	Scheme and Structure of T.E. (Mechanical Engineering)									
		Teaching Scheme Hrs/week			Examination Scheme					
Subject No.	Subject	Theory	Practical	Total	Class Test	Theory	Term Work	Practical	Total	Duration of Theo. Paper
	Part-I									
M/P	Machine Design-I	4	2	6	20	100	25	--	145	3 Hrs.
M/P	CAD/CAM	4	2	6	20	100	25	25	170	3 Hrs.
M/P	Engineering Metallurgy	4	2	6	20	100	25	25	170	3 Hrs.
M	Fluid Mechanics & Machinery	4	2	6	20	100	25	25	170	3 Hrs.
M/P	Industrial Economics & Management	4	--	4	20	100	--	--	120	3 Hrs.
M/P	Workshop Practice-V	--	2	2	--	--	25	--	25	
	Total of Part-I	20	10	30	100	500	125	75	800	
	Part-II									
M/P	Machine Design-II	4	2	6	20	100	25	25	170	3 Hrs.
M	Heat Transfer	4	2	6	20	100	25	25	170	3 Hrs.
M/P	Theory of Machine-II	4	2	6	20	100	25	25	170	3 Hrs.
M/P	Mecatronics-I (Sensors & Actuators)	4	2	6	20	100	25	--	145	3 Hrs.
M/P	Metrology & Quality Control	4	2	6	20	100	25	--	145	3 Hrs.
	Total of Part-II	20	10	30	100	500	125	75	800	
	Grant Total of Part I & II	40	20	60	200	1000	250	150	1600	

(M/P) Machine Design-I

Teaching Scheme:
Lectures: 4 Hours / week
Practicals: 2 Hours / week

Examination Scheme
Theory: 100 Marks (3hrs)
Class Test: 20 Marks
Term work: 25 Marks

1. Introduction: Design Process, steps of design process. (1 hrs)

2. Design Considerations: Basic Design equation induced and design stress factors of safety

A) Simple stress situation:
Tensile, compressive, shear and bearing stresses acting one at a time and induced due to direct loading, bending and twisting and design equation related to them.

B) Effect of combined stresses:
Different possible combinations such as
   i) Direct and bending stresses.
   ii) Normal and shear stresses, principal stresses, maximum shear stress and design equations using them.

C) Variable or fluctuating loads and stresses (3 hrs)

3. Selection of Material:
Basis of selection, I.S.S. and designation of commonly used materials such as steel, C.I. Aluminum, brass, bronze and other bearing materials, Principle of local quality. (2 hrs)

4. Theories of Failure:
Maximum principal stress, Maximum shear stress, maximum strain, Maximum total strain energy and maximum energy of distortion theories of failure. Their statements and derivations of design equations and applications comparison. (3 hrs)

5. Design of component under simple stresses:
Design of cotters, pins, levers, keys shafts subjected to only twisting subjected to only direct loading, shearing and tension.
Design of simple assemblies subjected to simple stresses such as cotter and knuckle joint, couplings. (3 hrs)

6. Combined Stresses -Direct and Bending:
Design of parts subjected to combined bending and direct stresses, e.g. C-clamp frame, screw press frame etc. (3 hrs)

7. Fatigue Loading:
Endurance test, S.N. diagram, endurance limit. Soderberg diagram, Goodman diagram and equation for design under fluctuating load.
Modified Goodman, diagram. Low cycle and high cycle fatigue, life and load, relationship during high cycle fatigue designing for a definite life. Basquin's equation designing for variable combined stresses. Notch sensitivity stress concentration, methods to reduce the stress concentration methods to improve fatigue strength, Interpretation of brittle fracture,

Miner equation of cumulative damage, short time testing.
(7 hrs)

8. Design of Power Screw:
Types of threads used, standard square and Acme Efficiency of screw, Use of maximum shear stress the maximum energy of distortion theory buckling of screw of nut, materials, single and multistart differential and come right and left handed type efficiency, in power screw, self locking of power screw.
(4 hrs)

9. Design of Bolted, Riveted and Welded Joints:
Coarse, fine, extra fine series used in threaded fasteners, types of threaded fasteners, preloading of bolts, empirical design equations and exact analysis load to open the joint, improvement of factor of safety by preloading for bolted assembly subjected to fluctuating loads. Riveted joints, types, strength of joint, welded joints, types, weld symbols, methods to reduce the distortion and warping in welding, stress concentration, strength of are welds subjected to direct, bending and twisting loads.
(4 hrs)

10. Springs: Functions, types and spring rate. Close coiled helical springs, design equation, Wahl's correction factor, springs in parallel and series. Variable loading, effect of end turns, surging of compression springs, optimum design, springs with non-circular sections. Leaf spring, design equations, construction, extra full-length leaves, stress equations. Torsion springs, design equations.
(5 hrs)

11. Manufacturing Considerations: Limitations of manufacturing processes such as Forging, Casting, Welding, Machining, Heat Treatment and their effect on design of the component. (2 hrs)

12. Standardization: Preferred numbers, company, national and international standards, practical aspects of standardization, interchangeability.
(2 hrs)

13. Aesthetic and Ergonomic consideration in design: Appearance, functional requirements, design of display and controls.
(1 hr)

Term Work

Term work shall consist of

A. Two imperial size sheets consisting of details and assembly and a report of the calculations; based on any two projects out of the following.

Sheet: I
At least two problems of the following: Cotter joint (different types), knuckle joint, levers spring loaded or lever loaded safety valve, Details and assembly.
Thermodynamic concept in design of valve not to be considered

Sheet: II
One-problem details and assembly out of
Screw jack, Screw press, Coupling, Toggle jack, Shaft straightner.

B. Assignments on the following.

1. One problem on variable loading

2. One prob1em each on coil and leaf spring design
3. One problem each on bolted, welded and riveted joint
4. Design process with respect to one identified need

Recommended Books.

1. Design of Machine Elements by J, E. Shigley, TMH Publication
2. Design or Machine Elements by M. F. Spotts
3. Machine Design TMH Schaum Series
4. Machine Design by Pandya and Shah, Charotar Publication.
5. Machine Design by V.B.Bhandari, TMH Publication.

(M/P) Engineering Metallurgy

Teaching scheme	Examination scheme
Theory Lectures / week: 4 Hrs.	Theory Examination : 100 marks (3 Hrs)
Practical / week: 2 Hrs.	Class Test : 20 marks
	Term Work : 25 marks
	Practical Examination: 25 marks

1. General engineering: Properties of metals like Y.S.T.C. Toughness, impact strength, creep and
Fatigue resistance etc. and their relevance in the selection of materials. (2 hrs)

2. Classification of Metallurgy as Ferrous and Non Ferrous Metallurgy, Brie[idea about - Iron and Steel Making, Cast Iron Manufacture, Extraction of Nonferrous metals, Importance of Non I
Ferrous metals in engineering applications.
(2 Hrs)

3. Equilibrium Diagrams: Their construction with reference of solidification of metals and alloys;
Cooling curves, equilibrium diagram for systems like isomorphism, eutectic, peritectic, etc. Lever
rule and its application.
(3 Hrs)

4. Iron-carbon Diagram: study of different types of invariant reactions, study of different phases and compounds, Critical temperatures and their significance during heating and cooling: Introduction to, classification of ferrous materials. Concept of Structure -" Property co-
relationship.
(8 Hrs)

5. Heat Treatment of Steels: Necessity of heat treatments, transformations of steels during heating and cooling, Non-equilibrium cooling and transformation products of austenite, TTT diagrams Different hardening methods, quenching media, tempering of plain C-steels and its effects, other heat treatments like annealing, normalizing etc., concept of hardenability, critical diameter,
Jominy End quench test; metallurgical aspects of weldments and their heat treatments.
(8 Hrs)

6. Surface/Case Hardening, of steels: Necessity of surface/case hardening to engineering components, Principles of case hardening- changing and without changing the composition, Classification of the process, Flame and Induction Hardening, ,Solid, Liquid, Gas Carburizing,
Nitriding, Carbo-nitriding processes. Relative merits and demerits, Selection of the process for
an engineering component. (3 Hrs)

7. Defects in Heat-treatment: Defects during heating, Over heating of steels, Grain coarsening;
decarburization, oxidation, remedies, ASTM Grain size, control and measurement, Defects
during cooling, warping, cracking, Section sensitivity, remedies.

(3 Hrs)

8. Classification of plain C-steels and alloy steels, Specifications and their,

significance. (IS, BS,
AISI, En series), some well known specifications. (1 Hrs)

9. Alloy steels: classifications of alloying elements effect of alloying elements on Fe-C, TTT diagrams, study of tool steels like HCHC, Micro alloyed steels, Free-cutting steels, spring steels,

HSLA steels, Maraging steels, and their heat treatments, properties and uses. HSS, their heat

Treatment, subzero treatment, Stainless Steels, classification, Problem, of Sensitization weld
decay and its remedies.
(4 Hrs)

10. Cast irons: Maurer's diagram, classification of cast irons, effect of shape, size and distribution, of graphite on the properties. Gray C.I., Mechanite, malleable C.I. Nodular C.I. their manufacture
and applications. Comparison of steels and C.I.'s.
(3 Hrs)

11. Engineering Non-ferrous metals and alloys: Copper alloys, Phase diagrams for Cu-Zn and CU-Sn systems, Brasses, Bronzes, Aluminum alloys, Al-Si, Al-Cu systems, Age hardening, Bearing.
materials and their essential properties, Important heat treatments of non- ferrous alloys.
(3 Hrs).

Term Work

The term work shall consist of the experiments based on the above Syllabus as mentioned below

1. Study of the different Crystal Systems.
2. Study of the Metallurgical Microscope.
3. Preparation of the specimen for the microscopic examination.
4. Mounting of the specimen in a plastic mould.
5. Study of the microstructures of the plain carbon steels.
6. Study of the microstructures of Alloy steels.
7. Study of the microstructures of Cast Irons.
8. Study of the microstructures of the Non-ferrous alloys.
9. Observation in the change of mechanical properties due to the change in the microstructures.
10. Study of the change in the structures due to Surface/Case hardening of steels.

Practical Examination

It shall consist of the Practical/Oral based on the syllabus, mentioned above.

Recommended Books

1. Metallurgy and Material Sciences By V.D. Kodgire, Everest Publishing.
2. Introduction to Engineering Materials By B.K.Agrawal, Tata Mc Graw Hill Publication.
3. Material Science and Engineering, By V. Raghvan, PHI Publication.
4. Physical Metallurgy; By S. Avner, Mc Graw Hill Publication.
5. Physical Metallurgy, Clarke- Warney, CBS Publication.
6. Engineering Metallurgy By Higgins R.A.
7. Engineering Physical Metallurgy and Heat Treatment By Y.U. Lakhtin.
8. Physical Metallurgy, By Albert Guy.
9. ASM Handbook - Vol. 12, Materials Characterization.
10. ASM Handbook - Vol. 12, Properties and Selection.

(M/P) COMPUTER AIDED DESIGN / COMPUTER AIDED MANUFACTURING (CAD /CAM)

Teaching Scheme:
Theory: 4 Hrs per week
Practical: 2 Hrs per week

Examination Scheme:
Theory: 100 Marks, 3 Hrs.
Class Test: 20 Marks
Term Work: 25 Marks
Practical: 25 Marks

1. Introduction to CAD; CAM, CIM and CAE, Product cycle, Mathematical model for product life cycle. (1 hr)

2. Fundamentals of CAD: The basic design process and computer, Principles, of concurrent engineering, the manufacturing date base benefits of CAD. (2 hrs)

3. Hardware in CAD: Hardware configuration of a CAD system, display devices like raster scan devices, Direct view storage devices, plasma panels, liquid crystal displays. Types of images like- halftone, grayscale, colour, Memory requirement for raster scan graphics terminal. Concept of pointing and positioning. (4 hrs)

4. Software in CAD: Ground rules for graphics software, software configuration of a graphics system, functions of a graphics package, geometric model, coordinate representation. 20 and 3D transformations including homogenous transformation matrix (4 hrs)

5. Curves and Surfaces: Parametric and non-parametric representation of Bezier curves, Bspline curve, Bezler curve Bspline surface. (4 hrs)

6. 3 D Modelling: Wire frame modelling, solid modelling, representing solids, boolean operations, primitive instancing sweep representations, boundary representations, cell decomposition, constructive solid geometry (4 hrs)

7. Standard for CAD: Introduction, need, GKS, IGES, STEP (ISO10303) (1 hr)

8. Robotics: Physical configuration, basic robot motion, technical features of a robot, methods of robot programming, introduction to direct, and inverse kinematics, forward kinematics using transformation matrices, end effectors. industrial applications. (5 hrs)

9. NC Machine tools: Basic components of NC, CNC and DNC system NC coordinate systems, Nt motion control systems, drive of NC systems, NC Part programming: Manual, APT, Post. Processor (9 hrs)

10. Group Technology and CAPP: Introduction, concept & methods grouping of Part families, part classification and coding, OPITZ, MICLASS, computer aided process planning. (5 hrs)

11. Computer control Applications: Introduction to CAQC,CIMS (1 hr)

Term Work

Performing minimum' 8 experiments out of the following and preparing a record of these experiments.

1. Study of input & output hardcopy devices of a CAD system.
2. Developing program in C for 2D transformations.
3. Developing program in C for 3D transformations.
4. Creating a 2-D model on any drafting package and get its hardcopy output.
5. Developil1g program in C for graphical output of anyone type of curve / surface.
6. Developing program in C forward Kinematics of a Robot.
7. Developing and executing a part program for contouring on an NC milling maching.
8. Developing and executing a: part program for an NC lathe machine.
9. Developing and executing a part program for point to point on NC drilling machine or milling machine.
10. Study Classification and Coding of a part family using Optiz coding system.
11. Assignments on Chapter No.11

Practical Examination

Practical Examination will consist of a oral based on the above syllabus and the record of the experiments / assignments submitted by the candidate.
The assessment will be based on.

1. Record of experiments / assignments submitted by the candidate
2. Viva- Voce based on the syllabus.

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Recommended Books

1. CAD /CAM- by Zimmer & Groover, PHI Publications.
2. Elements of Computer Graphics - By Rogers OF and Adams JA - McGraw Hill Pub.
3. Numerical Control Machines -'By P. S. Pabla, PHI Pub.
4. Numerical Control, machine tools - Yoran Koran / Joseph Ben (Khanna Publication)
5. CAD/CAM/ClM - By RadhaKrishnan.
6. Computer Graphics - Donald Hem, M Pauline Baker (PHI)
7. Computer Graphics - Principles and Practice - Foley, Van Dam, Fringer, Hughes' (Addison Wosley.
8. Computer aided Manufacturing - P.N. Rao, N.K. Tiwari, T.K. Kundra (TMH)
9. CAD / CAM - Principles, Practices & Manufacturing Management - Chris McMahon and Jimmie Browne (Addison Wesley)
10. Principles of' Interactive' Computer, Graphics William M Newman, Robert F Sproull (McGraw Hill Books *Co.).*
11. Robotics - Control, Sensing and Intelligence - K.S. fu, R.C. Gonzalez, Lee
12. CAD / CAM 'Theory & Practice -lbrahim Zeid (TMH)
13. Group Technology In The Engineering Industry - John L Burbridge, Mechanical Engineering Publication, London (ISBN 0 85298 402 2)
14. Automation, Production Systems and Computer Integrated Manufacturing Mikell P. Groover. (PHI).

(M) Fluid Mechanism and Machinery

Teaching Scheme:
Lectures: 4 Hours / week
Practical: 2 Hours / week

Examination Scheme
Theory: 100 Marks (3 hrs)
Class Test: 20 Marks
Term work: 25 Marks
Practical: 25 Marks.

1. **Introduction to Fluid Mechanics:** Properties of fluids, Ideal and real fluids, Newtonian and non-Newtonian, compressible and incompressible, viscosity and its units, surface tension and capillarity. (2 hrs)

2. **Fluid Statics:** Pressure in fluids at rest, Pascal's law, Manometry, hydrostatics force on immersed plane and curved surfaces, center of pressure and resultant force, engineering applications, Buoyant force and center of buoyancy, kind of equilibrium of floating bodies, finding of metacentric height analytically and experimentally; oscillation of floating bodies and engineering applications. (4 hrs)

3. **Principles of Fluid flow:** Continuity equation in Cartesian and cylindrical co-ordinates, Euler's equation of motion, Bernoulli's equation from Euler's equation, practical applications o of Bernoulli's equation, momentum and energy correction factors, Engineering applications of momentum equations as force on pipe bend and jet propulsion of ships. (4 hrs)

4. **Dimensional analysis and model testing:** Dimensions of different fluid parameters, Buckingham's, Pie theorem, calculations of dimensionless groups, physical meaning of important groups of fluid mechanics model ana1ysis and type of similarities, practical applications of dimensional analysis for model testing. (3 hrs)

5. **Flow through pipes and piping design:** Loss of energy in pipes, concept of equivalent pipe length for losses other than friction loss, flow through pipe in series, parallel and' branched pipe, condition for maximum power / max efficiency of power transmission, introduction to water hammer in pipes. . . (4 hrs)

6. **Introduction to, Fluidics:** The Quanta effect, fluidic amplifiers, oscillators and modulators, fluidic velocity. Sensors, analog and digital fluidic devices, fluidic sensors, fluid logic. (3 hrs)

Hydraulic Machines.

1. **Impact of Jet:** Force of jet impinging normal to a fixed plate, force of a jet on an inclined fixed plate, force on hinged plates, force on moving plate, force on series of moving plates, force of on jet impinging on fixed curved vane, force on moving curved vane. (3 hrs) .

2. **Impulse turbines:** Introduction, pelton wheel components, work done by an Impulse turbine, power produced efficiencies of impulse turbine, number of' Jets, size of buckets, number of buckets, design of pelton wheels, governing of Pelton wheel other impulse turbines. (3 hrs) .

3. **Reaction turbines:** Introduction, components of a reaction turbine, difference between impulse and reaction turbine, classification of reaction turbines, radial, axial and mixed flow turbines, inward and outward flow, reaction turbines, efficiencies of reaction turbine, Francis and Kaplan turbines, draft tube, type of draft tubes, efficiency of draft tube, other reaction turbines. (4hrs) .

4. **Performance' of Turbines:** Introduction, characteristics of turbine, unit power, unit speed unit, discharge and their significance, specific speed, of a turbine, significance of specific speed, selection of turbines based on specific speed and shape of reaction turbines runners, characteristics curves of various types of turbines, cavitations in turbine. (2 Hrs)

5. Centrifugal Pumps: Introduction types of pumps, types of casings, work supplied to a centrifugal pump, manometric head, efficiencies of centrifugal pump, discharge *of* a centrifugal pump, power required to drive a centrifugal pump, increase in water pressure, minimum starting speed of a centrifugal pump, multistage centrifugal pump, self pumping pump. (4 hrs)

6. Performance of Pumps: Principals of similarity applied to centrifugal pump, specific speed, selection *of* pump based on specific speed, characteristics of pump, NPSH , cavitations in pumps. (3 hrs)

7. Introduction to Reversible Pump Turbines: Tube turbine, Bulb turbine, Axial flow pump turbines, Tidal power plants, Head capacity and power capacity relation. (3 hrs)

Term Work

The term work shall consist. of the record of at least 10 (five from fluid mechanics and *five* from hydraulic machines) experiments performed from the following list of experiments :

List *of* experiment in Fluid Mechanics.

1. Red wood viscometer.
2. Reynolds experiment.
3. Measurement of flow by orifice and venturimeter.
4. Verification of momentum principle.
5. Determination of *force* due to impact of *Jet.*
6. Determination *of* metacentric height of a floating body.

List *of* experiments in hydraulic Machines.

1. Pelton wheel trail.
2. Francis turbine trial.
3. Kaplan Turbine trail.
4. Centrifugal pump trail.
5. Gear pump trail.
6. Visit *of* hydroelectric power station and writing a report on it.

Practical Examination.

The practical examination shall consist of performing an experiment based on the practical work during the course, viva-voce based on syllabus and term work, The assessment will be based on

1. Performing an experiment
2. Viva-voce *on* the syllabus.

Recommended Books.

1. Fluid Mechanics and Hydraulic Machines - S.K. Agrawal. IMH Publication
2. Fluid mechanics and Hydraulic Machinery, Dr. R.K Bansal, Laxmi Publication
3. Hydraulic Machines - Dr. Jagdish LaL
4. Fluid Mechanics and Hydraulic Machines - Modi and Seth.
5. Reversible Axial Flow pump turbine - Dr. K.K. Sudevan
6. Fluid Mechanics and, Hydraulic Machines, Subrayamanam, TMH Publication
7. Fluid Mechanics - Shames.
8. Fluid Mechanics - Streeter and Wylie.
9. Fluidic logic & Control - Dr. Subirkar.
10. Fluid Mechanics - KL. Kumar.
11. Hydraulic Machine -.: Prof. V.M. Deshpande.

(M/P) Industrial Economics & Management

Teaching Scheme	Examination Scheme
Theory lecture / week: 4 Hrs.	Theory Examination: 100 marks (3 Hrs)
	Class Test: 20 marks

1. **Management and Organization:** Definition, Difference between Management, Administration and Organization, Levels of management, scientific management, Contribution of F. W. Taylor; Henry Fayol.
   Organization: Definition, Principles of organization, types of organization. (4 hrs) .
2. **Industrial Ownership:** Types, concepts, advantages, disadvantages and applications of Different types of owner-ship like Propertiorship, Partnership, Joint Stock Company, State & Central Government owned. (2 hrs.)
3. **Functions of Management:** Planning, Forecasting, Co-ordinating, Directing, Decision Making, Communication, Controlling, Motivation etc. (2hrs)
4. **Industrial Psychology:** Definition, Concepts, objectives, scope, individual difference in behavior, group dynamics, Theory X and Y, Motivation, Industrial fatigue, working conditions communication. (4hrs.)
5. **Job Evaluation and Merit Rating:** Definition, Concepts, objectives, Procedure and methods of Job Evaluation and Merit Rating. (2hrs)
6. **Industrial labour Legislation:** Important and necessity, types of laws, study of different acts, (3hrs.)
7. **Industrial safety:** Definition and need, accidents, cost, causes, and types of accidents, accident prevention and accidents proneness. (2 hrs.)
8. **Costing:** Elements of Cost, Direct material Cost, Direct Labour Cost, overheads, Classification of overheads, Methods of apportionment of overheads, Machine Hour rate, Cost estimate sheet.
   Depreciation: Definition, need, methods of calculating depreciation. (4hrs.).
9. **Replacement Analysis:** Introduction, reasons for replacement; factors, factors affecting on replacement, various methods for selecting alternative (seven methods), uniform gradient series, selection of best alternative using uniform gradient series. (5hrs)
10. **Introduction to Modem Management Concept:** Just- In-Time Manufacturing, Kaizen, POKA YOKE, Bench Marking, Business Process Reengineering (BPR), BPO, MBO. (6 hrs.)
11. **Nature and Significance of Economics:** Science, Engineering and Technology, their Relationship with economic development. Basic economic concepts, human wants-, Economic goods, utility, value, price, cost, wealth, and capital. Demand, supply, elasticity of demand and supply. Concept of profit and revenue, economics of scale. (6hrs.)

Recommended Books

1. Industrial Management - Earnest Dale, McGraw Hill Publishers.
2. Industrial Engineering and Management- O.P. Khanna, Dhanapt Rai & Sons.
3. Industrial Engineering and Management. A new perspective - Hicks, McGraw Hill Publishers.
4. Principles of Management- Koontz and O'Donnel-TATA McGraw Hill
5. Personnel administration- Pogors and Mayers, Mc:Graw Hill
6. Management of organizational behavior- Hersey and Blanc-hard, 1981 ,Prentice Hall.
7. New Patterns of Management-Renis Lickert.
8. Industrial Engineering and Management Systems - S. Dalela and Mansoor Ali, Standard Publishers, New Delhi.
9. Organization & Management - R.D. Agrawal, TMH.

(M/P) WORKSHOP

Teaching Scheme:
Practical: 2 Hours / Week

Examination Scheme
Term Work: 25 Marks

Study of the machine tools: Milling machine, shaper, grinding machine (cylindrical, surface vertical, horizontal, face etc.), tool and cutter grinder, radial drill machine, slotting machine, planer, broach, boring machine etc. available in the workshop. Also study of different tools and fixtures of each machine and study of the different attachments used on all above machine tools.

Prepare job on the machines involving at least the following operations: Milling, indexing in milling, shaping, surface or cylindrical grinding, slotting (If more machine tools are available; operations on them are recommended)

Grinding of single and multiple, point tools on Tool and Cutter Grinder.

The jobs can be, composite jobs, involving more than one operation on them. The work must be sufficient to create complete awareness about the machine tools and operations done on them. The blanks must be prepared by turning.
(e. g: A job can have preparation of gear blank by turning, external milling of gear teeth involving calculations for indexing, drilling, boring, internal splines cut on a slotting machine and surface grinding can finish the faces, Another job for grinding a tool on the tool and cutter grinder) .

Term work shall comprise of completing and submitting of the jobs mentioned above designed by the Workshop Superintendent of the Institute and a workshop diary containing details of the work done, duly certified by the Workshop Superintendent.

(M) Heat Transfer

Teaching Scheme:
Theory: 4 Hrs per week
Practical: 2 Hrs per week

Examination Scheme:
Theory: 100 Marks, 3 Hrs.
Class Test: 20 Marks
Term Work: 25 Marks
Practical: 25 Marks

1. **Introduction:** Modes of heat transfer, combined modes, basic laws governing modes of heat transfer, mass transfer and momentum transfer. (2 hrs.)
2. **Conduction:** General three-dimensional heat conduction equation in Cartesian and cylindrical co-ordinate only, simplification to steady state unidirectional heat transfer and temperature distribution in slabs, hollow cylinders, holl0w spheres with material having varying thermal conductivity, electrical analogy. Thermal conductivity and its dependence on various parameters, contact resistance, composite systems, heat transfer with internal heat generation, critical thickness of insulation. (7 hrs.)
3. **Fins:** Theory of finned surface heat transfer, fin efficiency, effectiveness and temperature coefficient of effectiveness for array of fins, generalized heat transfer equation for finned surface with various end conditions simplification to pin fin and rectangular circumferential fins with numericals, thermometric
Error by fin theory. (4 hrs.)
4. Unsteady state heat transfer for lumped capacity system criterion for lumped Capacity system, time constant of thermocouples. (3 hrs.)
5. **Radiation:** Mechanism of radiation, thermal radiation, definitions e.g. black body, white body, gray body, reflectivity, absorptivity, transmittivity, emissivity, emissive power. Monechromatic emissive power, solid angle, intensity of lamberts cosine law, kirchoffs law, plancks distribution law, Wiens displacement law, radiation shape factor for geometrical arrangement, radioity irradiation, electrical analogy in radiative heat transfer, heat transfer between two large gray surface placed at distance with different temperature, heat transfer between concentric cylinder. Spheres with different temperature, use of radiation shields with numericals, errors in thermo couple reading, irradiative heat transfer. (9 hrs.)
6. **Convection:** Thermal boundary layer, heat transfer in flow through pipe, entry length, heat transfer in high speed flow, free and forced convection over vertical/horizontal plate, pipe/cylinders, and sphere using empirical relations only, cup temperature film wise / drop wise condensation, pool boiling, Nusselt theory of condensation. Heat transfer through pipe at a) Constant temperature
b) Constant, heat flow. ' (8 hrs.)
7. **Heat exchanger:** Classification, applications, fouling and fouling factors, determination of overall heat transfer coefficient, LMTD Method, NTU effectiveness method of design, pressure drop optimizations. Design algorithm for double pipe and shell and tube (1-1) heat exchanger having both side liquid, design by LMTD method for condenser (7 hrs.)

Term Work

The practical work shall consist of a record of set of experiments (any eight) as listed below:

1. Measurement of thermal conductivity (metal).
2. Measurement of thermal conductivity of insulating material.
3. Determination of heat transfer coefficient (forced) between surface and fluid.
4. Study of effect on heat transfer by using different fins from a given surface.
5. Experiments on heat exchanges for different flow arrangement and for same or Different fluids.
6. Measurement of emissivivity.
7. Determination of Stefan-Boltzman's constant.
8. Boiling heat transfer, determination of critical heat flux and observe the phenomena.
9. Determination and study of different types of insulating materials.
10. Observations of the phenomena of drop wise film wise condensation.

Practical Examination

The practical examination shall consist of performing an experiment based on the practical work during the course, viva-voce based on syllabus and term work. .

The assessment will be based on
I. Performing an experiment.
2. Viva-voce on the syllabus.

Recommended Books

1. Heat Transfer by, S P. Sukhatme.
2. Heat transfer by James Sucec, JAICO publishing house, New Delhi. 3. Heat transfer by Gupta And Prakash.
4. Heat transfer by Holman. J. P. McGraw Hill Publishing
5. Heat transfer by Krieth.
6. Heat and Mass Transfer Data Book by Kothandraman.

(M/P) Machine Design-II

Teaching Scheme:
Lectures : 3 Hours *I* week
Practicals : 2 Hours / week.

Examination Scheme:
Theory: 100 Marks (3 Hrs.)
Class Test: 20 Marks
Tenn. work: 25 Marks
Practical: 25 Marks.

1. Gearing:

Spur gear. nomenclature. force analysis. types of failures. Beam and wear strength equations, dynamic effect. Buckingham's Spott's equation, design of gear blank. methods of gear cutting, material, Different approaches used in design.
Helical gear, formative number of teeth, force analysis Design equations.
Bevel gear, Bevel factor, relations of different angles, force analysis, Design equations.
Worm Gearing:
Geometry, force analysis, efficiency, design for beam strength, wear consideration and heat dissipation, empirical relationship, materials. (10 Hrs)

2. Gear Trains and Gear Reducer Design:

Types of gear trains, compound, reverted, non parallel axes, planetary. Gear box design principles, different arrangements, selection of arrangement, materials, lubrication. (4 Hrs)

3. Bearings and Lubrication:

Viscosity, Petroff's law, hydrodynamic theory, Reynolds equation, Sommerfeld number, hydrodynamic bearing performance, use of Raimondi and Boyde' s charts and tables, hydrostatic lubrication. (4 Hrs)

4. Rolling contact Bearing: *I*

Hertz contact stresses, Striebeck equation, elements of rolling contact bearings, applications, life, static and dynamic capacity of rolling contact bearing, relationship between life and dynamic load, equivalent load, variable load acting on rolling contact bearing. Nomenclature and selection. (4 Hrsl)

5. Belt, Rope and Chain Drive:

Types of belt drives, ratio of belt tensions, effect of centrifugal force, centrifugal tension, condition for maximum power transmission, initial tension, creep, length of belt in open and cross. belt drive, stress induced in flat belt, materials design based on catalogs.
V -belt construction, design equations and use of manufactures catalog rope drive.
Design of flat and V belt pulleys and pulleys used for rope drive. Construction of roller chains, design equations, polygonal action. (4 Hrs)

6. Brakes:

Types, short shoe brakes, frictional torque, long shoe brakes, internal and external shoe brakes, frictional torque and force analysis, simple, differential and additive type of band brakes.
Heat dissipation in brakes, material for lining. (4hrs)

7. Clutches:

Friction clutches uniform intensity of pressure and uniform rate of wear in; conical and flat pivot, and their applications in clutches. Materials and design equations for single, multiple plate, cone and centrifugal clutch. (4 hrs)

8. **Optimum Design**: Introduction to optimum design for mechanical element adequate and optimum design, primary and subsidiary design equation, .limit equation, design problems with non specification for axial loading, bending and twisting moment combined loading, the procedure of optimum design redundant specifications. (4 Hrs)

9. Statistical Consideration in Design: Probability theories, random variation, the normal distribution, population combination, statistical factor of safety based on reliability. (2 hrs)

Term Work

Term work shall consist of Two imperial size sheets consisting of details and assembly and a report of the calculations, based on any two projects out of the following.
Single plate clutch, multi-plate clutch, centrifugal clutch, belt drive, band brake, short and long shoe brake, spur gear drive, helical gear drive, gear drive, gear train etc.

Practical Examination

Practical Examination shall consist of Oral based on above term work and syllabus.
The assessment will be based on Viva-voce based on the syllabus and tenn work;

Recommended Books.

I. Design of Machine Elements by J. E. Shigley, TMH Publication 2. Design of Machine Elements by M. F. Spotts
3. Machine Design TMH Schaum Series
4. Machine Design by Pandya and Shah, Charotar Publication
5. Machine Design by V.B.Bhandari., TMH Publication
6. Optimum Design - R.C. Johnson

(M/P) Theory of Machines-II

Teaching scheme
Theory lectures *I* week: 4 Hrs.
Practical/week: 2 Hrs

Examination scheme
Theory Examination: 100 marks (3 Hrs)
Class test : 20 marks
Term work : 25marks
Practical Examination: 25marks

I. TOOTHED GEARING:

Gear terminology, types of gears, field of applications. Spur Gear: Condition for correct gearing, conjugate profiles, cycloidal, Involutes. Interference and undercutting. Methods of eliminating interference, determination of length of path of contact, length of path and arc of approach and recess.

Spiral Gear: Spiral angles, Normal pitch, and centre to centre distance. Efficiency of power transmission, force analysis.

Helical and Herringbone gears. their relative merits and demerits over spur gear. (6Hrs)

2. GOVERNOR:

Working principle of centrifugal and Inertia type governor. Watt, Porter, Powel. spring loaded governors, controlling force diagrams, sensitivity and stability. (4Hrs)

3. GYROSCOPE:

Gyroscopic couple. gyroscopic effect in vehicles, ships, planes, gyroscopic stabilization. (4 Hrs)

4. FLYWHEEL:

Torque - crank angle diagram for different I.C.and steam engines, fluctuation of energy, use of flywheel, coefficient of fluctuation of energy, determination of mass of flywheel for different applications. (4 Hrs)

5. FRICTION:

Sliding and rolling friction, laws of sliding friction, friction circle, friction axis, friction in screw threads. (4 Hrs)

6. BRAKES AND DYNOMOMETERS:

Short shoe brakes, band brakes, band and block brakes, force analysis of all types of brakes. Absorption and transmission type of dynamometers, power calculations. (4 Hrs)

7. BELT, ROPE AND CHAIN DRIVES:

Types of belts, slip in belt drives, velocity ratio, belt tension ratio, types of pulleys used in belt drives, power transmission in belt drives.

Rope drives, ratio of tension in rope drives, kinematics of chain drives, angular velocity ratio, construction of Bush and Roller chain, power transmitted by chain (4Hrs)

8. VIBRATIONS:

Introduction, cause, effects and terminology.

Single degree of freedom system: undamped tree vibration, development of differential equation of motion and its solution for different undamped systems, computation of natural frequency.

Damped free vibrations: differential equation of motion, logarithmic decrement, damping methods, damped natural frequency of vibrations (analysis of viscous damping only)

Forced Vibrations: vibration due to harmonic force excitation centric mass excitation, support excitation, steady state response curves, phase lag angle, motion and force transmissibility, seismic instruments. (10 Hr)

TERM WORK

AI least ten out of the following experiments shall be conducted during the course and a record of the same shall be submitted by the candidate and Term work.

I. To generate involute tooth profile with the help of a rack on gear blank.
2. Study of interference and undercutting.
3. Determination of gyroscopic couple.
4. To determine moment *of* inertia of a disc by using
   a) Single rotor system
   b) Trifillar suspension
   c) Compound pendulum
5. To determine moment *of* inertia of a uniform rod by using
   a) Bifilar suspension
   b) Compound pendulum
6. To determine equivalent mass *of* a spring for a spring mass system.
7. To determine the damping coefficient for a spring mass dash pot system.
8. To obtain experimentally,
   a) Frequency response curves,
   b) Transmissibility curves
9. Determination of gyroscopic couple.
10. Assignment problems on chapter 4
11. Assignment problems on chapter 5
12. Assignment problems on chapter 6
13. Assignment problems on chapter 7

PRACTICAL EXAMINATION

The practical examination shall consist of performing an experiment based on the practical work done during the course, viva voce based on the syllabus and term work.
The assessment will be based on

a. performing an experiment
b. viva voce based on the syllabus and record.

RECOMMENDED BOOKS

I. Theory of Machines. S.S.Rattan, TMH Publication
2. The Theory of Machines, T. Beven, CBS Publisher
3. Theory Of Machines and Mechanisms, J.E. Shiglay / Vickers, Mc Graw Hill Publication
4. Theory of Machines, P. Ballaney, Khanna Publication
5. Mechanical Vibration. G.K.Groover, New Chand and Brothers
6. Theory Of Machines and Mechanisms, Dr. Jagdish Lal , Metropolitan Publication

(M/P) Mechatronics-I
(Sensors and Actuators)

Teaching scheme		Examination scheme	
Theory lectures/ Week	: 4 Hrs.	Theory Examination	: l00 marks (3hrs)
Practical/week	: 2 Hrs	Class test	: 20 marks
		Term work	; 25 marks

I. Introduction: Mechatronics: Definition, need. Importance, concurrent system. Difference between Mechatronic and concurrent system, Components of a Mechatronic system, function of each component. Examples of mechatronic system. (3 Hrs.)

2. Measurement and measurement systems:
Significance, types, methods, classification, analog and digital mode, functions of instrument and measurement, elements of generalized measurement system.(2 Hrs.)

3. Static characteristics of instrument and measurement systems:
Accuracy, static error, reproducibility, drift, sensitivity, errors in measurements, linearity, hysterisis, bias, input and output impedance, loading effect. (2Hrs.)

4. Detector Transducers:
Primary and secondary transducers, mechanical transducers, resistive transducers, inductive transducers, capacitive transducers, photoelectric transducers, piezoelectric transducers, optical transducers. (4Hrs.)

5. Signal conditioning and data presentation D.C and A.C. Type signal conditioning system, amplifiers, and filters. .
Data presentation: - Type of output, galvanometers, ohmmeters, attraction type and repulsion type instruments, C.R.O. , Recorders: galvanometer type, potentiometer type, strip chart, magnetic tape recorder, ultra violet recorder. (4Hrs.)

6. **Measurement of force, torque and power- methods and devices.**
Measurement of pressure and vacuum- methods and devices.
Measurement of flow - methods and devices.
Measurement of temperature - methods and devices.
Measurement of speed- methods and devices.
Measurement of velocity and acceleration- methods and devices.
Strain gauges and their application in measurement. (8Hrs.)

7**. Sensors:**
Introduction, proximity sensors and switches, digital optical encoder, strain gauges, potentiometers, Wheatstone bridge. (3Hrs.)

8. **Solenoids and relays, D.C. Motors**, permanent magnet D.C. Motors, Pulse width modulation (PWM) amplifier, stepper motors, selection of a motor. (3Hrs.)

9. Hydraulics and Pneumatics:
(a) Introduction to hydraulics and pneumatics systems, comparison of mechanical, hydraulic and pneumatic systems, hydraulic and pneumatic symbols. (3Hrs.)
(b) Review of hydraulic pumps, directional control valves: two way valves, solenoid operated valves, three way valves, four way valves, one directional valve, poppet valves, spool valve, pressure relief valve, hydraulic cylinders,

hydraulic motors, operation of a hydraulic system. operation of an electro
. hydraulic system. (5Hrs.)

(c) Pneumatic motors: Sliding vane type, gear type. Air filters, pressure regulators and lubricators, operation of a pneumatic system and electro pneumatic system. (3Hrs.)

Term Work

A. Performing minimum five experiments term the list of experiments. from Sr.no. 1to8.

I. Study of generalized measurement system with a typical instrument

2. Assignment on different static characteristics.

3. Study and demonstration of use of
   - a. Strain Gauge and
   - b. L.V.D.T.

4. Force Measurement
   - a. Load Cell
   - b. Spring balance
   - c. Proving ring

5. Flow measurement:
   - a. Orifice/Venturimeter
   - b. Rotameter
   - c. Pitot tube
   - d. Water meter

6. Pressure measurement:
   - a. U tube manometer.
   - b. Bourdon gauge
   - c. Dead weight pressure gauge.

7. Temperature measurement
   - a. Mercury thermometer
   - b. Resistance thermometer
   - c. Thermocouple.
   - d. Pyrometer

8. Speed Measurement
   - a. Stroboscope
   - b. Tachometer
   - c. Digital Optical Encoder

B. Assignment on hydraulic and pneumatic symbols

C. Constructing a hydraulic circuit with the help of hydraulic trainer and drawing of a hydraulic circuit.

D. Constructing a pneumatic circuit with the help of pneumatic trainer and drawing of a pneumatic circuit.

F. Study and demonstration of working of stepper motor.

Recommended Books

I. Introduction to Mechtronics and measurement systems- David G.A1citore and Michael B. Histand, TMH Publication .

2. Mechanical Measurement and Instrumentation-Dhanpat Rai & Sons Publication

3. Mechanical Measurement –Beckwith and Buck

4. Measurement System – Doeblin Ernest 0, TMH Publication

5. Mechanical Measurement - R.K.Jain

6. Pneumatics and Hydraulics - Harry L Stewart , Audel Series

(P) METROLOGY AND QUALITY CONTROL

Teaching scheme
Theory lectures / week: 4 Hrs.
Practical/week : 2 Hrs

Examination scheme
Theory Examination: 100 marks (3Hrs)
Class test : 20 marks
Term work : 25 marks
Practical Examination : 25 marks

I. Introduction: Definition & concepts of metrolology, Standardization and standardizing organizations, International system of units, Methods of measurement. (1Hr)

2. Standards of Measurement: Standards, Standards for linear measurement, Line standard including linear standard meter, End standard, Wavelength standard, Classification of standards of traceability . (1Hr)

3. Linear Measurement: Surface plate, angle plate, V block, Bench centers, Combination set, radius gauges, Feeler gauges, Angle gauges, Pitch screw gauge, Principle of verniers, vernier height gauge. Vernier depth gauge, Micrometers, Types of micrometers, slip gauges, wringing of slip gauges, care in case of slip gauges (3Hrs)

4. Limits, Fits & Gauges:

a) Limits, tolerances, different ways of expressing tolerances like unilateral & bilateral, tolerance accumulation, relationship between tolerance & cost, maximum & minimum metal conditions, Indian standard (IS 919-1963),
Fits: Terminology for limits & fits, types of fits, hole basis system, shaft basis system, selection of fits, types of assemblies like trial & error, interchangeable assembly

b) Gauges: Plain gauges, ring gauges, snap gauges, adjustable gap gauges, control & profile gauges, material for gauges.

c) Gauge Design: Taylor's principle, gauge maker's tolerance, wears allowance, numericals on gauge design. (7 Hrs)

5. Comparators: Introduction, types of Comparators, construction & working of different types of comparators like mechanical, optical, electrical, pneumatic (2 Hrs)

6. Interferometer: Monochromatic lights, principle of interference, optical flat, fringe applications & their interpretations, application of optical flat in flatness testing, surface contour testing, parallelism testing, Interferometers including Nicholson Interferometer, NPL flatness interferometer. (2 Hrs)

7. Angular measurement: Vernier bevel protractor, universal bevel protractor, optical bevel protractor, sine bar, angle gauges, optical instrument like auto collimator, angle dekkor. (2 Hrs)

8. Measurement of surface finish: Definitions, terminology, methods of measuring surface finish. Analysis of surface traces, assessment of surface roughness as per Indian standards.
(2 Hrs)

9. Metrology of screw threads: screw threads terminology, errors in threads & their effects, measurement of various elements of threads. (2 Hrs)

QUALITY CONTROL

I. **Introduction:** The meaning of quality and quality control, inspection and quality control, quality variables and attributes design, quality conformance, quality of performance, quality assurance, cost of poor quality. (1Hr)

2 Statistical Quality Control: The concept of variation, the normal distribution, central limit theorem, the concept of population (universe).
Control charts: Introduction, types of control charts for variables and attributes: Objective, sample size, construction, advantages, limitations, interpretations, applications. Simple numericals on control charts
Process capability analysis. 5 Hrs

3. Acceptance Sampling: Introduction, Sampling inspection, objectives, different types of sampling plans, formation of inspection lot, Sampling methods, Operating Characteristic (OC) curve, ideal & realistic OC curve, Producer's risk and consumer's risk, AQL, RQL,IQL,AOQ, AOQL. 5 Hrs

4. Reliability Engineering: Introduction, Reliability and quality, need for a Reliable product, definition of Reliability, product life cycle, failure patterns for complex products, bath tub curve, MTIF, MTBF (only theoretical treatment) 1Hr

5. ISO 9000 Standards: Need for Standardization, overview of ISO series of standards, benefits by becoming an ISO 9000 organization 2 Hrs

6. QUALITY CIRCLE: Philosophy, organization & operation of quality circles, significance, old and new SQC tools, brain storming. 2 Hrs

7. Total Quality Control: Quality policy, total quality control, total quality management 1Hr

TERM WORK

Term work shall consists of any six experiments from group A and all assignments from B

GROUP A : List of experiments:

1. Study and demonstration of measuring Instruments for linear measurements. .
2. Study and demonstration of sine bar, sine centre.
3. Study and demonstration of comparators of different types
4. Study and demonstration of Autocollimator / angle Dekkor.
5. Study and demonstration of Interferometry.
6. Study and demonstration of surface finish measuring instruments.
7. Study and demonstration of screw thread measuring instruments

GROUP B : List of Assignments:

I. Assignment on Quality Mindedness and Quality Cost
2. Assignment on Statistical Quality Control
3. Assignment on Acceptance Sampling
4. Assignment on Quality Circle.
5. Drawing *of* a control chart one each for variables and attributes.

PRACTICAL EXAMINATION

The practical examination shall consist of performing all experiment based on the practical work done during the course and viva voce based on the syllabus and term work.

The assessment will be based on

a. performing an experiment
b. viva voce based on syllabus & record

RECOMMENDED BOOKS

I . Engineering Metrology by R. K. Jain.
2. Practical Metrology by K.G. Hume
3. Statistical Quality Control, By E. L. Grant and Leavenwai1n (TMH)
4. Quality Planning and Analysis, By Juran (TMH)
5. Taguchi Techniques for Quality Engineering, By Philip J. Rose;
6. Quality Circle Programmes through Participation, By S. R. Upade (TMH)
7. lSO-9000, Terry L. Johnson (Mc Graw Hill Publication.)
8. Total Quality Essentials, By Sarvo Singh Soin (Mc Graw Hill Publication.)
9. Quality Control & Total Quality Management - P.L.Jain (TMH)
10. Production & Operations Management -- S.N. Chary (TMH)