First Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
BS	Mathematics-I	3-1	4	100	50	-	-	-
BS	Chemistry/ Physics	3-0	3	100	50	2	1	50
ES	Basics of Electronics / Basic Electrical Engineering	3-0	3	100	50	2	1	50
ES	Mechanics/ Thermodynamics	3-0	3	100	50			
ES	Programming in 'c"	3-0	3	100	50	2	2	50
HS	English Communication Skill	3-0	2	100	50	2	1	50
ES	Engineering Workshop/ Engineering Drawing					4	2	100
Total		16	18	600	300	18	7	300
Total Marks: 1200								
Total Credits: 25								

Second Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/ week L/T**	**Credit Theory**	**University marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
BS	Mathematics-II	3-1	4	100	50	-	-	-
BS	Chemistry/ Physics	3-0	3	100	50	2	1	50
ES	Basics of Electronics / Basic Electrical Engineering	3-0	3	100	50	2	1	50
ES	Mechanics/ Thermodynamics	3-1	3	100	50			
ES	Data Structure Using 'C"	3-0	3	100	50	2	2	50
HS	Business communication	3-0	2	100	50	2	1	50
ES	Engineering Workshop/ Engineering Drawing					4	2	100
MC	NSS/NCC	-	-	-	-			
Total		17	18	600	300	14	7	300
Total Marks: 1200								
Total Credits: 25								

Second Year Engineering

Third Semester

		Theory				Practical		
Code	**Course Name**	**Hours/ week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
PC	Mechanics of Solids	3-0	3	100	50	2	1	50
PC	Introduction to Physical Metallurgy &Engg Materials	3-0	3	100	50			
PC	Fluid Mechanics & Hydraulics Machines	3-0	3	100	50	2	1	50
PC	Engg. Thermodynamics	3-0	3	100	50	2	1	50
PC	Kinematics & Dynamics Machines	3-1	4	100	50	2	1	50
HS	Engineering Economics/ Organizational Behavior	2-1	3	100	50			
Total		19	19	600	300	8	4	200
Total Marks: 1100								
Total Credits: 23								
For Honours and Minor Specialization		4	4	100	50			

Fourth Semester

		Theory				Practical		
Code	**Course Name**	**Hours/ week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
HS	Purely Applied Mathematics for Specific Branch of Engineering	3-0	3	100	50			
PC	Mechanisms & Machines	3-0	3	100	50	2	1	50
PC	Basic Manufacturing Process	3-0	3	100	50	2	1	50
PC	IC Engine & Gas Turbine	3-0	3	100	50	2	1	50
PC	Mechanical Measurement, Metallurgy & Reliability	3-0	3	100	50	2	1	50
HS	Engineering Economics/ Organizational Behavior	2-1	3	100	50			
	*Skill Project and Hands on					6	3	100
Total		18	18	600	300	14	7	300
Total Marks: 1200								
Total Credits: 25								
For Honours and Minor Specialization		4	4	100	50			

- *College should conduct at least one NSDC program under this category.

Third Year Engineering

Fifth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/week L/T**	**Credit Practical**	**Marks**
PC	Design of Machine Elements	3-0	3	100	50			
PC	Machining Science & Technology	3-0	3	100	50	2	1	50
PC	Heat Transfer	3-0	3	100	50	2	1	50
PE	Optimization in Engg./Project Management/Quality Management & Reliability	3-1	4	100	50	2	1	50
OE	Energy Conversion Techniques/Human Resources Management/Marketing Management/ C++ & Object Oriented Programming/Internet & Web Technology/Analog & Digital Electronics/Digital Signal Processing	3-1	4	100	50			
PC	Advance Lab-I					8	4	200
Total		17	17	500	250	14	7	350
Total Marks: 1100								
Total Credits: 24								
For Honours and Minor Specialization		4	4	100	50			

Sixth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/week L/T**	**Credit Practical**	**Marks**
PC	Production & Operation Management	3-0	3	100	50	2	1	50
PC	Refrigeration & Air Conditioning	3-0	3	100	50	2	1	50
PE	Product Design & Production Tooling/Computer Integrated Manufacturing & FMS/CAD & CAM	3-1	4	100	50			
PE	Compressive Flow & Gas Dynamics/Automobile Engg./ Non-Conventional Energy Sources	3-1	4	100	50			
MC & GS	Environmental Science & Engineering	3-0	3	100	50			
OE	Industrial Lecture #					3	1	50
HS	Presentation Skill & Skill for Interview # #	2-0	1		50	4	2	100
MC	Yoga					2	1	50
Total		19	18	500	300	13	6	300
Total Marks: 1100								
Total Credits: 24								
For Honours and Minor Specialization		4	4	100	50			

To be conducted by the Training & Placement department by inviting experts from the industry. No academician to be called. Record may be asked by the University for verification. Evaluation to be done by the TPO.

To be conducted by the Training & Placement department of the College.

Final Year Engineering

Seventh Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/week L/T**	**Credit Practical**	**Marks**
GS	Nano Science & Bio Technology	3-1	4	100	50			
PE	Mechanical Vibration/Tribology/Fatigue Creep & Fracture	3-1	4	100	50			
PE	Robotics/Simulation,Modelling& Control/Mechatronics & MEMs	3-1	4	100	50			
OE	Soft Computing */ Other subjects	3-1	4	100	50			
PC	Advance Lab-II/ Project/3D Printing					8	4	200
	Projects on Internet of Things					8	4	200
Total		16	16	400	200	16	8	400
Total Marks: 1000								
Total Credits: 24								
For Honours and Minor Specialization		4	4	100	50			

*Student can choose from any department but subject must be running in that semester.

Eighth Semester						
	Training cum Project				Evaluation Scheme	
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**Total Marks**		**Marks**
	Industrial Training cum Project/ Entrepreneurship Training cum Project / Stratup Training cum Project	30	20	1000	Evaluation by the Industry / Training Organisation	500
					Evaluation by the Institute (Report & Institute Viva)	500
Total		30	20	1000		1000
Total Marks:1000						
Total Credits:20						

Note- Minimum Pass Mark from Industry Evaluation is 300 (i.e. 60%).

Distribution of Credit Semester wise:

Semester	Credit
First	25
Second	25
Third	23
Fourth	25
Fifth	24
Sixth	24
Seventh	24
Eighth	20
Total	190

Internal Evaluation Scheme

Attendance & Class Interaction	05
Assignment	05
Surprise Test	05
Quiz	05
Class Test I & II	30
Total	50
Class Test Time(Hrs.): 1	

Pass Mark in Internal is 50% of total marks i.e. 25

External Evaluation Scheme

University Semester Examination of 3 Hours duration.

Pass mark will be 35% which means students have to score 35 out of 100.

Practical/Sessional Evaluation Scheme

Pass mark will be 50% which means students have to score 25 out of 50.

Evaluation Scheme

Attendance & Daily Performance	-10
Lab Record	- 10
Lab Quiz	- 05
Final Experiments & Viva	– 25
Total	=50

All Lab examinations are to be completed one week before the end semester examination and marks are to be displayed on the college notice board.

DETAIL SYLLABUS

FROM
III - VIII SEMESTER OF B.TECH. DEGREE PROGRAMME

for

ADMISSION BATCH 2015-16

BRANCH-MECHANICAL ENGINEERING

Second Year Engineering								
Third Semester								
	Theory					**Practical**		
Code	**Course Name**	**Hours/ week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
PC	Mechanics of Solids	3-0	3	100	50	2	1	50
PC	Introduction to Physical Metallurgy &Engg Materials	3-0	3	100	50			
PC	Fluid Mechanics & Hydraulics Machines	3-0	3	100	50	2	1	50
PC	Engg. Thermodynamics	3-0	3	100	50	2	1	50
PC	Kinematics & Dynamics Machines	3-1	4	100	50	2	1	50
HS	Engineering Economics/ Organizational Behavior	2-1	3	100	50			
Total		19	19	600	300	8	4	200
Total Marks: 1100								
Total Credits: 23								
For Honours and Minor Specialization		4	4	100	50			

MECHANICS OF SOLID

Theory L/T (Hours per week): 3/0, Credit: 3

MODULE - I (10 Lectures)

1. Concept of Stress:

Load, Stress, Principle of St.Venant, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads,

Analysis of Axially Loaded Members : Composite bars in tension and compression - temperature stresses in composite rods, Concept of Statically indeterminate problems.

Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.

2. Biaxial State of Stress :

Analysis of Biaxial Stress.Plane stress, Principal plane, Principal stress, Mohr's Circle for Biaxial Stress. Stresses in thin cylinders and thin spherical shells under internal pressure, wire winding of thin cylinders.

MODULE - II (10 Lectures)

3. . Biaxial State of Strain:

Two dimensional state of strain, Principal strains, Mohr's circle for strain, Calculation of principal stresses from principal strains, Strain Rossette.

4. Shear Force and Bending Moment Diagrams:

Shear force and bending moment. Types of load and Types of support. Support reactions, Relationship between bending moment and shear force, Point of inflection. Shear Force and Bending Moment diagrams.

5. Bending of Beams:

Theory of simple bending of initially straight beams, Bending stresses, Shear stresses in bending, Distribution of normal and shear stress, Composite beams.

MODULE - III (8 Lectures)

6. Deflection of Beams :

Differential equation of the elastic line, Slope and deflection of beams by integration method and area - moment method.

7. Theory of Columns:

Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio, Eccentric loading of short column

MODULE - IV (8 Lectures)

8. Torsion:

Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, strength of solid and hollow circular shafts. Strength of shafts in combined bending and twisting, Close - Coiled helical springs.

TEXT BOOKS

1. Elements of Strength of Materials by S.P.Timoshenko and D.H.Young, Affiliated East West Press
2. Strength of Materials by G. H. Ryder, Macmillan Press
3. Strength of Materials by R.Subramaniam, Oxford University Press

REFERENCE BOOKS

1. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
2. Mechanics of Materials by R.C.Hibbeler, Pearson Education
3. Mechanics of Materials by William F.Riley, Leroy D.Sturges and Don H.Morris, Wiley
    a. Student Edition
4. Mechanics of Materials by James M. Gere, Thomson Learning
5. Strength of Materials by James M. Gere and Barry J. Goodno, Cengage Learning
6. Strength of Materials by S.S.Rattan, Tata Mc Graw Hill
7. Engineering Machanics of Solids by Egor P. Popov, Prentice Hall of India

MECHANICS OF SOLID LABORATORY

Practical L/T/P (Hours per week): 0/0/2, Credit: 3

Laboratory Experiments (Minimum 8 experiments)

1. Determination of tensile strength of materials by Universal Testing Machine
2. Determination of compressive strength of materials by Universal Testing Machine
3. Determination of bending strength of materials by Universal Testing Machine
4. Double shear test in Universal Testing Machine
5. Determination of Impact strength of material (Charpy and Izod)
6. Determination of Hardness strength of materials (Brinnel, Rockwell and Vickers)
7. Determination of Rigidity modulus of material
8. Determination of Fatigue strength of material
9. Estimation of Spring Constant under Tension and Compression.
10. Load measurement using Load indicator, Load Cells.
11. Strain measurement using Strain Gauge.
12. Stress measurement using strain rosette.

INTRODUCTION TO PHYSICAL METALLURGY AND ENGINEERING MATERIALS

Theory L/T (Hours per week): 3/0, Credit: 3

MODULE-I (08 Lectures)

Classification of Engineering Materials, Engineering properties of materials. Characteristic property of metals, bonding in solids, primary bonds like ionic, covalent and metallic bond, crystal systems, common crystal structure of metals, representations of planes and directions in crystals, atomic packing in crystals, calculation of packing density, voids in common crystal structures and imperfections crystals.

MODULE-II (08 Lectures)

Concept of plastic deformation of metals, critical resolve shear stress, dislocation theory, deformation by slip and twin, plastic deformation in polycrystalline metals, yield point phenomenon and related effects, concept of cold working preferred orientation. Annealing ; recovery; recrystalization and grain growth; hot working.

Concept of alloy formation, types of alloys, solid solutions, factors governing solids solubility viz. size factor, valency factor, crystal structure factor and chemical affinity factor; order-disorder transformation.

MODULE-III (10 Lectures)

Binary phase diagrams (a) Isomorphism system, (b) Eutectic system, (c) Peritectic system, (d)Eutectoid system and (e) Peritectoid system. Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviors and microstructure of different alloys belonging to those systems, Effect of non-equilibrium cooling, coring and homogenization.

Iron-cementite and iron-graphite phase diagrams, microstructure and properties of different alloys (alloy steels; stainless steel, tool steel, HSS, high strength low alloy steel) types of cast iron, their microstructures and typical uses. Specification of steel.

T.T.T. diagram: concept of heat treatment of steels i.e. annealing, normalizing, hardening and tempering; microstructural effects brought about by these processes and their influences on mechanical properties; factor affecting hardenability.

MODULE-IV (10 Lectures)

Optical properties of Materials: Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres- Principle, structure, application of optical fibres.

Plastic-: Thermosetting and thermoplastics.
Ceramics: Types, structure, Mechanical properties, application
Composite Materials: Agglomerated Materials: Cermets .Reinforced Materials: Reinforced Concrete. Fibre reinforced plastics, Properties of composites, Metal matrix composites, manufacturing procedure for fiber reinforced composite.

Text Books:

1. Introduction to Physical Metallurgy by Avner, Tata McGraw Hill
2. Materials Science and Engineering by W.D.Callister, Wiley and Sons Inc.
3. Physical Metallurgy: Principles and Practice by Ragahvan, PHI

Reference Books

1. Engineering Physical Metallurgy and Heat Treatment by Y.Lakhtin, Mir Publisher, Moscow.
2. Elements of Material Science and Engineering, L.H.Van Vlack, Addison Wesley
3. Materials Science and Engineering by V.Raghavan, Prentice Hall of India Pvt.Ltd.
4. Elements of Materials Science & Engineering by Van Vlack, Pearson
5. Mechanical Metallurgy by Dieter, Tata MacGraw Hill
6. Composite Material science and Engineering by K. K. Chawla, Springer
7. Material Science and Metallurgy, by U. C. Jindal, Pearson

FLUID MECHANICS AND HYDRAULIC MACHINES

Theory L/T (Hours per week): 3/0, Credit: 3

Module I (12 Lectures)

Introduction: Scope of fluid mechanics and its development as a science

Physical property of Fluid: Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.

Fluid statics: Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, manometer.

Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical submerged plane surface.Buoyancy and floatation, Archimedes' principle, stability of immersed and floating bodies, determination of metacentric height.

Module II (14 Lectures)

Fluid kinematics: Introduction, description of fluid flow, classification of fluid flow. Reynold's number, Acceleration of fluid particles, flow rate and continuity equation, differential equation of continuity,

Mathematical definitions of irrotational and rotational motion. Circulation, potential function and stream function. Flow net

Fluid dynamics : Introduction,Introduction to N-S equation, Euler's equation along a streamline, energy equation, Bernoulli's equation and its application to siphon, venturimeter, orificemeter, pitot tube.

Flow in pipes and ducts: Loss due to friction, Minor energy losses in pipes Hydraulic Gradient Line (HGL), Total Energy Line (TEL), Power transmission in the fluid flow in pipes, fluid flow in pipes in series and parallel. Flow through nozzles.

Module III (8 Lectures)

Hydraulic turbines: Classification, Impulse and Reaction turbine; Tangential, Radial and axial turbine.

Impulse turbine, Pelton wheel, bucket dimensions, number of buckets in pelton wheel, efficiency and performance curves.

Reaction Turbines: Francis turbine and Kaplan turbine, velocity triangle and efficiencies, performance curve. Function of draft tube and casing cavitation

Module IV (06 Lectures)

Centrifugal Pump: constructional features, vane shape, velocity triangles, Efficiencies, Multi stage centrifugal pumps, Pump Characteristic, NPSH and Cavitation.

Positive displacement pumps: Reciprocating Pump, Working principle, Discharge, work done and power requirement, Slip, Indicator diagram

Text Books

1. Fluid Mechanics, Y A Cengel, TMH
2. Fluid Mechanics and Hydraulic Machines, Modi & Seth
3. Fluid Mechanics, A.K. Mohanty, PHI
4. Fluid Mechanics and Machinery, Mohd. Kareem Khan, OXFORD

Reference Books:

1. Fluid Mechanics and Machinery, CSP Ojha and P.N. Chandramouli, Oxford University Press
2. Fluid Mechanics and Fluid Machines by A.K.Jain, Khanna Publishers
3. Introduction to Fluid Mechanics and Fluid Machines, S.K. Som and G. Biswas, TMH
4. Introduction to Fluid Mechanics, Fox, McDonald, Willey Publications
5. Fluid Mechanics by Kundu, Elsevier
6. An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge University Press
7. Engineering Fluid Mechanics by Garde et. al., Scitech
8. First course in Fluid Mechanics by Narasimhan, University press
9. Fluid Mechanics by J.F.Douglas, J.M.Gasiorek, J.A.Swaffield and L.B.Jack, Pearson Education
10. Fluid Mechanics and Machines, Sukumar Pati, TMH

Practical (Hours per week): 2, Credit: 1

Laboratory Exp[eriments (Minimum 8 experiments)

1. Determination of Metacentric Height and application to stability of floating bodies.
2. Determination of Cv and Cd of Orifices.
3. Experiments on impact of Jets
4. Experiments on performance of Pelton Turbine
5. Experiments on performance of Francis Turbine
6. Experiments on performance of Kaplan Turbine
7. Experiments on performance of centrifugal pump
8. Experiments on performance of reciprocating pump
9. Experiments on Reynold's Apparatus
10. 12 Experiments on Flow through pipes
11. Experiments on performance of Gear pump
12. Verifications of momentum equation

ENGINEERING THERMODYNAMICS

Theory L/T (Hours per week): 3/0, Credit: 3

Module-I (10 Lectures)

1. Review of First and Second laws:

First law analysis of unsteady flow control volumes, Entropy generation ,Entropy balance for closed systems and steady flow systems, Available energy, Quality of energy, Availability for non flow and flow process, Irreversibility, Exergy balance, Second law efficiency.

Module- II (12 Lectures)

2. Vapour Power Cycles:

The Carnot vapor cycle and its limitations, The Rankine cycle, Means of increasing the Rankine cycle efficiency, The reheat cycle, The regenerative feed heating cycle, Cogeneration (Back pressure and Pass-out turbines), Combined-cycle power generation systems, Binary vapour cycles.

3. Gas Power Cycles:

Air standard cycles- Otto, Diesel, Dual Combustion and Brayton cycles, The Brayton cycle with non-isentropic flow in compressors and turbines, The Brayton cycle with regeneration, reheating and intercooling, Ideal jet propulsion cycles.

Module- III (12 Lectures)

4. Refrigeration cycles:

Reversed Carnot cycle, Reversed Brayton cycle (Gas refrigeration system), The vapor compression cycle, The vapor absorption cycle.

5. General Thermodynamic property relations:

The Maxwell relations, The Clapeyron equation, The TdS relations, Isothermal compressibility and volume expansivity, The Joule-Thomson coefficient.

Module- IV (06 Lectures)

6. Reciprocating Air Compressors:

Introduction (Uses of compressed air), The reciprocating cycle neglecting and considering clearance volume, Volumetric efficiency and its effect on compressor performance, Limitations of single stage compression, Multistage compression and intercooling, Optimum intercooler pressure, Performance and design calculations of reciprocating compressors, Air motors.

Text Books

1. Engineering Thermodynamics by P. K. Nag, Publisher:TMH
2. Engineering Thermodynamics by P. Chattopadhyay, OXFORD
3. Fundamentals of Thermodynamics by Sonntag, Borgnakke, Van Wylen, John Wiley & Sons
4. Fundamentals of Engineering Thermodynamics by E. Rathakrishnan, PHI

Reference

1. Engineering Thermodynamics by M.Achyuthan, PHI
2. Engineering Thermodynamics by Y.V.C. Rao, University Press
3. Thermodynamics and Thermal Engineering by Kothandaraman & Domkundwar, Dhanpat Rai
4. Applied Thermodynamics by P.L.Ballaney, Khanna Publishers
5. Steam Tables in SI Units by Ramalingam, Scitech
6. Steam Tables by C.P.Kothandaraman, New Age International

Practical (Hours per week): 2, Credit: 1

Laboratory Experiments: (Minimum 8 experiments)

1. Study of Cut-Sections of 2 stroke and 4 stroke Diesel Engine.
2. Study of Cut-Sections of 2 stroke and 4 stroke Petrol Engine.
3. Study of steam power plant.
4. Study of refrigeration system.
5. Study of gas turbine power plant.
6. Performance analysis of reciprocating air-compressor.
7. Performance analysis of Centrifugal / Axial Flow compressor.
8. Determination of performance characteristics of gear pump.
9. Measurement of steam quality using calorimeter
10. Verification of Joule-Thomson coefficient.

KINEMATICS AND DYNAMICS OF MACHINES

Theory L/T (Hours per week): 3/1, Credit: 4

Module – I : (10 Lectures)

1. Kinematic fundamental: Basic Kinematic concepts and definitions, Degrees of freedom, Elementary Mechanism : Link, joint, Kinematic Pair, Classification of kinematic pairs, Kinematic chain and mechanism, Grüebler's criterion, Inversion of mechanism, Grashof criteria, Four bar linkage and their inversions, Single slider crank mechanism, Double slider crank mechanism and their inversion. Transmission angle and toggle position, Mechanical advantage.

2. Kinematic Analysis : Graphical analysis of position, velocity and acceleration of four bar and Slider crank mechanisms. Instantaneous centre method, Aronhold-Kennedy Theorem, Rubbing velocity at a Pin-joint.Coriolis component of acceleration.

Module – II : (10 Lectures)

3. Mechanism Synthesis : Graphical methods of synthesis, Chebychev spacing for precision positions, Freudenstein's equation applicable to four bar linkages.
4. Mechanism Trains: Gear Terminology and definitions, Analysis of mechanism Trains: Simple Train, Compound train, Reverted train, Epicyclic train and their applications.

Module – III : (8 Lectures)

5. **Combined Static and Inertia Force Analysis:** Inertia forces analysis**,** velocity and acceleration of slider crank mechanism by analytical method, engine force analysis - piston effort, force acting along the connecting rod, crank effort. dynamically equivalent system, compound pendulum, correction couple.

6. Friction Effects: Screw jack, friction between pivot and collars, single, multi-plate and cone clutches, anti friction bearing, film friction, friction circle, friction axis,

Module – IV : (8 Lectures)

7. Flexible Mechanical Elements: Belt, rope and chain drives, initial tension, effect of centrifugal tension on power transmission, maximum power transmission capacity, belt creep and slip.

8. Brakes &Dynamometers : Classification of brakes, Analysis of simple block, Band and internal expanding shoe brake, Braking of a vehicle. Absorption and transmission dynamometers, Prony brake, Rope brake dynamometer, belt transmission, epicyclic train, torsion dynamometer.

Text Books

1. Kinematics and Dynamics of Machinery by R L Norton, Tata MacGraw Hill
2. Theory of Machines and Mechanisms by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
3. Theory of Machines by S.S.Rattan, Tata MacGraw Hill

Reference

1. Theory of Machines by Thomas Bevan, CBS Publications
2. Kinematics and Dynamics of Machinery by Charles E. Wilson and J.Peter Saddler, Pearson Education
3. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New Age International.
4. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East West Press.
5. Kinematics and Dynamics of Machines by G.H. Martin, McGraw-Hill.
6. Theory of Machines and Mechanisms by P.L.Ballaney, Khanna Publishers
7. Theory of Mechanisms and Machines by C.S.Sharma and K.Purohit, PHI.

Practical (Hours per week): 2, Credit: 1

Laboratory Experiments: (Minimum 8 experiments)

1. Design of any one working model related to Kinematics of Mechanisms i.e., Module I and II.
2. Design of any one working model related to Dynamics of Machinery i.e., Module III and IV.
3. Radius of gyration of compound pendulum
4. Radius of gyration of connecting rod
5. TRI –FILAR / BI-FILAR System
6. Experiment on Screw Jack
7. Experiment on Journal Bearing Apparatus
8. Experiment/Study on clutches
9. Experiment on Epicyclic Gear Train
10. Experiments on Simple/Compound/Reverted Gear trains
11. Experiment on Dynamometer
12. Experiment on Brake
13. Experiment on Coriolis component of acceleration

ENGINEERING ECONOMICS

Theory L/T (Hours per week):2/1, Credit: 3

Module I (12 hours)

Engineering Economics- Nature, Scope, Basic problems of an economy, Micro Economics and Macro Economics.

Demand- Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Elasticity of demand & its measurement (Simple numerical problems to be solved), Supply-Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).

Production-Production function, Laws of returns: Law of variable proportion, Law of returns to scale

Module II (12 hours)

Cost and revenue concepts, Basic understanding of different market structures, Determination of equilibrium price under perfect competition (Simple numerical problems to be solved), Break Even Analysis-linear approach (Simple numerical problems to be solved).

Banking -Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank.

Inflation-Meaning of inflation, types, causes, measures to control inflation.

National Income-Definition, Concepts of national income, Method of measuring national income.

Module III (12 hours)

Time value of money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.

Evaluation of engineering projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects .

Depreciation- Depreciation of capital assert, Causes of depreciation, Methods of calculating depreciation (Straight line method, Declining balance method), After tax comparison of project.

Text Books

1. Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India
2. Principles of Economics, Deviga Vengedasalam; Karunagaran Madhavan, Oxford University Press.
3. Engineering Economy by William G.Sullivan, Elin M.Wicks, C. Patric Koelling, Pearson
4. R.Paneer Seelvan, " Engineering Economics", PHI
5. Ahuja,H.L., "Principles of Micro Economics" , S.Chand & Company Ltd
6. Jhingan,M.L., "Macro Economic Theory"
7. Macro Economics by S.P.Gupta, TMH

ORGANIZATIONAL BEHAVIOUR

Credit- 3 Class Hours - 40

Objectives:

1. To develop an understanding of the behavior of individuals and groups inside organizations
2. To enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.
3. To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Unit	Contents	Class Hours
01	**Fundamentals of OB**: Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), behavioristic and social cognitive), Limitations of OB.	6
02	**Attitude:** Importance of attitude in an organization, Right Attitude, Components of attitude, Relationship between behavior and attitude, Developing Emotional intelligence at the workplace, Job attitude, Barriers to changing attitudes.	10

Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications.

Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Attribution theory, Perceptual process, Social perception (stereotyping and halo effect).

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

03	**Foundations of Group Behavior:** The Meaning of Group & Group behavior & Group Dynamics, Types of Groups, The Five – Stage Model of Group Development. **Managing Teams:** Why Work Teams, Work Teams in Organization, Developing Work Teams, Team Effectiveness & Team Building. **Leadership:** Concept of Leadership, Styles of Leadership, Trait Approach Contingency Leadership Approach, Contemporary leadership, Meaning and significance of contemporary leadership, Concept of transformations leadership, Contemporary theories of leadership, Success stories of today's Global and Indian leaders.	**9**
04	**Organizational Culture** : Meaning & Definition of Organizational Culture, creating & Sustaining Organizational Culture, Types of Culture (Strong vs. Weak Culture, Soft Vs. Hard Culture & Formal vs. Informal Culture), Creating Positive Organizational Culture, Concept of Workplace Spirituality.	**8**
05	**Organizational Change:** Meaning, Definition & Nature of Organizational Change, Types of Organizational Change, Forces that acts as stimulants to change. Implementing Organizational Change : How to overcome the Resistance to Change, Approaches to managing Organizational Change, Kurt Lewin's-Three step model, Seven Stage model of Change & Kotter's Eight-Step plan for Implementing Change, Leading the Change Process, Facilitating Change, Dealing with Individual & Group Resistance, Intervention Strategies for Facilitating Organizational Change, Methods of Implementing Organizational Change, Developing a Learning Organization.	**7**

Reference Books

1. Understanding Organizational Behaviour, Parek, Oxford
2. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.
3. Organizational Behaviour, K. Awathappa,HPH.
4. Organizational Behaviour, VSP Rao, Excel
5. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
6. Organizational Behaviour, Hitt, Miller, Colella, Wiley

HONOURS ELECTIVE

APPLIED MATHEMATICS (L/T: 4/0, Credit: 4)

Module-I (15 Hours)
Probability:
Probability, Random variables, Probability distributions, Mean and variance of distribution, Binomial, Poisson, and Hyper-geometric distributions, Normal and exponential distribution, Distribution of several random variables.

Statistics:
Random sampling, Estimation of Parameters, Confidence Intervals, Testing of hypothesis, Acceptance sampling, Regression Analysis, Fitting Straight Lines, Correlation analysis

Module-II (15 Hours)
Partial Differential Equation:
Partial differential equation of first order, Linear partial differential equation, Non-linear partial differential equation, Homogenous and non-homogeneous partial differential equation with constant co-efficient, Cauchy type, Monge's method, Second order partial differential equation
The vibrating string, the wave equation and its solution, the heat equation and its solution, Two dimensional wave equation and its solution, Laplace equation in polar, cylindrical and spherical coordinates.

Module-III (08 Hours)
Complex Analysis:
Analytic function, Cauchy-Riemann equations, Laplace equation, Conformal mapping,
Complex integration: Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions

Module-IV (06 hours)
Power Series, Taylor's series, Laurent's series, Singularities and zeros, Residue integration method, evaluation of real integrals.

Text books:
1. E. Kreyszig," Advanced Engineering Mathematics:, Eighth Edition, Wiley India
2. B.V. Ramana, " Higher Engineering Mathematics", Tata McGraw Hill

Reference books:
1. E.B. Saff, A.D.Snider, " Fundamental of Complex Analysis", Third Edition, Pearson
2. Jay L. Devore, "Probability and Statistics for Engineering and Sciences", Seventh Edition, Thomson/CENGAGE Learning India Pvt. Ltd
3. P. V.O'Neil, "Advanced Engineering Mathematics", CENGAGE Learning, New Delhi
4. Mathematical Methods by Potter Goldberg Publisher: PHI

MINOR SPECIALIZATION
APPLIED THERMAL ENGINEERING
Theory L/T (Hours per week): 4/0, Credit: 4

Module-I (8 Lectures)

Review of First and Second laws:

First law analysis of unsteady flow control volumes, Entropy change for different process, Entropy generation ,Entropy balance for closed systems and steady flow systems, Available energy, Quality of energy, Availability for non flow and flow process, Irreversibility, Second law efficiency.

Module – II (8 Lectures)

Air Standard Cycle & Introduction to I.C. Engine: Otto, diesel and dual cycles, description and operation of four and two stroke cycle engine, comparison of SI and CI engines, valve timing diagram, power output and efficiency calculation. Brayton cycle, Gas turbine, Jet engines.

Reciprocating Air Compressors: Introduction (Uses of compressed air), The reciprocating cycle neglecting and considering clearance volume, Volumetric efficiency and its effect on compressor performance, Limitations of single stage compression, Multistage compression and intercooling, Optimum intercooler pressure, Performance and design calculations of reciprocating compressors, Air motors

Module – III (12 Lectures)

Steam and Steam Generator:- Properties of steam, measurement of dryness fraction, use of steam table and Mollier chart. T-S and H-S diagrams for representing thermodynamic processes. Boiler, Classification of boiler, comparison between water tube boiler and fire tube boiler. Boiler mountings and accessories. Description of Cochran & Babcock -Wilcox boiler.

Steam Nozzles:- Types of nozzles, isentropic flow through nozzles, effect of friction on nozzle efficiency. Critical pressure ratio and maximum discharge, throat and exit area.

Module – IV (14 Lectures)

Steam Turbines &Condensers:- Turbine type and applications. Impulse turbine, pressure and velocity compounding, velocity diagram, work output, losses and efficiency. Impulse reaction turbine, velocity diagram, degree of reaction, work output, losses and efficiency. Jet and surface condensers. Condenser vacuum and vacuum efficiency.

Heat Transfer: Basic modes of heat transfer, one dimensional steady state, conduction through slab, cylinder and sphere ; basic theory of radiant heat transfer, black body & mono chromatic radiation, total emissive power, heat exchangers.

Refrigeration system: Reversed Carnot cycle, Reversed Brayton cycle (Gas refrigeration system), The vapor compression cycle, The vapor absorption cycle, air conditioning.

Text Books

1. Engineering Thermodynamics by P. Chattopadhyay, OXFORD
2. Power plant Engineering by P. K. Nag, Publisher:TMH
3. Applied Thermodynamics by P.L.Ballaney, Khanna Publishers.

Reference

1. Fundamentals of Thermodynamics by Sonntag, Borgnakke, Van Wylen, John Wiley & Sons
2. Fundamentals of Engineering Thermodynamics by E. Rathakrishnan, PHI
3. Engineering Thermodynamics by M. Achyuthan, PHI
4. Engineering Thermodynamics by Y.V.C. Rao, University Press
5. Thermodynamics and Thermal Engineering by Kothandaraman & Domkundwar, Dhanpat Rai
6. Steam Tables in SI Units by Ramalingam, Scitech
7. Steam Tables by C.P.Kothandaraman, New Age International

Fourth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/ week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours /Week L/T**	**Credit Practical**	**Marks**
HS	Purely Applied Mathematics for Specific Branch of Engineering	3-0	3	100	50			
PC	Mechanisms & Machines	3-0	3	100	50	2	1	50
PC	Basic Manufacturing Process	3-0	3	100	50	2	1	50
PC	IC Engine & Gas Turbine	3-0	3	100	50	2	1	50
PC	Mechanical Measurement, Metallurgy & Reliability	3-0	3	100	50	2	1	50
HS	Engineering Economics/ Organizational Behavior	2-1	3	100	50			
	*Skill Project and Hands on					6	3	100
Total		18	18	600	300	14	7	300
Total Marks: 1200								
Total Credits: 25								
For Honours and Minor Specialization		4	4	100	50			

FOURTH SEMESTER
THEORY

MECHANISMS AND MACHINES

MODULE – I (8 HOURS)

1. Mechanisms with lower pairs : Motor Vehicle Steering Gears - Davis Steering Gear & Ackermann Steering Gear, Hooke's Joint.

2. Cams Design: Fundamental law of Cam, Cam Terminology, Classification of Cams and followers, Analysis of follower motions (Displacement, velocity, Acceleration and jerk) – Simple Harmonic, Uniform Velocity and Constant Acceleration & Retardation Types, Generation of Cam Profiles by Graphical Method, Introduction on Cams with specified contours.

MODULE – II (8 HOURS)

3. Turning Moment Diagram and Flywheel: Turning moment diagram. Turning moment diagrams for different types of engines, Fluctuation of energy and fluctuation of speed. Dynamic Theory of Flywheel, Flywheel of an internal combustion engine and for a punch machine. Determination of flywheel size from Turning Moment Diagram.

4. Gears : Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Force analysis, Path of contact, Arc of contact, Contact ratio, Interference and Undercutting, Methods for eliminating Interference, Minimum number of teeth to avoid interference.

MODULE III (8 HOURS)

5. Mechanism for Control (Governors): Governors - Watt, Porter, Proell, Hartnell, Wilson-Hartnell Governor. Performance parameters: Sensitiveness, Stability, Hunting, Isochronism. Governor Effort and Power, Controlling Force & Controlling Force Curve, Friction & insensitiveness, Comparison between governor and flywheel.

6. Mechanism for Control (Gyroscope): Introduction to Gyroscopes. Gyroscopic forces and Couple. Effect of Gyroscopic Couple on Aeroplanes, Gyroscopic stabilization of ship, Stability of Two Wheelers and Four Wheelers. Rigid disc at an angle fixed to rotating shaft.

MODULE IV (8 HOURS)

7. Balancing of rotating components and linkages: Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses rotating in same plane and in Different planes. Effect of Inertia Force due to Reciprocating Mass on Engine Frame, Partial balance of single cylinder engines. Primary and Secondary Balance of Multi-cylinder In-line Engines. Balancing of locomotive: variation of tractive force, swaying couple, hammer blow. Direct and Reverse Crank method of balancing for radial engines. Balancing of V-engine. Balancing machines: Pivoted-Cradle Balancing Machine.

8. Vibrations: Introduction to Mechanical Vibration – Definitions, elements of vibratory system, Longitudinal, Torsional & Transverse Systems. Differential equations and solutions of motion for a coupled spring mass system. Determination of natural frequency of vibratory systems using energy method, equilibrium method and Rayleigh's method, Free and Forced Vibration of Un-damped and Damped Single Degree Freedom Systems, Logarithmic decrement, Magnification factor, Vibration isolation and transmissibility, whirling of shafts and Evaluation of Critical Speeds of shafts.

TEXT BOOKS

1. Theory of Machines by S.S.Rattan, Tata MacGraw Hill
2. Theory of Machines and Mechanisms (India Edition) by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
3. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New Age International.
4. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East West Press.

REFERENCE

1. Theory of Machines by Thomas Bevan, CBS Publications.
2. Kinematics and Dynamics of Machinery by R.L.Norton, Tata MacGraw Hill
3. Kinematics & Dynamics of Machinery-Charles E. Wilson & J.Peter Saddler,Pearson Ed.
4. Theory of Mechanisms and Machines by C.S.Sharma and K.Purohit, PHI
5. Theory of Machines by Shah Jadwani, Dhanpat Rai
6. Theory of Machines by Abdulla Shariff, Dhanpat Rai
8. Theory of Machines by Sadhu Singh, Pearson Education.

PRACTICAL

Practical (0-0-2) Credit: 1

1 and 2 are compulsory. In addition, minimum six experiments from sl. No. 3-10 to be performed.

1. Design of any one working model related to Mechanisms and Machines i.e., Module I and II.
2. Design of any one working model related to Mechanisms and Machines i.e., Module III and IV.
3. Determination of gyroscopic couple using gyroscopic test rig.
4. Performance characteristics of a spring loaded governor
5. Determination of critical speed of rotating shaft
6. Experiment on static and dynamic balancing apparatus
7. Determination of natural frequencies of un-damped as well as damped vibrating systems.
8. Study of interference and undercutting for gear drives
9. Experiment on Cam Analysis Apparatus.
10. Experiment on evaluation of damping in a vibrating system

BASIC MANUFACTURING PROCESS

MODULE - I (10 LECTURES)

1. Foundry :
   a. Types of patterns, pattern materials and pattern allowances.
   b. Molding Materials - sand molding, metal molding, investment molding, shell molding.
   c. Composition of molding sand, Silica sand, Zircon sand, binders, additives, Binders - clay, binders for CO_2 sand, binder for shell molding, binders for core sand.
   d. Properties of molding sand and sand testing.
   e. Melting furnaces - cupola, resistance furnace, induction and arc furnace.
   f. Solidification of castings, design of risers and runners, feeding distance, centre line freezing resistance chills and chaplets.
   g. Degasification and inoculation of metals.
   h. Casting methods like continuous casting, centrifugal casting, disc casting.
   i. Casting defects.

MODULE – II (8 LECTURES)

2. Welding and cutting: Introduction to gas welding, cutting, Arc welding and equipment's. TIG (GTAW) and MIG (GMAW) welding, resistance welding and Thermit welding. Weldablity
   Modern Welding methods like plasma Arc, Laser Beam, Electron Beam, Ultrasonic, Explosive and friction Welding, edge preparation in butt welding.
   Brazing and soldering, welding defects.
   Destructive and non-destructive testing of castings and welding.

MODULE – III (08 LECTURES)

3. Brief introduction to powder metallurgy processes.
4. Plastic deformation of metals: Variables in metal forming and their optimization. Dependence of stress strain diagram on Strain rate and temperature. Hot and cold working of metals, classification of metal forming processes.
5. Rolling: Pressure and Forces in rolling, types of rolling mills, Rolling defects.
6. Forging: Smith Forging, Drop and Press forging, M/c forging, Forging defects.

MODULE – IV (08 LECTURES)

7. Extrusions: Direct, Indirect, Impact and Hydrostatic extrusion and their applications, Extrusion of tubes.
8. Wire drawing methods and variables in wire-drawing, Optimum dies shape for extrusion and drawing.
9. Brief introduction to sheet metal working: Bending, Forming and Deep drawing, shearing.
10. Brief introduction to explosive forming, coating and deposition methods.

TEXT BOOKS

1. Manufacturing technology by P.N.Rao, Tata McGraw Hill publication.
2. Welding Technology by R.A. Little, TMH
3. Manufacturing Science by A.Ghosh and A K Malick, EWP

REFERENCE BOOKS

1. Fundamentals of metal casting technology by P.C. Mukherjee, Oxford PIBI.
2. Mechanical Metallurgy by Dieter, Mc-Graw Hill
3. Processes and Materials of Manufacture by R.A Lindberg, Prentice hall (India)
4. A Text Book of Production Engineering by P.C.Sharma, S.Chand

PRACTICAL (BASIC MANUFACTURING PROCESS LABORATORY)

LIST OF EXPERIMENTS:

1. Determination of grain size, clay content, permeability and green compressive strength of Molding sand. (2 to 3 experiments)
2. Foundry Practices
3. Preparation of a wood pattern.
4. Determination of strength of brazed and solder joints
5. Practice and preparation of job in TIG/MIG welding
6. Practice and preparation of job in sheet metal using processes like forming and deep drawing.
7. Demonstration of different rolling mills
8. Demonstration of Extrusion processes

INTERNAL COMBUSTION ENGINES AND GAS TURBINES

MODULE - I (11 HOURS)

Introduction :

Classification, Engine nomenclature, engine operating and performance parameters, Valve timing diagram of SI & CI Engines, Comparison of SI and CI engine.

Thermodynamic Analysis of cycles :

Significance of Fuel-Air & Actual cycles of I.C. engines. Comparison with Air Standard Cycles. Analysis of Fuel-Air & Actual cycles (Effect of chemical equilibrium and variable specific heats. Effect of air fuel ratio and exhaust gas dilution. Time Loss Factor, Heat Loss Factor, Exhaust Blow down, Loss Due to Gas Exchange Processes, Volumetric Efficiency, Loss due to Rubbing Friction)

Fuels : Fuels of SI and CI engine, Fuel additives, Properties, potential and advantages of alternative liquid and gaseous fuels for SI and CI engines (biofuels, LPG and CNG)

Fuel Induction Techniques in IC engines :

Fuel induction techniques in SI and CI engines, Mixture Requirements at Different Loads and Speeds.

Carburetion: Factors Affecting Carburetion, Principle of Carburetion, Simple Carburetor and its drawbacks, Calculation of the Air–Fuel Ratio, Modern Carburetors.

MODULE II (12 HOURS)

Fuel Injection: Functional Requirements of an Injection System, Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Injection Pump Governor, Mechanical Governor,Pneumatic Governor, Fuel Injector, Nozzle, Injection in SI Engine, Electronic Injection Systems, Multi-Point Fuel Injection (MPFI) System, Functional Divisions of MPFI System, Injection Timing, Group Gasoline Injection System, Electronic Diesel Injection System.

Ignition : Energy requirement for ignition, requirements of an ignition system, conventional ignition systems, modern ignition systems (TCI and CDI), firing order, Ignition timing, Spark advance mechanism,

Combustion : Stages of combustion in SI and CI engines, effects of engine variables on flame propagation and ignition delay, Abnormal combustion, Preignition & Detonation, Theory of Detonation. Effect of engine variables on Detonation, control of Detonation. Diesel Knock & methods to control diesel knock, Requirements of combustion chambers. Features of different types of combustion chambers system for S.I. engine. (I-head, F-head combustion chambers), C.I. engine combustion chambers -Open and divided type, Air swirl turbulence-M. type combustion chamber. Comparison of various types of combustion chambers.

Super Charging &Scavenging : Thermodynamics Cycles of supercharging. Effect of supercharging, Efficiency of supercharged engines. Methods of super charging, supercharging and scavenging of 2-stroke engines.

Module-III (8 hours)

Testing and Performances : Power, fuel & air measurement methods, Performance characteristic curves of SI & CI engines, variables affecting performance and methods to improve engine performance.

Cooling & Lubricating Systems, Engine Emission &Controls : Air cooling & water cooling systems, Effect of cooling on power output & efficiency, Properties of lubricants and different types of lubricating system.

Modern developments in IC Engines, EGR, MPFI, CRDI, GDI, HCCI, dual fuel engine, Lean burn engine, Stratified engine (basic principles).

Engine Emission and control :

Mechanism of pollutant formation and its harmful effects. Methods of measuring pollutants and control of engine emission.

Module-IV (9 hours)

Gas Turbines : Introduction, Open and closed cycle gas turbines, Analysis of practical gas turbine cycle.

Air Craft Propulsion : Analysis of Turbo Jet, Turbo Prop, Turbo fan & Ram jet engines.

Axial Flow & Centrifugal Compressor : Basic construction of centrifugal and axial flow compressor, Velocity diagram, performance characteristics of centrifugal and axial flow compressor, effects of slip, surging and stalling on compressor.

Text Books:

1. IC Engines, Mathur & Sharma
2. Internal Combustion Engines, V. Ganesan, TMH, 3rd edition
3. Gas Turbines, V.Ganesan, TMH, 3rd edition

Reference books:

1. Fundamentals IC Engines, J.B.Heywood, McGraw Hill
2. A course in IC Engines, V.M.Domkundwar, Dhanpat rai and sons
3. Gas Turbines, Cohen and Roser
4. An Introduction to Energy Conversion, Vol.III, V.Kadambi and Manohar Prasad, New Age International
5. Fundamentals of Internal Combustion Engines, H.N.Gupta, PHI
6. Internal Combustion Engines, K.K.Ramalngam, Scitech Publications

PRACTICAL (I. C. ENGINE LABORATORY)

1. Valve timing diagram of an IC engine
2. Study of a modern carburetor (e.g.Solex Carburtor)
3. Study of fuel injection system of a diesel engine
4. Analysis of exhaust gas of automobile
5. Study of different cooling systems in automobiles (Air cooling and water cooling).
6. Study of lubrication systems in automobiles.
7. Load test on 4-stroke single cylinder C.I. engine.
8. Load test on 4-stroke single cylinder S.I. engine.
9. Morse Test on multi-cylinder S.I. or C.I. engine
10. Load test on variable compression ratio S.I. engine
11. Load test and Heat balance on 2 stroke S.I. Engine

MECHANICAL MEASUREMENT, METROLOGY & RELIABILITY

MODULE – I (16 HOURS)

Definition and methods of measurement, classification of measuring instruments, Measuring systems, performance characteristics of measuring devices, types of errors. Functional elements of measuring system. Static and Dynamic Characteristics of Instruments:

Static Performance Parameters, Impedance Loading and Matching, Selection and Specifications of Instruments, Dynamic Response, Compensation.

Transducer Elements: Analog Transducers, Digital Transducers, Basic detector transducer elements : Electrical transducer, Sliding Contract devices, Variable-inductance transducer elements, the differential transformer, Variable-reluctance transducers, Capacitive transducers. The piezoelectric effect, photo-electric transducer, electronic transducer element.

Intermediate Elements: Amplifier, Operational Amplifier, Diffential and Integrating Elements, Filters, A-D and D-A Converters

Strain Measurement

The electrical resistance strain gauge. The metallic resistance strain gauge, Selection and Installation factors for metallic strain gauge, Circuitry, metallic strain gauge. The strain gauge ballast circuit, the staring gauge bridge circuit, Temperature compensation.

Measurement of Pressure

Pressure measurement systems, Pressure measurement transducers, Elastic diaphragms, strain gauge pressure cells, measurement of high pressure, Measurement of low pressures, dynamic characteristics of pressure measuring systems.

Measurement of Fluid Flow

Flow characteristics obstruction meters, Obstruction meter for compressible fluids- Orifice, Venturi meter and Pitot tube, The variable-area meter, Turbine Flow meters.

Temperature Measurement

Use of bimetals pressure thermometers, Thermocouples, Pyrometry, Calibration of temperature measuring devices.

Force, Power, Speed and Torque Measurement :

Load Cell, Dynamometers, Tachometer and Tacho-generator, Stroboscope, The seismic instrument.- Vibrometers and accelerometers

MODULE – II (10 HOURS)

Principles of Measurements, Line and End & optical Standards, Calibration, accuracy and Precision, Random error and systemic error.

Measurement of Surface Roughness, Screw Thread and Gears.

Limits, Fits and Gauges, Assembly by full, partial and group interchangeability, geometric tolerances.

Measurement of straightness, Flatness and circularity.

MODULE – III (10 HOURS)

Definition, bath-tub-curve, system reliability, reliability improvement, maintainability and availability, Availability of single repairable system using Markov model, Life tests, acceptance sampling plan based on life tests, Sequential acceptance sampling plan based on MTTF & MTBF.

TEXT BOOKS :

1. Engineering Metrology & Measurement, N.V.Raghavendra and L. Krishnamurthy, OXFORD University Press
2. Instrumentation Measurement and Analysis, B.C.Nakra and KK.Chaudhry, Tata Mc Graw Hill, Third Edition.
3. Engineering Metrology,R.K. Jain, Khanna Publisher, Delhi
4. Reliability Engg. And Terotechnology , A.K. Gupta, Macmillan India.

Reference Books:

1. Metrology & Measurement, A. K. Bewoor and V.A.Kulkarni, Mc Graw hill
2. Mechanical Measurements, T.G. Beckwith and N. Lewis Buck, Oxford and IBH Publishing Co.
3. A text book of Engineering Metrology I.C. Gupta, Dhanpat Rai & sons, Delhi.
4. Introduction to /reliability and Maitainability Engg E. Ebeling, MC-Graw Hill.

PRACTICAL

(MECHANICAL MEASUREMENT, METROLOGY & RELIABILITY LAB)

(Minimum 08 Experiments/Studies)

List of Experiments:

1. Calibration of LVDT using indicator / CRO
2. Calibration of load cell using electrical resistance strain gauge
3. Calibration of a Rotameter for fluid flow measurement
4. Calibration of thermo couples
5. Calibration of Bourden Tube Pressure Gauge and measurement of pressure using manometer
6. Experiment on Pneumatic trainer
7. Experiment on Hydraulic trainer
8. Determination of damping coefficient of vibration absorbing materials using vibration measuring equipment.
9. Strain measurement using resistant strain gauge
10. Measurement of straightness and flatness
11. Measurement of roughness of the surface
12. Experiment on slip gauges and sine bar

SURFACE ENGINEERING (HONORS ELECTIVE)

MODULE – I (14 HOURS)

Mechanisms of Wear and Metal Cleaning: Basic Mechanisms of wear-abrasive, adhesive wear, contact fatigue, Fretting corrosion, Testing of wear resistance, practical diagnosis of wear, general cleaning process for ferrous and non ferrous metals and alloys selection of cleaning processes, alkaline cleaning, emulsion cleaning, ultrasonic cleaning, pickling salt bath descaling, abrasive bath cleaning, polishing and buffing shot peening.

MODULE – II (16 HOURS)

Thermal Spraying Processes and Electrodeposited Coatings: Thermal spraying materials, characteristics of thermal spray processes, Design for thermally sprayed coatings coating production, spray fused coatings, Principles of electroplating, Technology and control-electroplating systems, Properties and applications of electrodeposits, Non aqueous and electroless deposition, plasma coating.

Hot Dip Coating and Diffusion Coating: Principles, Surface preparation, Batchcoating and continuous coating process, Coating properties and application, Principles of cementation, Cladding-vacuum deposition, Sprayed metal coating, Structure of diffusion coatings, Chemical vapour deposition (CVD), Physical vapour deposition (PVD).

MODULE – III (14 HOURS)

Non-Metallic Coating Oxide and Conversion Coatings: Plating coating, lacquers, rubbers and elastomers, viterous enamels, anodizing Chromating, application to aluminium, magnesium, tin, zinc, cadmium copper and silver, phosphating primers.

Quality Assurance, Testing and Selection af Coatings: The quality plan, design, testing and inspection, thickness and porosity measurement, selection of coatings, industrial applications of engineering coatings.

TEXT BOOKS :

1. Engineering Coatings-design and application- S. Grainger, Jaico Publishing House.
2. Principles of Metals surface treatment and protection- D. R. Gabe, Pergamon.

REFERENCE BOOKS:

1. Electroplating Handbooks- N.V.Parathasarathy, Prentice Hall.
2. Advances in surface treatment- Niku-Lavi, Pergamon.

RAPID MANUFACTURING PROCESS (HONORS ELECTIVE)

MODULE – I (14 HOURS)

Product Development: Classification of manufacturing processes, Different manufacturing systems, Introduction to rapid Prototyping (RP), Need of RP in context to batch production, FMS and CIM and its application. Product prototyping – solid modeling and prototype representation, reverse engineering, prototyping and manufacturing using CNC machining.

Basic principles of RP steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP

MODULE – II (14 HOURS)

Rapid Manufacturing Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation. Classification of different RP techniques based on raw materials, layering technique (2D or 3D) and energy sources.

Process technology and comparative study of stereo lithography (SL) with photopolymerisation, SL with liquid thermal polymerization, solid foil polymerization, selective laser sintering, selective powder binding, Ballastic particle manufacturing – both 2D and 3D, Fused deposition modeling, Shape melting

MODULE – III (16 HOURS)

Laminated object manufacturing solid ground curing, Repetitive masking and deposition.
Beam interference solidification, Holographic interference solidification special topic on RP using metallic alloys, Programming in RP modeling, Slicing, Internal Hatching, Surface skin films, support structure.

Software for RP: STL files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools.

TEXT BOOKS :

1. Rapid Prototyping and Engineering Applications, Frank W. Liou, CRC Press
2. Introduction to Rapid Prototyping, Amitav Ghosh, North West Publication, New Delhi.

REFERENCE BOOKS:

1. Rapid Manufacturing, Flham D.T & Dinjoy S.S Verlog London 2001. \
2. Rapid Prototyping Materials, Gurumurthi, IISc Bangalore.
3. Rapid Automated, Lament wood. Indus press New York
4. Stereo Lithography and other RP & M Technologies**,** Paul F. Jacobs: SME, NY 1996

FLUID MECHANICS AND HYDRAULIC MACHINES
(Minor Specialization)

MODULE I (12 LECTURES)

Introduction: Scope of fluid mechanics and its development as a science
Physical property of Fluid: Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.

Fluid statics: Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, manometer.

Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical submerged plane surface. Buoyancy and floatation, Archimedes' principle, stability of immersed and floating bodies, determination of metacentric height.

MODULE II (12 LECTURES)

Fluid kinematics: Introduction, description of fluid flow, classification of fluid flow. Reynold's number, Acceleration of fluid particles, flow rate and continuity equation, differential equation of continuity,
Mathematical definitions of irrotational and rotational motion. Circulation, potential function and stream function. Flow net
Fluid dynamics : Introduction,Introduction to N-S equation, Euler's equation along a streamline, energy equation, Bernoulli's equation and its application to siphon, venturimeter, orificemeter, pitot tube.
Flow in pipes and ducts: Loss due to friction, Minor energy losses in pipes Hydraulic Gradient Line (HGL), Total Energy Line (TEL), Power transmission in the fluid flow in pipes, fluid flow in pipes in series and parallel. Flow through nozzles.

MODULE III (10 LECTURES)

Hydraulic turbines: Classification, Impulse and Reaction turbine; Tangential, Radial and axial turbine.
Impulse turbine, Pelton wheel, bucket dimensions, number of buckets in pelton wheel, efficiency and performance curves.
Reaction Turbines: Francis turbine and Kaplan turbine, velocity triangle and efficiencies, performance curve. Function of draft tube and casing cavitation

MODULE IV (06 LECTURES)

Centrifugal Pump: constructional features, vane shape, velocity triangles, Efficiencies, Multi stage centrifugal pumps, Pump Characteristic, NPSH and Cavitation.
Positive displacement pumps: Reciprocating Pump, Working principle, Discharge, work done and power requirement, Slip, Indicator diagram

Text Books

1. Fluid Mechanics, A.K.Jain, Khanna Publishers
2. Fluid Mechanics and Hydraulic Machines, Modi & Seth
3. Introduction to Fluid Mechanics and Fluid Machines, S.K. Som and G. Biswas, TMH
4. Fluid Mechanics and Machinery, Mohd. Kareem Khan, OXFORD

Reference Books:

1. Fluid Mechanics, A.K. Mohanty, PHI
2. Introduction to Fluid Mechanics, Fox, McDonald, Willey Publications
3. Fluid Mechanics by Kundu, Elsevier
4. An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge University Press
5. Engineering Fluid Mechanics by Garde et. al., Scitech
6. First course in Fluid Mechanics by Narasimhan, University press
7. Fluid Mechanics by J.F.Douglas, J.M.Gasiorek, J.A.Swaffield and L.B.Jack, Pearson Education
8. Fluid Mechanics and Machines, Sukumar Pati, TMH

Fifth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/week L/T**	**Credit Practical**	**Marks**
PC	Design of Machine Elements	3-0	3	100	50			
PC	Machining Science & Technology	3-0	3	100	50	2	1	50
PC	Heat Transfer	3-0	3	100	50	2	1	50
PE	Optimization in Engg./Project Management/Quality Management & Reliability	3-1	4	100	50	2	1	50
OE	Energy Conversion Techniques/Human Resources Management/Marketing Management/ C++ & Object Oriented Programming/Internet & Web Technology/Analog & Digital Electronics/Digital Signal Processing	3-1	4	100	50			
PC	Advance Lab-I					8	4	200
Total		17	17	500	250	14	7	350
Total Marks: 1100								
Total Credits: 24								
For Honours and Minor Specialization		4	4	100	50			

FIFTH SEMESTER

DESIGN OF MACHINE ELEMENTS

[Only specified data book as mentioned in the syllabus is permitted during examination]

MODULE-I (8 HOURS)

1. Mechanical engineering design: Introduction to design procedure, Stages in design, Code and Standardization, Interchangeability, Preferred numbers, Fits and Tolerances, Engineering materials: Ferrous, Non-ferrous, Non-metals, design requirements – properties of materials, Material selection, Use of Data books.

2. Fundamentals of Machine Design: Types of load, Modes of failure, factor of safety concepts, Theories of Failure, concept and mitigation of stress concentration, Fatigue failure and curve, endurance limit and factors affecting it, Notch sensitivity, Goodman, Gerber and Soderberg criteria.

MODULE-II (8 HOURS)

3. Machine Element Design: Design of Joints: Rivets, welds and threaded fasteners based on different types of loading, Boiler joints, cotter joints and knuckle joints.

MODULE-III (10 HOURS)

4. Design of Keys, Shaft and Couplings: Classification of keys and pins, Design of keys and pins, Theories of failure, Design of shafts: based on strength, torsional rigidity and fluctuating load, ASME code for shaft design, Design of couplings: Rigid coupling, Flexible coupling.

5. Design of Mechanical Springs: Types of helical springs, Design of Helical springs, bulking of spring, spring surge, end condition of springs, Design of leaf springs: nipping.

MODULE-IV (6 HOURS)

6. Bearings: Types and selection of ball and roller bearings, Dynamic and static load ratings, Bearing life, Design of sliding contact bearings, Journal bearing, foot step bearing.

TEXT BOOKS:

1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill
2. Mechanical Engineering Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH

REFERENCE BOOKS:

1. Machine Design, P.Kanaiah, Scietech Publications
2. Fundamentals of Machine Component Design by R.C.Juvinall and K.M.Marshek, John Wiley & Sons
3. Machine Drawing by N.Sidheswar, McGraw-Hill
4. Machine Design, P.C.Sharma and D.K.Agrawal, S.K.Kataria & Sons
5. Machine Design, Pandya and Shah, Charotar Book Stall
6. Machine Design, Robert L. Norton, Pearson Education Asia.
7. Design of Machine Elements by C. S. Sharma and K. Purohit, PHI

DESIGN DATA HAND BOOKS:

1. P.S.G. Design Data Hand Book, PSG College of Tech Coimbature
2. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed. 2003.
3. Design Hand Book by S.M.Jalaluddin ; Anuradha Agencies Publications
4 .Design Data Hand Book by K.Mahadevan and B.Reddy,CBS Publishers

PRACTICAL (DESIGN OF MACHINE ELEMENTS)

1. Design of any one working model related to Design of machine elements i.e., Module I and II.
2. Design of any one working model related to Design of machine elements i.e., Module III and IV.

} Compulsory

3. Design & drawing of Riveted joint
4. Design and drawing of Cotter joint
5. Design and drawing of Knuckle joint
6. Design of shafts subjected to combined loading
7. Design and drawing of Flange coupling
8. Design of spring
9. Design of bearing

} Total no. of Drawing: 6
3 in drawing sheets
3 in AutoCad/Pro-E/ CATIA/ANSYS

Total number of Design : Minimum 8 nos including 2 working model.

MACHINING SCIENCE AND TECHNOLOGY

MODULE – I (13 HOURS)

Geometry of cutting tools in ASA and ORS, Effect of Geometrical parameters on cutting force and surface finish, Mechanics of chip formation, Merchant's theory, Force relationship and velocity relationship, Cutting tool materials, Types of Tool Wear: Flank wear, Crater wear, Wear measurement, Cutting fluid and its effect; Machinability Criteria, Tool life and Taylor's equation, Effect of variables on tool life and surface finish, Measurement of cutting force, Lathe tool dynamometer, Drill tool dynamometer. Economics of machining.

MODULE – II (13 HOURS)

Conventional machining process and machine tools – Turning, Drilling, Shaping, Planning, Milling, Grinding. Machine tools used for these processes, their specifications and various techniques used.

Principles of machine tools : Kinematics of machine tools, speed transmission from motor to spindle , speed reversal mechanism, mechanism for feed motion, Tool holding and job holding methods in different Machine tools, Types of surface generated, Indexing mechanism and thread cutting mechanism, Quick return mechanism,.

Production Machine tools – Capstan and turret lathes, single spindle and multi spindle semiautomatics, Gear shaper and Gear hobbing machines, Copying lathe and transfer machine

MODULE – III (10 HOURS)

Non-traditional Machining processes :

Ultrasonic Machining, Laser Beam Machining, Plasma Arc Machining, Electro Chemical Machining, Electro Discharge Machining, Wire EDM , Abrasive Jet Machining

TEXT BOOKS :

1. Fundamentals of Machining and Machine Tools, G.Boothroyd and W.A.Knight, CRC Press
2. Metal Cutting Principles, M.C.Shaw, Oxford University Press
3. Metal Cutting Theory and Practice, A.Bhattacharya, Central Book Publishers

REFERENCE BOOKS :

1. Manufacturing Technology – by P.N.Rao, Tata McGraw Hill publication.
2. Modern Manufacturing Processes, P.C.Pandey, H.S.Shan, Tata McGraw Hill
3. Manufacturing Science, Ghosh and Mallik, East West Press.
4. Metal Cutting Theory and Practice, D.A.Stephenson and J.S.Agapiou, CRC Press
5. Machining Technology; Machine Tools and Operation, H.A.Youssef and H. El-Hofy, CRC Press
6. Machine Tools and Manufacturing Technology, Krar, Rapisarda and Check, Cengage Learning
7. Technology of Machine Tools, Krar, Gill and Smidt, Tata McGraw Hill
8. Principles of Metal Cutting, G.Kuppuswamy, Universities Press
9. Metal Cutting and Machne Tools, G.T.Reddy, Scitech
10. Fundamentals of tool Engineering Design, S.K.Basu, S.K.Mukherjee, R. Mishra , Oxford & IBH Pub Co.
11. Machine Tools, R.N.Datta, New Central Book Agency

PRACTICAL (MACHINING SCIENCE AND TECHNOLOGY LAB.)

(Minimum 08 Experiments/Studies)

LIST OF EXPERIMENTS:

1. Job on lathe with tapper turning, thread cutting, knurling and groove cutting (3 experiments).
2. Gear cutting (with index head) on milling machine
3. Working with shaper, Planner and slotting machine.
4. Working with surface and cylindrical grinding.
5. Determination of cutting force using Lathe tool dynamometer.
6. Determination of cutting force in drilling using drill tool dynamometer.
7. Study of Non-traditional machining processes.(USM, AJM, EDM, ECM)
8. Study of CNC Lathe and demonstration of making job in CNC lathe.
9. Study of CNC Milling machine and demonstration of making job in CNC Milling machine

HEAT TRANSFER

MODULE-I (12 HOURS)

1. **Introduction:**
   Modes of heat transfer: conduction, convection, and radiation ,Mechanism & basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity, Thermal conductance &Thermal resistance, Contact resistance, convective heat transfer coefficient, radiation heat transfer coefficient , Electrical analogy, combined modes of heat transfer.initial conditions *and* Boundary conditions of 1st, 2nd and 3rd Kind.
2. **Heat Conduction:**
   The General heat conduction in Cartesian, polar-cylindrical and polar-spherical co-ordinates, Simplification of the general equation for one and two dimensional steady/ transient conduction with constant/ variable thermal conductivity with / without heat generation. Solution of the one dimensional steady state heat conduction problem in case of plane walls, cylinders and spheres for simple and composite cases. Critical insulation thickness, Heat transfer in extended surfaces (pin fins) without heat generation, Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and fin effectiveness. Conduction in solids with negligible internal temperature gradient (Lumped heat analysis).

MODULE-II (12 HOURS)

3. **Convective Heat Transfer:**
   Introduction to convective flow - forced and free. Dimensional analysis of forced and free connective heat transfer. Application of dimensional analysis, physical significance of Grashoff , Reynolds, Prandtl, Nusselt and Stanton numbers.
   Conservation equations for mass, momentum and energy for 2-dimensional convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. Critical Reynolds number; general expressions for drag coefficient and drag force Reynolds-Colbourn analogy. Thermal boundary layer; general expression for local heat transfer coefficient; Average heat transfer Coefficient; Nusselt number. Flow inside a duct- velocity boundary layer, hydrodynamic entrance length and hydro

dynamically developed flow; flow through tubes (internal flow). Use of empirical relations for solving turbulent conditions for external and internal flow.

Mechanism of heat transfer during natural convection, Experimental heat transfer correlations for natural convection in the following cases

(a) Vertical and horizontal plates

(b) Inside and outside flows in case of tubes

Module-III (8 hours)

4. **Radiative heat exchange :**
   Introduction, Radiation properties, definitions of various terms used in radiation heat transfer; Absorptivity,reflectivity & transmissivity.Emissive power & emissivity, Kirchoff's identity, Planck's relation for monochromatic emissive power of a black body, Derivation of Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies, Heat exchange between gray bodies. Radiosity and Irradiation, Electrical analogy and radiation network for 2-body and 3-body radiations exchange in non-absorbing medium, Radiation shields.

Module-IV (8 hours)

5. **Heat transfer for boiling liquids and condensing vapours :**
   Types of condensation, use of correlations for condensation on vertical flat surfaces, horizontal tube and; regimes of pool boiling, pool boiling correlations. Critical heat flux, concept of forced boiling. Numerical problems.
6. **Heat Exchangers :**
   Introduction, Types of heat exchanger, The overall heat transfer coefficient and fouling factors, LMTD and _ - NTU analysis of heat exchangers.

Text Books :

1. Heat Transfer Incropera and Dewitt, Willey publications
2. Heat Transfer : J.P.Holman, TMH Publications
3. Heat Transfer: P.S.Ghosdastidar, Oxford University Press
4. Fundamentals of Engineering Heat and Mass Transfer: R.C.Sachdeva, New Age International Publishers, 4th Edition

References :

1. Heat Transfer by P.K. Nag, TMH
2. Heat Transfer by S.P. Sukhatme, TMH
3. Heat Transfer: A.F.Mills and V.Ganesan, Pearson Education, 2nd Edition
4. Heat and Mass Transfer: Domkundwar and Arora, Danpatrai and sons
5. Heat Transfer : R.K.Rajput, Laxmi Publications
6. Heat and Mass Transfer: A Practical Approach, Y.A.Cengel, Tata Macgraw Hills Education Private Limited

PRACTICAL (HEAT TRANSFER LABORATORY)

1. Determination of Thermal conductivity of composite slab
2. Determination of heat transfer coefficient in natural/forced convention.
3. Determination of surface emissivity
4. Performance test on parallel flow and counter flow heat exchanger
5. Efficiency and effectiveness of fins (Natural / Forced convection)
6. Determination of Critical heat flux during boiling heat transfer.
7. Verification of Stefan Boltzman's law.

OPTIMIZATION IN ENGINEERING (PROFESSIONAL ELECTIVE)

MODULE-I (10 HOURS)

Idea of Engineering optimization problems, Classification of optimization algorithms, Modeling of problems and principle of modeling. Linear programming: Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method , Sensitivity analysis in linear programming .

MODULE -II (10 HOURS)

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method Assignment problems: Hungarian method for solution of Assignment problems Integer Programming: Branch and Bound algorithm for solution of integer Programming Problems Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, Multiple server, Finite sources, Queue discipline.

MODULE -III (10 HOURS)

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming Introduction to Genetic Algorithm.

TEXT BOOKS

1. A. Ravindran, D. T. Philips, J. Solberg, " Operations Research- Principle and Practice", Second edition, Wiley India Pvt Ltd
2. Kalyanmoy Deb, " Optimization for Engineering Design", PHI Learning Pvt Ltd
3. Prabhakar Pai, Operation Research, Oxford University Press

REFERENCE BOOKS:

1. Stephen G. Nash, A. Sofer, " Linear and Non-linear Programming", McGraw Hill
2. A.Ravindran, K.M.Ragsdell, G.V.Reklaitis," Engineering Optimization", Second edition, Wiley India Pvt. Ltd
3. H.A.Taha,A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, "Operations Research", Eighth Edition, Pearson Education
4. F.S.Hiller, G.J.Lieberman, " Operations Research", Eighth Edition, TMH.
5. P.K.Gupta, D.S.Hira, "Operations Research", S.Chand and Company Ltd.

PROJECT MANAGEMENT (PROFESSIONAL ELECTIVE)

MODULE-I PROJECT MANAGEMENT CONCEPTS AND NEEDS IDENTIFICATION

Attributes of a Project, Project Life Cycle, The Project management Process, Benefits of Project Management, Needs Identification, Project Selection, Project organization, the project as part of the functional organization.

Project feasibility Analysis: Technical feasibility, commercial and financial visibility, Environment Analysis.

MODULE-II PROJECT PLANNING AND SCHEDULING:

Design of project management system; project work system; work breakdown structure,

project execution plan, work packaging plan, project procedure manual; project scheduling; bar charts, line of balance (LOB) and Network Techniques (PERT / CPM)/ GERT, Resource allocation, Crashing and Resource Sharing, capacity planning and expansion capacity decision.

MODULE III PROJECT MONITORING AND CONTROL AND PROJECT PERFORMANCE

Planning, Monitoring and Control; Design of monitoring system; Computerized PMIS (Project Management Information System). Coordination; Procedures, Meetings, Control; Scope/Progress control, Performance control, Schedule control, Cost control, Performance Indicators; Project Audit; Project Audit Life Cycle, Responsibilities of Evaluator/ Auditor, Responsibilities of the Project Manager.

BOOKS:

1. Project Planning, Analysis, Selection, Financing, Prasana Chandra, TMH
2. Project Management, Grey, TMH.
3. Project Management, Richman, PHI
4. Project Management, Vasant Desai, HPH
5. Project Management, Bhavesh M.Patel, Vikash
6. Project Engineering & Management- Prasanna Chandra, Prentice Hall.

DESIGN OF MACHINE COMPONENTS
(HONOURS ELECTIVE)

MODULE I (8 HOURS)

1. **Design of Pressure vessels:** Thin pressure vessels: cylindrical and spherical vessels, Design of end Closures, Thick cylindrical shells.
2. **Design of Lever:** Classification, Design of levers, Cranked lever, Lever of safety - valve.

MODULE II (8 HOURS)

3. **Design of belt drive and power screw:** Design of belt drive and pulley, Power screw design with square thread such as screw jack.
4. **Design of clutch and brake**: Friction clutch, Cone clutch and Centrifugal clutch, Block brake, Band brake, Internal expanding shoe brake.

MODULE III (8 HOURS)

5. **Gears:** Design of Spur, Helical, bevel and worm gears.
6. **Flywheel:** Design of Flywheel.

MODULE IV (8 HOURS)

7. **Design of I.C. Engine components:** Design of Cylinder, Piston, Connecting Rod, Crank Shaft.
8. **Introduction to Finite Element Method:** FEM fundamental concepts, Procedure of FEM, Finite Element Modeling of one dimensional problems. Finite Element Analysis of 2-D problems: Shape function, Strain Displacement Relation, Element Characteristics Matrix.

TEXT BOOKS:

1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill
2. Design of Machine Elements by C. S. Sharma and K. Purohit, PHI

REFERENCE BOOKS:

1. Mechanical Engineering Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH
2. Machine Design, P.Kanaiah, Scietech Publications
3. Fundamentals of Machine Component Design by R.C.Juvinall and K.M.Marshek, John Wiley & Sons
4. Machine Drawing by N.Sidheswar, McGraw-Hill
5. Machine Design, P.C.Sharma and D.K.Agrawal, S.K.Kataria & Sons
6. Machine Design, Pandya and Shah, Charotar Book Stall
7. Machine Design, Robert L. Norton, Pearson Education Asia.

DESIGN DATA HAND BOOKS:

1. P.S.G. Design Data Hand Book, PSG College of Tech Coimbature
2. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed. 2003.
3. Design Hand Book by S.M.Jalaluddin ; Anuradha Agencies Publications
4. Design Data Hand Book by K.Mahadevan and B.Reddy,CBS Publishers

ADVANCED MECHANICS OF SOLIDS
(Honours Elective)

MODULE – I (12 HOURS)

Elementary concept of elasticity, stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr's Circle for 3-D state of stress, Octahedral Stresses, State of pure shear, Differential equations of equilibrium and compatibility conditions, plane stress. Analysis of strain, State of strain at a point, Strain Invariant, Principal Strains, Plane state of strain, Strain measurements. Theories of Failure, Various yield criteria

MODULE – II (14 HOURS)

Energy Methods: Work done by forces and elastic strain energy stored. Reciprocal relations, Theorem of virtual work, Castigliano's theorems, Bending of beams: Asymmetrical bending, Shear centre, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links., Deflection of thick curved bars. Axisymmetric problems: Thick walled cylinder subjected to internal and external pressures, Compound cylinders, Shrink fit,

MODULE – III (10 HOURS)

Repeated stresses and fatigue in metals, Fatigue tests and fatigue design theory, Goodman, Gerber and Soderberg criteria, Concept of stress concentration, Notch sensitivity. Introduction to Mechanics of Composite Materials: Lamina and Laminates, Micromechanics of FRP Composites. Introduction to Fracture Mechanics: Basic modes of fracture, Fracture toughness evaluation.

TEXT BOOK:

1. Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill
2. Advanced Mechanics of Materials : Boresi and Schmdt, Willey

REFERENCE BOOK:

1. Advanced Mechanics of Materials : Siley and Smith
2. Strength of Materials Vol.II, by S.Timoshenko
3. Mechanical Metallurgy by Dieter
4. Strength of Materials by G. H. Ryder, Macmillan Press
5. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
6. Mechanics of Materials by R.C.Hibbeler, Pearson Education
7. Mechanics of Materials by William F.Riley, Leroy D.Sturges & Don H.Morris, Wiley Student.
8. Mechanics of Materials by James M. Gere, Thomson Learning
9. Engineering Machanics of Solids by Egor P. Popov, Prentice Hall of India
10. Strength of Materials by S.S.Rattan, Tata Mc Graw Hill

EXPERIMENTAL STRESS ANALYSIS
(Honours Elective)

MODULE – I (12 HOURS)

Elementary Elasticity : Stress at a point, Principal Stresses in 2D and 3D stress systems, strain and stressstrain velations, principal strains, plane stress and plane strain problems. Theory of Photo elasticity: Photo elasticity methods- Light and optics as related to photoelasticity, polarization of light, plane and circularly polarized light, plane polariscopes. The stress-optic law, effects of a stressed model in plane and civculor polariscopes. Dark field and light field arrangements.

MODULE – II (12 HOURS)

Photoelestic model materials for two-dimensional applications, calibration methods. Analysis techniques, Isochromatic and Isoclinic fringe Patterns, Compensation techniques, stress separation techniques, scaling model to prototype stresses. Birefringent coatings and scattered light in Photo-elasticity, reflection polariscope.

MODULE – III (14 HOURS)

Strain-measurement methods and related instrumentation Electrical resistance strain gauges, Gage construction, gage factor, selection, temperature compensation, semiconductor strain gauges. Strain gage circuits, Wheatstone and Potentiometer bridge circuits, Rosette Analysis, recording instruments, Dynamic strain measurements. Brittle coating methods, Behaviour of stress coats and its application. Grid Technique of displacement/strain analysis.

TEXT BOOKS:

1. Experimental Stress Analysis by James W. Dally and William F. Riley, Mc Graw Hill Pub. Co., 1965
2. Experimental stress Analysis and Motion Measurements by Dove and Adams Prentice Hall of India (P) Ltd.

REFERENCES :

1. Timoshenko, S. P. and Goodier, J.N., Theory of Elasticity, Mc Graw Hill Book Co., NY, 1951
2. Durelli, A.J., Phillips, E. and Tsao, C.H., Introduction to the Theoretical and Experimental Analysis of Stress and Strain, Mc Graw Hill Book Co., NY, 1958.
3. Frocht, M.M., Photoelasticity, John Wiley and Sons, Inc., NY, 1948. (vol I & II).
4. Durelli, A.J. Applied stress Analysis, Prentice Hall of India (P) Ltd.

MANUFACTURING PROCESSES (MINOR SPECIALIZATION)

MODULE – I (16 HOURS)

Definition and classification of manufacturing processes. Principle of casting, components of casting process including riser and gating system, pattern and types of pattern, pattern material, mould and moulding materials, properties, melting furnaces (copula), solidification of casting, casting methods and casting defects.

Introduction to gas welding, cutting, Arc welding and equipment's. TIG (GTAW) and MIG (GMAW) welding, resistance welding and Thermit welding(Basic Principles). Brazing and soldering, welding defects.

Plastic deformation of metals. Hot and cold working of metals, classification of metal forming processes. Rolling: types of rolling mills, Rolling defects. Forging: Smith Forging, Drop and Press forging, M/c forging (Basic Principles), Forging defects.

MODULE – II (14 HOURS)

Conventional machining process and machine tools – Turning, Drilling, Shaping, Planning, Milling, Grinding. Machine tools used for these processes, their specifications and various techniques used.

MODULE – III (14 HOURS)

Non-traditional Machining processes : Ultrasonic Machining, Laser Beam Machining, Plasma Arc Machining, Electro Chemical Machining, Electro Discharge Machining, Wire EDM , Abrasive Jet Machining

Concept of Flexible manufacturing process, concurrent engineering, production tools like capstan and turret lathes, rapid prototyping processes.

TEXT BOOKS :

1. Manufacturing technology(Vol.I &II) by P.N.Rao, Tata McGraw Hill publication
2. Welding Technology by R.A. Little, TMH
3. A Text Book of Production Engineering (vol. I & II) by P.C.Sharma, S.Chand

REFERENCE BOOKS:

1. Modern Manufacturing Processes, P.C.Pandey, H.S.Shan, Tata McGraw Hill
2. Manufacturing Science, Ghosh and Mallik, East West Press.
3. Rapid Prototyping by Amitav Ghosh

ADVANCED LAB-I

MACHINE DRAWING

Orthographic and Sectional drawing of Machine components: (Any seven)
Screw threads, Screwed fastenings, Turn Buckle, Keys, Cotter joints and Knuckle joints; Pulley; Flanged coupling, Pedestal Bearing or Plummer Block.
Fundamentals of AutoCAD (Two classes)

1. Dimension & annotations
2. Use of Layers
3. Working with constraint in dimension
4. Creating assembly
5. Axi-symmetrical parts
6. Creating surface features
7. Working with bill of material

Drawing of the following using AUTOCAD: (Any two)

1. Projection of solids
2. Nut & bolt and Fasteners
3. Cotter joint
4. Expansion joint
5. Shaft coupling

TEXT BOOKS:

1. Machine Drawing by N.D.Bhatt, V.M.Panchal, Charotar Publishing House.
2. Machine Drawing by N.D.Junarkar, Pearson Education
3. Machine Drawing with AutoCAD by Goutam Pohit and Goutam Ghosh, Pearson
1. Education
4. Machine Drawing includes AutoCAD by Ajeet Singh, Tata MacGraw Hill

REFERENCE BOOKS:

1. Machine Drawing by K.L.Narayana, P.Kannaiah, K.Venkata Reddy, New Age International
2. Engineering Drawing and Graphics using AUTOCAD by T.Jayapoovan, Vikas Publishing

Sixth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/week L/T**	**Credit Practical**	**Marks**
PC	Production & Operation Management	3-0	3	100	50	2	1	50
PC	Refrigeration & Air Conditioning	3-0	3	100	50	2	1	50
PE	Product Design & Production Tooling/Computer Integrated Manufacturing & FMS/CAD & CAM	3-1	4	100	50			
PE	Compressive Flow & Gas Dynamics/Automobile Engg./ Non-Conventional Energy Sources	3-1	4	100	50			
MC & GS	Environmental Science & Engineering	3-0	3	100	50			
OE	Industrial Lecture #					3	1	50
HS	Presentation Skill & Skill for Interview ##	2-0	1		50	4	2	100
MC	Yoga					2	1	50
Total		19	18	500	300	13	6	300
Total Marks: 1100								
Total Credits: 24								
For Honours and Minor Specialization		4	4	100	50			

SIXTH SEMESTER

PRODUCTION AND OPERATION MANAGEMENT

Objective : The course aims at acquainting all engineering graduates irrespective of their specializations the basic issues and tools of managing production and operations functions of an organization.

MODULE I

1. Operations Function in an Organization, Manufacturing Vrs Service Operations, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantage, Operations Quality and Productivity Focus, Meeting Global Challenges of Production and Operations Imperatives. **(3 Hours)**
2. Designing Products, Services and Processes: New Product Design- Product Life Cycle, Product Development Process, Process Technology : Project, Jobshop, Batch, Assembly Line, Continuous Manufacturing; Process Technology Life Cycle, Process Technology Trends, FMS, CIM, CAD, CAM; Design for Services, Services Process Technology. **(4 Hours)**
3. Work Study: Methods Study- Techniques of Analysis, recording, improvement and standardization; Work Measurement : Work Measurement Principles using Stopwatch Time Study, Predetermined Motion Time Standards and Work Sampling, Standard Time Estimation. **(4 Hours)**

MODULE II

4. Location and Layout Planning : Factor Influencing Plant and Warehouse Locations, Impact of Location on cost and revenues. Facility Location Procedure and Models : Qualitative Models, Breakeven Analysis, location Model, centroid method.
   Layout Planning: Layout Types : Process Layout, Product Layout, Fixed Position Layout Planning, block diagramming, line balancing, computerized layout planning- overview.
   Group Technology **(4 Hours)**
5. Forecasting : Principles and Method, Moving Average, weighted Moving Average, Exponential Smoothing, Winter's Method for Seasonal Demand, Forecasting Error.**(4 Hours)**
6. Manufacturing Planning and Control : The Framework and Components : Aggregate Planning, Master Production Scheduling, Rough-cut-Capacity Planning, Material Requirements Planning, Capacity Requirements Planning. **(5 Hours)**

MODULE III

7. Sequencing and Scheduling : Single Machine Sequencing : Basics and Performance Evaluation Criteria, Methods for Minimizing Mean Flow Time, Parallel Machines : Minimization of Makespan, Flowshop sequencing : 2 and 3 machines cases : Johnson's Rule and Jobshop Scheduling : Priority dispatching Rules. **(3 Hours)**
8. Inventory Control : Relevant Costs, Basic EOQ Model, Model with Quantity discount, Economic Batch Quantity, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABC Analysis. **(4 Hours)**
9. Modern Trends in Manufacturing : Just in Time (JIT) System : Shop Floor Control By Kanbans, Total Quality Management, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, Poka Yoke, Supply Chain Management. **(4 Hours)**

REFERENCE BOOK:

1. S.N.Chary, "Production and Operations Management", Tata McGraw Hill.
2. R. Paneerselvam, "Production and Operations Management, Prentice Hall of India.
3. Aswathappa & Bhatt – Production & Operations Management, HPH.
4. Gaither & Frazier - Operations Management, Cengage Publication
5. Russell & Taylor - Operations Management, PHI Publication
6. Chase, Aquilanno, Jacob & Agarwal - Operations Management, TMH Publication.
7. E.E. Adam and R.J. Ebert "Production and Operations Management", Prentice Hall of India

REFRIGERATION AND AIR CONDITIONING

THEORY

MODULE I (12 HOURS)

1. Air Refrigeration System : Introduction, Unit of refrigeration, Coefficient of performance, Reversed Carnot Cycle, Temperature limitations, maximum COP, Bell Coleman air cycle, Simple Air Cycle System for Air-craft with problems.
2. Vapour Compression System : Analysis of theoretical vapour compression cycle, Representation of cycle on T - S and p - h diagram, Simple saturation cycle, sub-cooled cycle and super-heated cycle, Effect of suction and discharge pressure on performance, Actual vapour compression cycle. Problem illustration and solution.
3. Multi-stage compression and Multi-evaporator systems : Different arrangements of compressors and inter-cooling, Multistage compression with inter-cooling, Multi-evaporator system, Dual compression system. Simple problems

MODULE II (12 HOURS)

4. Vapour Absorption System : Simple Ammonia - absorption system, Improved absorption system, Analysis of vapour absorption system (Specifically of analyzing coloumn and rectifier), Electrolux / Three fluid system, Lithium-bromide-water vapour absorption system, comparison of absorption system with vapour compression system. Simple Problems and solution.
5. Thermoelectric Refrigeration: Basics and Principle. Defining the figure of Merit. (No Problem)
6. Refrigerants ; Classification of refrigerants and its degignation- Halocarbon (compounds, Hydrocarbons, Inorganic compounds, Azeotropes, Properties of refrigerants, comparison of common refrigerants, uses of important refrigerants, Brines. Alternative refrigerants (Organic and inorganic compounds).

MODULE III (10 HOURS)

7. Psychrometrics : Properties of air-vapour mixture, Law of water vapour-air mixture, Enthalpy of moisture, Psychrometric chart, simple heating and cooling, Humidification, De-humidification, Mixture of air streams. Review question and discussions
   Requirements of comfort air conditioning: Oxygen supply, Heat removal, moisture removal, air motion, purity of air, Thermodynamics of human body, comfort and comfort chart, effective temperature, factors governing optimum effective temperature

MODULE IV (06 HOURS)

8. Air Conditioning System: Process in air conditioning : Summer air conditioning, Winter air conditioning and year round air conditioning, Cooling load calculations. Review question and discussions.

TEXT BOOKS :

1. Refrigeration and Air Conditioning by R.C. Arora , PHI Publication
2. Refrigeration and Air conditioning by C.P. Arora, Tata McGraw Hill.
3. 2Refrigeration and Air Conditioning by S.C. Arora and S. Domkundwar, Dhanpat Rai & Sons. Chapters ; 3,4,5,6,7,11,16,17,19,20
4. Refrigeration and Airconditioning Data book by Manohar Prasad

REFERENCE BOOKS :

1. Refrigeration and Air conditioning by P.L. Ballney, Khanna Publishers.
2. Refrigeration and Air conditioning by Manohar Prasad,New Age international publishers.

PRACTICAL (REFRIGERATION & AIR CONDITIONING LAB)

1. Determination of C.O. P on vapour compression system

2. Determination of C.O. P on vapour absorption system

3. Performance test on Air conditioning test rig (Window type)

4. Performance test on Air conditioning test rig (Duct type)

5. Determination of C.O.P of ice plant

6. Determination of C.O.P of Heat Pump

7. Performance analysis in an experimental cooling tower.

PROFESSIONAL ELECTIVES

PRODUCT DESIGN AND PRODUCTION TOOLING

MODULE – I (14 HOURS)

Product Design-Product design considerations, product planning, product development, value analysis, product specification. Role of computer in product design.

Process Planning – selection of processes, machines and tools. Design of sequence of operations, Time & cost estimation

MODULE – II (14 HOURS)

Forging design- allowances, die design for drop forging, design of flash and gutter, upset forging die design.

Sheet metal working- Design consideration for shearing, blanking piercing, deep drawing operation, Die design for sheet metal operations, progressive and compound die, strippers , stops, strip layout.

MODULE – III (16 HOURS)

Design of jigs and fixtures, principle of location and clamping, clamping methods, locating methods, Drill Jig bushing, Indexing type drilling Jig.

Design of single point cutting tool, broach and form tool. Tooling design for turret lathe and automats. Design of limit gauges.

TEXT BOOKS :

1. Product Design & Manufacturing, A K Chitale, R C Gupta, Eastern Economy Edition, PHI.
2. Product Design & Development, Karl T Ulrich, Steven D Eppinger, Anita Goyal, Mc Graw Hill.
3. A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co

REFERENCE BOOKS:

1. Fundamentals of Tool Engineering design, S.K. Basu, S.N. Mukherjee, R. Mishra, Oxford & IBH Publishing co.
2. Technology of Machine Tools, Krar, Gill, Smid, Tata Mc Graw Hill
3. Jigs & Fixture Design, Edwrd G Hoffman, Cengae Learning.

COMPUTER INTEGRATED MANUFACTURING & FMS

(PROFESSIONAL ELECTIVE)

MODULE – I (14 HOURS)

Fundamentals of Manufacturing and Automation: Production systems, automation principles and its strategies; Manufacturing industries; Types of production function in manufacturing; Automation principles and strategies, elements of automated system, automation functions and level of automation; product/production relationship, Production concept and mathematical models for production rate, capacity, utilization and availability; Cost-benefit analysis.

Computer Integrated Manufacturing: Basics of product design, CAD/CAM, Concurrent engineering, CAPP and CIM.

MODULE – II (14 HOURS)

Industrial Robotics: Robot anatomy, control systems, end effectors, sensors and actuators; fundamentals of NC technology, CNC, DNC, NC part programming; Robotic programming, Robotic languages, work cell control, Robot cleft design, types of robot application, Processing operations, Programmable Logic controllers: Parts of PLC, Operation and application of PLC, Fundamentals of Net workings; Material Handling and automated storage and retrieval systems, automatic data capture, identification methods, bar code and other technologies.

MODULE – III (16 HOURS)

Introduction to manufacturing systems: Group Technology and cellular manufacturing, Part families, Part classification and coding, Production flow analysis, Machine cell design, Applications and Benefits of Group Technology.

Flexible Manufacturing system: Basics of FMS, components of FMS, FMS planning and implementation, flexibility, quantitative analysis of flexibility, application and benefits of FMS.

Computer Aided Quality Control: objectives of CAQC, QC and CIM, CMM and Flexible Inspection systems.

TEXT BOOKS :

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover, Pearson Publication.
2. Automation, Production systems & Computer Integrated Manufacturing, M.P Groover, PHI.
3. CAD/CAM/CIM, P.Radhakrishnan, S.Subramanyam and V.Raju, New Age International
4. Flexible Manufacturing Systems in Practice, J Talavage and R.G. Hannam, Marcell Decker

REFERENCE BOOKS:

1. CAD/CAM Theory and Practice, Zeid and Subramanian, TMH Publication
2. CAD/CAM Theory and Concepts, K. Sareen and C. Grewal, S Chand publication
3. Computer Aided Design and Manufacturing, L. Narayan, M. Rao and S. Sarkar, PHI.
4. Principles of Computer Integrated Manufacturing, S.K.Vajpayee, PHI
5. Computer Integrated Manufacturing, J.A.Rehg and H.W.Kraebber, Prentice Hall

COMPUTER AIDED DESIGN AND COMPTER AIDED MANUFACTURING (CAD&CAM)

(PROFESSIONAL ELECTIVE)

MODULE – I (14 HOURS)

Fundamentals of CAD: Design process, Applications of computer for design, Creating the Manufacturing Database, The Design workstation, Graphical Terminal, Operator input Devices, Plotters and other devices, Central Processing Unit, Memory types.

MODULE – II (14 HOURS)

Computer graphics Software and Database: Configuration, Graphics Packages, Constructing the Geometry, Transformations of geometry, Database structure and content, Wire frame versus solid modeling, Constraint– Based modeling, Geometric commands, Display control commands, Editing.

MODULE III (14 HOUR)

CAM - Numerical Control and NC Part Programming: Numerical Control, Numerical Control elements, NC Cordinate system, NC motion control system, Manual and Computer Aided programming, the APT language, Miscellaneous Functions, M, Advanced part-programming methods.

Problems with conventional NC, NC technology: CNC, DNC, Combined DNC/ CNC system, Adaptive control manufacturing systems, Computer Integrated Manufacturing system, Machine Tools and related equipment, Materials Handling system: AGV, Robots, Lean manufacturing.

TEXT BOOKS :

1. CAD/CAM Computer Aided Design and Manufacturing, M.P.Goover and E.W.Zimmers, Jr., Pearson.
2. CAD & CAM, J Srinivas, Oxford University Press

REFERENCE BOOKS:

1. CAD/CAM Theory and Practice, Zeid and Subramanian, TMH
2. CAD/CAM Principles, Practice and Manufacturing Management, McMahon and Browne, Pearson Education
3. CAD/CAM Concepts and Applications, C.R.Alavala, PHI
4. Computer Aided Design and Manufacturing, Lalit Narayan, Mallkarjuna Rao and Sarcar, PHI
5. CAD/CAM Theory and Conepts, K.Sareen and C.Grewal, S.Chand Publication
6. CAD/CAM/CAE, N.K.Chougule, Scitech

AUTOMOBILE ENGG

(PROFESSIONAL ELECTIVE)

MODULE I (14 HOURS)

Introduction

Main units of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act.

Power for Propulsion

Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

Breaking systems

Hydraulic breaking system, breaking of vehicles when applied to rear, front and all four wheel, theory of internal shoe brake, design of brake lining and brake drum, different arrangement of brake shoes, servo and power brakes.

MODULE II (12 HOURS)

Transmission Systems

Layout of the transmission system, main function of the different components of the transmission system, transmission system for two wheel and four wheel drives. Hotchkiss and torque tube drives.

Gear box : Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission.

Hookes joint, propeller shaft, differential, rear axles, types of rear axles, semi floating, there quarter floating and full floating types.

MODULE III (14 HOURS)

Front wheel Geometry and steering systems : Camber, castor, kingpin inclination, toe-in and toe-out, centre point steering condition for true rolling, components of steering mechanism, power steering.

Electrical system of an automobile : Starting system, charging system, ignition system, other electrical system.

Electrical vehicles:

History, electrical vehicles and the environment pollution, description of electric vehicle, operational advantages, present EV performance and applications, battery for EV, Battery types and fuel cells, Solar powered vehicles, hybrid vehicles.

TEXTBOOKS :

1. Automobile Mechanics , N.K.Giri, Khanna publishers
2. Automobile Engineering, K.M. Gupta, VolI & II, Umesh Publication

REFERENCE BOOKS

1. Automotive mechanics: William h. Crouse and Donald L. Anglin, TMH
2. The motor vehicle, Newton and Steeds
3. Automobile Mechanics, J. Heitner, East West Press
4. Automobile Engineering, Jain and Asthana, Tata McGraw Hill
5. Automobile Engineering, K.K.Ramalingam, Scitech
6. Automobile Engineering, Vol. I & II, Kirpal Singh, Standard Publications

7. A Text Book of Automobile Engineering, R.K.Rajput, Laxmi Publishers

NON CONVENTIONAL ENERGY SOURCES

(PROFESSIONAL ELECTIVE)

MODULE I (6 CLASSES)

1. Energy, Ecology and environment: Introduction, Classification of Energy Resources, Common Forms of Energy, Energy Chain, Advantages and Disadvantages of Conventional Energy Sources, Importance and Salient Features of Non-Conventional Energy Sources, Environmental and ecological Aspects of Energy use, Environment-Economy-Energy and Sustainable Development, World Energy Status, Energy Scenario in India.
   Energy Conservation and Energy Storage: Salient Features of "Energy Conservation Act, 2001", Various Aspects of Energy Conservation, Principles of Energy Conservation, General Electrical ECO's (Energy Conservation Opportunities),

MODULE II (15 CLASSES)

2. Solar Energy: Basics, The Sun as a Source of Energy, Sun, Earth Radiation Spectrums, Extraterrestrial and Terrestrial Radiations, Spectral Energy Distribution of Solar Radiation, Depletion of Solar Radiation, Measurements of Solar Radiation, Solar Time (Local Apparent Time), Solar Radiation Geometry, Solar Day Length, Empirical Equations for Estimating Solar Radiation(Hourly Global, Diffuse and Beam Radiations) on Horizontal Surface Under loudless and Cloudy Skies, Solar Radiation on Inclined Plane Surface only (empirical relations for numerical)

3. Solar Thermal Systems: Solar Collectors: Flat plate and concentric collectors, Solar Water Heater, Solar Passive Space - Heating and Cooling Systems, Solar Refrigeration and Air-Conditioning Systems, Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, Solar Distillation (or Desalination of Water), Solar Photovoltaic Systems: Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell, Module, Panel and Array Construction, Solar PV Systems, Solar PV Applications.

MODULE III (08 CLASSES)

4. Wind Energy: Origin of Winds, Nature of Winds, Wind Turbine Siting, Major Applications of Wind Power, Wind Turbine Types and Their Construction, Wind Energy Conversion Systems (WECS), Effects of Wind Speed and Grid Condition (System Integration),
5. Biomass Energy: Photosynthesis Process, Usable Forms of Biomass, their Composition and Fuel Properties, Biomass Resources , Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification ,Biomass Liquefaction, Biomass to Ethanol Production, Biogas Production from Waste Biomass, Energy Farming.

MODULE IV (08 CLASSES)

6. Geothermal Energy: Applications, Origin and Distribution of Geothermal Energy, Types of
   a. Geothermal Resource.
7. Ocean Energy: Tidal Energy, Wave Energy, Ocean Thermal Energy
8. Fuel Cell Technology: Types, Principle of operation, Advantages and disadvantages.

TEXT BOOK:

1. Solar Energy Technology: Sukhatme and Nayak, TMH
2. Renewable Energy Sources and Emerging Technology: D.P.Kothari and etal., PHI
3. Renewable Energy Sources & Conversion Technology: N.K.Bansal, Manfred Kleenman & Michael Meliss, TMH Publication.
4. Non Conventional Energy Sources: B.M Khan, TMH Publications

REFERENCE:

1. Renewable Energy Sources:Fundamentals & Applications:G.N.Tiwari & M.K.Ghosal, Narosa Pub
2. Non Conventional Energy Resources: D.S. Chauhan and S.K.Srivastava, New Age International
3. Non Conventional Energy Sources: H.P.Garg
4. Non-Conventional Energy Systems: G.D.Rai, Khanna publications
5. Renewable Energy, Godfrey Boyle, Oxford University Press

POWER PLANT ENGINEERING

(HONOURS ELECTIVE)

MODULE- I (8 HRS)

1. INTRODUCTION
   Different sources (Conventional and non-conventional) of energy and the principle of power generation only, Types of power plant and site selection, overall view of a steam power plant.
2. STEAM GENERATOR
   Fossil fuel steam generators, classification, circulation in water tube boilers, Modern high pressure water tube boilers(both sub critical and super critical), Boiler mounting and accessories, Combustion equipment: air supply systems (Natural and Mechanical Draught Systems). Pulverized coal burning systems and Basics of Fluidized bed combustion, Feed water treatment (Necessity & general consideration only). Boiler performance calculations.

MODULE – II (10HRS)

3. FLOW THROUGH NOZZLES
   Types of nozzles and their area of application & related calculation, critical pressure & chocked flow, super saturated flow. Effect of friction and nozzle efficiency
4. STEAM TURBINES
   Turbine types, Variation of Pressure and Velocity in different types of turbines, Simple impulse Turbines, Flow through turbine blades and velocity diagram, Pressure - compounded impulse turbines and Velocity compounded impulse turbines. Turbine power and related calculations.

MODULE – III (10HRS)

5. REACTION TURBINES
   Reaction turbines Flow through blades and velocity diagram, degrees of reaction, Parsons turbine, power and related calculations, Blade height calculations, Losses in steam turbines, Reheat factor & condition line, Governing of turbines.
6. STEAM CONDENSER & CIRCULATING WATER SYSTEMS
   Types, Surface condenser, Performance calculation, Air removal methods, Vacuum & vacuum efficiency. Cooling towers.(types, principle of operation and performance)

MODULE – IV (8HRS)

7. NUCLEAR POWER PLANT
   Introduction, Nuclear fuels, Nuclear fission, Reactor components, & materials and classification,, Boiling Water Reactor (BWR), Pressurized water Reactor (PWR),CANDU Reactor, Gas cooled Reactors, Liquid metal fast breeder Reactor. Heavy water Reactors .Waste disposal and Safety of Nuclear power plant
8. ECONOMICS OF POWER PLANT
   Basic definitions, cost of electrical energy(Fixed cost and operating cost), Types of tariff, Types of loads(typical load curves), Economic Load sharing

TEXT BOOKS

1. Power plant Engineering ; - By P.K. Nag (2nd edition) TMH
2. Power Plant Engineering by Arora and Domkundwar, Dhanpat Rai publications

REFERENCE:

1. 1.. Power Plant Engineering by Yadav
2. Power Plant Engineering by Rajput
3. Power plant technology : By E.I. Wakil TMH
4. Power Plant Engineering by C.Elanchezhian, Sarvanakumar, Vijayramnath, IK International Publishing house Pvt Ltd

ADVANCED FLUID MECHANICS

(HONOURS ELECTIVE)

MODULE I (08 HRS.)

Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, Scalar and vector fields, Eulerian and Lagrangian description of flow. Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential.

MODULE II (10 HRS.)

Transport theorems, constitutive equations, derivation of Navier Stokes equations for compressible flow. Exact solutions of Navier Stokes equations : plane Poiseuille flow
and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stoke's first and second problem, Hiemenz flow, flow near a rotating disk, flow in convergent- divergent channels. Slow viscous flow: Stokes and Oseen's approximation,

MODULE III (10 HRS.)

Theory of hydrodynamic lubrication. Boundary layer: derivation, exact solutions, Blasius, Falkner Skan, series solution and numerical solutions. Approximate methods. Momentum integral method.

MODULE IV (08 HRS.)

Two dimensional and axisymmetric jets.Description of turbulent flow, velocity correlations, Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution.

TEXT BOOK:

1. Advanced Fluid Mechanics, Som and Biswas, Tata McGraw Hill

REFERENCE BOOKS:

1. Fluid Mechanics, A.K.Mohanty, PHI
2. Fundamentals of Fluid Mechanics, Schlitching
3. Introduction to Fluid Mechanics, Shaughnessy, Oxford University Press
4. Fluid Mechanics:-Frank M .White, TMH
5. Fluid Mechnics:- Cengel and Cimbala, TMH

MECHANICS OF SOLID

(MINOR SPECIALIZATION)

MODULE - I (10 LECTURES)

1. Load, Stress, Principle of St.Venant, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads,
   Analysis of Axially Loaded Members : Composite bars in tension and compression - temperature stresses in composite rods, Statically indeterminate problems.
   Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.
2. Members in Biaxial State of Stress :
   Stresses in thin cylinders, thin spherical shells under internal pressure - wire winding of thin cylinders. Analysis of Biaxial Stress. Plane stress, Principal stress, Principal plane, Mohr's Circle for Biaxial Stress.

MODULE - II (11 Lectures)

3. Strain Deformation :
   Two dimensional state of strain, Mohr's circle for strain, Principal strains and principal axes of strain measurements, Calculation of principal stresses from principal strains.
4. Shear Force and Bending Moment for Simple Beams
   Shear force and bending moment. Types of load and Types of support. Support reactions, Relationship between bending moment and shear force, Point of inflection. Shear Force and Bending Moment diagrams.
5. Simple Bending of Beams :
   Theory of simple bending of initially straight beams, Bending stresses, Shear stresses in bending, Distribution of normal and shear stress, beams of two materials, Composite beams.

MODULE - III (8 LECTURES)

6. Deflection of Beams :
   Differential equation of the elastic line, Slope and deflection of beams by integration method and area - moment method.
7. Theory of Columns:
   Eccentric loading of a short strut, Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio

MODULE - IV (7 LECTURES)

8. Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, strength of solid and hollow circular shafts. Stresses due to combined bending and torsion, Strength of shafts in combined bending and twisting.
9. Close - Coiled helical springs.

TEXT BOOKS

1. Elements of Strength of Materials by S.P.Timoshenko and D.H.Young, Affiliated East-West Press
2. Strength of Materials by G. H. Ryder, Macmillan Press
3. Strength of Materials by James M. Gere and Barry J. Goodno, Cengage Learning

REFERENCE BOOKS

1. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
2. Mechanics of Materials by R.C.Hibbeler, Pearson Education
3. Mechanics of Materials by William F.Riley, Leroy D.Sturges and Don H.Morris, Wiley Student Edition
4. Mechanics of Materials by James M. Gere, Thomson Learning
5. Engineering Machanics of Solids by Egor P. Popov, Prentice Hall of India
6. Strength of Materials by S.S.Rattan, Tata Mc Graw Hill
7. Strength of Materials by R.Subramaniam, Oxford University Press
8. Strength of Materials by Sadhu Singh, Khanna Publishers

Seventh Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/ week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ week L/T**	**Credit Practical**	**Marks**
GS	Nano Science & Bio Technology	3-1	4	100	50			
PE	Mechanical Vibration/Tribology/Fatigue Creep & Fracture	3-1	4	100	50			
PE	Robotics/Simulation,Modelling& Control/Mechatronics & MEMs	3-1	4	100	50			
OE	Soft Computing */ Other subjects	3-1	4	100	50			
PC	Advance Lab-II/ Project/3D Printing					8	4	200
	Projects on Internet of Things					8	4	200
Total		16	16	400	200	16	8	400
Total Marks: 1000								
Total Credits: 24								
For Honours and Minor Specialization		4	4	100	50			

SEVENTH SEMESTER
PROFESSIONAL ELECTIVES

NANO SCIENCE AND BIOTECHNOLOGY

"will be uploaded soon"

MECHANICAL VIBRATION

MODULE – I [12]

1. INTRODUCTION & IMPORTANCE OF MECHANICAL VIBRATION:
Brief history of Mechanical Vibration, Types of Vibration, Simple Harmonic Motion (S.H.M.), Principle of superposition applied to S.H.M., Beats, Fourier Analysis, Concept of degree of freedom for different vibrating systems.
2. UNDAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Modeling of Vibrating Systems, Evaluation of natural frequency – differential equation, Energy & Rayleigh's methods, Equivalent systems.
3. DAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Different types of damping, Equivalent viscous damping, structural damping, Evaluation of damping using free and forced Vibration technique, Concept of critical damping and its importance, study of vibration response of viscous damped systems for cases of under damping, critical damping and over damping, Logarithmic decrement.

MODULE – II [15]

4. FORCED VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Steady state solution with viscous damping due to harmonic force, reciprocating and rotating unbalance mass, vibration isolation and transmissibility due to harmonic force excitation and support motion. Vibration measuring instruments – vibrometer and accelerometer. Whirling of shaft with single disc and withour damping, Concept of critical speed and its effect on the rotating shaft.
5. UNDAMPED VIBRATION OF TWO DEGREE FREEDOM SYSTEMS: Free vibration of spring coupled and mass coupled systems, Longitudial, Torsional and transverse vibration of two degree freedom systems, influence coefficient technique, Un-damped vibration Absorber.

MODULE – III [13]

6. INTRODUCTION TO MULTI-DEGREE FREEDOM SYSTEMS: Normal mode vibration, Co-ordinate coupling-close coupled and far coupled systems, Orthogonality of mode shapes, Methods of matrix iteration, Holzer's method and Stodola method. Torsinal vibration of two, three and multi-rotor systems. Dunkerley's lower bound approximate method.
7. CONTINOUS SYSTEMS: Vibration of strings, longitudinal vibration of rods, torsional vibration of rods, transverse vibration of Euler-beams.

TEXT BOOKS:

1. Theory of vibration with Applications: W.T. Thomson and Marie Dillon Dahleh, Pearson Education 5th ed. 2007.

2. Introductory Course on theory and Practice of Mechanical Vibrations. J.S. Rao & K. Gupta, New Age International Publication, New Delhi, 2007.

REFERENCE BOOKS:

1. Mechanical Vibrations: S.S. Rao, Prarson Education Inc, 4th ed. 2003
2. Mechanical Vibrations: S. Graham Kelly, Schaum's outline series, Tata McGraw Hill, Special Indian ed., 2007
3. Mechanical Vibrations: V.P. Singh, Dhanpat Rai & company Pvt. Ltd. 3rd ed., 2006
4. Elements of vibration Analysis: Leonard Meirovitch, Tata McGraw Hill, Special Indian ed., 2007

TRIBOLOGY

(PROFESSIONAL ELECTIVE)

MODULE - I (12 HOURS)

Introduction : Lubricant and lubrication, Types of bearings, properties and testing of lubricants,
Basic equations: Generalized Reynolds equation, Flow and Shear Stress, Energy equation, Equation of state
Hydro dynamic lubrication :
Mechanism of pressure development and load carrying capacity, Plane-slider bearing, Idealized slider bearing with a pivoted shoe, Step bearing, Idealized journal bearing. – infinitely long journal bearing, Petroffs equation for a lightly loaded bearing, narrow bearing,

MODULE - II (11 HOURS)

Oil flow and thermal equilibrium - Heat balance of lubricants
Hydrostatic Bearing **:**
Principles, Component of hydrostatic lubrication , Hydrostatic circular thrust bearing , calculation of pressure, load carrying capacity, flow rate , power loss in bearing due to friction.

MODULE - III (12 HOURS)

Concept of gas lubricated bearing
Concept of Elastohydrodynamic lubrication, Design and selection of antifiction bearing
Friction and wear of metals :
Theories of friction, surface contaminants, Effect of sliding speed on friction, classification and mechanism of wear, Wear resistant materials.

TEXT BOOKS

1. Introduction to Tribology of Bearing , B.C .Majumdar , S. Chand & Co

REFERENCE BOOKS

1. Fundamentals of Tribiology , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2006
2. Basic Lubrication theory, A. Cameron, John Wiley & sons
3. Lubrication Fundamentals, D.M.Pirro and A.A.Wessol, CRC Press
4. Theory and Practice of Lubrication for Engineers**,** Fuller, D., New York company 1998
5. Principles and Applications of Tribiology**,** Moore, Pergamaon press 1998
6. Tribiology in Industries**,** Srivastava S., S Chand and Company limited, Delhi 2002
7. Lubrication of bearings – Theoretical Principles and Design**,** Redzimovskay E I., Oxford press company 2000

FATIGUE CREEP AND FRACTURE

(PROFESSIONAL ELECTIVE)

MODULE – I : (12 HOURS)

Design philosophy : (i) Infinite life, (ii) Safe life, (iii) Fail safe and (iv) Damage tolerant design concepts.

Fatigue Design : Cyclic stress and stress reversals, Fatigue and progressive fracture, Endurance limit, Fatigue Tests : Cantilever and Beam type of Fatigue Tests, Axial Fatigue Tests. Influence of mean stress on fatigue : Gerber, Goodman and soderberg's criteria. Effect of compressive cyclic stress on fatigue. Fatigue design formula for axial, bending, torsional and combined loading.

Fatigue controlling factors: Effect of frequency, Temperature, size, form, stress concentration factors, Notch, sensitivity & surface conditions, residual stresses.

MODULE – II : (12 HOURS)

Improvement of fatigue strength' by chemical/metallurgical processes such as ritriding, flame hardening, case carburizing. Fatigue strength enhancement by mechanical work : cold rolling, peening, shot peening.

Effect of environment : Corrosion Fatigue, Concept of cumulative fatigue damage

Fracture Mechanics : Ductile and brittle fracture Theoretical cohesive strength of metasl, Griffith Theory of brittle Fracture, Oruron's modification to Griffith Theory.

MODULE – III (14 HOURS)

Modes of fracture : Mode I, II and III, fatigue creek growth Behaviour of metals, Linear Elastic Fracture Mechanics (LEFM), Stress Intensity Factor(SIF), Stress field near the crack tip, Critical SIF and Fracture Toughness, Experimental determination of fracture toughness K_{IC}, COD gauges and standard ASTM Tests.

Strain Energy Release Rates (SERR), Elasto-Plastic Fracture Mechanics (EPFM), Plastic zone size and its evaluation, J-Integral Method.

Creep Analysis :

Definition, Constant stress and constant, strain creep tests. Uniaxial creep tests : Baily's Power Law, Creep relaxation : strain hardening and time hardening creep relaxation. Introduction to Creep bending and deflection of simple problems.

Text Books:

1. George E. Dieter, Mechanical Metallurgy, - Mc Graw Hill, NY, 1988
2. Joseph Marin, Mechanical Behaviour of Engg. Materials, - Prentice Hall of India, 1966
3. Stephens, R.I. and Fuchs, H.O., Metal Fatigue in Engg. ,- Wiley, NY 2001
4. Finnie, I. and Heller, W.R., Creep of Engg. Materials, - Mc Graw Hill Book Co., 1959
5. Prasant Kumar, Fracture Mechanics

Reference Books:

1. L.S. Srinath, Advanced Mechanics of Materials, - Tata Mc Graw Hill Ltd., ND, 2009.
2. Norman E, Dowling, Mechanical Behaviour of Materials, - Prentice Hall, NJ, 1999.
3. Lessells, J.M., strength and resistance of materials, - John wiley & sons, 1954
4. Peterson, R.E., Stress Concentration Design Factors,- John Wiley & Sons, 1953
5. Meguid, S.A., Fracture Mechanics,- John Wiley & Sons, 1996
6. Kare Hellan, Introduction to Fracture Mechanics, - Mc Graw Hill Book Co., 1985

ROBOTICS

(PROFESSIONAL ELECTIVE)

MODULE – I

1. Fundamentals of Robotics: Evolution of robots and robotics, Definition of industrial robot, Laws of Robotics, Classification, Robot Anatomy, Work volume and work envelope, Human arm characteristics, Design and control issues, Manipulation and control, Resolution; accuracy and repeatability, Robot configuration, Economic and social issues, Present and future application.
2. Mathematical modeling of a robot: Mapping between frames, Description of objects in space, Transformation of vectors.
Direct Kinematic model: Mechanical Structure and notations, Description of links and joints, Kinematic modeling of the manipulator, Denavit-Hartenberg Notation, Kinematic relationship between adjacent links, Manipulator Transformation matrix.

MODULE – II

3. Inverse Kinematics: Manipulator workspace, Solvable of inverse kinematic model, Manipulator Jacobian, Jacobian inverse, Jacobian singularity, Static analysis.
4. Dynamic modeling: Lagrangian mechanics, 2D- Dynamic model, Lagrange-Euler formulation, Newton-Euler formulation.
5. Robot Sensors: Internal and external sensors, force sensors, Thermocouples, Performance characteristic of a robot.

MODULE – III

6. Robot Actuators: Hydraulic and pneumatic actuators, Electrical actuators, Brushless permanent magnet DC motor, Servomotor, Stepper motor, Micro actuator, Micro gripper, Micro motor, Drive selection.
7. Trajectory Planning: Definition and planning tasks, Joint space planning, Cartesian space planning.
8. Applications of Robotics: Capabilities of robots, Material handling, Machine loading and unloading, Robot assembly, Inspection, Welding, Obstacle avoidance.

TEXT BOOKS:

1. Robotics and Control**,** R.K. Mittal and I.J. Nagrath, Tata McGraw Hill
2. Introduction to Robotics: Mechanics and control, John J Craig, PHI
3. Robotics Technology and Flexible Automation, S.R.Deb and S. Deb, TMH

REFERENCE BOOKS:

1. Introduction to Robotics, S. K. Saha, Tata McGraw Hill
2. Robotics: Control, Sensing, Vision and Intelligence, K.S.Fu, R.C.Gonzalez and C.S.G.Lee, McGraw Hill
3. Robotics, Appuu Kuttan K.K., I.K. international
4. Robot Dynamics and Control, M.W.Spong and M. Vidyasagar , Wiley India.
5. Industrial Robotics Technology, programming and application, M.P.Groover, TMH.
6. Introduction to Robotics: Analysis, Systems, Applications, S.B.Niku, PHI
7. Robotics: Fundamental Concepts and Analysis, A. Ghosal, Oxford University Press
8. Fundamentals of Robotics: Analysis and Control, R. J. Schilling, PHI
9. Robotic Engineering: An Integrated Approach, R.D. KLAFTER, T. A. Chmielewski, and M. Negin, PHI
10. Robot Technology: Fundamentals: J. G. Keramas, Cengage Learning

SIMULATION, MODELING AND CONTROL

(PROFESSIONAL ELECTIVE)

MODULE I 14 HOURS

Basic simulation modeling, Discrete event simulation, Simulation of queuing and Monte Carlo simulations.
inventory systems, Continuous, Discrete-continuous and Mon
Statistical models in simulation, Discrete and continuous distributions, Poisson process, Empirical distribution, Generation of pseudo random numbers, Analysis of simulation data, Parameter estimation, Goodness-of-fit tests, Multivariable time
series models.

MODULE II 12 HOURS

Overview of feedback control systems, Dynamics of mechanical systems, Differential equations and state variable form, Models of electromechanical, Heat-and fluid flow models, Linearization and scaling, Models from experimental data, Dynamic response using pole-zero locations, Time domain specifications, Classical 3-term controllers and its digital implementation, Stability analysis by Routh Criterion.

MODULES III 10 HOURS

Simulation of manufacturing and material handling systems, Goals and performance measures, Modeling downtime and failures, Trace driven models, Case studies.

TEXT BOOKS :

1. Discrete-Event system simulation by Jerry Banks, J.S. Carson, B.L. Nelson and D.M. Nicol (Pearson Publications).
2. Feedback control of dynamic systems by G.F. Franklin, J.D. Powell, A-Naeini, Pearson Publications.
3. Simulation modeling and analysis by A.M. Law, W.D. Kelton, Tata McGrawHill Publications.

MECHATRONICS

(PROFESSIONAL ELECTIVE)

MODULE 1 (10 HOURS)

Evolution of Mechatronics, components of mechatronic system, types of mechatronic products, Signal theory, signal analysis and processing, Laplace transformation, Z-transformation modulation and de-modulation.

Electrical components and Electronic device –Resister, inductor and capacitor, reactance and impedance. Basic electronics devices junction diodes, Bipolar transistors

MODULE II (10 HOURS)

Basic Digital Technology : Digital number system, Binary number system, Hexadecimal number system, Binary addition, Boolean Algebra, Logic function, Universal GATES, FLIP-FLOP, Registers counters.

System modeling : Frequency response, Mechanical system, electrical system, Thermal system, Fluid system.

MODULE III (16 HOURS)

Actuators- Electric motors; D.C. Motors, Stepper motor, , Hydraulic actuators, Pneumatic actuators

Transducer and Sensors : Principles, difference between transducer and sensors, transducer types – photo emissive, photo conductive, photovoltaic, thermistors, Thermocouple, Inductive, capacitive, Peizoelectric, Hall effect transducers, Ionization transducer, Encoders- Incremental encoder, Optical encoder, Bimetallic strip, Strain gauge, load cell.

Programmable Logic controller : Basic Structure - Programming : Ladder diagram Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls, data handling , Analog input / output , PLC Selection &Application.

Microprocessor ad Microcontroller : Microprocessor based Digital control, registers, Program counter, Intel -8085 microprocessor

TEXT BOOKS

1. A Text Books of Mechatronics, R.K.Rajput, S.Chand & company
2. Mechatronics, N.G. P.C Mahalik, Tata McGraw Hill
3. Mechatronics, D.G. Alciator, M.B. Histand, Tata McGraw Hill

REFERENCE BOOKS :

1. Mechatronics, A.Smaili & F Mrad, Oxford University Press
2. Mechatronics, K.P.ramchandran, G,K Vijay Raghavan, M. S Balachandran
3. Mechatronics An Intigrated approach, Clarence W de Sliva, CRC Press

MICRO-ELECTRO-MECHANICAL SYSTEMS (MEMS)

(PROFESSIONAL ELECTIVE)

MODULE-I 14 LECTURES

Overview of MEMS and Microsystems. (Chapter 1 of Text Book 1)

Micromachining Techniques: Silicon as material for micromachining, Photolithography, thin film deposition, doping, wet and dry etching, surface and bulk micromachining, Wafer bonding, packaging. (Chapter 3 and Section 8.2 of Text Book 1, Chapter 2 of Text Book 2)

Module II 10 lectures

Microsystem Modeling and Design: Mechanics of deformable bodies, Energy method, Estimation of stiffness and damping for different micro-structures, Modeling of electromechanical systems, Pull-in voltage. (Section 4.1 to 4.3 and 6.2.2 of Text Book 1, Section 3.4 of Text Book 2)

MODULE III 15 LECTURES

MEMS Applications: Mechanical sensors and actuators: Piezoresistive pressure sensors, MEMS capacitive accelerometer, Gyroscopes, Piezoelectric actuators. (Section 8.3 of Text Book 1 and Section 5.3 and 5.11 of Text Book 2)

Optical: Micro-lens, Micro-mirror, Optical switch (Section 7.5 to 7.7 of Text Book 2)

Radio frequency MEMS: Inductor, Varactor, Filter, Resonator. (Section 9.3 to 9.7 of Text Book 2)

Microfluidics: Capillary action, Micropumping, Electrowetting, Lab-on-a-chip. (Section 10.1 to 10.8 of Text Book 2)

TEXT BOOKS:

1. G.K. Ananthsuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat and V.K. Atre: Micro and Smart Systems, Wiley India, New Delhi, 2010.
2. N.P. Mahalik: MEMS, Tata McGraw-Hill, New Delhi, 2007.

REFERENCE BOOK:

1. T. Hsu: MEMS and Microsystems: Design and Manufacture, Tata McGraw-Hill, New Delhi, 2002.

COMPUTATIONAL FLUID DYNAMICS

(HONOURS ELECTIVE)

MODULE-I (10 HRS.)

1. Basics of Computational Fluid Dynamics (CFD)- Introduction to One dimensional computation: Finite difference methods (FDM)-Finite element method(FEM)-Finite volume method(FVM). Solution of Discretised Equations:
2. The tri-diagonal matrix algorithm (Thomas Algorithm for one dimensional case) The Finite Volume Method for Diffusion Problems-Introduction -Finite volume method for one-dimensional steady state diffusion -Worked examples: one-dimensional steady state diffusion

MODULE-II (12 HRS.)

1. The Finite Volume Method for Convection-Diffusion Problems – Introduction - Steady one-dimensional convection and diffusion –
2. The central differencing scheme - Assessment of the central differencing scheme for convection-diffusion problems - The upwind differencing scheme - Assessment of the upwind differencing scheme - The hybrid differencing scheme - Assessment of the hybrid differencing scheme - The power-law scheme - Higher order differencing schemes for convection-diffusion problems - Quadratic upwind differencing scheme: the QUICK scheme .

MODULE-III (08 HRS.)

1. The Finite Volume Method for Unsteady Flows - Introduction - One-dimensional unsteady heat conduction - Explicit scheme - Crank-Nicolson scheme - The fully implicit scheme - Illustrative examples

MODULE-IV (08 HRS)

1. Implicit method for two- and three-dimensional problems - Discretisation of transient convection-diffusion equation - Worked example of transient convection-diffusion using QUICK differencing.

TEXT BOOK

1. Versteeg, H. K. , Malalasekera W , An Introduction to Computational Fluid Dynamics- The Finite Volume Method, Longman Scientific & Technical.
2. Patenkar V. Subas, Numerical Heat Transfer & Fluid Flow, Taylor & Francis
3. Muralidhar, K. and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Norosa Publishing House, N. Delhi.

REFERENCE BOOKS

1. Ozisik, M. N. , Finite Difference Method, CRC Press.
2. Anderson, D. A. Jr, Computational Fluid Mechanics and Heat Transfer, McGraw-Hill

FINITE ELEMENT METHOD

(HONOURS ELECTIVE)

MODULE – I (12 HOURS)

Review of 2-D and 3-D stress analyses, vibration, fluid flow and heat conduction problems. FEM fundamental concepts, Variational principles, Rayleigh Ritz and Galerkin Methods.
Finite Element Modeling of one dimensional problems.
Finite Element Analysis of 2-D and 3-D framed structures.

MODULE – II (12 HOURS)

FEM formulation of 2-D and 3-D stress analysis problems.
Axisymmetric solids subjected to axisymmetric loadings.
Two-dimensional isoparametric elements and numerical integration.

MODULE – III (12 HOURS)

FE modeling of basic vibration problems
Finite element modeling of fluid flow and heat conduction problems
Computer programs: preprocessing and post processing.
Exposure to commercial FE codes such as ANSYS, NASTRAN and IDEAS etc.

TEXT BOOKS

1. Finite Elements in Engineering, T.R.Chandraputla and A.D.Belegundu, PHI
2. The Finite Element Method – Its Basis & Fundamentals, Zienkiewicz, Taylor and Zhu, Elsevier, 6^{th} Edn

REFERENCE

1. Introduction to Finite Element Method, C.Desai and J.F.Abel, CBS publishers
2. Introduction to Finite Element Method, J.N.Reddy, Tata McGraw Hill
3. Numerical Methods in Finite Element Analysis, K.J.Bathe and E.L.Wilson, PHI
4. Concepts & Applications of Finite Element Analysis,Cook, D.S.Malkus & M.E.Plesha, Wiley
5. The Finite Element Method in Engineering, S.S.Rao, Elsevier
6. A First Course in the Finite Element Method, D.L.Logan, Cengage Learning
7. Fundamentals of Finite Element Analysis, David V. Hutton, Tata McGraw Hill

AUTOMATIC CONTROL SYSTEM

(HONOURS ELECTIVE)

MODULE I (10 HOURS)

Introduction: Basic concept of control system, Open loop and Close loop control systems. Control System and components.

Laplace Transform: Laplace transformation, Laplace transforms theorems, inverse Laplace transform.Mathematical model of physical systems: modeling of fluid systems and thermal systems Liquid level systems, pneumatic systems, hydraulic systems, thermal systems. Feedback Characteristics of control systems, Types of feedback, effects of different feedbacks on control systems.

MODULE II (16 HOURS)

Time response analysis:

Standard input signals, Step, ramp, parabolic and impulse inputs. Time response of fist and second order systems to input signals. Time response specifications, Steady state error and error constants of different types of control systems.

Concept of stability , Necessary condition for stability, Routh's stability criterion, application of Routh's criterion for linear feed back system, relative stability.

Root-locus analysis : Root locus concepts, rules for construction of root loci, root contours, systems with transportation lead and lag.

MODULE III (16 HOURS)

Frequency response analysis : Bode diagrams, polar plots, Nyquist stability criterion, Stability analysis, relative stability in frequency domain.

Controllers: Proportional, derivative and integral control actions, PD, PI and PID controllers and their applications to feed back control systems.

Mathematical modeling of Dynamic systems in state space, state-space representation of mechanical and electrical systems. State equation and transfer functions, Characterisic equation , Eigenvalue and eigenvector of state matrix. Design of control systems in state space.

BOOKS

1. Modern Control Engineering, K, Ogata
2. Automatic Control system, B. C. Kuo
3. Control Systems Engineering, L. J. Nagrath, M. Gopal

ADVANCE LAB-II

NUMERICAL COMPUTATION & SOLIDS MODELING LAB

(ANY TWO FROM GROUP A, B OR C)

(A) NUMERICAL COMPUTATION

(Using MATLAB or other software/language)

1. Basics of MATLAB or similar software/language
2. Finding solution by Numerical Methods (including graphics) for the following: **(Minimum 06 problems)**

    a. Bisection Method
    b. Newton-Raphson Method
    c. Secant Method
    d. Gauss Elimination Method
    e. Numerical Differentiation
    f. Numerical Integration (e.g. Newton Cotes Quadrature)
    g. Curve fitting Method
    h. Initial-Value Problems (e.g. Runge-Kutta Method)
    i. Boundary Value Problem (eg. Shooting Method)
    j. Eigen Value Problem

(B) SOLIDS MODELING

(Using Solid Modeling software eg. AUTOCAD/ProE/CATIA/SolidWorks etc)

1. Learning the Basics of Solid Modeling Software
2. Describe and Apply the CONE, SPHERE and TORUS command to draw solid primitives

Describe and Apply the EXTRUDE and REVOLVE command to draw solid models that can not be drawn with a composition of primitives

(C) COMPUTER SIMULATION AND ANALYSIS ON FINITE ELEMENT METHODS OR COMPUTATIONAL FLUID DYNAMICS PROBLEMS

(four or five problems) using any software/language (MATLAB, ANSYS, NASTRAN etc.)

BOOKS

01. Applied Numerical Methods with MATLAB, S.C.Chapra, TMH
02. Numerical Methods for Engineers and Scientists, J.D.Hoffman, CRC Press
03. Numerical Methods, E Balagurusamy, TMH
04. Numerical Methods for Engineers, Chapra and Canale, TMH
05. MATLAB Programming for Engineers, Chapman, Thomson Learning
06. Getting Started with MATLAB, Rudra Pratap, Oxford University Press
07. Mastering MATLAB 7, Hanselman and Littlefield, Pearson Education