of HRM, Role of HR department, HR environment in India.

Module II: Human Resource Planning and Job Analysis: (7 Hours)

Meaning, Significance and Process of Human Resource Planning, Meaning, Importance and Process of Job Analysis. Job Design: Job Enlargement, Job Enrichment and Job Rotation.

Module III: Recruitment and Selection (7 Hours)

Meaning and Concept, Significance, Process and Sources of Recruitment, Concept, Significance and Process of Selection, Selection Techniques: Tests and Interviews.

Module IV: Training and Development (8 Hours)

Meaning and Significance of Training and Development, Process, Training Needs Analysis, Methods of Training: On the Job and Off the Job Methods, Career planning and development.

Module V: Performance Appraisal (7 Hours)

Meaning, Importance, Objective and Process of Performance Appraisal, Traditional and Modern methods of Performance Appraisal, Potential Appraisal, Job evaluation : concept & methods**.**

Section B

At Least one Case Study from each module

Questions will be case/inferences/application based

Recommended Books:

1. Byars, L & Rue, L. Human Resource Management. McGraw Hill.
2. Aswathappa, K. Human Resource Management. Tata McGraw-Hill.
3. Dessler, Varkkey. Human Resource Management. Pearson.
4. Jyothi. Human Resource Management. Oxford University Press.
5. Mondy, R. Human Resource Management. Prentice Hall.

MINOR SPECIALIZATION

IN

ENERGY ENGINEERING

MEL431: FUNDAMENTALS OF THERMAL SYSTEMS

B.Tech. (Mechanical) 4th semester
3L+0T

Syllabus

Unit-1 (Thermodynamics)

Thermodynamic Systems, Properties and State of a System. Equilibrium Processes and Cycles, Equations of State, Quasiequilibrium Work Due to a Moving Boundary, The First Law of Thermodynamics Applied to a Cycle and Various Processes, Applications of the Energy Equation, Heat Engines, Heat Pumps, and Refrigerators, Statements of the Second Law of Thermodynamics, Reversibility, Carnot Engine, Entropy. Entropy for Ideal Gas with Constant Specific Heats,

Unit-2 (Thermodynamics)

Rankine Cycle, Vapor Refrigeration Cycle, Air Standard Cycle, Carnot Cycle, Otto Cycle, Diesel Cycle, Brayton Cycle, Gas Refrigeration Cycle, Air-Vapor Mixture, Psychometric Chart, Air-Conditioning Processes.

Unit-3 (Fluid Mechanics)

Fluid Properties, Hydrostatic law, Center of pressure, Buoyancy, Metacentre and Metacentric height, Fluids at Rest, Description of Fluids in Motion. Classification of Fluid Flows.

Unit-4 (Fluid Mechanics)

The Bernoulli Equation, Conservation of Mass. Energy Equation. Momentum Equation, Dimensional Analysis, Similitude, Laminar Flow in a Pipe, Laminar Flow Between Parallel Plates, Turbulent Flow in a Pipe.

Unit-5 (Heat Transfer)

Modes of heat transfer, Fourier's law of heat conduction, Concepts of Thermal Resistance, General heat conduction equation, Natural and Forced Convections, Overall heat transfer coefficient, Types of heat exchanger, LMTD, Laws of black body radiation (Planck's Law, Wein's Displacement Law, Stefan-Boltzmann Law and Kirchhoff's law),view factor.

Recommended books

1. Engineering Thermodynamics by P K Nag (Tata McGraw Hill)
2. Heat Transfer by JPHalman(Tata McGraw Hill)
3. Fluid Mechanics by Cengel(Tata McGraw Hill)

Course Outcomes

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

CO1 Learn the basic concept and laws of thermodynamics

CO2 Apply the concepts of thermodynamics in systems.

CO3 Compare different types of fluid flow and evaluate the pressure and center of pressure.

CO4 Understand and apply Bernoulli's equation.

CO5 Describe various modes of Heat transfer and apply the concept of conduction, convection and radiation in thermal systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**										
CO2	**3**	**3**										
CO3	**3**	**3**										
CO4	**3**	**3**										
CO5	**3**	**3**										

MEL432 : RENEWABLE ENERGY TECHNOLOGIES

B.Tech. (Mechanical) 4th semester
3L+0T

Unit	CONTENTS	Contact Hours
I	Global and National scenarios, Form and characteristics of renewable energy sources. **Solar Energy:** Solar radiation, its measurements and prediction, Solar thermal collectors, flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers, conversion of heat energy in to mechanical energy, solar thermal power generation systems.	**2**
	Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication, **Photovoltaic applications:** battery charger, domestic lighting, street lighting, water pumping, power generation schemes	**3**
II	**Wind Energy:** Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS- classification, characteristics, applications.	**3**
III	**Ocean Energy:** Ocean energy resources, ocean energy routes, Principles of ocean thermal energy conversion systems, ocean thermal power plants, Principles of ocean wave energy conversion and tidal energy conversion.	**4**
IV	**Other Sources:** Nuclear fission and fusion, Geothermal energy- Origin, types of geothermal energy sites, site selection, geothermal power plants, Magneto-hydro-dynamic (MHD) energy conversion, Formation of biomass, photosynthesis, Biomass resources and their classification, Chemical constituents and physicochemical characteristics of biomass, Biomass conversion processes.	**5**
V	**Fuel Cells:** Thermodynamics and electrochemical principles, Basic design, types, applications. **Hydrogen Energy:** Economics of hydrogen, Production methods.	**5**
	TOTAL	**40**

TEXT BOOK		**Ed.**
1	Power Generation through Renewable Source of Energy, Rai and Ram Prasad, Tata McGraw-Hill, New Delhi.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub Year .**
2	Renewable Energy Sources and Conversion Technology, Bansal, Kleemann and Meliss, TMH	2013
3	Solar Energy: Fundamental and Applications, H. P. Garg J Prakash, TataMcGraw-Hill	2006
4	Solar Energy: Principles of Thermal Collection and Storage, S P Sukhatme, TMH	1994

CO 1	To understand the various renewable systems
CO 2	To learn the various sources of renewable energy
CO 3	To examine the operating conditions of systems
CO 4	To explore the systems and apply for various purposes

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	1	-	-	-	-	-	-	-	-
C02	3	2	1	2	-	-	-	-	-	-	-	-
C03	3	3	2	1	-	-	-	-	-	-	-	-
C04	3	3	1	2	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	-	-	-	-

MEL433: Design of Heat Exchangers

B.Tech. (Mechanical) 4th semester
3L+0T

Course Content (Syllabus):

Unit No.	Description	Hrs
1	**Introduction to Heat Exchangers:** Mechanism of heat exchange, Classification, Geometrical construction of Tubular, plat and compact heat exchanger, Applications and Selection.	**6**
2	**Basic Design Methods of Heat Exchanger:** Basic equations in design, overall heat transfer coefficient, LMTD, NTU Method for parallel and counter flow heat exchangers, multi-pass and cross flow heat exchangers, Heat exchanger design calculation- heat transfer and pressure drop calculation, Heat exchangers design methodology- rating and sizing.	**6**
3	Fouling Of Heat Exchangers: Effect of fouling, Categories of fouling, Process of Fouling, Prediction of fouling, Design of heat exchanger courseed to fouling, Operation of heat exchanger under fouling, Control of fouling	**6**
4	Shell And Tube Heat Exchanger: Basic components, TEMA and other standards, Basic design methodology –	**6**
	heat transfer and pressure drop calculation, Shell side calculation- KERN'S and Bell-Delaware Method.	
5	Compact and Plate Heat Exchanger: Plate fin and tube fin heat exchanger- application, construction and heat transfer and pressure drop calculation. Plate Heat Exchanger: Application, mechanical features, operational characteristics, flow arrangement, heat transfer and pressure drop calculation.	**6**
6	Condensers and Evaporators: Features, types, construction, working, design and operational considerations, and thermal analysis.	**6**

Recommended books:

1. Kakac, Sadik, Hongtan Liu, and Anchasa Pramuanjaroenkij. Heat exchangers: selection, rating, and thermal design. CRC press, 2012.
2. R K Shah, Fundamental of Heat Exchanger Design
3. Kays and London, Compact heat exchanger, Krieger Pub Co,., 1998
4. Hessel greaves, John E. Compact heat exchangers: selection, design and operation. Gulf Professional Publishing, 2001.
5. T. Taborek, G.F. Hewitt and N. Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980
6. Taborek, Jerry. "Industrial Heat Exchangers: A Basic Guide By G. Walker, Hemisphere Pub L. Corp. Washington Dc, 1982, $41.50, 408 Pg." AIChE Journal 29, no. 2 (1983): 349-350.
7. Fraas, Arthur P. Heat exchanger design. John Wiley & Sons, 1989.

Course outcomes: Upon successful completion of the course, students should be able to

1. have knowledge of different techniques of heat exchanger analysis and be aware of common heat exchangers with their constructions, working principles and performance parameters,
2. Understand the significance of contents of the course for the design and development of heat exchangers.
3. Apply their knowledge for thermal design of a heat exchanger such as shell and tubes, compact and plate heat exchanger,
4. Analyze an existing heat exchanger with reference to rating and sizing.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	1	1	2	-	-	-	-	-	-	-	-
C02	3	3	1	3	-	-	-	-	-	-	-	-
C03	2	3	1	3	-	-	-	-	-	-	-	-
C04	2	2	3	3	-	-	-	-	-	-	-	-

MEL436: HEATING VENTILATION AND AIR CONDITIONING

B.Tech. (Mechanical) 6th semester
3L+0T

Unit	Contents	Contact Hours
I	Introduction: Refrigeration and second law of Thermodynamics, Refrigeration effect and unit of Refrigeration, Heat pump, reversed Carnot cycle. Vapour Compression Refrigeration System: Analysis of simple vapour compression Refrigeration cycle by p-h and T-S diagram. Effect of operating conditions.	5
	Multiple Evaporator and compressor system: Application, air compressor system, Individual compressor, compound compression, cascade system. Application, air compressor systems, individual compressor, compound compression, cascade system	3
II	Gas Cycle Refrigeration: Limitation of Carnot cycle with gas, reversed Brayton cycle, Brayton cycle with regenerative heat exchanger.	4
	Air cycle for air craft: Necessity of cooling of air craft, Basic cycle, boot strap, regenerative type air craft refrigeration cycle.	4
III	Vapour absorption refrigeration system, Electrolux refrigerator, Lithium Bromide - Water system,	4
	Refrigerants: Classification, Nomenclature, selection of Refrigerants, global warming potential of CFC Refrigerants. Refrigeration Equipments: Compressor, condenser, evaporator, expansion devices, types & working.	4
IV	Psychrometry: Psychrometric properties, psychometric relations, pyschrormetric charts, psychrometric processes, cooling coils, By-pass factor, Apparatus Dew point temperature and air washers.	5
	Human Comfort: Mechanism of body heat losses, factors affecting human comfort, effective temperature, comfort chart.	3
V	Cooling load calculations: Internal heat gain, system heat gain, RSHF,ERSHF, GSHF, cooling load estimation, heating load estimation, psychrometric calculation for cooling.	5
	Selection of air conditioning: Apparatus for cooling and dehumidification, Air conditioning system, year round air conditioning.	3

TEXT BOOK

1 Arora, C.P., Refrigeration and Air Conditioning, Tata McGraw Hill

Reference Book

SN Name of Authors /Books /Publisher Year of Pub.

1 Stoecker W.F., "Refrigeration & Air Conditioning" McGraw Hill Publication. 2000

2 Andrew D. Althouse., "Modern Refrigeration & Air Conditioning" GoodHeartWillcox Co. 2002

3 Jorden & Priester, Refrigeration & Air Conditioning, Prentice Hall of India. 2003

4 Roy J. Dossat, Principal of Refrigeration, Pearson Education, New Delhi. 2014

5 Edward G. Pita, Air Conditioning Principles and Systems, Pearson Education,New Delhi. 2003

6 Jain V.K., Refrigeration & Air Conditioning, Tata McGraw Hill New Delhi. 2004

Course Outcomes and mapping of CO's with Program Outcomes (PO's) sheet

Course Outcomes: After learning the course the students will be able to:	
CO1	Understand the principles and remember the applications of refrigeration systems
CO2	Analyze performance of vapor compression refrigeration system
CO3	Study the working principles of vapour absorption, vortex, thermoelectric, steam jet refrigeration system.
CO4	Understand and analyze the air conditioning processes using principles of Psychrometry.
CO5	Evaluate and develop the ability to compute cooling and heating loads in an air conditioning system.

Mapping CO's with PO's:												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3						3					2
CO2	3	3	3									2
CO3	3	3		2								2
CO4	3	3	3	2		2	3					2
CO5	3	3	3	3		2	3				3	2

MEL438: GREEN ENERGY SYSTEMS

B.Tech. (Mechanical) 7th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Passive Heating and Cooling**: Passive Heating concepts, Direct Heat gain, Indirect Heat gain, isolated gain and sunspaces. Passive cooling concepts: Evaporation cooling, radiation cooling, Application of wind, water and earth for cooling, Shading, Paints and cavity walls for cooling, Roof radiation trays, Earth air tunnel.	**8**
II	**Green Buildings**: Opportunities and Techniques for energy conservation in Buildings. Sustainable Buildings, Green Materials for building construction, Material selection for sustainable design, Green Building certification, Intelligent Buildings, Rating of Buildings, Efficient Use of Buildings, Solar Passive Architecture, Eco-housing concepts and National and International norms. Methods for increasing energy efficiency of Buildings, Sustainable cities and Sustainable Transport.	**8**
III	**Energy Conservation Building Code (ECBC)**: Energy Conservation Act 2001 and its features, Notifications under Act, Schemes of Bureau of Energy Efficiency (BEE), Energy conservation building code (ECBC), Compliance and approach of ECBC, Energy performance index, Integrated Energy Policy, National Plan for Climate change	**8**
IV	**Energy Management and Audit**: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Instruments Used in Energy systems: Load and power factor measuring equipment, Wattmeter, flue gas analysis, Temperature and thermal loss measurements, air quality analysis etc.	**8**
V	**Impact of Energy Systems on Environment**: Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environmental and health problems due to energy plants. Methods of Environmental Impact Assessment.	**8**