ANNA UNIVERSITY COIMBATORE

CURRICULAM & SYLLABI - REGULATION 2008

B.E.MECHANICAL ENGINEERING CURRICULUM

SEMESTER-5

Code No.	Course title	L	T	P	M	C
THEORY						
	THERMAL ENGINEERING	3	1	0	100	4
	COMPUTER AIDED MANUFACTURING	3	0	0	100	3
	DESIGN OF MACHINE ELEMENTS (Common for Mechanical and Automobile Engineering)	3	2	0	100	5
	DYNAMICS OF MACHINERY	3	2	0	100	5
	HYDRAULIC & PNEUMATIC SYSTEMS (Common for Mechanical and Automobile Engineering)	3	0	0	100	3
	COMPOSITE MATERIALS (Common for Mechanical and Automobile Engineering)	3	0	0	100	3
PRACTICAL						
	THERMAL ENGINEERING LABORATORY	0	0	3	100	2
	KINEMATICS & DYNAMICS LABORATORY	0	0	3	100	2
	ELECTRONICS & MICROPROCESSORS LABORATORY	0	0	3	100	2
	Total	18	5	9	900	29

SEMESTER-6

Code No.	Course title	L	T	P	M	C
THEORY						
	FINITE ELEMENT ANALYSIS (Common for Mechanical and Automobile Engineering)	3	1	0	100	4
	DESIGN OF TRANSMISSION SYSTEM	3	2	0	100	5
	AUTOMOBILE ENGINEERING	3	0	0	100	3
	POWER PLANT ENGINEERING	3	0	0	100	3
	GAS DYNAMICS AND JET PROPULSION	3	0	0	100	3
	ENGINEERING ECONOMICS AND FINANCE (Common for Mechanical and Automobile Engineering)	3	0	0	100	3
PRACTICAL						
	SIMULATION & ANALYSIS LABORATORY	0	0	3	100	2
	COMPUTER AIDED MANUFACTURING LABORATORY	0	0	3	100	2
	HEAT POWER LABORATORY	0	0	3	100	2
	COMPREHENSION LABORATORY AND MINI PROJECT	0	0	3	100	2
	Total	18	3	12	1000	29

SEMESTER-7

Code No.	Course title	L	T	P	M	C
THEORY						
	BUSINESS CONCEPTS (Common for Mechanical and Automobile Engineering)	3	0	0	100	3
	DESIGN OF JIGS, FIXTURES, PRESS TOOLS AND MOULDS	3	1	0	100	4
	METROLOGY & MEASUREMENTS	3	0	0	100	3
	MECHATRONICS	3	0	0	100	3
	ELECTIVE – I	3	0	0	100	3
	ELECTIVE – II	3	0	0	100	3
PRACTICAL						
	METROLOGY & MEASUREMENTS LABORATORY	0	0	3	100	2
	MECHATRONICS LABORATORY	0	0	3	100	2
	TECHNICAL SEMINAR	0	0	3	100	2
	PROJECT WORK PHASE-I	0	0	3	100	2
	Total	18	1	9	900	27

ELECTIVES - SEMESTER 7

Code No.	Course title	L	T	P	M	C
1	OPTIMIZATION TECHNIQUES	3	1	0	100	**4**
2	COMPUTATIONAL FLUID DYNAMICS	3	1	0	100	4
3	REFRIGERATION & AIR-CONDITIONING	3	1	0	100	4
4	INTERNAL COMBUSTION ENGINES	3	1	0	100	4
5	TURBO MACHINERY	3	1	0	100	4
6	INDUSTRIAL TRIBOLOGY	3	1	0	100	4
7	DESIGN FOR MANUFACTURE & ASSEMBLY	3	1	0	100	4
8	TOOL DESIGN	3	0	0	100	3
9	MANAGEMENT INFORMATION SYSTEMS	3	0	0	100	3
10	SOFTWARE ENGINEERING	3	0	0	100	3
11	UNCONVENTIONAL MACHINING PROCESSES	3	0	0	100	3
12	INDUSTRIAL ROBOTICS	3	0	0	100	3
13	MICRO ELECTRO MECHANICAL SYSTEM (MEMS)	3	0	0	100	3
14	FACILITIES PLANNING AND DESIGN	3	0	0	100	3
15	VIBRATION AND NOISE CONTROL	3	1	0	100	4
16	DESIGN OF PLASTIC COMPONENTS	3	0	0	100	3

SEMESTER-8

Code No.	Course title	L	T	P	M	C
THEORY						
	TOTAL QUALITY MANAGEMENT	3	0	0	100	3
	ELECTIVE –III	3	0	0	100	3
	ELECTIVE –IV	3	0	0	100	3
	PROJECT WORK	0	0	12	100	6
	Total	9	0	12	400	15

ELECTIVES - 8

Code No.	Course title	L	T	P	M	C
1	ALTERNATIVE ENERGY SOURCES	3	0	0	100	3
2	CRYOGENIC ENGINEERING	3	0	0	100	3
3	NUCLEAR ENGINEERING	3	0	0	100	3
4	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	100	3
5	PRODUCT DESIGN, DEVELOPMENT AND LIFE CYCLE MANAGEMENT	3	0	0	100	3
6	ENTREPRENEURSHIP DEVELOPMENT	3	0	0	100	3
7	ENTERPRISE RESOURCE PLANNING	3	0	0	100	3
8	PRODUCTION PLANNING & COST ESTIMATION	3	0	0	100	3
9	MAINTENANCE ENGINEERING	3	0	0	100	3
10	INDUSTRIAL SAFETY	3	0	0	100	3
11	PROFESIONAL ETHICS & HUMAN VALUES	3	0	0	100	3
12	RAPID PROTOTYPING, TOOLING AND REENGINEERING	3	0	0	100	3
13	SIX SIGMA AND LEAN MANUFACTURING	3	0	0	100	3
14	PROJECT MANAGEMENT	3	0	0	100	3
15	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	3	0	0	100	3

REGULATION 2008: B.E.MECHANICAL ENGINEERING SYLLABUS

SEMESTER-5

	THERMAL ENGINEERING	3	1	0	100	4

UNIT I	GAS POWER CYCLES	9

Stirling, Ericsson, Otto, Diesel, Dual, Lenoir, Atkinson, Brayton cycles. Calculation of mean effective pressure and air standard efficiency, actual and theoretical PV diagrams of four stroke and two stroke engines.

UNIT II	INTERNAL COMBUSTION ENGINES	10

Classification of I.C engines, four stroke and two stroke cycle engines, combustion phenomenon and characteristics of combustion chamber design in SI and CI engine, detonation, knocking, delay period - timing diagrams – super-charging - ignition system and fuel injection system. Engine tests - performance, heat balance, and retardation - Morse test.

UNIT III	NOZZLES, TURBINES & STEAM POWER CYCLES	9

Steam nozzles- flow through steam nozzles, effect of friction, critical pressure ratio and super saturated flow. Steam turbines- impulse and reaction turbine, compounding, velocity diagram, condition for maximum efficiency, multi stage turbines, conditional lines, cycles with reheating and regenerating heating, reheat factor, degree of reaction, governing of turbines. Steam power cycle-properties of steam, Rankine Cycle, Determination of Dryness fraction of steam.

UNIT IV	AIR COMPRESSORS	8

Classifications of compressors - Reciprocating air compressor - performance characteristics, effect of clearance volume, free air delivery and displacement, intercooler, after cooler - Rotary compressor - vane type, centrifugal and axial, flow performance characteristics - Screw compressor - performance characteristics

UNIT V	REFRIGERATION AND AIR CONDITIONING	9

Fundamentals of refrigeration – COP - Vapour compression refrigeration system - cycle, p-h chart, Vapour absorption system- comparison, properties of refrigerants. Fundamentals of air conditioning system, cycle, controls, air handling and distribution, simple cooling and heat load estimation

Use of standard thermodynamic table, Mollier diagram, Psychometric chart and Refrigeration property table are permitted in the examination)

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

REFERENCES

1	R.K.Rajput, “Thermal Engineering” , Laxmi Publications, New Delhi, Sixth edition, 2005
2	Kothandaraman C.P, Domkundwar and A.V. Domkundwar, “A course in Thermal Engineering”, Dhanpat Rai & Sons, Fifth Edition, 2002
3	Holman J.P. “Thermodynamics”, McGraw-Hill, 1985.
4	Arora C.P., “Refrigeration and Air conditioning”, Tata McGraw-Hill, New Delhi, 1994
5	Sarkar B.K., “Thermal Engineering”, Tata McGraw-Hill, New Delhi New Delhi, 1998
6	V.Ganesan, “Internal Combustion Engines”, Tata McGraw-Hill, New Delhi, 1994

	COMPUTER AIDED MANUFACTURING	3	0	0	100	3

UNIT I	CAD/CAM INTERFACE	5

Current trends in Manufacturing Engineering-Group Technology-Design for Manufacturing and Assembly-Total approach to product development-Concurrent Engineering-Rapid prototyping – Introduction to CAD/CAM software packages.

UNIT II	FUNDAMENTALS OF CNC MACHINES	10

CNC Technology-Functions of CNC Control in Machine Tools-Classification of CNC systems-Contouring System-Interpolators, open loop and closed loop CNC systems-CNC Controllers, Hardware features-Direct Numerical Control (DNC systems).

UNIT III	CONSTRUCTIONAL FEATURES OF CNC MACHINES	8

Design considerations of CNC machines for improving machining accuracy-Structural members-Slide ways-Sides linear bearings-Ball screws-Spindle drives and feed drives-work holding devices and tool holding devices-Automatic Tool changers. Feedback devices-Principles of Operation-Machining Centres-Tooling for CNC machines.

UNIT IV	PART PROGRAMMING FOR CNC MACHINES	10

Numerical control codes-Standards-Manual Programming-Canned cycles and subroutines-Computer Assisted Programming, CAD/CAM approach to NC part programming-APT language, machining from 3D models.

UNIT V	COMPUTER AIDED PROCESS PLANNING AND DATA BASE FOR CAM	12

Process planning - role of process planning in CAD/CAM integration - approaches to computer aided process planning -variant approach and generative approaches.

Development of databases -database terminology- architecture of database systems-data modeling and data associations -relational data bases - database operators - advantages of data base and relational database. Emerging Challenges in CAD/CAM, product Data management-Product Modeling-Assembly and Tolerance Modeling.

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

REFERENCES

1	Ibrahim Zeid.” CAD-CAM Theory and Practice”, Tata McGraw-Hill Publishing Co.Ltd., 1988.
2	Mikell.P.Groover “Automation, Production Systems and computer integrated manufacturing”, Pearson Education 2001.
3	Yoram Koren,” Computer Control of Manufacturing Systems”, McGraw-Hill Book Company, 1986.
4	Mc Mahon and J.Browne, “CAD/CAM”, Addison-Wesley, 1998
5	P.Radhakrishnan,”Computer Numerical Control”, New Central Book Agency, 1992
6	G.T.Smith,” CNC-Machining, Techniques-Vol.1,2 & 3”, verlag, 1992.
7	S.Kant Vajpayee,”Principles of Computer Integrated Manufacturing”, Prentice Hall of India Ltd., 1999

	DESIGN OF MACHINE ELEMENTS (Common for Mechanical and Automobile Engineering)	**3**	**2**	**0**	**100**	**5**

UNIT I	**STEADY AND VARIABLE STRESSES**	**9**

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties, Fits and Tolerances, Preferred numbers – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – Design of curved beams – crane hook and 'C' frame - Factor of safety - theories of failure – stress concentration – design for variable loading – Soderberg, Goodman and Gerber relations.

UNIT II	**DESIGN OF SHAFTS AND COUPLINGS**	**9**

Design of solid and hollow shafts based on strength, rigidity and critical speed – Design of keys and key ways - Design of rigid and flexible couplings – Introduction to gear and shock absorbing couplings - design of knuckle joints.

UNIT III	**DESIGN OF FASTNERS AND WELDED JOINTS**	**9**

Threaded fastners - Design of bolted joints including eccentric loading – Design of welded joints for pressure vessels and structures - theory of bonded joints. (Riveted joints - self study)

UNIT IV	**DESIGN OF SPRINGS AND LEVERS**	**9**

Design of helical, leaf, disc and torsional springs under constant loads and varying loads – Concentric torsion springs - Belleville springs – Design of Levers

UNIT V	**DESIGN OF BEARINGS AND FLYWHEELS**	**9**

Design of bearings – sliding contact and rolling contact types. – Cubic mean load – Design of journal bearings – Mckees equation – Lubrication in journal bearings – calculation of bearing dimensions – Design of flywheels involving stresses in rim and arm.

Note: (Use of P S G Design Data Book is permitted in the University examination)

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

REFERENCES

1	Norton R.L, "Design of Machinery", Tata McGraw-Hill Book Co, 2004.
2	Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
3	Ugural A.C, "Mechanical Design – An Integral Approach, McGraw-Hill Book Co, 2004.
4	Spotts M.F., Shoup T.E "Design and Machine Elements" Pearson Education, 2004.

STANDARDS

1	IS 10260: Part 1: 1982 Terms, definitions and classification of Plain bearings Part 1: Construction.
2	IS 10260: Part 1: 1982 Terms, definitions and classification of Plain bearings Part 2: Friction and Wear.
3	IS 10260 : Part 1 : 1982 Terms, definitions and classification of Plain bearings Part 3 : Lubrication

	DYNAMICS OF MACHINERY	3	2	0	100	5

UNIT I	FORCE ANALYSIS	9

Applied and constraint forces-static equilibrium conditions-two, three force members – equations of motion - dynamic force analysis - inertia force and inertia torque – D'Alemberts principle - the principle of superposition - dynamic analysis in reciprocating engines – gas forces - equivalent masses - bearing loads - crank shaft torque - turning moment diagrams - fly wheels – Coefficient of fluctuation of energy and speed Weight of flywheel required

UNIT II	BALANCING	9

Static and dynamic balancing - balancing of rotating masses - balancing of single and multi-cylinder engines - balancing of reciprocating masses- partial balancing in locomotive engines - balancing linkages - balancing machines-inline and V-engines

UNIT III	CONTROL MECHANISMS	9

Governors - types - centrifugal governors - gravity controlled and spring controlled centrifugal governors characteristics – stability- sensitiveness-hunting, isochronisms-effect of friction - controlling force Gyroscopes - gyroscopic forces and torques - gyroscopic stabilization - gyroscopic effects in automobiles, ships and airplanes

UNIT IV	LONGITUDINAL VIBRATION	9

Undamped free vibration of single degree of freedom system- simple pendulum, compound pendulum -springs in series, springs in parallel and combinations. Damped free vibration of single degree of freedom system, types of damping-viscous damping, critically damped, under damped system. Logarithmic decrement. Forced vibration of single degree of freedom system-constant harmonic excitation, steady state vibration, magnification factor, vibration isolation and transmissibility.

UNIT V	TRANSVERSE AND TORSIONAL VIBRATIONS	9

Transverse vibrations of beams-natural frequency- energy method - Dunkerly"s method. critical speed –whirling of shafts.

Torsional systems- natural frequency of two and three rotor systems, equivalent shafts, geared systems, Holzer's method, Signature Analysis.

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

REFERENCES

1	Rattan S.S, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2007.
2	Rao J.S and Dukkipati R.V, "Mechanism and Machine Theory", New Age International, New Delhi, 2007.
3	Thomas Bevan, "Theory of Machines" CBS Publishers and Distributers, 1984.
4	Ballaney.P.L "Theory of Machines", Khanna Publishers,1990.
5	Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw-Hill, Inc., 1995.
6	Sadhu Singh "Theory of Machines", Pearson Education, 2002.
7	Rao J.S and Gupta.K,"Introduction course on theory and practice of Mechanical Vibrartions", Second edition, New Age International Publishers, 1999.

	HYDRAULICS AND PNEUMATIC SYSTEMS	3	0	0	100	3

UNIT I	FLUID POWER SYSTEMS AND FUNDAMENTALS	9

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols.

Basics of Hydraulics-Applications of Pascals Law- Laminar and Turbulent flow – Reynold's number – Darcy's equation – Losses in pipe, valves and fittings.

UNIT II	HYDRAULIC SYSTEM AND COMPONENTS	9

Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, construction and working of pumps – pump performance – Variable displacement pumps.

Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders like tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors.

UNIT III	DESIGN OF HYDRAULIC CIRCUITS	9

Construction of Control Components : Director control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram.

Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier – Intensifier circuit.

UNIT IV	PNEUMATIC SYSTEMS AND COMPONENTS	9

Pneumatic Components: Properties of air – Compressors – Filter, Regulator, Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators.

Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

UNIT V	DESIGN OF PNEUMATIC CIRCUITS	9

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves.

Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.

LECTURE	:	45
TUTORIAL	:	-
TOTAL	:	45

TEXT BOOKS	
1	Anthony Esposito, “Fluid Power with Applications”, Pearson Education 2000
2	Majumdar S.R., “Oil Hydraulics”, Tata McGraw-Hill, 2000.
REFERENCES	
1	Majumdar S.R.,“Pneumatic systems – Principles and maintenance”, Tata McGraw Hill, 1995
2	Anthony Lal, “Oil hydraulics in the service of industry”, Allied publishers, 1982.
3	Harry L. Stevart D.B, “Practical guide to fluid power”, Taraoeala sons and Port Ltd. Broadey, 1976
4	Michael J, Prinches and Ashby J. G, “Power Hydraulics”, Prentice Hall, 1989.
5	Dudelyt, A. Pease and John T. Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.

	COMPOSITE MATERIALS (Common for Mechanical and Automobile Engineering)	**3**	**0**	**0**	**100**	**3**

UNIT I	**INTRODUCTION**	**9**

Definition – Classification of Composite materials based on structure – based on matrix. Advantages of composites – application of composites – functional requirements of reinforcement and matrix.

Reinforcement types – Fibres – continuous, particulate and whisker reinforcements – Properties - Applications – Comparison of fibre strengths –. Matrix materials – Properties.

Wettability fibre with matrix – Effect of surface roughness – Interfacial bonding

UNIT II	**REINFORCEMENTS AND MATRICES**	**9**

Different types of fibers - Manufacturing , properties and applications of glass fibers, carbon fibers, Kevlar fibers. Thermoset and thermoplastic matrices - properties of polyester, epoxy and nylon matrices , polypropylene and PEEK matrices

UNIT III	**MANUFACTURING OF ADVANCED COMPOSITES**	**9**

Polymer matrix composites: Preparation of Moulding compounds and pre-pregs – hand lay up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding.

UNIT IV	**MECHANICS OF LAMINATED COMPOSITES**	**9**

Stress-strain relationship for anisotropic and orthotropic materials - Rule of Mixtures - invariant properties of orthotropic laminates – strength of an orthotropic lamina - failure criteria of orthoptropic lamina - macro mechanical behavior of laminates - classical laminate theory - inter laminar stresses.

UNIT V	**COMPOSITE STRUCTURES**	**9**

Fatigue – S-N curves – Fatigue behaviors of CMCs – Fatigue of particle and whisker reinforced composites – Hybrid composites – Thermal fatigue.

Introduction to structures - selection of material, manufacturing and laminate configuration - design of joints - bonded joints - bolted joints - bonded and bolted – laminate optimization.

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

REFERENCES:

1	Mallick, P.K., “Fiber Reinforced Composites: Materials, Manufacturing and Design”, Third Edition, Marcel Dekker Inc, 2007.
2	Agarwal, B.D., and Broutman L.J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, 2006.
3	Autar K. Kaw, “Mechanics of Composite Materials” CRC Press, 2006
4	Robert M. Jones, “Mechanics of Composite Materials” Taylor and Francis, 1999
5	Chawla K.K Composite Materials: Science and Engineering., Springer – Verlag, 2008
6	Ronald Gibson, “Principles of Composite Material Mechanics", Tata McGraw Hill, 2007.

	THERMAL ENGINEERING LABORATORY	0	0	3	100
1	Study of IC Engines				
2	Valve Timing and Port Timing Diagrams.				
3	Performance Test on 4-stroke Diesel Engine.				
4	Heat Balance Test on 4-stroke Diesel Engine.				
5	Morse Test on Multi cylinder Petrol Engine.				
6	Retardation Test to find Frictional Power of a Diesel Engine.				
7	Study of Steam Boilers and Turbines.				
8	Determination of Viscosity using Red Wood Viscometer.				
9	Determination of Flash Point and Fire Point.				
10	Performance Test on Steam Turbine.				
11	Performance test on reciprocating air compressor				
12	Performance test on centrifugal blower				

	KINEMATICS & DYNAMICS LABORATORY	0	0	3	100	
LIST OF EXPERIMENTS						
1	Kinematics of 4 bar mechanisms – Slider crank and Crank Rocker Mechanism - Determination of velocity and acceleration.					
2	Kinematics of Universal Joints – Determination of velocity and acceleration					
3	Kinematics of Gear Trains – Simple, Compound, Epi-cyclic and Differential : Determination of velocity ratio and Torque					
4	Governors - Determination of sensitivity, effort, etc. for Watt, Porter, Proell, Spring controlled Governors					
5	Cam – Determination of jump speed and profile of the cam.					
6	Motorized Gyroscope-Verification of laws -Determination of gyroscopic couple.					
7	Whirling of shaft-Determination of critical speed of shaft with concentrated loads.					
8	Balancing of rotating and reciprocating masses.					
9	Determination of moment of inertia by oscillation method for connecting rod and flywheel.					
10	Vibrating system - Spring mass system - Determination of damping co-efficient of single degree of freedom system					
11	Determination of torsional frequencies for compound pendulum and flywheel system with lumped Moment of inertia.					
12	Transverse vibration –free- Beam. Determination of natural frequency and deflection of beam.					
	Total No of periods			**:**	**45**	

	ELECTRONICS AND MICROPROCESSOR LAB	0	0	3	100	2
	ELECTRONICS					
1	V-I Characteristics of PN Junction and 'Zener' diode.					
2	Transistor characteristics in Common Emitter mode.					
3	Study of RC-Phase shift Oscillator.					
4	Study of Logic gates and verification of their truth tables.					
5	Study of Half-adder and Full adder and verification of their truth tables.					
6	Study of Flip-flops. (i) R-S Flip-flop. (ii) D Flip-flop. (iii) J-K Flip-flop. (iv) T- Flip-flop.					
	MICROPROCESSOR					
7	Writing Assembly level programming in 8085 microprocessor for the following (i) 8-bit Addition. (ii) 8-bit Subtraction. (iii) 8-bit Multiplication. (iv) 8-bit Division.					
8	Writing Assembly level programming in 8085 microprocessor for finding Maximum and Minimum number in a block of data.					
9	Writing Assembly level programming in 8085 microprocessor for transferring a block of data from one block to another block.					
10	Writing Assembly level programming in 8085 microprocessor for sorting data.					
11	Stepper motor Interfacing in 8085 Microprocessor.					
	Total No of Periods :45					

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SEMESTER-6

	FINITE ELEMENT ANALYSIS (Common to Mechanical and Automobile Engineering)	**3**	**1**	**0**	**100**	**4**

UNIT I	**Introduction**	**8**

Historical background – Relevance of FEA to design problems, Application to the continuum – Discretisation – Matrix approach, Matrix algebra – Gaussian elimination – Governing equations for continuum – Classical Techniques in FEM – Weighted residual method – Ritz method, Galerkin method

UNIT II	**ONE DIMENSIONAL PROBLEMS**	**12**

Finite element modeling – Coordinates and shape functions – Potential energy approach– Element matrices and vectors – Assembly for global equations – Boundary conditions – Higher order elements - Shapes functions – Applications to axial loadings of rods – Extension to plane trusses – Bending of beams – Finite element formulation of stiffness matrix and load vectors – Assembly to Global equations –boundary conditions – Solutions and Post processing - Example Problems.

UNIT III	**TWO DIMENSIONAL PROBLEMS – SCALAR VARIABLE PROBLEMS**	**6**

Finite element modeling – CST element – Element equations, Load vectors and boundary conditions – Assembly – Application to heat transfer - Examples

UNIT IV	**TWO DIMENSIONAL PROBLEMS – VECTOR VARIABLE PROBLEMS**	**10**

Vector Variable problems – Elasticity equations – Plane Stress, Plane Strain and Axisymmetric problems – Formulation – element matrices – Assembly – boundary conditions and solutions Examples

UNIT V	**ISOPARAMETRIC ELEMENTS FOR TWO DIMENSIONAL PROBLEMS**	**9**

Natural coordinates, Iso parametric elements, Four node quadrilateral element– Shape functions – Element stiffness matrix and force vector – Numerical integration - Stiffness integration – Displacement and Stress calculations – Examples.

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

TEXT BOOKS

1	Chandrupatla T.R., and Belegundu A.D., “Introduction to Finite Elements in Engineering”, Pearson Education 2002, 3rd Edition.
2	Logan D.L., “A First course in the Finite Element Method”, Third Edition, Thomson Learning, 2002

REFERENCE BOOKS

1	Rao S.S., “The Finite Element Method in Engineering”, Pergammon Press, 1989.
2	David V Hutton “Fundamentals of Finite Element Analysis”2004. McGraw-Hill Int. Ed.
3	Robert D.Cook., David.S, Malkucs Michael E Plesha, “Concepts and Applications of Finite Element Analysis” 4 Ed. Wiley, 2003.
4	Reddy J.N., “An Introduction to Finite Element Method”, McGraw-Hill International Student Edition, 1985

	DESIGN OF TRANSMISSION SYSTEMS	3	2	0	100	5

UNIT I	TRANSMISSION SYSTEMS USING FLEXIBLE ELEMENTS	9

Selection of V belts and pulleys – selection of Flat belts and pulleys – Selection of Transmission chains and Sprockets. Design of pulleys and sprockets

UNIT II	SPUR GEARS AND PARALLEL AXIS HELICAL GEARS	9

Gear Terminology-Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials – Module and Face width-power rating calculations based on strength and wear considerations - Parallel axis Helical Gears – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces and stresses. Estimating the size of the helical gears.

UNIT III	BEVEL AND WORM GEARS	9

Straight and spiral bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight and spiral bevel gears.
Worm Gear: Merits and demerits- terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

UNIT IV	DESIGN OF GEAR BOXES	9

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

UNIT V	DESIGN OF POWER SCREWS, CLUTCHES AND BRAKES	9

Types of screw threads used for power screws – Torque requirements – Stresses in Power screws, Design of Screw Jack.
Design of plate clutches – axial clutches - cone clutches - internal expanding rim clutches – Types of brakes and their applications – Design of internal and external shoe brakes.

LECTURE	**:**	**45**
TUTORIAL	**:**	**30**
TOTAL	**:**	**75**

Note: (Usage of P.S.G Design Data Book is permitted in the University examination)

TEXT BOOKS

1	Juvinall R. C., Marshek K.M., “Fundamentals of Machine component Design”, – John Wiley & Sons Third Edition, 2002.
2	Bhandari, V.B., “Design of Machine Elements”, Tata McGraw-Hill Publishing Company Ltd., 1994.

REFERENCES

1	Maitra G.M., Prasad L.V., “Hand book of Mechanical Design”, II Edition, Tata McGraw-Hill, 1985
2	Shigley J.E and Mischke C. R., “Mechanical Engineering Design”, McGraw-Hill International Editions, 1989
3	Norton R.L, “Design of Machinery”, McGraw-Hill Book co, 2004.
4	Hamrock B.J., Jacobson B., Schmid S.R., “Fundamentals of Machine Elements”, McGraw-Hill Book Co., 1999.

STANDARDS

1	IS 4460 : Parts 1 to 3 : 1995, Gears – Spur and Helical Gears – Calculation of Load Capacity
2	IS 7443 : 2002, Methods of Load Rating of Worm Gears
3	IS 15151: 2002, Belt Drives – Pulleys and V-Ribbed belts for Industrial applications – PH, PJ, PK, Pl and PM Profiles : Dimensions
4	IS 2122 : Part 1: 1973, Code of practice for selection, storage, installation and maintenance of belting for power transmission : Part 1 Flat Belt Drives.
5	IS 2122: Part 2: 1991, Code of practice for selection, storage, installation and maintenance of belting for power transmission: Part 2 V-Belt Drives.

	AUTOMOBILE ENGINEERING	3	0	0	100	3

UNIT I	VEHICLE STRUCTURE AND ENGINES	10

Types of Automobiles - Vehicle Construction – Chassis – Frame and Body – Components of Engine – Their forms, Functions and Materials - Review of Cooling and Lubrication systems in Engine – Turbo super Chargers – Engine Emission standards- Emission Control by 3–Way Catalytic Controller – Electronic Engine Management System.

UNIT II	ENGINE AUXILIARY SYSTEMS	10

Carburetor – basic type and working principle only - Electronic fuel injection system – Single point and MPFI Systems – Diesel Injection - CRDI System- Construction, Operation and Maintenance of Lead Acid Battery - Electrical systems – Generator – Starting Motor and Drives – Lighting and Ignition (Magneto Coil and Electronic Type) - Regulators-cut outs.

UNIT III	TRANSMISSION SYSTEMS	10

Clutch – Types and Construction –Clutch Linkages- Gear Boxes, Manual and Automatic – Simple Floor Mounted Shift Mechanism – Over Drives – Transfer Box Fluid flywheel-Torque converters– Propeller shaft – Slip Joint – Differential and Rear Axle – Hotchkiss Drive and Torque Tube Drive

UNIT IV	STEERING, BRAKES AND SUSPENSION SYSTEMS	8

Wheels and Tyres – Wheel Alignment Parameters - Steering Geometry and Types of steering gear box– Power Steering – Types of Front Axle – Suspension systems front and rear end - Conventional and air suspension – Braking Systems – Types and Construction – Diagonal Braking System.

UNIT V	ALTERNATIVE FUEL AND SAFETY DEVICES	7

Use of Natural Gas, LPG, Bio-diesel, Alcohol and Hydrogen in Automobiles – Concepts of Electric and Hybrid Vehicles, Fuel Cells – Antilock Braking System - Airbags - Stabilizers

Note: Practical training in dismantling and assembling of Engine parts Transmission System should be given to the students

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

TEXT BOOKS

1	Sethi H.M, “Automobile Technology”, Tata McGraw-Hill-2003
2	Newton, Steeds and Garret, “Motor vehicles”, Butterworth Publishers, 1989

REFERENCES

1	Crouse and Anglin “Automotive Mechanism”, 9th Edition. Tata McGraw-Hill, 2003
2	Kirpal Singh “Automobile Engineering Vol. 1& 2”, Standard Publishers, New Delhi.
3	Srinivasan.S , “ Automotive Mechanics” 2nd edition, 2003, Tata McGraw-Hill.
4	Joseph Heitner, “Automotive Mechanics”, 2nd edition, East-West Press, 1999.

	POWER PLANT ENGINEERING	3	0	0	100	3

UNIT I	INTRODUCTION TO POWER PLANTS & BOILERS	9

Layout of Hydel power plants – Types – Standalone – Pumped Storage. Steam Boilers and cycles – High pressure and supercritical boilers – Fluidized bed boilers – Analysis of power plant cycles - Combined power cycles – comparison and selection.

UNIT II	STEAM POWER PLANT	9

Layout and types of Steam Power Plants - Fuel and Ash handling systems – combustion equipment for burning coal – Mechanical stokers – Pulverizers – Electrostatic precipitator – Draught – different types, Surface condenser types, Cooling towers, Pollution Controls.

UNIT III	NUCLEAR POWER PLANTS	9

Nuclear energy - Fission, Fusion reaction - Layout of nuclear power plants - Types of reactors, pressurized water reactor - Boiling water reactor - Gas cooled reactor - Fast breeder reactor - Waste disposal and safety.

UNIT IV	DIESEL AND GAS TURBINE POWER PLANTS	9

Layout and types of Diesel power plants and components, selection of engine type, applications. Gas Turbine power plant – Layout - Fuels, gas turbine material, types of combustion chambers - reheating, regeneration and inter - cooling.

UNIT V	POWER PLANT ECONOMICS	9

Economics of power plant – Actual load curves-cost of electric energy-fixed and operating costs-energy rates – Types of Tariffs – Economics of load sharing – variable load operation - comparison of economics of various power plants.

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

TEXT BOOKS

1	El-Wakil M.M. ‘ Power Plant Technology’ Mc-Graw Hill 1984
2	Arora S.C. and Domkundwar.S, ‘A Course in Power Plant Engineering’, Dhanpatrai, 2001
3	Nag P.K., ‘Power Plant Engineering’, Tata-McGraw Hill, 1998

REFERENCES

1	Frank D.Graham,’Power Plant Engineers Guide’, D.B. Taraporevala Sons&Co., New Delhi, 1993.
2	T.Morse Frederick,’Power Plant Engineering’, Prentice Hall of India, 1998.
3	R.K.Rajput,’Power Plant Engineering’, Laxmi Publications,1995.
4	G.D.Rai,’Introduction to Power Plant Technology”, Khanna Publishers, 1995.

	GAS DYNAMICS AND JET PROPULSION	3	1	0	100	4

UNIT I	COMPRESSIBLE FLOW – FUNDAMENTALS	9

Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility.

UNIT II	FLOW THROUGH VARIABLE AREA DUCT	9

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

UNIT III	FANNO AND RAYLEIGH FLOW	9

Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno equation, variation of flow properties, variation of Mach number with duct length.

Isothermal flow with friction in constant area ducts – Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer.

UNIT IV	NORMAL SHOCK	9

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl-Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock, normal shock in Fanno and Rayleigh flows, flows with oblique shock (elementary treatment only).

UNIT V	PROPULSION	9

Aircraft propulsion- types of jet engines-energy flow through jet engines, study of turbojet engine components-diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines-thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engines, ram jet and pulse jet engines.

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

TEXT BOOKS

1. Yahya.S.M., ‘Fundamentals of Compressible flow” , New Age International (P) Ltd., New Delhi, 1996.
2. Rathakrishnan.E, “ Gas Dynamics” , Prentice Hall of India, New Delhi, 2001

REFERENCES

1. Patrich.H.Oosthvizen, Willam E.Carscallen, “Compressible fluid flow”, McGraw-Hill, 1997.
2. Cohen. H., Rogers R.E.C and Sravanamutoo, “Gas turbine theory”,AddisonWesleyLtd.,1987
3. Ganesan .V., “Gas Turbines”, Tata McGraw-Hill, New Delhi,1999
4. Zucker,R.D. and Biblarz,O., Fundamentals of Gas Dynamics,2nd ed., John Willey, 2002

	ENGINEERING ECONOMICS AND FINANCE (Common to Mechanical and Automobile Engineering)	**3**	**0**	**0**	**100**	**3**

UNIT I	**INTRODUCTION TO ECONOMICS**	**8**

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics - Elements of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

UNIT II	**VALUE ENGINEERING**	**10**

Make or buy decision, Value engineering – Function, aims, and Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

UNIT III	**CASH FLOW**	**9**

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods

UNIT IV	**REPLACEMENT AND MAINTENANCE ANALYSIS**	9

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

UNIT V	**DEPRECIATION**	**9**

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

Text Book

1. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, NewDelhi, 2001

REFERENCES:

1. Chan S.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2002
2. Donald.G. Newman, Jerome.P.Lavelle, “Engineering Economics and analysis” Engg. Press, Texas, 2002
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, Macmillan, New York, 1984
4. Grant.E.L., Ireson.W.G., and Leavenworth, R.S, “Principles of Engineering Economy”, Ronald Press, New York,1976.
5. Smith, G.W., “Engineering Economy”, Lowa State Press, Iowa, 1973.

	SIMULATION AND ANALYSIS LABORATORY	0	0	3	100	

LIST OF EXPERIMENTS

1 Simulation using SOFTWARES LIKE MATLAB, MATHCAD, LABVIEW

1. Simulation of Air conditioning system with condenser and evaporator temperatures as input to estimate COP
2. Simulation of Hydraulic / Pneumatic cylinder.
3. Simulation of cam and follower mechanism.
4. Simulation of Spring Mass Damper System Control.
5. Simulation of heat exchanger process.

2 Analysis (Simple Treatment only)

1. Stress analysis of rectangular L bracket.
2. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
3. Mode frequency analysis of beams. (Cantilever, Simply supported, Fixed ends)
4. Harmonic analysis of a 2D component.
5. Thermal stress analysis of a 2D component.
6. Conductive heat transfer analysis of a 2D component.

Total No of periods	**:**	**45**

	COMPUTER AIDED MANUFACTURING (CAM) LABORATORY	0	0	3	100	

LIST OF EXPERIMENTS

1	Manual part programming (Using G and M Codes) in CNC lathe

Part programming for Linear and Circular interpolation, Chamfering and Grooving
Part programming using standard canned cycles for Turning, Facing, Taper turning and Thread cutting.

2	Manual part programming (using G and M codes) in CNC milling

2.1 Part programming for Linear and Circular interpolation and Contour motions.
2.2 Part programming involving canned cycles for Drilling, Peck drilling, and Boring.

3	Exposure to Component Modeling and CL data generation using CAD/CAM Software like Unigraphics, Pro/E, Edge CAM etc., NC code generation using CAD/CAM software-Post processing for standard CNC control like FANUC, SINUMERIC etc.,

Total No of periods	**:**	**45**

	HEAT POWER LABORATORY	0	0	3	100	

LIST OF EXPERIMENTS

1 Heat Transfer

1. Thermal conductivity measurements by guarded plate method
2. Thermal conductivity of pipe insulation using lagged pipe apparatus.
3. Natural convection heat transfer from a vertical cylinder
4. Forced convection inside tube.
5. Heat Transfer from Pin-fin (Natural & Forced convection modes)
6. Determination of Stefan- Boltzman constant
7. Determination of Emissivity of a grey surface.
8. Effectiveness of parallel/ Counter flow heat Exchanger.

2 Refrigeration and Air conditioning

1. Study of Refrigeration and Air conditioning systems.
2. Determination of COP of a Refrigeration system.
3. Determination of COP of an air conditioning system.

Total No of periods	**:**	**45**

COMPREHENSION LABORATORY AND MINI PROJECT

Comprehension Laboratory

The objective of comprehension is to provide opportunity for the student to revise the fundamental knowledge acquired during the earlier semesters and apply to real life problems. The student is expected to take up objective and other types of testing processes and prove his/her understanding of the fundamentals.

Mini Project

Students could join (maximum 3) together, form a small team and execute a simple project in the area of Design, Analysis, Fabrication, and Thermal Engg relevant to Mechanical Engineering field under the guidance of a faculty.

The mini project shall be submitted in a report form and should be presented before a committee constituted by the head of the Institution, which shall evaluate the project work done for 25 marks.

The committee will consist of head of the department, the supervisor of the mini project and two senior faculty member of the department.

Evaluation Procedure

<table>
<tr><td rowspan="5">Comprehension</td><td>Subject Area</td><td>No. of Tests and duration</td><td>No. of objective type questions for each test</td><td>Mark Weightage</td><td>Marks</td><td>Total Marks</td></tr>
<tr><td>Design Engineering[(a)]</td><td>3 tests each 1½ hr</td><td>100</td><td>20</td><td rowspan="4">75</td><td rowspan="5">100</td></tr>
<tr><td>Thermal & Fluid Engineering[(b)]</td><td>3 tests each 1½ hr</td><td>100</td><td>20</td></tr>
<tr><td>Materials and Manufacturing Engineering[(c)]</td><td>3 tests each 1½ hr</td><td>100</td><td>20</td></tr>
<tr><td>Design, Thermal, Fluid and Manufacturing Engineering</td><td>1 test 3 hours</td><td>200</td><td>15</td></tr>
<tr><td>Mini Project</td><td colspan="3">On topics relevant to Mechanical Engineering field</td><td>25</td><td>25</td></tr>
</table>

(a) Engineering Mechanics, Kinematics and Dynamics of Machines, Mechanics of Materials and Design of machine elements, etc.

(b) Engineering Thermodynamics, Thermal Engineering, Fluid Mechanics and Machinery, etc.

(c) Materials Science, Engineering Metallurgy, Machine Tool Engineering, Production Processes, Metrology and Measurements, Computer Aided manufacturing, etc.

REGULATION 2008: B.E.MECHANICAL ENGINEERING SYLLABUS
SEMESTER-7

	BUSINESS CONCEPTS (Common for Mechanical and Automobile Engineering)	**3**	**0**	**0**	**100**	**3**

UNIT I	**BUSINESS ENVIRONMENT**	**10**

Nature and purpose of business, classification of business activities: industry, commerce and trade, objective of business and essential of successful business, economic environment –basic problems of scarcity and choice, allocation of resources ,opportunity cost, Business growth and measurement of size ,International Environment-balance of trade ,the trade gap ,and balance of payments, role and methods of trade protectionism, Business Ethics.

UNIT II	**BUSINESS STRUCTURE AND ORGANIZATION**	**7**

Historical view of business development forms of business organization: sole proprietorship, partnership, join stock companies, co-operative societies, public enterprise-Definition, Meaning, characteristics, Advantages and Disadvantages, Role of Government in business activity, organization charts.

UNIT III	**ELEMENTS OF BUSINESS ACTIVITY**	**9**

Purchasing-choosing suppliers, overview of stock control, production-scale of production, main features of job, mass, and batch production systems, Marketing-concept and role of marketing, marketing mix, channels of distribution, Finance-sources of finance, assessing business performance.

UNIT IV	**HUMAN RESOURCES**	**10**

Demographic trends and their impact on business concerns, unemployment-effects and types of unemployment, local trends in employment in various sectors, selection, recruitment, training of workers, motivation, basic knowledge of working age, contract of work, minimum wage, statutory hours of work, statutory benefits.

UNIT V	**FOREIGN TRADE AND BANKING**	**9**

Foreign trade-meaning, nature, importance, procedure of export and import, globalization, MNC, MNE, Introductory idea about commercial banks-functions and services, Insurance-meaning, types, principles, benefits.

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

REFERENCES

1	Joel Dean - Managerial Economics, Prentice Hall/Pearson, 2007
2	Rangarajan - Principles of Macro Economics, Tata McGraw Hill
3	Marketing Management - Philip Kotler - Pearson Education- Millennium Edition
4	Gary Dessler, "Human Resource Management", Seventh edition, Prentice-Hall of India P.Ltd., Pearson

	DESIGN OF JIGS, FIXTURES, PRESS TOOLS AND MOULDS	3	1	0	100	4

UNIT I	LOCATING AND CLAMPING PRINCIPLES	8

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

UNIT II	JIGS AND FIXTURES	10

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

UNIT III	PRESS WORKING TERMINOLOGIES & ELEMENTS OF CUTTING DIES	9

Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

UNIT IV	BENDING FORMING AND DRAWING DIES	9

Difference between bending, forming and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads- ironing – Design and development of bending, forming, drawing reverse re-drawing and combination dies – Blank development for axi- symmetric, rectangular and elliptic parts – Single and double action dies

UNIT V	DESIGN OF MOULDS	9

Types of moulds and dies for various processing methods - Mould and Die Design Concept and Materials. Injection Mould Design - Basics of mould construction - Methodical Mould Design - Design of Feed System, Ejection System - Venting - Design of Cooling system - Mould alignment concepts and De-moulding Techniques. Moulds with a slide core - Split cavity moulds.

(Use of Approved Design Data Book is permitted).

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

TEXT BOOKS	
1	Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004
2	Donaldson, Lecain and Goold “Tool Design”, III rd Edition Tata McGraw Hill, 2000
REFERENCES	
1	K. Venkataraman, “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.Kempster, “Jigs and Fixture Design”, Hoddes and Stoughton – Third Edition 1974.
2	R.G.W.Pye, Injection Mould Design, SPE Publication, 2000
3	Hoffman “Jigs and Fixture Design” – Thomson Delmar Learning, Singapore, 2004
4	ASTME Fundamentals of Tool Design Prentice Hall of India

	METROLOGY AND MEASUREMENTS	3	0	0	100	3

UNIT I	CONCEPT OF MEASUREMENT	9

General concept – Generalised measurement system-Units and standards-measuring instruments- sensitivity, readability, range of accuracy, precision-static and dynamic response-repeatability-systematic and random errors-correction, calibration, interchangeability.

UNIT II	LINEAR AND ANGULAR MEASUREMENT	9

Definition of metrology-Linear measuring instruments: Vernier, micrometer, interval measurement, Slip gauges and classification, interferometery, optical flats, limit gauges-Comparators: Mechanical, pneumatic and electrical types, applications. Angular measurements: -Sine bar, optical bevel protractor – Taper measurements.

UNIT III	FORM MEASUREMENT	9

Measurement of screw threads-Thread gauges, floating carriage micrometer-measurement of gears-tooth thickness-constant chord and base tangent method-Gleason gear testing machine – radius measurements-surface finish, straightness, flatness and roundness measurements.

UNIT IV	LASER AND ADVANCES IN METROLOGY	9

Precision instruments based on laser-Principles- laser interferometer-application in linear, angular measurements and machine tool metrology

Coordinate measuring machine (CMM)- Constructional features – types, applications – digital devices- computer aided inspection.

UNIT V	MEASUREMENT OF POWER, FLOW AND TEMPERATURE RELATED PROPERTIES	9

Force, torque, power:-mechanical, pneumatic, hydraulic and electrical type-Flow measurement**:** Venturi, orifice, rotameter, pitot tube –Temperature: bimetallic strip, pressure thermometers, thermocouples, electrical resistance thermister.

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

REFERENCES:

1.	Beckwith T.G, and N. Lewis Buck, “Mechanical Measurements”, Addison Wesley, 1991
2.	Jain R.K., “Engineering Metrology”, Khanna Publishers, 1994
3.	Alan S. Morris, “The Essence of Measurement”, Prentice Hall of India, 1997
4.	Gupta S.C, “Engineering Metrology”, Dhanpat rai Publications, 1984
5.	Jayal A.K, “Instrumentation and Mechanical Measurements”, Galgotia Publications 2000
6	Donald D Eckman, “Industrial Instrumentation”, Wiley Eastern, 1985.

	MECHATRONICS	3	0	0	100	3

UNIT I	INTRODUCTION	7

Evolution, scope, components of mechatronic systems, overview of mechanical, hydraulic & pneumatic actuators. Control Systems: Automatic control, open loop and closed loop control, servomechanism, block diagram algebra, concept of transfer function. Modes of control: on/off, P, PI, PD and PID

UNIT II	SENSORS & ACTUATORS	9

Performance, terminology, characteristics, types, binary and analog. Position Sensors: Limit switch, photoelectric switches, proximity sensors, pneumatic limit valves and backpressure sensors, pressure switches, resolvers, incremental & absolute encoders, decoders & relays. Displacement: Potentiometer sensors, LVDT, capacitive displacement sensors. Velocity sensors: Tachogenerator, use of encoders

Actuator types, Specifications and Control, Characteristics of AC Motors: Pulse width modulation to control AC frequency, cycloconvertor for AC frequency control. DC Motors: Brushless DC servomotors, timing motors, SCR (Silicon Controlled Rectifiers) motors, factors for selecting motor, piezoelectric actuators, solenoids, torque motors.

UNIT III	PROGRAMMABLE CONTROLERS AND SIGNAL CONDITIONING	9

Review of logic gates, programmable logic controllers (PLC): basic structure, i/o processing, programming, ladder diagrams, logic functions, latching, sequencing, timers, jumps, analog i/o, applications.

Signal conditioning process, clock signal, voltage divider, rectification, Operational Amplifiers: inverting and non-inverting, summing, integrating, differential, logarithmic, comparator. Interfacing input output ports, serial and parallel interfacing requirements, buffers, handshaking, polling and interrupts.

UNIT IV	COMPUTER NUMERICAL CONTROL SYSTEMS & MICROCONTROLLER	10

Structure of CNC controller, reference pulse & sampled data type CNC system. (a) Position and velocity control loops for i) Point to Point control: incremental and absolute, open and closed control loops, deceleration diagram in PTP system, loop comparator in absolute systems; ii) Continuous Path Control loop for position and velocity control, two axis contouring system for constant frequency & constant velocity commands. (b) Adaptive Control: Principle, Adaptive control for a machine tool, adaptive control with optimization (ACO) and with constraints (ACC), applications for m/c tools like lathe, grinding etc.

Comparison between microprocessor and micro controller, organization of a microcontroller system, architecture of MCS 51 controller, pin diagram of 8051, addressing modes, instruction types and set - Applications.

UNIT V	MEMS AND DESIGN OF MECHATRONIC SYSTEMS	10

Overview of MEMS & Microsystems, Typical MEMS & Micro system products & applications. (i) Micro sensors and micro actuators: Phototransistors, pressure sensors, thermal sensors, micro grippers, micro motors, micro valves, micro pumps. (ii) Micro manufacturing: Bulk manufacturing, surface manufacturing, LIGA Process.

The design process, traditional and mechatronic designs, A few case studies like piece counting system, pick and place manipulator, simple assembly task involving a few parts, part loading / unloading system, automatic tool and pallet changers etc

LECTURE	:	45
TUTORIAL	:	-
TOTAL	:	45

TEXT BOOK	
W. Bolton, “Mechatronics’, 3/e, Addison Wesley, 1999.	
REFERENCES:	
1.	Ogata k., “Modern Control Engineering” Pearson Education, 2002, ISBN 81-7808-579-8
2.	David. W. Pessen , “Industrial Automation”,John Wiley & Sons, ISBN 9971- 51-054-5.
3.	S. Brain Morriss, “Automated Manufacturing Systems: Sensors, Actuators”, McGraw Hill, 1994
4.	Singh M.D. and Joshi J.G., Mechatronics, PHI Learning Private Limited, 2009
5.	Dan Necsulescu , “Mechatronics”, Pearson Education, ISBN 81-7808 -676 – X.
6	Yoram Koren , “Computer Control Of Manufacturing systems” McGraw Hill, ISBN 0-07-066379-3

	METROLOGY AND MEASUREMENT LABORATORY	0	0	3	100	2

LIST OF EXPERIMENTS

1. Calibration of Vernier, Micrometer and Dial Gauge
2. Checking Linear and angular Dimensions of a part using slip gauges / sine bars
3. Measurement of Taper Angle using sine bar / bevel protractor
4. Measurement of cutting tool parameters using tool makers microscope
5. Measurement of straightness and flatness using auto-collimator
6. Measurement of thread parameters using Profile projector and Floating carriage micrometer
7. Checking the limits of dimensional tolerances using comparators (Mechanical / Pneumatic / Electrical)
8. Measurement of Temperature using Thermocouple / Pyrometer
9. Measurement of Displacement using Strain Gauge / LVDT / Wheatstone Bridge
10. Measurement of Force using load cell / proving ring
11. Measurement of Torque using Torque sensor
12. Measurement of Gear tooth dimensions using Gear Tooth Tester

Total No of periods	**:**	**45**

	MECHATRONICS LABORATORY	0	0	3	100	2

LIST OF EXPERIMENTS

1. Design and testing of fluid power circuits to control
2. (i)velocity (ii) direction and (iii) force of single and double acting actuators
3. Design of circuits with logic sequence using Electro pneumatic trainer kits.
4. Simulation of basic Hydraulic, Pneumatic and Electric circuits using software
5. Circuits with multiple cylinder sequences in Electro pneumatic using PLC.
6. Servo controller interfacing for open loop
7. Servo controller interfacing for closed loop
8. PID controller interfacing
9. Stepper motor interfacing with 8051 Micro controller
10. (i). Full step resolution (ii) Half step resolution
11. Modeling and analysis of basic electrical, hydraulic and pneumatic systems using LAB VIEW
12. Computerized data logging system with control for process variables like pressure flow and temperature

Total No of periods	**:**	**45**

TECHNICAL SEMINAR

- ✳ It is mandatory that each student will give individually a seminar on exclusive topic.
- ✳ During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for duration of not less than 30 minutes.
- ✳ Also, the student has to submit a hard copy of the technical topic, in the form of a report consisting of a title page, Introduction, body chapters and a conclusion with references, running to not less than 20 pages; this will be evaluated by the faculty coordinator/guide.
- ✳ In a session of three periods per week, 5 students are expected to present the seminar.
- ✳ In 13 weeks all students of the class would have completed giving the seminar.
- ✳ For every 10 students or for different area of their branch specialization, a faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- ✳ Students are encouraged to use various teaching aids such as over head projectors, power point presentation and demonstrative models.
- ✳ This will enable them to gain confidence in technical presentation skills and to face the placement interviews.

PROJECT PHASE - I

1. The students are expected to get formed into a team of convenient groups of not more than 4 members on a project.
2. Every project team shall have a guide who is the member of the faculty of the institution. Identification of student group and their faculty guide has to be completed within the first two weeks from the day of beginning of 7^{th} semester.
3. The group has to identify and select the problem to be addressed as their project work; make through literature survey and finalize a comprehensive aim and scope of their work to be done.
4. 25% of the total work to be done for the project work has to be completed by end of 7^{th} semester.
5. A mini project report (of the phase-I) to this effect has to be submitted by each student group.
6. One mid semester review and another end semester review of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member of the faculty team.
7. The same team of faculty will evaluate the project phase-I report. This evaluation will form 50% of the internal assessment mark. The remaining 50% of the internal assessment mark will be given at the end of the 8^{th} semester, at the time of completing the project work.

ELECTIVE SUBJECTS – SEMSTER - 7

	OPTIMIZATION TECHNIQUES	**3**	**1**	**0**	**100**	**4**

UNIT I	**UNCONSTRAINED OPTIMIZATION TECHNIQUES**	**10**

Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT II	**CONSTRAINED OPTIMIZATION TECHNIQUES**	**9**

Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming.

UNIT III	**DYNAMIC PROGRAMMING**	**7**

Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization,

UNIT IV	**UNCONVENTIONAL OPTIMIZATION TECHNIQUES**	**12**

Genetic algorithms, Simulated Annealing and Ant Colony techniques; Neural network & Fuzzy logic principles in optimization

UNIT V	**APPLICATIONS**	**7**

Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

REFERENCES

1	Kalyanamoy Deb, “Optimization for Engineering design algorithms and Examples”, Prentice Hall of India Pvt. Ltd. 2006.
2	Rao, Singaresu, S., “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, 2000.
3	Johnson Ray, C., “Optimum design of mechanical elements”, Wiley, John & Sons, 1990.
4	Goldberg, D.E., “Genetic algorithms in search, optimization and machine”, Barnen, Addison-Wesley, New York, 1989.

	COMPUTATIONAL FLUID DYNAMICS	3	1	0	100	4

UNIT I	GOVERNING EQUATIONS AND BOUNDARY CONDITIONS	8

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations

UNIT II	FINITE DIFFERENCE METHOD	9

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations.

UNIT III	FINITE VOLUME METHOD (FVM) FOR DIFFUSION	9

Finite volume formulation for steady state One and Two dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes

UNIT IV	FINITE VOLUME METHOD FOR CONVECTION DIFFUSION	10

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes

UNIT V	CALCULATION FLOW FIELD BY FVM	9

Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, two equation (k-Є) models – High and low Reynolds number models

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

TEXT BOOKS:

1	T.J. Chung, Computational Fluid Dynamics, Cambridge University, Press, 2002
2	Versteeg, H.K., and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The finite volume Method, Longman, 1998

REFERENCES:

1	Patankar, S.V. Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004
2	Muralidhar, K., and Sundararajan, T., computationsl Fluid Flow and Heat Transfer, Narosa Publishing House, NewDelhi, 1995.
3	Ghoshdastidar , P.S., computer Simulation of flow and heat transfer, Tata McGraw Hill Publishing Company Ltd., 1998
4	Prodip Niyogi, Chakrabarty .S.K., Laha .M.K. Introduction to Computational Fluid Dynamics, Pearson Education, 2005.
5	Anil W. Date ,Introduction to Computational Fluid Dynamics Cambridge University Press, 2005.

	REFRIGERATION AND AIR CONDITIONING	3	1	0	100	4

UNIT I	REFRIGERATION CYCLE	9

Review of thermodynamic principles of refrigeration. Concept of Aircraft refrigeration system - Vapour compression refrigeration cycle - use of P-H charts - multistage and multiple evaporator systems - cascade system - COP comparison. Vapor absorption refrigeration system. Ammonia water and Lithium Bromide water systems. Steam jet refrigeration system.

UNIT II	REFRIGERANTS AND SYSTEM COMPONENTS	9

Compressors - reciprocating & rotary (elementary treatment.) - condensers - evaporators - cooling towers. Refrigerants - properties - selection of refrigerants – Eco Friendly refrigerants - Refrigeration plant controls - testing and charging of refrigeration units. Balancing of system components. Applications to refrigeration systems - ice plant - food storage plants - milk - chilling plants – refrigerated cargo transports.

UNIT III	PSYCHROMETRY	9

Psychrometric processes- use of psychrometric charts - - Grand and Room Sensible Heat Factors - bypass factor - requirements of comfort air conditioning - comfort charts - factors governing optimum effective temperature, recommended design conditions and ventilation standards.

UNIT IV	COOLING LOAD CALCULATIONS	9

Types of load - design of space cooling load - heat transmission through building. Solar radiation - infiltration - internal heat sources (sensible and latent) - outside air and fresh air load - estimation of total load - Domestic, commercial and industrial systems - central air conditioning systems

UNIT V	AIR CONDITIONING	9

Air conditioning equipments – air cleaning and air filters - humidifiers - dehumidifiers - air washers - condenser – cooling tower and spray ponds - elementary treatment of duct design - air distribution system. Thermal insulation of air conditioning systems. - applications: car, industry, stores, and public buildings

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

TEXT BOOKS

1. Manohar Prasad, "Refrigeration and Air Conditioning", Wiley Eastern Ltd., 1983
2. Arora. C.P., "Refrigeration and Air Conditioning", Tata McGraw-Hill New Delhi, 1988

REFERENCES

1. Roy.J Dossat, “Principles of Refrigeration”, Pearson Education 1997.
2. Jordon and Prister, “Refrigeration and Air Conditioning”, Prentice Hall of India PVT Ltd., New Delhi, 1985
3. Sapali S.N., "Refrigeration and Air Conditioning", PHI Learning Private Ltd, 2009.
4. W.F.Stocker and J.W.Jones, “Refrigeration and Air Conditioning", McGraw-Hill, 1985.
5. Ahmadul Ameen "Refrigeration and Air Conditioning", Prentice Hall of India Pvt. Ltd. 2007.

	INTERNAL COMBUSTION ENGINES	3	1	0	100	

UNIT I	SPARK IGNITION ENGINES	9

Introduction to thermodynamic Analysis of S.I.engine combustion.- spark ignition engine mixture requirements – carburetors and fuel injection systems – Single point and multi point injection – stages of combustion – normal and abnormal combustion – Factors affecting knock – measurement of knock – Anti knock agent – types of combustion chambers.

UNIT II	COMPRESSION IGNITION ENGINES	9

Introduction to thermodynamic analysis of C.I. engine combustion – States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion Chambers – Fuel spray behaviors – Spray structure, spray penetration and evaporation – Air motion

UNIT III	ALTERNATIVE FUELS	9

Methanol, Ethanol, Hydrogen, Natural gas, Biogas, Bio diesel, Liquefied petroleum gas – Properties, suitability, Engine Modifications, Merits and Demerits as fuels.

UNIT IV	RECENT TRENDS	9

Lean Burn Engines – stratified Charge engines – gasoline direct injection engine – homogeneous charge compression ignition - plasma ignition – Zero emission vehicle, Variable compression ratio engines, turbo charged engines

UNIT V	POLLUTANT FORMATION CONTROL	9

Pollutant – Sources and types – formation of Nox – Hydrocarbon Emission Mechanism – carbon Monoxide Formation – Particulate emissions – Effect of pollutant, emission standards – Methods of controlling Emissions – Catalytic converters and Particulate Traps - Method of measurement and Driving cycles.

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

TEXT BOOKS

1	V.Ganesan, Internal combustion Engines, 3rd edn., Tata McGraw Hill Pub. Co. Ltd., 2007
2	Gupta H. N., “Internal Combustion Engines, PHI Learning Private Limited, 2009

REFERENCES

1	Willard W. Pulkrabek. Engineering Fundamentals of the Internal Combustion Engine, PHI Learning Private Limited, 2008
2	John B.Heywood, Internal combustion Engines Fundamentals, McGraw Hill, 1988
3	R.B. Mathur and R.P. Sharmal, Internal combustion engines
4	Rowland S.Benson and N.D.Whitehouse, Internal combustion Engines, Vol.I and II, Pargamon press, 1983.
5	Duffy Smith, Auto Fuel Systems, The Good Heart Willox Company, Inc.1987.
6	R.K. Mohanty “ A text book of internal combustion engines,standard book House,2007.

	TURBO MACHINERY	3	1	0	100	4

UNIT I	PRINCIPLES	9

Energy transfer between fluid and rotor-classification of fluid machinery - Euler's equation - dimensionless parameters - specific speed – applications - velocity triangles - work and efficiency.

UNIT II	CENTRIFUGAL FANS AND BLOWERS	9

Types - stage and design parameters - flow analysis in impeller blades - volute and diffusers, losses, characteristic curves and selection, fan drives and fan noise.

UNIT III	CENTRIFUGAL COMPRESSOR	9

Construction details, impeller flow losses, slip factor, diffuser analysis, losses and performance curves

UNIT IV	AXIAL FLOW COMPRESSOR	9

Stage velocity diagrams, enthalpy - entropy diagrams, stage losses and efficiency, work done in single stage design - problems and performance characteristics

UNIT V	AXIAL AND RADIAL FLOW TURBINES	9

Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics.

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

TEXT BOOKS

1	Yahya, S.H., Turbines, Compressor and Fans, Tata McGraw Hill Publishing Company, 1996.
2	Venkanna B.K., Fundamentals of Turbo-machinery, PHI Learning Private Limited, 2009.

REFERENCES

1	Earl Logan, Jr., Hand book of Turbomachinery, Marcel Dekker Inc., 1992.
2	Dixon, S.I., Fluid Mechanics and Thermodynamics of Turbomachinery, Pergamon Press, 1990.
3	Shepherd, D.G., Principles of Turbomachinery, Macmillan, 1969.
4	Ganesan, V., Gas Turbines, Tata McGraw Hill Pub. Co., 1999.
5	Gopalakrishnan .G and Prithvi Raj .D, A Treatise on Turbomachines, Scifech Publications (India) Pvt. Ltd., 2002.

	INDUSTRIAL TRIBOLOGY	3	1	0	100	4

UNIT I	SURFACES AND FRICTION	9

Topography of Engineering surfaces- Contact between surfaces - Sources of sliding Friction – Adhesion – Ploughing - Energy dissipation mechanisms Friction Characteristics of metals - Friction of non metals. Friction of lamellar solids - friction of Ceramic materials and polymers - Rolling Friction - Source of Rolling Friction – Stick slip motion - Measurement of Friction.

UNIT II	WEAR	9

Types of wear - Simple theory of Sliding Wear Mechanism of sliding wear of metals - Abrasive wear – Materials for Adhesive and Abrasive wear situations - Corrosive wear - Surface Fatigue wear situations - Brittle Fracture - wear - Wear of Ceramics and Polymers - Wear Measurements

UNIT III	LUBRICANTS AND LUBRICATION TYPES	9

Types and properties of Lubricants - Testing methods – Concepts of Hydrodynamic, Hydrostatic, Elasto-hydrodynamic, and Boundary Lubrication. Thin film and thick film lubrication – Methods of lubrication – Semi solid and Solid Lubrication.

UNIT IV	FILM LUBRICATION THEORY	9

Fluid film in simple shear - Viscous flow between very close parallel plates - Shear stress variation Reynolds Equation for film Lubrication - High speed unloaded journal bearings - Loaded journal bearings – Reaction torque on the bearings - Virtual Co-efficient of friction - The Sommerfeld diagram.

UNIT V	SURFACE ENGINEERING AND MATERIALS FOR BEARINGS	9

Surface modifications - Transformation Hardening, surface fusion - Thermo chemical processes – Surface coatings - Plating and anodizing - Fusion Processes - Vapour Phase processes - Materials for rolling Element bearings - Materials for fluid film bearings - Materials for marginally lubricated and dry bearings.

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

TEXT BOOKS

1	A.Harnoy “ Bearing Design in Machinery “Marcel Dekker Inc, New York, 2003
2	Basu S.K. et. Al., “Fundamentals of Tribology” PHI Learning Private Limited, 2009.

REFERENCES

1	M.M.Khonsari & E.R.Booser, “ Applied Tribology”,John Willey &Sons,New York,2001
2	E.P.Bowden and Tabor.D., " Friction and Lubrication ", Heinemann EducationalBooks Ltd., 1974.
3	A.Cameron, “Basic Lubrication theory ", Longman, U.K.., 1981.
4	M.J.Neale (Editor), “Tribology Handbook ", Newnes. Butter worth, Heinemann, U.K., 1995.

	DESIGN FOR MANUFACTURING AND ASSEMBLY	3	1	0	100	4

UNIT I	SELECTION OF MATERIALS AND PROCESSES	9

Phases of design – General requirements for material and process selection, effect of material properties and manufacturing process on design – DFM approach - DFM Guidelines – Product design for manual assembly, automatic assembly and robotic assembly – Computer aided DFMA.

UNIT II	TOLERANCE ANALYSIS	9

Process capability – metrics – costs aspects – Feature tolerance – geometric tolerance – surface finish, review of relationship between attainable tolerance grades and difference machining process – Cumulative effect of tolerances; sure fit law , normal law and truncated normal law. Tolerance charting technique**:** Tolerance worksheets and centrality analysis, examples – Computer aided tolerance charting

UNIT III	SELECTIVE ASSEMBLY AND DATUM SYSTEMS	9

Interchangeable selective assembly – Control and axial play; introducing secondary machining operations, laminated shims, examples. Datum systems : Degrees of freedom, grouped datum systems different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess pair and tongue – slot pair – computation of translational and rotational accuracy, geometric analyses and applications.

UNIT IV	TRUE POSITION THEORY	9

Comparison between co-ordinate and convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, examples.

UNIT V	DESIGN FOR MACHINING	9

Design features to facilitate machining – Functional and manufacturing datum features, component design, machining considerations, redesign for manufacture, examples. Form design**:** Form design of castings and weldments – Redesign of castings based on parting line considerations, minimizing core requirements – redesigning case members using weldments.

LECTURE	**:**	**45**
TUTORIAL	**:**	**15**
TOTAL	**:**	**60**

REFERENCES

1	Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2	Bralla, Design for Manufacture handbook, McGraw hill, 1999.
3	Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
4	Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.

	TOOL DESIGN	3	0	0	100	3

UNIT I	TOOLING MATERIALS AND HEAT TREATMENT	9

Broad Classification of Tools-Cutting tools, Dies , Holding and Measuring tools Introduction – Properties of Materials – Ferrous Tooling Materials – Tool steels – Cast Iron – Mild, or low-carbon Steel – Nonmetallic Tooling Materials – Nonferrous Tooling Materials – Metal cutting Tools – Single-point cutting tools – Milling cutters – Drills and Drilling – Reamer classification – Taps – Tap classification- the selection of carbide cutting tools – Determining the insert thickness for carbide tools

UNIT II	DESIGN OF CUTTING TOOLS:	9

Single Point and multi-pint cutting tools. Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, planers etc. Chip breakers and their design. **Tools**: Classification and specification, nomenclature, Design of drills, milling cutters, broaches, taps etc. **Design of Form Tools:** Flat and circular form tools, their design and application.

UNIT III	DESIGN OF DIES	9

Classification of dies, Design of Dies for Bulk metal Deformation-Wire Drawing, Extrusion, Forging and Rolling; Design of Dies for Sheet metal: Blanking and Piercing, Bending and Deep-drawing; Design of Dies used for Casting and Moulding, Powder Metallurgy die design;

UNIT IV	DESIGN OF JIGS AND FIXTURES	9

Classification of Jigs and Fixtures, Fundamental Principles of design of Jigs and Fixtures, Location and Clamping in Jigs and fixtures, Simple design for drilling Jigs, Milling fixtures etc. Indexing Jigs and fixtures.

UNIT V	TOOL DESIGN FOR NUMERICALLY CONTROLLED MACHINE TOOLS	9

Introduction – The need for numerical control – A basic explanation of numeric control – Numerical control systems in use today – Fixture design for numerically controlled machine tools – Cutting tools for numerical control – Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool presetting – Introduction – General explanation of the Brown and sharp machine – tooling for Automatic screw machines

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

REFERENCES:

1.	Cyrll Donaldson, George H.LeCain, V.C. Goold, “Tool Design”, Tata McGraw Hill Publishing Company Ltd., 2000.
2.	Pollack, H.W. Tool Design, Reston Publishing Company, Inc. 1966
3.	Kempster, M.H.A. Principles of Jig and Tool Design, English University Press Ltd
4.	Prakash Hiralal Joshi, “Tooling data”, Wheeler Publishing, 2000

	MANAGEMENT INFORMATION SYSTEMS	3	0	0	100	3

UNIT I	INTRODUCTION	9

MIS concepts and structure – Role and impact of MIS – Functions of a manager. Management as a control system – Management by exception – Process of management – Planning, Organising, coordinating, Directing, Controlling – Role of information system- Organisation as a system – Information system activities – Types of Information systems- Basics of MIS.

UNIT II	DECISION MAKING:	9

Concepts, methods, tools and procedures – Behavioral concepts in decision making – Organisational decision making – Information – concepts, Classification, value of information, Methods of data and information collection. System – System analysis and design – Development of MIS.

UNIT III	MANAGING INFORMATION TECHNOLOGY	9

Managing information resources and technologies – Information System architecture and management – Centralised, Decentralised and Distributed Electronic Data Input – Supply chain management and Global information technology management. Ethics for Information system professional – Societal challenges for information technology – cyber crime.

UNIT IV	TECHNOLOGY OF INFORMATION SYSTEM	9

Database - Terminologies - Entities and attributes - Data models, schema and subschema - Data Independence – ER Diagram - Hierarchical model - Network approach - Relational Data model - concepts, principles, keys, relational operations - functional dependence - Normalisation, types - Query languages- MIS and RDBMS – Object oriented technology concepts – Objected oriented analysis – Business Process Re-engineering (BPR) – Data warehouse – e-Business.

UNIT V	APPLICATION OF MIS:	9

Production management, Personnel management, Financial management, Material and marketing management – Decision Support System (DSS) – Artificial Intelligence (AI) – Knowledge based Expert System (KBES)- Enterprise Management System (EMS) – Enterprise Resource Planning (ERP) – ERP features, selection, benefits, implementation – EMS and MIS – Overview of neutral networks, fuzzy logic, genetic algorithms.

LECTURES	**:**	**45**
TUTORIALS	**:**	**-**
TOTAL	**:**	**45**

REFERENCES

1	James A. O'Brien, "Management Information Systems", Sixth Edition, TMH, 2004.
2	Effy Oz, "Management Information Systems". Vikas Publishing, 2003 Third Edition.
3	William S. Jawadekar, "Management info Systems" TMH publishing co. Third edition.2006
4	O'Brien, James; Marakas, George"Management Information Systems", Seventh Edition, Tata McGraw-Hill, 2006.
5	R.Elmasri, S.B. Navathe "Fundamentals of Database Systems', (2007) 5th Edition, Addison-Wesley, USA

	SOFTWARE ENGINEERING	3	0	0	100	3

UNIT I		9
The Evolving role of Software – Software – The changing Nature of Software – Legacy software —A generic view of process– A layered Technology – A Process Framework – The Capability Maturity Model Integration (CMMI) – Process Assessment – Personal and Team Process Models. Product and Process. Process Models – The Waterfall Model – Incremental Process Models – Incremental Model – The RAD Model – Evolutionary Process Models – Prototyping – The Spiral Model – The Concurrent Development Model – Specialized Process Models – the Unified Process.		

UNIT II		9
Software Engineering Practice – communication Practice – Planning practice Modeling practice– Construction Practice –Deployment. Requirements Engineering - Requirements Engineering tasks – Initiating the requirements Engineering Process- Eliciting Requirements – Developing Use cases – Building the Analysis Models – Elements of the Analysis Model – Analysis pattern – Negotiating Requirements – Validating Requirements		

UNIT III		9
Requirements Analysis – Analysis Modeling approaches – data modeling concepts – Object oriented Analysis – Scenario based modeling – Flow oriented Modeling – Class based modeling – creating a behavior model		

UNIT IV		9
Design Engineering – Design process -Design Quality-Design model-User interface Design – Testing strategies- strategies Issues for conventional and object oriented software-validation testing –system testing –Art of debugging – Project management		

UNIT V		9
Software evolution - Verification and Validation -Critical Systems Validation – Metrics for Process, Project and Product-Quality Management -Process Improvement –Risk Management-Configuration Management		

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

TEXT BOOKS:

1	Roger S.Pressman, Software Engineering: A Practitioner's Approach, McGraw Hill international edition, Sixth edition, 2005.
2	Rajib Mall, Fundamentals of Software Engineering, PHI Learning Private Limited, 2009

REFERENCES:

1.	Stephan Schach, Software Engineering, Tata McGraw Hill, 2007
2.	Ian Sommerville, Software Engineering, 8th Edition, Pearson Education, 2008, (UNIT V)
3.	Pfleeger and Lawrence Software Engineering: Theory and Practice, Pearson Education, second edition, 2001
4	Carlo Ghezzi et. Al., Fundamentals of Software Engineering, PHI Learning Private Limited, 2009

	UNCONVENTIONAL MACHINING PROCESSES	**3**	**0**	**0**	**100**	**3**
UNIT I	**INTRODUCTION**					**9**
Need for non-traditional machining methods-Classification of modern machining processes – considerations in process selection. Materials. Applications. Ultrasonic machining – Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent development						
UNIT II	**MECHANICAL PROCESSES**					**9**
Abrasive jet machining, Water jet machining and abrasive water jet machining Basic principles, equipments, process variables, mechanics of metal removal, MRR, application and limitations. Ultrasonic Machining. (AJM, WJM and USM). Working Principles – equipment used – Process parameters – MRR-Variation in techniques used – Applications						
UNIT III	**ELECTRO – CHEMICAL PROCESSES**					**9**
Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, Tool design, Surface finish and accuracy economic aspects of ECM – Simple problems for estimation of metal removal rate. Fundamentals of chemical, machining, advantages and applications.						
UNIT IV	**THERMAL METAL REMOVAL PROCESSES -I**					**9**
General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting processes – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications.						
UNIT V	**THERMAL METAL REMOVAL PROCESSES -II**					**9**
Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes –General Principle and application of laser beam machining – thermal features, cutting speed and accuracy of cut. Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries. Chemical machining-principle-maskants –etchants- applications. Magnetic abrasive finishing, Abrasive flow finishing.						
					LECTURE	**: 45**
					TUTORIAL	**: -**
					TOTAL	**: 45**

REFERENCES:

1.	Vijay.K. Jain “Advanced Machining Processes” Allied Publishers Pvt. Ltd., New Delhi (2002) ISBN 81-7764-294-4.
2.	Benedict. G.F. “Nontraditional Manufacturing Processes” Marcel Dekker Inc., New York (1987)
3.	Pandey P.C. and Shan H.S. “Modern Machining Processes” Tata McGraw-Hill, New Delhi (1980).
4.	Mc Geough, “Advanced Methods of Machining” Chapman and Hall, London (1998)

	INDUSTRIAL ROBOTICS	3	0	0	100	3

UNIT I	FUNDAMENTALS OF ROBOT	7

Robot – Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Their Functions – Need for Robots – Different Applications

UNIT II	ROBOT DRIVE SYSTEMS AND END EFFECTORS	10

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of all these Drives.

End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations

UNIT III	SENSORS AND MACHINE VISION	10

Requirements of a sensor, Principles and Applications of the following types of sensors – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors

Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Image Processing and Analysis – Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms. Applications – Inspection, Identification, Visual Serving and Navigation.

UNIT IV	ROBOT KINEMATICS AND ROBOT PROGRAMMING	10

Forward Kinematics, Inverse Kinematics and Differences –Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – DH matrices - Deviations and Problems.

Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs

UNIT V	IMPLEMENTATION AND ROBOT ECONOMICS	8

RGV, AGV; Implementation of Robots in Industries – Various Steps; Safety Considerations for Robot Operations; Economic Analysis of Robots – Pay back Method, EUAC Method, Rate of Return Method

LECTURE	:	45
TUTORIAL	:	-
TOTAL	:	45

TEXT BOOKS	
1	M.P.Groover, “Industrial Robotics – Technology, Programming and Applications”, McGraw-Hill, 2001
REFERENCES	
1	Fu.K.S. Gonzalz.R.C., and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw-Hill Book Co., 1987
2	Yoram Koren, “Robotics for Engineers”, McGraw-Hill Book Co., 1992
3	Janakiraman.P.A., “Robotics and Image Processing”, Tata McGraw-Hill, 1995

	MICRO ELECTRO MECHANICAL SYSTEM	3	0	0	100	3

UNIT I	INTRODUCTION TO MICROSYSTEMS	7

Review of microelectronics manufacture and introduction to MEMS Overview of Microsystems technology. Laws of scaling. The multi disciplinary nature of MEMS. Survey of materials central to micro engineering. Applications of MEMS in various industries.

UNIT II	MICRO MANUFACTURING TECHNIQUES	10

Photolithography, Film deposition, Etching processes, Bulk micro machining, silicon surface micro machining, LIGA process, Rapid micro product development.

UNIT III	MICRO SENSORS AND MICRO ACTUATORS	10

Energy conversion and force generation, Electromagnetic Actuators, Reluctance motors, piezoelectric actuators, bi-metal-actuator Friction and wear.

Transducer principles, Signal detection and signal processing, Mechanical and physical sensors, Acceleration sensor, pressure sensor, Sensor arrays.

UNIT IV	INTRODUCTION TO MICRO / NANO FLUIDS	10

Fundamentals of micro fluidics, Micro pump – introduction – Types – Mechanical Micro pump – Non Mechanical micro pumps, Actuating Principles, Design rules for micro pump – modeling and simulation, Verification and testing – Applications.

UNIT V	MICROSYSTEMS DESIGN AND PACKAGING	8

Design considerations, Mechanical Design, Process design, Realization of MEMS components using intellisuite. Micro system packaging, Packing Technologies, Assembly of Microsystems, Reliability in MEMS

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

TEXT BOOKS

1	Mohamed Gad – el – Hak , MEMS Handbook, CRC Press, 2002
2	Rai-Choudhury P. MEMS and MOEMS Technology and Applications, PHI Learning Private Limited, 2009.

REFERENCES

1	Sabrie Solomon, Sensors Handbook, Mc Graw Hill, 1998
2	Marc F Madou, Fundamentals of Micro Fabrication, CRC Press, 2nd Edition, 2002
3	Francis E.H. Tay and W.O.Choong , Micro fluidics and Bio mems application, IEEE Press New York, 1997.
4	Trimmer William S., Ed., Micromachanics and MEMS, IEEE Press New York, 1997.
5	Maluf, Nadim, An introduction to Micro electro mechanical Systems Engineering, AR Tech house, Boston 2000.

	FACILITIES PLANNING AND LAYOUT DESIGN	3	0	0	100	3

UNIT I	FACILITY LOCATION AND ANALYSIS	9

Location decisions - Qualitative and Quantitative factors, Simple models in single facility and multi facility problems

UNIT II	LAYOUT DESIGN	9

Facilities requirement, need for layout study – types of layout; Design cycle – SLP procedure – Algorithms – ALDEP, CORELAP, CRAFT

UNIT III	CELLULAR LAYOUT	9

Group technology – Production Flow analysis (PFA), ROC (Rank Order Clustering) – Assembly Line balancing

UNIT IV	INTRODUCTION TO MATERIAL HANDLING	9

Principles, unit load concept, material handling system design, handling equipment types, selection and specification, containers and packaging.

UNIT V	WAREHOUSE DESIGN	9

Introduction – Measuring & Benchmarking warehouse performance – Warehouse operations, Receiving and put away principles, Pallet Storage and Retrieval system - Case Picking systems – Warehouse layout – Computerizing warehouse operations.

LECTURE	**:**	**45**
TUTORIAL	**:**	**-**
TOTAL	**:**	**45**

REFERENCES:

1.	Tompkins, J.A. and J.A.White, “Facilities planning”, John Wiley, 2003
2.	Richard Francis.L. and John A.White, “Facilities Layout and location - An analytical approach, Prentice Hall of India Pvt. Ltd. 2006.
3.	James Apple, M.Plant layout and “Material Handling”, John Wiley, 1977
4.	Sundaresh Heragu, “Facilities Design”, PWS Publishing Company, Boston, 1997
5.	Edward Frazelle, “World-Class Warehousing and Material Handling”, McGraw Hill Publishers, 2002.

	VIBRATION AND NOISE CONTROL	3	1	0	100	4
UNIT I	**BASICS OF VIBRATION**					**9**
Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.						
UNIT II	**VIBRATION OF CONTINUOUS SYSTEMS**					**9**
Vibration of continuous systems: exact methods, boundary value problem, eigen value problem, axial vibration of rods, transverse vibration of beams, response of system by modal analysis, general elastic waves, approximate methods to analyse system, different methods like Rayleigh's energy method, Rayleigh-Ritz method, Dunkerleys method.						
UNIT III	**CONTROL TECHNIQUES**					**9**
Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.						
UNIT IV	**BASICS OF NOISE**					9
Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise level, legislation, measurement and analysis of noise, measurement environment and equipment, frequency analysis, tracking analysis, sound quality analysis.						
UNIT V	**INDUSTRIAL NOISE AND CONTROL**					**9**
Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine accessory contributed noise, transmission noise. Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers						
					LECTURE :	**45**
					TUTORIAL :	**15**
					TOTAL :	**60**

TEXT BOOKS	
1.	Ambekar A.G. “Mechanical Vibrations and Noise Engineering” Prentice Hall of India Pvt. Ltd, 2008
2.	Singiresu S.Rao - “Mechanical Vibrations” - Pearson Education, ISBM –81-297-0179-0 - 2004.
REFERENCES:	
1	Rao V. Dukkipati & Srinivas J. “Mechanical Vibrations” - Prentice Hall of India Pvt. Ltd, 2008
2	Kewal Pujara “Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 1992.
3	Theory of Vibrations with applications – W. T. Thomson, CBS Publishers
4	Rao, J.S., & Gupta, K. – “Ind. Course on Theory and Practice Mechanical Vibration”, New Age International (P) Ltd., 1984.

	DESIGN OF PLASTIC COMPONENTS	3	0	0	100	

UNIT I	SELECTION OF PLASTICS	9

Mechanical Properties- Material Selection for Strength – Degradation - Wear Resistance and Frictional Properties- Special Properties - Processing - Costs. Mechanical Behavior of Plastics- Short term testing -Long term testing -Design Methods for Plastics using deformation data - Pseudo-Elastic design method for plastics-Thermal stresses and Strains- - Time Temperature Superposition - Fracture behavior - Creep behavior - Impact behavior.

UNIT II	DESIGN OF INJECTION MOULD COMPONENTS	9

Manufacturing Considerations - Mold Filling Considerations - Weld line-Shrinkage and Warpage - Cooling and Solidification - Structural design Considerations - Structural Members-Design for Stiffness - Processing Limitations in Product Design.

UNIT III	INTRODUCTION TO MOULD DESIGN	9

Types of moulds and dies for various processing methods - Mould and Die Design Concept and Materials. Injection Mould Design - Basics of mould construction - Methodical Mould Design - Design of Feed System, Ejection System - Venting - Design of Cooling system - Mould alignment concepts and De-moulding Techniques.

UNIT IV	COMPRESSION AND TRANSFER MOULD DESIGN	9

Basics of mould construction - Mould design -Positive moulds- Positive moulds with Lands- Multi-cavity moulds with individual, common Loading Chamber - Moulds with a slide core - Split cavity moulds.

UNIT V	BLOW MOULD DESIGN	9

Materials Selection, Mould Cooling, Clamping Force, Venting, Pinch-off, Head die design, Parison Diameter Calculation, Wall Thickness, Vertical-load strength, Blow ratio, Base pushup, Neck and Shoulder Design, Thread and beads, Bottom Design. Extrusion Die Design - Die geometry, Die Design, Materials and Classification.

LECTURES	**:**	**45**
TUTORIALS	**:**	**-**
TOTAL	**:**	**45**

TEXT BOOKS

1. R.G.W.Pye, Injection Mould Design, SPE Publication, 2000

REFERENCES

1	P.S.Cracknell and R.W Dyson, Handbook of Thermoplastics - Injection Mould Design, Chapman & Hall, 1993.
2	Laszlo Sors and Imre Balazs, Design of Plastics Moulds and Dies, Elsevier, Amsterdam, 1989.
4	R J Crawford, Plastics Engineering, Butterworth-Heinemann, Oxford, 1999
5	Edward Miller(Ed), Plastics Product Design Handbook Part A – Materials and Components, Marcel Dekker, 1981.

REGULATION 2008: B.E.MECHANICAL ENGINEERING SYLLABUS

SEMESTER-8

	TOTAL QUALITY MANAGEMENT	**3**	**0**	**0**	**100**	

UNIT I	**INTRODUCTION**	**9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM.

UNIT II	**TQM PRINCIPLES**	**9**

Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III	**TQM TOOLS & TECHNIQUES I**	**9**

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT VI	**TQM TOOLS & TECHNIQUES II**	**9**

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

UNIT V	**QUALITY SYSTEMS**	**9**

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

	Total	**45**

TEXT BOOK:

1.	Dale H.Besterfiled, et al., “Total Quality Management”, Pearson Education Asia, III Ed, Indian Reprint , 2006.

REFERENCES:

1	James R. Evans and William M. Lindsay, “The Management and Control of Quality”, (6^{th} Edition), South-Western (Thomson Learning), 2005.
2	Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
3	Subburaj R., “Total Quality Management”, Tata McGraw-Hill Education Private Ltd, 2005
4	Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006.
5	Janakiraman,B and Gopal, R.K, “Total Quality Management – Text and Cases”, Prentice Hall (India) Pvt. Ltd., 2006.

PROJECT WORK - Phase - II

8. The students are expected to get formed into a team of convenient groups of not more than 4 members on a project.
9. Every project team shall have a guide who is the member of the faculty of the institution. Identification of student group and their faculty guide has to be completed within the first two weeks from the day of beginning of the semester.
10. The group has to identify and select the problem to be addressed as their project work; make through literature survey and finalize a comprehensive aim and scope of their work to be done.
11. No change of guide or team members will be permitted after one month (unless the faculty or student has left the college). Head of the department is made responsible to ensure this.
12. Six periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, for library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the project.
13. The progress of the project is to be evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.
14. Each student shall finally produce a comprehensive report covering background information, literature survey, problem statement, project work details and conclusion. This final report shall be typewritten form as specified in the guidelines of university.
15. The project work is evaluated jointly by external and internal examiners constituted by the University based on oral presentation and the project report.

	ALTERNATIVE ENERGY SOURCES	**3**	**0**	**0**	**100**	**3**

UNIT I	**SOLAR ENERGY**	**9**

Solar Radiation – Measurements of solar Radiation and sunshine – Solar Thermal Collectors – Flat Plate and Concentrating Collectors – Solar Applications – fundamentals of photo Voltaic Conversion – solar Cells – PV Systems – PV Applications.

UNIT II	**WIND ENERGY**	**9**

Wind Data and Energy Estimation – wind Energy Conversion Systems – Wind Energy generators and its performance – Wind Energy Storage – Applications – Hybrid systems

UNIT III	**BIO - ENERGY**	**9**

Biomass, Biogas, Source, Composition, Technology for utilization – Biomass direct combustion – Biomass gasifier – Biogas plant – Digesters – Ethanol production – Bio diesel production and economics

UNIT VI	**OTEC, TIDAL, GEOTHERMAL AND HYDEL ENERGY**	**9**

Tidal energy – Wave energy – Data, Technology options – Open and closed OTEC Cycles – Small hydro, turbines – Geothermal energy sources, power plant and environmental issues.

UNIT V	**NEW ENERGY SOURCES**	**9**

Hydrogen - generation, storage, transport and utilization – Applications - power generation, transport – Fuel cells – technologies, types – economics and the power generation.

Total		**45**

TEXT BOOK:

1. G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.
2. Kothari D.P. et. al., Renewable Energy Sources and Emerging Technologies, Prentice Hall of India Pvt. Ltd. 2008

REFERENCES:

1	Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 1996.
2	Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 1986
3	G.N. Tiwari, solar Energy – Fundamentals Design, Modelling & applications, Narosa Publishing House, New Delhi, 2002.
4	L.L. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990.
5	S.P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

	CRYOGENIC ENGINEERING	3	0	0	100	3

UNIT I	INTRODUCTION	8

Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of cryogenics in space, Food Processing, super Conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry.

UNIT II	LIQUEFACTION CYCLES	10

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve – Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Helium Refrigerated Hydrogen Liquefaction Systems. Critical Components in Liquefaction Systems.

UNIT III	SEPARATION OF CRYOGENIC GASES	9

Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis – McCabe Thiele Method. Adsorption Systems for purification.

UNIT VI	CRYOGENIC REFRIGERATORS	8

Joule Thomson Cryocoolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators. Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators.

UNIT V	STORAGE, INSULATION AND INSTRUMENTATION	10

Cryogenic Storage vessels, Transportation, and Transfer Lines., Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation and Cryo-pumping. Instrumentation to measure Pressure, Flow, Level and Temperature

Total		45

TEXT BOOKS

1. Randali F. Barron, Cryogenic Systems, McGraw-Hill, 1985

REFERENCES:

1	Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989
2	Scott R.B., Cryogenic Engineering, Van Nostrand and Co., 1962.

	NUCLEAR ENGINEERING	3	0	0	100	3

UNIT I	NUCLEAR PHYSICS	7

Nuclear model of an atom-Equivalence of mass and energy-binding- radio activity-half life-neutron interactions-cross sections.

UNIT II	NUCLEAR REACTIONS AND REACTION MATERIALS	9

Mechanism of nuclear fission and fusion- radio activity- chain reactions-critical mass and composition-nuclear fuel cycles and its characteristics-uranium production and purification-Zirconium, thorium, beryllium.

UNIT III	REPROCESSING	9

Reprocessing: nuclear fuel cycles-spent fuel characteristics-role of solvent extraction in reprocessing-solvent extraction equipment

UNIT VI	NUCLEAR REACTOR	11

Nuclear reactors: types of fast breeding reactors-design and construction of fast breeding reactors-heat transfer techniques in nuclear reactors- reactor shielding. Fusion reactors.

UNIT V	SAFETY AND DISPOSAL	9

Safety and disposal: Nuclear plant safety - safety systems-changes and consequences of accident-criteria for safety-nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation.

	Total		45

TEXT BOOK:

1. P. K. Nag, Power plant Engineering - stream & nuclear, Tata Mc Graw Hill

REFERENCES:

1	Collier J.G., and Hewitt G.F, “Introduction to Nuclear power”, Hemisphere publishing, New York. 1987
2	Wakil M.M.El., “Power Plant Technology” – McGraw-Hill International, 1984.
3	Lipschutz R.D “Radioactive Waste-Politics, Technology and Risk”, Ballingor, Cambridge, 1980
	Thomas J.Cannoly, “Fundamentals of nuclear Engineering” John Wiley 1978.

	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	100	3

UNIT I	IMPORTANCE OF ENERGY CONSERVATION AND MANAGEMENT	8

World, national Energy consumption – environmental aspects – Energy prices, policies – Energy auditing: methodology, analysis, energy accounting – Measurements – Thermal and Electrical.

UNIT II	ELECTRICAL SYSTEMS	12

AC / DC current systems, Demand control, power factor correction, load management, Motor drives : motor efficiency testing, energy efficient motors, motor speed control – Lighting : lighting levels, efficient options, day lighting, timers, Energy efficient windows – electrical distribution systems – Transformers – Power quality – harmonic distortion.

UNIT III	THERMAL SYSTEMS	10

Boiler – efficiency testing, excess air control, Steam distribution & use – steam traps, condensate recovery, flash steam utilization, Thermal Insulation. Heat exchanger networking – concept of pinch, target settling, problem table approach

UNIT VI	ENERGY CONSERVATION	8

Energy conservation in Pumps, Fans (flow control) and blowers, Compressed Air Systems, Refrigeration and air conditioning systems – Waste heat recovery recuperators, heat sheets, heat pipes, heat pumps.

UNIT V	ENERGY MANAGEMENT, ECONOMICS	7

Energy resource management – Energy Management information systems – Computerized energy management – Energy economics – discount rate, payback period, internal rate of Return, life cycle costing – Financing energy conservation Projects.

Total		45

TEXT BOOK:

1. L.C. Witte, P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.

2. O. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.

REFERENCES:

1	I.G.C. Dryden, “The Efficient Use of Energy” Butterworths, London, 1982
2	W.C. turner, “Energy Management Hand book” Wiley, New York, 1982.
3	W.R. Murphy and G. Mc KAY “Energy Management” Butterworths, London 1987

	PRODUCT DESIGN, DEVELOPMENT AND LIFE CYCLE MANAGEMENT	3	0	0	100	3

UNIT I	INTRODUCTION	9

Product Development process – Product development organizations, Gather raw data – Interpret raw data- organize the needs into a hierarchy – Relative importance of the needs. Product life cycle management - concepts, benefits, value addition to customer. Life cycle models- creation of projects and roles, users and project management, system administration, access control and its use in life cycle.

UNIT II	PRODUCT SPECIFICATIONS	9

Establishing the product specifications– Target specifications – Refining specifications, concept generation-Clarify the problem – Search internally – Search externally – Explore systematically.

UNIT III	PRODUCT ARCHITECTURE	9

Concept selection- Screening – scoring, Product architecture – Implication of architecture – Establishing the architecture – Related system level design issues.

UNIT VI	INDUSTRIAL DESIGN	9

Need for industrial design – Impact of industrial design – Industrial design process – Management of industrial design process – Assessing the quality of industrial design, design for manufacturing- cost considerations, Impact of DFM decisions on other factors.

UNIT V	PRINCIPLES OF PROTOTYPING AND ECONOMIC ANALYSIS	9

Principles of prototyping – Planning for prototypes, economics of product development projects, Elements of economic analysis – Base – Case financial model – Sensitivity analysis – Influence of the quantitative factors.

Total		45

TEXT BOOK:

1. Karal, T.Ulrich steven D.Eppinger, Product Design and Development, McGraw Hill, International Editions, 2003

REFERENCES:

1	S.Rosenthal, Effective Product Design and Development, Irwin, 1992.
2	Charles Gevirtz Developing New products with TQM, McGraw Hill International Editions, 1994.

	ENTREPRENEURSHIP DEVELOPMENT	3	0	0	100	3

UNIT I	ENTREPRENEURSHIP	9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth

UNIT II	MOTIVATION	9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Entrepreneurial skills - Self Rating, Business Game, Thematic Appreciation Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III	BUSINESS	9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT VI	FINANCING AND ACCOUNTING	9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT / CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V	SUPPORT TO ENTREPRENEURS	9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting

	Total		45

TEXT BOOK:

1.S.S.Khanka “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi, 1999

2.Kurahko & Hodgetts, “ Enterprenuership – Theory, process and practices”, Thomson learning 6th edition.

REFERENCES:

1	Hisrich R D and Peters M P, “Entrepreneurship” 5th Edition Tata McGraw-Hill, 2002.
2	Mathew J Manimala,” Enterprenuership theory at cross roads: paradigms and praxis” Dream tech 2nd edition 2006.
3	Mathew J Manimala,” Enterprenuership theory at cross roads: paradigms and praxis” Dream tech 2nd edition 2006.
4	EDII “Faulty and External Experts – A Hand Book for New Entrepreneurs” Publishers: Entrepreneurship Development” Institute of India, Ahmedabad, 1986.

	ENTERPRISE RESOURCE PLANNING	3	0	0	100	3

UNIT I	INTRODUCTION	10

Principle – ERP framework – Business Blue Print – Business Engineering vs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

UNIT II	TECHNOLOGY	10

Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

UNIT III	ARCHITECTURE	10

Overview – Architecture – AIM – applications I– Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organisational and social issues.

UNIT iV	APPLICATIONS	7

SAP, People soft, Baan and Oracle – Comparison – Oracle SCM applications - Before and after Y2K – critical issues – Training on various modules of IBCS ERP Package - Oracle ERP and MAXIMO, including ERP on the NET

UNIT V	PROCUREMENT ISSUES	8

Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies

	Total		45

TEXT BOOKS

1. Vinod Kumar Garg and Venkitakrishnan N.K. “Enterprise Resource Planning – Concepts and Practice”, Prentice Hall of India Pvt. Ltd. 2008.

REFERENCES:

1	Sadagopan.S , ERP-A Managerial Perspective, Tata Mcgraw Hill, 1999.
2	Jose Antonio Fernandez, the SAP R/3 Handbook, Tata Mcgraw Hill, 1998
3	ERPWARE , ERP Implementation Framework, Garg & Venkitakrishnan, Prentice Hall,1999.
4	Thomas E Vollmann and Bery Whybark , Manufacturing and Control Systems, Galgothia Publications, 1998.
5	Rahul V. Altekar, “Enterprise Resource Planning – Theory and Practice”, Prentice Hall of India Pvt. Ltd. 2008.

	PRODUCTION PLANNING AND COST ESTIMATION	3	0	0	100	3

UNIT I	PRODUCTION PLANNING AND CONTROL	9

Demand forecasting – time series forecasting models – Delphi method of forecasting, aggregate production planning, master scheduling, bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems

UNIT II	ESTIMATING AND COSTING	5

Importance and aims of Cost estimation – Functions of estimation – Costing – Importance and aims of Costing – Difference between costing and estimation – Importance of realistic estimates – Estimation procedure.

UNIT III	ELEMENT OF COST	12

Introduction – Material Cost – Determination of Material Cost Labour Cost – Determination of Direct Labour Cost – Expenses – Cost of Product (Ladder of cost) – Illustrative examples. Analysis of overhead expenses – Factory expenses – Depreciation – Causes of depreciation – Methods of depreciation – Administrative expenses – Selling and Distributing expenses – Allocation of overhead expenses.

UNIT VI	PRODUCT COST ESTIMATION	10

Estimation in forging shop – Losses in forging – Forging cost – Illustrative examples. Estimation in welding shop – Gas cutting – Electric welding – illustrative examples. Estimation in foundry shop – Estimation of pattern cost and casting cost – Illustrative examples

UNIT V	ESTIMATION OF MACHINING TIME	9

Estimation of machining time for Lathe operations – Estimation of machining time for drilling, boring, shaping, planning, milling and grinding operations – Illustrative examples.

	Total		45

TEXT BOOK:

1. M. Adithan and B.S. Pabla, “Estimating and Costing”, Konark Publishers Pvt. Ltd. 1989.

2. A.K. Chitale and R.C. Gupta, “Product Design and Manufacturing”, Prentice Hall Pvt. Ltd., 1997.

REFERENCES:

1	Nanua Singh, “System approach to Computer Integrated Design and Manufacturing”, John Wiley and Sons, Inc., 1996
2	Joseph G. Monks, “Operations Management, Theory & Problems”, McGraw Hill Book Company, 1982.
3	S.N. Chary, “Production and Operations Management,” Tata McGraw Hill, 1994.
4	Adam & Ebert – “Production and Operations Management,” Prentice Hall of India, 1995.
5	Banga T.R., and Sharma S.C., “Mechanical Estimation and Costing”, Khanna Publishers, 1993.
6	Mukhopadhyay S.K. ” Production planning and Control – Text and Cases” Prentice Hall of India Pvt. Ltd. 2007.

	MAINTENANCE ENGINEERING	3	0	0	100	3

UNIT I	PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING	10

Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.

UNIT II	MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE	9

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repairs cycle - Principles and methods of lubrication – TPM.

UNIT III	CONDITION MONITORING	9

Condition Monitoring – Cost comparison with and without CM – On-load testing and off-load testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis

UNIT VI	REPAIR METHODS FOR BASIC MACHINE ELEMENTS	10

Repair methods for beds, slideways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location

UNIT V	REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT	8

Repair methods for Material handling equipment - Equipment records – Job order systems -Use of computers in maintenance.

	Total		45

TEXT BOOK:

1.Srivastava S.K., “Industrial Maintenance Management”, - S. Chand and Co., 1981

2.Bhattacharya S.N., “Installation, Servicing and Maintenance”, S. Chand and Co., 1995

REFERENCES:

1	White E.N., “Maintenance Planning”, I Documentation, Gower Press, 1979.
2	Mishra R.C. and Pathak K. “Maintenance Engineering and Management” Prentice Hall of India Pvt. Ltd. 2007.
3	Garg M.R., “Industrial Maintenance”, S. Chand & Co., 1986.
4	Higgins L.R., “Maintenance Engineering Hand book”, McGraw Hill, 5th Edition, 1988
5	Armstrong, “Condition Monitoring”, BSIRSA, 1988.
6	Davies, “Handbook of Condition Monitoring”, Chapman &Hall, 1996

	INDUSTRIAL SAFETY	3	0	0	100	3

UNIT I	BASICS OF SAFETY ENGINEERING & ACTS	9

Evolution of modern safety concept – safety audit – Concept of an accident investigation and reporting – safety performance monitoring. Acts – factories act – 1948 – Statutory authorities – inspecting staff – Tamilnadu Factories Rules 1950 under Safety and health – environment act – 1986 – Air act 1981, water act 1974 – other acts. Safety in industries – General safety concepts, machine guarding, hazards in metal removing process, welding process, cold and hot working process.

UNIT II	OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE (Basic concepts, related hazards and exposure limits)	10

Physical Hazards – Noise, heat, recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases. Biological and Ergonomical Hazards-Basic concepts. Occupational Health-Concept and spectrum of health – functional units and activities of occupational health services, pre-employment and post-employment medical examinations – occupational related diseases, levels of prevention of diseases, notifiable occupational diseases. Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, Preliminary Hazard Analysis (PHA), human error analysis, hazard operability studies (HAZOP), safety warning systems.

UNIT III	FIRE ENGINEERING AND EXPLOSIVE CONTROL	8

Fire properties of solid, liquid and gases – fire triangle – principles of fire extinguishing – active and passive fie protection systems – various classes of fires – A, B, C, D, E – types of fire extinguishers – Principles of explosion – Explosion Protection – Electrical Safety. Electrical Hazards – Primary and Secondary hazards – concept of earthing – protection systems – fuses, circuit breakers and over load relays – first aid.

UNIT VI	ERGONOMICS	9

Introduction to ergonomics: The focus of ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, attempts to humanize work, modern ergonomics, future directions for ergonomics. Anatomy, Posture and Body Mechanics: Some basic body mechanics, anatomy of the sprine and pelvis related to posture, posture stability and posture adaptation, low back pain, risk factors for musculoskeletal disorders in the workplace, behavioural aspects of posture, effectiveness and cost effectiveness. Anthropometry and its uses in ergonomics, principles of applied anthropometry in ergonomics. Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine – concepts of bio mechanics.

UNIT V	SAFETY EDUCATION AND TRAINING	9

Importance of training – identification of training needs – training methods – programmes, seminars, conferences, competitions – method of promoting safe practice – motivation – communication – role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

Total		45

TEXT BOOK:	
1. Krishnan N.V., “Safety Management in Industry”, Jaico Publishing House, Bombay, 1997.	
2. Hand book of “Occupational Safety and Health”, National Safety Council, Chicago, 1982.	
REFERENCES:	
1	The factories Act 1948, Madras Book Agency, Chennai, 2000
2	Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt. Ltd., New Delhi.
3	Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt. Ltd., New Delhi
4	Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process Safety, AICHE 1992
5	Introduction to Ergonomics, R.S. Bridger, Taylor & Francis
6	Derek, James, “Fire Prevention Hand Book”, Butter Worths and Company, London, 1986.
7	Fordham Cooper, W., “Electrical Safety Engineering”, Butter Worths and Company, London, 1986

	PROFESSIONAL ETHICS AND HUMAN VALUES	3	0	0	100	3

UNIT I	HUMAN VALUES	10

Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality

UNIT II	ENGINEERING ETHICS	9

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories

UNIT III	ENGINEERING AS SOCIAL EXPERIMENTATION	9

Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger case study.

UNIT VI	SAFETY, RESPONSIBILITIES AND RIGHTS	9

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the three mile island and chernobyl case studies.
Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination

UNIT V	GLOBAL ISSUES	8

Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors - moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE), India, etc.

Total		45

TEXT BOOK:

1. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 1996.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2009.

REFERENCES:

1	Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available)
2	Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (Indian Reprint now available)
3	John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.
4	Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.

	RAPID PROTOTYPING, TOOLING AND RE-ENGINEERING	3	0	0	100	3

UNIT I	INTRODUCTION	7

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – Benefits- Applications – Digital prototyping - Virtual prototyping

UNIT II	LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS	10

Stereolithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT III	POWDER BASED RAPID PROTOTYPING SYSTEMS	10

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

UNIT VI	REVERSE ENGINEERING AND CAD MODELING	10

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation

UNIT V	RAPID TOOLING	8

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronic industries

Total	45

TEXT BOOK:

1.Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003

2. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.

REFERENCES:

1	Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003
2	Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou W.Liou, Frank W.Liou, CRC Press, 2007.
3	Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006

	SIX SIGMA AND LEAN MANUFACTURING	3	0	0	100	3

UNIT I	LEAN MANUFACTURING AND SIX SIGMA – OVERVIEW	2

Evolution of Lean; Traditional versus Lean Manufacturing; Business of Survival and Growth; Business Model Transformation; Ford Production System; Job Shop Concepts Concept of Lean; Toyota's foray in Lean;

UNIT II	DESIGN - VALUE STREAM MANAGEMENT	12

Definition; VSM Types;Product Family Selection; Value Stream Manager;Current State Map; Process Box; Value Stream Icons; 3 Ms - Muda, Mura, Muri - 7 Types of Muda; Future State Map;Value Stream Plan; Process Stability - Loss Reduction 7 Major Losses Reduction.
Demand Stage :Market Dynamics; Customer Demand;PQ Analysis; PR Analysis; TAKT Time; Pitch; Finished Goods Stock; Cycle Stock; Buffer Stock; Safety Stock.

UNIT III	SYSTEM IMPLEMENTATION	12

Flow Stage : Continuous Flow; Cell Layout; Line Balancing; Macro and Micro Motion Analysis; Standardised Work; Concept of Kaizen; Steps involved in Kaizen Deployment; Industrial Engineering - Concepts and Fundamentals; Kanban Concepts ; Types of Kanbans ; and Practical Application ; Concept of Pull; Changeover Time Reduction - External & Internal Single Minute Exchange of Die; Quick Die Change; Quality-Vendor,In Process and Customer Line ; Concept of PPM; Pokayoke; Prevention & Detection Types; Maintenance - Preventive, Time Based and Condition Based; Human Development for Lean (Training and Involvement through Autonomous Maintenance) Leveling Stage of Lean Implementation : Production Leveling ; Leveling Box; Concept of Water Spider

UNIT VI	LEAN METRICS AND LEAN SUSTENANCE	7

Identify Lean Metrics; Steps involved in Goal Setting; Corporate Goals; Kaizen Cloud identification in VSM ; Lean Assessment. Cultural Change; Reviews; Recognition; Improving Targets and Benchmarks;

UNIT V	SIX SIGMA AND DMAIC TOOLS	12

Project charter, stakeholder analysis, SIPOC, Voice of the customer, Rolled throughput yield, KANO Models, CTQ Tree, Process Mapping Data collection, measurement system analysis, sampling plans, process capability, cost of poor quality (COPQ), FMEA Regression Analysis, cause & effect diagram, Hypothesis testing, Design of experiments, Response Surface methodology, Poka-yoke, Quality Control, Control charts.

Total		45

REFERENCES:

1	Keki R. Bhote, “The ultimate six sigma” , Prentice hall India
2	Rath & Strong’s Six sigma pocket guide.
3	Don Tapping, Tom Luyster and Tom Shuker,“Value Stream Management” Productivity Press, 2002.
4	Tom Luyster and Don Tapping, “Creating Your Lean Future State: How to Move from Seeing to Doing”, Productivity Press, 2006.
5	Mike Rother and Rick Harris, “Creating Continuous Flow”, Publisher: Lean Enterprise Institute, Inc., 2001.
6	Rick Harris, Chris Harris & Earl Wilson, “Making Materials Flow”, Publisher: Lean Enterprise Institute, Inc., 2003.

	PROJECT MANAGEMENT	3	0	0	100	3

UNIT I	STRATEGIC MANAGEMENT AND PROJECT SELECTION	9

Project selection models, Project portfolio process, Analysis under uncertainty, Project organization, Matrix organization

UNIT II	PROJECT PLANNING	9

Work breakdown structure, Systems integration, Interface coordination, Project life cycle, Conflict and negotiation

UNIT III	PROJECT IMPLEMENTATION	9

Estimating Project Budgets, Process of cost estimation, Scheduling: Network Techniques PERT and CPM, Risk analysis using simulation, CPM - crashing a project, Resource loading, leveling, and allocation

UNIT IV	MONITORING AND INFORMATION SYSTEMS	9

Information needs and the reporting process, computerized PMIS, Earned value analysis, Planning - Monitoring - Controlling cycle, Project control: types of control processes, design of control systems, control of change and scope

UNIT V	PROJECT AUDITING	9

Construction and use of audit report, Project audit life cycle, Essentials of audit and evaluation, Varieties of project termination, the termination process, The Final Report – A project history

TOTAL		45

TEXT BOOKS

1. Panneerselvam R. and Senthilkumar P., “Project Management” PHI Learning Private Limited, 2009.

REFERENCES:

1	Jack R. Meredith, and Samuel J. Mantel Jr., “Project Management – A Managerial Approach”, John Wiley and Sons, 2006.
2	Harold Kerzner, “Project Management – A Systems Approach to Planning”, Scheduling and Controlling, John Wiley and Sons, 2006.
3	Larry Richman, “Project Management: Step-by-Step” PHI Learning Private Limited, 2008.

	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	3	0	0	100	3

UNIT I	LOGISTICS AND CUSTOMER SERVICE DIMENSION	9

Mission of logistics management, logistics environment, Customer service and retention, Setting customer service priorities and service standards. Measuring logistics – logistics costing – customer profitability analysis

UNIT II	STRATEGIC FRAMEWORK AND SUPPLY CHAIN NETWORKS	9

Objective, decision phases, process views, examples, strategic fit, supply chain drivers and metrics. Distribution networks, Facility networks and design options, Factors influencing, Models for facility location and capacity allocation, Transportation networks and design options, Evaluating network design decisions

UNIT III	MANAGING DEMAND AND SUPPLY IN A SUPPLY CHAIN	9

Predictable variability in a supply chain, Economies of scale and uncertainty in a supply chain – Cycle and safety Inventory, Optimum level of product availability, Forward Buying, Multi-echelon cycle inventory

UNIT IV	SOURCING AND PRICING IN A SUPPLY CHAIN	9

Cross-Functional drivers, Role of sourcing in a supply chain, Logistics providers, Procurement process, Supplier selection, Design collaboration, Role of Pricing and Revenue Management in a supply chain

UNIT V	INFORMATION TECHNOLOGY AND COORDINATION IN A SUPPLY CHAIN	9

The role of IT in supply chain, The supply chain IT frame work, Customer Relationship Management, Supplier relationship management, Future of IT in supply chain, E-Business in supply chain, Bullwhip effect – Effect of lack of co-ordination in supply chain, Building strategic partnerships, CPFR

TOTAL		45

TEXT BOOKS

1. Sunil Chopra and Peter meindl, “Supply Chain Management , Strategy, Planning, and operation”, PHI, Third edition,2007.
2. Martin Christopher, “Logistics and supply chain management”, Pearson Education, 2001

REFERENCES:

1	Jeremy F.Shapiro, “Modeling the supply chain”, Thomson Duxbury, 2002
2	James B.Ayers, “Handbook of Supply chain management”, St.Lucle press, 2000.
3	Agrawal, D K, “Logistics and supply chain management” Macmillan India, 2003