T.E. [Mechanical]

T.E. 2003 Structure (w.e.f. July – 2005)

Code	Subject	Teaching Scheme		Examination Scheme				
		Lect.	Pract/Dwg	Paper	TW	Oral	Pr.	Total
302041	Design of Machine Elements	4	2	100 **	50	-	-	150
302042	Heat Transfer	4	2	100	-	50	-	150
302043	Theory of Machines & Mechanisms II	4	2	100	-	50	-	150
302044	Industrial Engineering & Management	4	-	100	-	-	-	100
302045	Computer Oriented Numerical Methods	4	2	100	-	-	50	150
311046	Workshop Practice IV	-	2	-	50	-	-	50
Total of First Term		20	10	500	100	50	100	750

SECOND TERM

Code	Subject	Teaching Scheme		Examination Scheme				
		Lect.	Pract/Dwg	Paper	TW	Oral	Pr.	Total
302047	Transmission System Design**	4	2	100	25	50	-	175
311048	Metrology & Quality Control	4	2	100	25	-	-	125
302049	Tribology	4	-	100	-	-	-	100
302050	Fluid Machinery	4	2	100	-	50	-	150
302051	Refrigeration & Air Conditioning	4	2	100	-	50	-	150
302052	Technical Paper Presentation	-	2	-	50	-	-	50
Total of First Term		20	10	500	100	150	-	750

** Theory paper of 4 Hours duration.

T.E.(MECH) SYLLYBUS TERM –I

302041 Design of Machine Elements

Teaching Scheme:
Lectures- 4 Hrs / Week

Examination Scheme:
Paper-100 Marks (4 Hrs)

Practical -2 Hrs / Week Term Work-50Marks

UNIT - 1
Design Process:
Machine Design, Traditional design methods, Basic procedure of Machine Design, Requisites of design engineer , Design of machine elements, Sources of Design data , Use of standards in design, Selection of preferred sizes, Design Synthesis, Creativity in design.

Design of Simple Machine parts:
Factor of safety, Service factor, Design of simple machine parts - Cotter joint, Knuckle joint and Levers, Eccentric axial loading ,Stresses in curved beams (for circular cross-section only).

UNIT - 2
Shafts, Keys and couplings :
Transmission shaft, Shaft design on strength basis, Shaft design on torsional rigidity basis, A.S.M.E. code for shaft design, Keys – saddle, sunk, feather and Woodruff keys, Design of square, flat and Kennedy keys, Splines, Couplings – Muff coupling, Flange coupling and Flexible bushed pin coupling.
Design of shaft on the basis of lateral rigidity – Castigliano's theorem.

UNIT - 3
Threaded joints:
Basic types of screw fastenings-Cap screws and set screws,Bolts of uniform strength, Locking devices, I.S.O. Metric screw threads, Bolts under tension, Eccentrically loaded bolted joint in shear, Eccentric load perpendicular to axis of bolt, Eccentric load on circular base, Torque requirement for bolt tightening, Dimensions of standard fasteners, Design of cylinder bolts and turn buckle.

Welded joints:
Advantages and limitations of welded joints, Butt and fillet welds, Stresses in butt and fillet welds, Strength of butt parallel and transverse fillet welds, Axially loaded unsymmetrical welded joint, Eccentric load in plane of welds, Welded joint subjected to bending and torsional moments, Welding symbols.

UNIT – 4
Power screws:
Forms of threads, Multiple threaded screws, Torque analysis with square and trapezoidal threads, Self locking screw, Collar friction torque, Stresses in power screws, Screw jack and C-Clamp design.

UNIT – 5
Design for Fluctuating Loads :
Stress concentration – causes and remedies, Fluctuating stresses, Fatigue failure, S-N curve, Endurance limit, Notch sensitivity, Endurance strength modifying factors, Reversed stresses, Design for finite and infinite life, Cumulative damage in fatigue failure, Solderberg and Goodman diagrams, Modified Goodman diagram, Fatigue design of components under combined stresses such as shafts, bolts and springs.

UNIT - 6
Mechanical Springs:

Types, Applications and materials of springs, Stress and deflection equations for helical Springs, Style of ends, Design of helical compression and tension springs, Springs in series and Parallel, Concentric helical springs. Helical torsion Spring, Multi-leaf spring(theoretical treatment only), Shot peening,

Reference Books:

1. Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" – McGraw Hill Publication Co. Ltd.
2. Spotts M.F. and Shoup T.E. – "Design of Machine Elements" – Prentice Hall International.
3. Bhandari V.B. – "Design of Machine Elements" – Tata McGraw Hill Publication Co. Ltd.
4. Black P.H. and O. Eugene Adams – "Machine Design" – McGraw Hill Book Co. Inc.
5. Willium C. Orthwein – "Machine Components Design" – West Publishing Co. and Jaico Publications House.
6. "Design Data" – P.S.G. College of Technology, Coimbatore.
7. Juvinal R.C. – "Fundamentals of Machine Components Design" – John Wiley and Sons.
8. Hall A.S., Holowenko A.R. and Laughlin H.G. – "Theory and Problems of Machine Design" – Schaum's Outline Series.

Term Work:

1. Term work shall consist of TWO design projects. Each design project shall consist of two imperial size sheets –one involving assembly drawing with a part list and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file.
   Design projects should be in the form of 'Design of Mechanical System' comprising of machine elements studied and topics covered in the syllabus. Design data book shall be used wherever necessary to achieve selection of standardized components.

Recommendation:
As far as possible, preference should be given to prepare drawing sheets using computer.

302042 Heat Transfer

Teaching scheme : (hrs/week)	Examination scheme
Lectures: 4	Paper: 100 marks
Practical: 2	Practical: 50 Marks

Unit I

Introduction: Applications of Heat Transfer in different fields of engineering. Modes of heat transfer, Fourier's law of conduction, Newton's law of cooling. Stefan-Boltzmann's law of radiation. Isotropic and anisotropic materials. Three dimensional heat conduction equation in Cartesian coordinate for anisotropic material for unsteady state condition, thermal diffusivity and reduction to Fourier equation.

Laplace equation and Poisson's equation. Three dimensional form of heat conduction equation in cylindrical and spherical co-ordinates (no derivation).

One dimensional steady state heat conduction: - One dimensional steady state heat conduction through a plane wall, cylindrical wall and sphere, Analogy between Heat flow and electricity, heat conduction through a composite slab, cylinder and sphere, overall heat transfer coefficient, Concept of thermal resistance and conductance,.

Unit II

Critical radius of insulation, thermal contact resistance. Economic thickness of insulation.

Physical interpretation of Thermal conductivity and its variation with temperature for metals, non metallic solids, gases and liquids. One dimensional problems of variable thermal conductivity.

One dimensional steady state heat conduction with heat generation:-

Symmetrical and asymmetrical boundary condition in plane wall, Conduction in solid and hollow cylinder and sphere. Practical problems of heat generation.

Unit III

Extended Surfaces: Heat transfer through extended surfaces .Fins of different shapes. Derivation of differential equation for fins with constant cross section with different boundary conditions. Effectiveness and efficiency of a fin. Error in the measurement of temperature in a thermowell. Heat sinks- types and applications.

Unsteady state Heat Conduction: System with negligible internal resistance. Biot and Fourier numbers. Criteria for neglecting internal temperature gradient.

Unit IV

Convection: Introduction to hydrodynamic and thermal boundary layer . Laminar and turbulent flow over and inside a surface.

Convective heat transfer coefficients and their order of magnitude, Dimensional analysis of free and forced convection. Physical significance of the dimensionless parameters – Nusselt's number, Reynold's number, Prandtl's number, Grashoff's number, Stanton number, Rayleigh number.

Forced convection: Empirical correlations for heat transfer in laminar and turbulent flow over a flat plate and in a circular pipe .Concept of hydraulic diameter.

Natural convection: Empirical correlations for free convection heat transfer over horizontal, vertical plate and cylinder.

Unit V

Thermal Radiation: Fundamental concepts, Black body radiation, Kirchoff's law, Planck's distribution law, Wien's displacement law and Stefan Boltzmann's law. Surface emission, radiative properties of a surface .Grey, black, white and real surface. Solid angle and intensity of radiation, Lambert's cosine law. Heat exchange by radiation between two finite black surfaces .Radiation shape factor, use of shape factor charts.

Irradiation, radiosity, electrical network method of solving problems.

Heat exchange between non-black bodies, Heat exchange between two infinitely parallel planes, cylinders and spheres.

Radiation Shields, Gas radiation (elementary treatment only). Solar radiation.

Unit VI

Condensation and boiling: Film and drop wise condensation .Derivation of heat transfer coefficient for Laminar film condensation on vertical and inclined plate, correlations for condensation on and inside tubes.
Regimes of pool boiling and pool boiling curve and critical heat flux.
Forced Convection boiling.

Heat exchangers: Classification, Applications of heat-exchangers.
Heat Exchanger analysis – Logarithmic Mean Temperature Difference for parallel and counter flow heat exchangers. LMTD correction factors, fouling factor.
The Effectiveness –NTU method for parallel and counter flow heat exchangers. Design considerations for heat exchanger. Introduction to compact heat exchanger and heat pipe heat exchanger.

List of Practicals:
The term Work shall consist of any "eight' experiments out of the following:
Note: One of the experiments listed below must have computer interfacing.

1. Determination of thermal conductivity of insulating powder
2. Determination of thermal conductivity of metal rod.
3. Temperature distribution through a composite wall.
4. Temperature distribution along the length of a fin and determination of fin effectiveness and fin efficiency.
5. Natural convection heat transfer from a heated vertical cylinder.
6. Heat transfer in forced convection for a pipe losing heat to air flowing through it.
7. Determination of emissivity of a metal surface.
8. Determination of Stefan-Boltzmann constant.
9. Determination of critical heat flux in pool boiling.
10. Performance of a parallel flow and counter flow heat exchanger.

Reference Books:

1. J.P. Holman, "Heat Transfer", McGraw hill.
2. Frank P Incropera, David P De Witt, (1990), "Fundamentals of Heat Transfer", Wiley, Eastern Limited.
3. Sachdeva, R.C,(1988),"Fundamentals of Engineering Heat and Mass Transfer ,Wiley Eastern Limited IIIrd Edition.
4. Sukhatme S.P.(1989), "A text book on Heat Transfer ",III rd Edition, Orient Longmans Ltd,New Delhi.
5. Arora S C and Domkundwar.S. (1994),"A Course in Heat and Mass Transfer", Dhanpat Rai & Sons, IVth Edition.
6. Gupta and Prakash, (1994),"Engineering Heat Transfer", Nemchand and Brothers.
7. Karlekar & Desmond,"Principles of Heat Transfer ", Prentice hall of India Ltd, New Delhi.
8. M. Necati Ozisik, "Heat Transfer".

302050 : Theory of Machines and Mechanisms-II

Teaching Scheme	Examination Scheme
Lectures: 4 Hrs/Week	Paper : 100 Marks
Pract: 2Hrs/Week	Oral : 50 Marks

Unit-I

a) Friction – Dry friction, Inclined Plane theory, Friction between Screw and Nut, Friction in turning pairs, Friction Circle, Friction axis, Friction in Mechanisms.

b) Belt and Rope Drives- Flat and Vee belt, Rope, Limiting tension ratio, Power transmitted, Centrifugal effect, Maximum power transmitted by belt, Slip, Creep and Initial tension.

Unit-II

a) Friction Clutches- Pivot and Collar friction, Plate clutches, Cone clutch, Centrifugal clutch, Torque transmitting capacity, Clutch operating mechanisms

b) Brakes and Dynamometers- Different types of brakes, Shoe brakes, External and Internal shoe brakes, Block brakes, Band brakes, Band and Block brakes, Braking torques, Different types of absorption and transmission type dynamometers.

Unit-III

Cams and Followers- Types of cams and followers, Analysis of standard motions to the follower, Determination of cam profiles for given follower motions, Analysis of cams with specified contours- circular arc cam, tangent cam, eccentric cam, Kinematically equivalent system, Jump phenomenon, Introduction to Advanced cam curves.

Unit-IV

a) Flywheel- Turning moment diagram, Fluctuation of energy and speed, Determination of flywheel size for different types of engines and machines.

b) Governors- Function, Inertia and centrifugal type governors, Different types of centrifugal governors (Watt, Porter, Proell and Hartnell only), Controlling force analysis, Governor effort and governor power, sensitivity, stability, Isochronism and hunting, Friction, Insensitiveness.

Unit-V

Gears- Classification of gears,

Spur Gears-terminology of gearing, conjugate action, involute and cycloidal profile, path of contact, arc of contact, contact ratio, interference, undercutting, Methods to avoid interference and undercutting, Rack shift, Effect of center distance variation, friction between gear teeth, internal gears,

Helical Gears: Normal and transverse module, Torque transmitted by helical gears on parallel shafts. Virtual number of teeth.

Unit-V I

a) Spiral Gears- Spiral angle, shaft angle, Efficiency of spiral gears.

Worm and worm gears & Bevel Gears : Terminology, geometrical relationships, applications and tooth forces. Torque transmitted.

b) Gear trains: Types of gear trains. Velocity ratio, Tooth load, torque transmitted. Holding torque.

Reference Books:

1. Hannah and Stephans: Mechanics of Machines, Edward Arnolde Publication.
2. Beven T : Theory of Machines, Longman Publication

3. Shigley J. E. and Uicker, J J. 1995, Theory of Machines and Mechanisms, International Edition, MacGraw Hill Inc.
4. Ballaney P. L. Theory of Machines, Khanna Publications.
5. Jagdish Lal : Theory of Machines, Metrapolitan Book Co. Pvt. Ltd. N. Delhi.
6. Khurmi, R. S. and Gupta, J. K. 1996, Theory of Machines, Eurasia Publishing House (Pvt.) Ltd., New Delhi.
7. A. Ghosh Malik, " Theory of Mechanism and Machines", East-West Pvt. Ltd.

List of Practicals:
The practical shall consist of any eight of the following experiments

1. Study of belt drive systems and measurement of slip.
2. Study of various types of friction clutches and to measure torque transmitting capacity.
3. Study of various types of brakes and dynamometers and to measure the power transmitted.
4. Study of various types of cam and follower systems and Verification of cam jump phenomenon.
5. To draw cam profiles for various types of follower motions.
6. To determine the characteristics curve for centrifugal governor and to find its coefficient of insensitiveness and stability.
7. Study of various types of gearboxes such as Industrial gear box, Synchromesh gearbox, Differential gearbox, PIV gearbox.
8. To draw conjugate profile for any general type of gear tooth.
9. To generate involute gear tooth profile and to study the effect of undercutting and rack shift using models.
10. To study epicyclic gear trains and to measure torques- torque transmitted and holding torques.

302044 Industrial Engineering and Management

Teaching Scheme: Examination Scheme:
Lectures: 4 Hours / week Theory: 100 Marks

Unit 1 8 Hrs.
Introduction: Industrial Engineering. Basic Techniques involved. Method Study: Need for recording the activities, Symbols used in charting, various charts, Questioning Technique, Process Improvements, Installation of Improved Processes. Work Measurement: Aim, Time Study, Work / Activity Sampling, Predetermined Time Standards, computer applications in industrial engineering.

Unit 2 8 Hrs
Ergonomics: Definition and importance. Historical Background. Human Machine Systems – interfaces. Anthropometry: Need, Important Body Dimensions, Data Collection, Statistical Analysis, Percentile. Applied Anthropometry and Work Space Design & Seating, ergonomics and safety.

Unit 3 8 Hrs.
MANAGEMENT AND PRODUCTIVITY: Basic concepts of management, Management factors: Planning, Organizing, Leadership, Motivation and Control. Maslow's hierarchy of needs, Form of business organizations, long and short term perspective for

growth, Diversification in the context of changing environment: Social, economic, technological, etc. Productivity; Definitions, Scope and measurement, Productivity improvement methods for organizations, job evaluation and merit rating.

Unit 4 8 Hrs.

MANAGEMENT CONTROLS & SYSTEMS: Standard costing: variance analysis, budgetary control, zero-based budgeting, and contribution analysis. Profit centre, cost centre, investment centre concepts: transfer pricing. Financial planning and control: Working capital, investment, financial structure, dividend decisions, Capital evaluation techniques.

Unit 5 8 Hrs.

FACILITY LAYOUT AND DESIGN: Introduction: Nature, Significance and Scope of Facility layout and design. Facility Location: Location analysis, Single-facility and Multi-facility location problems. Steps in layout planning, Quantitative techniques. Material Handling: Principles of Material Handling, Equipment Selection. Storage and Warehousing: Functions, Objectives and Principles. Facility Services like air, water, electricity, drainage etc. computerised layout planning.

Unit 6 8 Hrs.

PRODUCTION PLANNING AND INVENTORY CONTROL: Materials management: Meaning, Functions and objectives. Production Planning and Control: Aggregate production planning and control, Hierarchical production planning and control, Desegregation of aggregate plan. Inventory Control: Purpose, types, functions, EOQ concept, ABC, VED & FMS analysis. Modern Techniques: Introduction to MRP & MRP II, JIT, Kanban, sales forecasting and techniques.

References :

1. Maynard, Industrial Engineering Handbook, Mc Graw Hill Book Company.
2. ILO, Introduction to Work study
3. Curie R. M. & Faraday, Work study
4. M. S. Sanders and Ernest J. McCormick, McGraw Hill Inc., Human Factors Engineering and Design.
5. E. Grad jean, Fitting Task to the Man.
6. Khanna O. P., Industrial Engineering and Management, Dhanapat Rai Publications, New Delhi.
7. Gopalkrishnan P. and Sudarshan, Materials Management, Prentice Hall India Ltd.
8. Arnold J R I: Intro To Materials Management. Prentice Hall Inc New Jercy, 1996. (658.7 ARN 015979)
9. Rathnam P V: Costing Adviser. Allahabad. Kitab Mahal, 2003. (658.155 RAT 023519)
10. Eilon S: Elements Of Production Planning And Control. Universal Publishing Bombay, 2001. (658.503 EIL 018303)
11. Tompkins J A & White J A: Facilities Planning. New York. John Wiley & Sons, 1984. (658.2 TOM 011425)
12. Aswathappa K: Organisational Behavior : Text , Cases, Games. Mumbai. Himalaya Publishing House, 2004. 81-7866-849-1 (658.4 ASW M01389)

302045 Computer Oriented Numerical Methods

Teaching Scheme:
Lectures: 4Hrs/Week

Examination Scheme:
Theory: 100 Marks

Practical: 2Hrs/Week Practical: 50 Marks

Unit I 8 Hrs

Errors and approximations:
Types of Errors, Absolute, Relative, Algorithmic, Truncation, Round off Errors. Error Propagation, Concept of Convergence, Relevance to Numerical Methods, Direct and Iterative Methods.

Linear Programming: Simplex Method

Unit II 8 Hrs

Interpolation: Langrange's Interpolation, Newton's forward, backward and central difference method, divided difference method, Inverse Interpolation,

Curve Fitting: least square criteria- 1^{st} and 2^{nd} Degree

Unit III
8 Hrs

Solution of linear simultaneous equations: Homogeneous/Non-homogeneous systems, Gauss Elimination, Gauss-Jordan, Gauss-Seidel Methods, LU-Decomposition, Cholesky Method

Numerical Differentiation: Forward, Backward and Central Difference Methods.

Unit IV 8 Hrs

Numerical Solution of Algebraic and Transcendental equations: Bisection Method, Secant Method, Regula-Falsi Method, Newton-Raphson Method, Successive Approximation Method

Numerical integration: Trapezoidal Rule, Simpson $1/3^{rd}$ and $3/8^{th}$ Rule, Weddle's Rule, Gauss Quadrature - Two and Three Point Formula, Double Integration.

Unit V 8 Hrs

Numerical Solution of Ordinary Differential Equation: Taylor Series Method, Euler Method, Modified Euler Method, Predictor-Corrector Methods – Milne's Method, Adam-Bashforth Method, Runge Kutta 2^{nd} and 4^{th} order method, Simultaneous Differential Equations and Second Order Differential Equations

Unit VI 8 Hrs

Numerical Solution of Partial Differential Equation: Finite Difference Method, Laplace's Equation. Poisson's Equation, One and Two Dimensional Heat Equations, Wave Equation.

Reference Books:

1. Chapra, S.C. & Canal, R. P., "Numerical Methods for Engineers",4^{th} Ed., Tata McGraw Hill Pub. Co. Ltd., New Delhi
2. Balagurusamy, E., "Numerical Methods", Tata McGraw Hill Pub. Co. Ltd., New Delhi
3. Rajaraman, V., "Computer Oriented Numerical Methods", Prentice Hall of India Ltd, New Delhi
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", Prentice Hall of India Ltd, New Delhi

5. Jain, M.K., Iyengar, S.R.K. AND Jain, R.K., "Numerical Methods for Scientific and Engineering Computations", 5th Ed., New Age International Ltd, New Delhi
6. Rajasekaran, S., "Numerical Methods in Science and Engineering – A practical Approach", S. Chand and Co. Ltd., New Delhi.
7. Rao, S.S., "Optimization – Theory and Applications", New Age International Ltd, New Delhi

List of Practicals:
Minimum NINE programming assignments shall be completed and submitted as term work in the form of a journal comprising of flowcharts, program listing and results.Out of these, MINIMUM ONE programming assignment must be based on EACH of the topics Listed Below:

1. Linear Programming
2. Interpolation
3. Curve Fitting
4. Linear simultaneous equations
5. Numerical Differentiation
6. Algebraic and Transcendental equations
7. Numerical integration
8. Ordinary Differential Equation
9. Partial Differential Equation

NOTE: At least 3 of the above assignments will be carried out using a mathematical solver such as MATLAB, TK Solver, Mathematica, etc. The remaining assignments will be completed using C/C++ language.

(311046) Workshop Practice – IV

Class: T.E. Mechanical Semester: I
Term Work: 50Marks Practical: 2 hrs/week

Each candidate is required to complete and submit any two of following:

Part A: One composite job consisting of machining of components covering operations on - Lathe, Drilling, Milling Machines and essentially consists of Thread Assembly.

Part B: Demonstration/Job on CNC machine which should consists of Step Turning and Taper Turning Operations/

Part C: One job on milling machine consisting of Gear Cutting Operations.

Journal should contain the report of above jobs.

T.E.(MECH) SYLLYBUS TERM –II

302047 Transmission System Design

Teaching Scheme :
Lectures : 4 Hrs/Week
Practical : 2 Hrs/Week

Examination Scheme:
Paper :100Marks(4 Hrs Duration)
Term work : 25 Marks
Oral : 50 Marks

UNIT – 1 Rolling contact bearings :
Types of rolling contact Bearings, Static and dynamic load carrying capacities, Stribeck's equation, Equivalent bearing load, Load-life relationship, Selection of bearing life, Selection of rolling contact bearings from manufacturer's catalogue, Taper roller bearing, Design for cyclic loads and speed, Bearing with probability of survival other than 90%, Lubrication and mounting of bearings, Preloading of rolling contact bearings, Types of failure in rolling contact bearings – causes and remedies.

UNIT – 2 Friction Clutches :
Classification and selection of friction clutches, Torque transmitting capacities and design of single-plate, multi-plate, Cone and Centrifugal clutches, Types of friction materials, their advantages, limitations and selection criteria, Concept of temperature rise in clutch operation.

Brakes :
Energy absorbed by brake, Design considerations in Pivoted block brake with long shoe, Internal expanding shoe brake and Disk brake, Temperature rise in brake operation.

UNIT – 3 Belts, Chain and Rope drives :
Materials and construction of flat and V belts, Geometric relationships for length of belt, Power rating of belts, Maximum power condition, Selection of flat and V belts from Manufacturer's catalogue, Belt tensioning methods, Relative advantages and limitations of flat and V belts, Construction and applications of timing belts.

Construction and materials of roller chain, Length of chain and number of links, Polygonal effect, Power rating of roller chains, Construction of sprocket wheels, Silent chains, Relative advantages and limitations of chain drives.

Rope drives, Construction of wire ropes, Lay of wire ropes, Stresses in wire rope, Selection of wire ropes, Rope drum construction and design.

UNIT – 4 Gear Drives :
Classification of gears, Selection of types of gears, Standard systems of gear tooth.

Spur gear
Number of teeth and face width, Types of gear tooth failure, Desirable properties and selection of gear material, Constructional details of gear wheel, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength (Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation, Methods of gear lubrication, Introduction to addendum modification and its advantages.

UNIT- 5 Helical gears
Transverse and normal module, Virtual no of teeth, Force analysis, Beam and wear strengths, Effective load on gear tooth, Estimation of dynamic load by velocity factor and Buckingham's equation, Design of helical gears.

Bevel Gears
Straight tooth bevel gear terminology and geometric relationship, Formative number of teeth, Force analysis, Design criteria of bevel gears, Beam and wear strengths, Dynamic tooth load by Velocity factor and Buckingham's equation, Effective load, Design of straight tooth bevel gears, Selection of materials for bevel gears, Introduction to spiral bevel gears and hypoid gears and comparison with straight tooth bevel gears, Lubrication and mounting of bevel gears, Bearing reactions, Types of failures in bevel gears.

UNIT- 6 Worm Gears
Worm and worm gear terminology and geometrical relationship, Types of worm and worm gears, Standard dimensions, Force analysis of worm gear drives, Friction in Worm gears and its efficiency, Worm and worm-wheel material, Strength and wear ratings of worm gears, Thermal consideration in worm gear drive, Types of failures in worm gearing, Methods of lubrication.

Reference Books

1. Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGrow Hill Pub. Co. Ltd.
2. Spott's M.F. and Shoup T.E. – "Design of Machine elements" – Prentice Hall International.
3. Bhandari V.B. – "Design of machine elements" – Tata McGrow Hill Public Co. Ltd.
4. Black P.H. and O. Eugene Adams – "Machine Design" – McGrow Hill Book Co. Ltd.
5. Willium C. Orthwine – "Machine Components Design" – West-Pub. Co. an Jaico Pub. House.
6. "Design Data" – P.S.G. College of Technology, Coimbatore.
7. Juvinal R.C. – "Fundamentals of Machine Components Design" – John Wiely and Sons.

8. Hall A.S., Holowenko A.R. and Laughlin H.G. – "Theory and Problems of Machine Design" – Schaum's outline series.

Term Work

1. Term work shall consist of "ONE" design project. The design project shall consist of two imperial size sheets – one involving assembly drawing with a part list and overall dimensions and the other sheet involving drawing of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified so as to make it working drawing. A design report giving all necessary calculations of the design of the components and assembly should be submitted in a separate file.

Design projects should include selection of prime mover and design of mechanical systems comprising of machine elements : 1) spur gears and helical/bevel/worm gears OR 2) belt/chain/rope and clutch/brake

Design data book shall be used extensively for the selection of the components.

The ORAL shall be based on Term Work done during the second term under the subject Transmission System Design Since there are no separate marks for Term Work under the subject Transmission System Design, due considerations should be given for this term work under the heading of oral examination of 50 marks.

Recommendations :

1. As far as possible, preference should be given to prepare drawing sheets using computer.
2. A study visit to industry may be arranged to see manufacture of machine elements and assemblies during the semester. During the same visit, the students are expected to visit design office to see design and drafting aids. A report of this visit may be included in the term work.

(311048) METROLOGY AND QUALITY CONTROL

Class: T.E. Mechanical Semester: II
Theory: 4 hrs/week Paper: 100 Marks
Practical: 2 hrs/week Term Work: 25 Marks

METROLOGY

Unit – I [8 hrs]

1.1. Introduction to measurement, errors, standards, various precision measuring instruments, straightness, flatness, squareness, roundness measurement, angular measurement, Calibration of all measuring instruments.

1.2. Principles of gauge design- types of gauges, Taylor's Principle of gauge design, Limits, Fits, Tolerances.

Unit – II [8 hrs]

2.1. Comparators – Types and working principle of mechanical, pneumatic, electronic, optical, electrical comparators and their applications.

2.2. Interferometer – Principles, Sources of light, Optical Flat, Fringe Patterns, Calibration of Optical Flat and It's applications, Tool Maker's Microscope, Profile Projector.

2.3. Surface Finish Measurement- Surface texture terminology, measurement of surface roughness and instruments

Unit – III [8 hrs]

3.1. Machine Tool Metrology – Alignment Test, Performance Test of Lathe, Milling and Drilling Machine,

3.2. Metrology of Screw Thread – Screw Thread Terminology, Thread Gauges, Measurement of Thread Element – Floating Carriage Micrometer.

3.3. Gear Metrology – Gear Terminology and its measurement, Measurement of Tooth Thickness by Gear Tooth Vernier Caliper- Base Tangent Method, Constant Chord Method, Span Micrometer method, Roller Method

3.4. Advances in Metrology – Coordinate Measuring Machine, Universal Measuring Machine, Application of Laser in Measurement, Meteroscope, Automatic Inspection System.

QUALITY CONTROL

Unit – IV [8 hrs]

4.1. Concept of Quality – Definitions of Quality, Dr. Deming and Juran's Contributions, Elements/Characteristics of Quality, Value of Quality, Cost of Quality, Quality Policy, Vision, Mission.

4.2. Quality Control – Definitions, Scope and Applications, Quality Assurance, Causes of Variation.

Unit – V [8 hrs]

5.1. Statistical Quality Control – Basic Statistics, Mean, Mode, Standard Deviation, Frequency Distribution, Control Chart for Variables, Attributes, Process Capability.

5.2. Acceptance Sampling – Sampling Inspection, Operational Characteristics Curve, Consumer's Risk, Producer's Risk, AQL, LTPD, AOQL,

Types of Sampling Plan – Single, Double, Multiple, Sequential Sampling Plan.

Unit – VI [8 hrs]

6.1. Six Sigma – Types of defects, DMAC, Six Sigma Program, Zero Defect

6.2. Quality Standards – ISO 9000:2001, TS 16949 Standard, FMECA (Failure Mode Effect Criticality Analysis), FTA (Fault Tree Analysis)

6.3. Quality Circle – Kaizen Practice, Cause and Effect Diagram, Pareto Analysis, Total Quality Management (TQM)

TERM WORK:

Term Work shall be in the form of the following

A) Experiments – Any eight of the following.

1) Determination of Linear/Angular dimensions of a part using precision/non-precision measuring instruments.
2) Precision Angular Measurement using Sine Bar/Sine Center, Autocollimator/Angle Dekkor.
3) Machine Tool Alignment Test on any machine like- Lathe, Milling, Drilling.
4) Measurement of Screw Thread using Floating Carriage Micrometer.
5) Measurement of Gear Tooth Thickness by Gear Tooth Vernier Caliper/Constant Chord/Span Micrometer.
6) Measurement of Circularity/Roundness using Mechanical Comparator.
7) Calibration of Dial Gauge using Dial Calibration Tester.

8) Interferrrometry- Study of Surfaces using Optical Flat.
9) Study and applications of profile projector and Tool Maker's Microscope.
10) Inspection of Production Job by Statistical Process Control.

B) Assignment - At least two assignments based on Syllabus of Quality Control

C) Industrial Visit Report on study of Metrology Subject.

REFERENCES

1) Jain R.K. – Engineering Metrology, Khanna Publication
2) Hume K.J – Engineering Metrology
3) Juran J.M. – Quality Handbook – McGraw Hill Publication
4) Grant S. P. – Statistical Quality Control – Tata McGraw Hill Publication.

302044: Tribology

Teaching Scheme — Examination Scheme
Lectures: 4Hrs/Week — Paper : 100 Marks

Unit I

Introduction to Tribology, tribology in design, Tribology in industry, Recycling of used oil & oil Conservation.Disposal of Scrap oil & oil emulsion. Lubricants - Properties- physical and chemical, Types of additives, extreme pressure lubricants.
Lubrication-introduction, basic modes of lubrication.
Types of sliding contact bearings .Comparison of Sliding and Rolling contact bearings.

Unit II

Friction : Introduction, Laws of friction, kinds of friction, causes of friction, friction measurement, theory of friction.
Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theory of wear.

Unit III

Hydrodynamic Lubrication: Theory of hydrodynamic lubrication. Mechanism of pressure development in oil film. Two dimensional Reynolds equation. Infinitely long journal bearing. Infinitely short journal bearing .Sommerfeld number ,Raimondi and Boyd method,Temperature rise. Parameters of bearing design- Length to diameter ratio, Unit bearing pressure, Radial clearance and minimum oil film thickness.

Unit IV

Hydrostatic Lubrication: Basic concept, advantages and limitations. Viscous flow through rectangular slot. Load carrying capacity and flow requirement of hydrostatic step bearing, energy losses. Optimum design of step bearing.

Unit V

Hydrostatic squeeze film: Introduction , circular and rectangular plates approaching a plane.
Gas Lubrication : Introduction ,Merits and demerits, Applications.
Lubrication in metal working: Rolling, Forging ,Drawing and extrusion.

Unit VI

Hydrodynamic Thrust bearing: Introduction, flat plate thrust bearing, pressure equation, load, centre of pressure. . Friction in tilting pad thrust bearing.

Elastohydrodynamic Lubrication: Principle and Application.
Bearing Materials and bearing constructions.
Oil seals & shields , Gaskets.

Reference Books

1. Fuller D. D., "Theory and Practice of Lubrication for Engineers ". John Wiley and Sons.
2. Halling J., "Principles of Tribology ", McMillan Press Ltd.
3. Cameron A. "Basic Lubrication Theory ", Wiley Eastern Ltd.
4. Neale M. J. "Tribology Hand Book ", Butterworths.
5. C. Majumdar "Introduction to Tribology and Bearings ", H. Wheeler and Company Pvt. Ltd.
6. O. P. Orlov, "Fundamentals of Machine Design ", Vol.IV, MIR.
7. Bhandari V.B., Design of Machine Elements, Tata-McGrawHill Publication Co. Ltd.
8. Handbook of Tribology by Bharat Bhushan.

302043 : Fluid Machinery
T. E. (Mechanical)

Teaching Scheme	Examination Scheme
Lectures : 4 Hrs/Week	Theory : 100 Marks
Practicals : 2 Hrs/Week	Oral: 50 Marks

UNIT 1
Introduction to Hydrodynamic machines
Classification, general theory, centrifugal heads, fundamental equations, degree of reaction, head on machines, various efficiencies, condition for maximum hydraulic efficiency.

Impulse Momentum equation and its application
Impulse momentum principle, fixed & moving flat plates & curved vanes , series of plates & vanes, water wheels, velocity triangles & their analysis, work done, efficiency etc.

UNIT 2
Impulse Turbines
Main components & constructional features of Pelton wheel, velocity diagrams & analysis, number of buckets, jets, non-dimensional parameters like speed ratio, flow ratio, condition for maximum efficiency. Introduction to other impulse turbines.

UNIT 3
Reaction Turbines
Types of reaction turbines Francis, Kaplan, Deriaz, bulb, reversible and low head turbines. Main components & constructional features, draft tube- types, efficiency, limitations for use of draft tubes, cavitation in reaction turbines.

UNIT 4

Governing, Performance & Selection of Turbines

Governing mechanism for Pelton wheel, Francis, Kaplan turbine, safety devices for turbine, pressure regulators, surge tanks, forebay. Performance of water turbines-characteristic curves, unit quantities, specific speed & shape of runner. Selection of turbine.

Similarity & Model analysis

Similitude – geometric, Kinematic, dynamic similarity. Model analysis - various model laws, model testing, scale effect. Similarity applied to turbines and pumps.

UNIT 5

Hydrodynamic Pumps

Classification, components of centrifugal pump. Various terms associated with centrifugal pump, various heads, velocity triangles & their analysis, effect of outlet blade angle, cavitation, NPSH, Thomas cavitation factor, priming of pumps, installation, specific speed & pump classification. Performance characteristics of centrifugal pump. Axial thrust, maintenance, troubles & remedies, series & parallel operation of pumps, system resistance curve, water hammer problem in pumping system.

UNIT 6

Reciprocating and Special Pumps

Reciprocating pump, Airlift pump, Hydraulic ram, deep well pump, submersible pumps, vertical turbine pump, regenerative pump, construction, principle of operation, energy analysis, performance characteristics.

Fluid coupling & torque converter

Construction, working, characteristics curves, applications.

Reference Books

1. Modi P N & Seth S N, " Hydraulics, Fluid Mechanics and Machinery " , Standard Book House ,New Delhi.
2. V.P. Vasandani, "Theory of Hydraulic Machinary", Khanna Publishers, Delhi.
3. Dr. J. Lal, "Hydraulic Machines", Metropolitan Book Co. Pvt. Ltd., Delhi.
4. Karassik, "Hand Book of Pumps", Tata McGraw Hills Ltd., New Delhi.
5. R. K. Srivastava, Critical Aspects in Rotodynamics Pumps & Systems, Techno Economic Research Institution, New Delhi.

List of Experiments

Minimum 8 experiments shall be performed out of which experiments at serial number 1, 2, 3 or 4, 5 are compulsory. Record of 8 experiments shall be submitted in the form of journal.

1. Verification of impulse momentum principle using flat, inclined & curved plates.
2. Study & trial on a Pelton wheel & plotting of operating characteristics.
3. Study & trial on a Francis turbine & plotting of main/ operating characteristics.
4. Study & trial on a Kaplan turbine & plotting of main/ operating characteristics.
5. Study & trial on a centrifugal pump & plotting of operating & variable speed characteristics.
6. Study & demonstration of different non conventional pumps such as air lift pump, jet pump, deepwell pump, hydraulic ram etc.
7. Study & trial on a torque converter & plotting operating characteristics.
8. Study and trial on reciprocating pump& plotting of operating characteristics

9. Design of a complete pumping system installation using standard tables, charts supplied by pump manufactures.
10. Visit to Hydro-electric power station & writing a report based on the visit.
11. Visit to pumping station & writing a report based on the visit.

REFRIGERATION AND AIR-CONDITIONING

Teaching Scheme:
Lecturers: 4Hrs/Week
Practical: 2 hours per week

Examination Scheme:
Theory: 100 Marks
Oral: 50 Marks

UNIT 1

Methods of Refrigeration:-Ice refrigeration, evaporative refrigeration, Refrigeration by expansion of air, refrigeration by throttling of gas, vapour refrigeration system, steam jet refrigeration system, and refrigeration by using liquid gases. Thermoelectric and ultrasonic refrigeration. Concept of COP, EER, SEER, IPLV.

Air Refrigeration Systems: Definition, refrigeration load, unit of refrigeration, reverse Carnot cycle, Bell-Coleman cycle, methods of air refrigeration systems, simple air cooling system, boot-strap system, reduced ambient system, regenerative system.

UNIT 2

Simple Vapour Compression system:-Limitations of air refrigeration system, development of vapour compression cycle (VCC), effect of operating parameters on VCC, use of P-h charts, actual vapour compression cycle. Various capacity control methods and its merits / demerits.

Refrigerants:-Desirable properties of refrigerants, classification of refrigerants, secondary refrigerants, alternative refrigerants for CFC's and HCFC's, ozone depletion Potential (ODP) Global Warming Potential(GWP), atmospheric life, total equivalent warming impact(TEWI), Refrigerant, reclaim, recycle methods.

UNIT 3

Multi Pressure Systems:-Introduction, multistage compression, two stage compression with flash gas removal, with liquid intercooler, complete two stage compression system multiple evaporator systems, cascade systems, Thermodynamic evaluation of various systems for two refrigerant (using properties).

Vapour Absorption System:-Introduction, simple vapour absorption system, practical vapour absorption system, COP of an ideal vapour absorption system, selection criteria of refrigerant-absorbent mixture, water ammonia system, Electrolux refrigerator, lithium bromide absorption system, comparison between VCC and VAC. Cycle used in absorbtion refrigeration (half effect, single effect, double effect, single double effect). Thermodynamic analysis of single simple effect cycle. For NH_3- H_2O.

UNIT 4

Psychrometry:- Introduction, psychrometric terms, use of psychrometric chart,psychrometric processes, adiabatic saturation temperature, evaporative cooling, by-pass factor of coil, efficiency of coil, adiabatic mixing of two air streams. Air washers, Thermodynamics of human body with environment, effective temperature, comfort chart, factor influencing human comfort, indoor air quality requirement, ventilation requirement.

UNIT 5

Air- Conditioning Systems:-Definition, factors, equipment used, classification, all air system, all water system, air water system, unitary and central air conditioning, infiltration and ventilation loads, concept of SHF,RSHF,GSHF,ERSHF,ADP.

Components of Refrigeration and Air Conditioning System: Compressors, condensers, evaporators, expansion devices such as capillary tubes, automatic expansion valves, thermostatic expansion valves and controls such as thermostats, humidistat, solenoid. Installation, charging, testing, and maintenance, and trouble shooting of system.

UNIT 6

Ducts:-Introduction, classification of ducts, duct material, pressure in ducts, flow through duct, pressure losses in duct, friction losses, dynamic losses, air flow through simple duct system, equivalent diameter, methods for determination of duct size, equal friction, velocity reduction, static regain method.

Food Preservation:- Cold storages, control and modified atmosphere (CAMA) , storages, mobile refrigeration and air conditioning, refrigerant piping selection, pressure drop, valves, fitting, accessories etc. … insulating materials.

Term Work:
The term shall consist of record of minimum eight experiments from the followings.

1. Trial on vapour compression test rig.
2. Trial on air conditioning test rig.
3. Trial on ice plant test rig.
4. Trial on vapour absorption test rig.
5. Study of non- conventional refrigeration systems
6. Study of different type of evaporators and condensers.
7. Determination of cooling load of air conditioning system (case study)
8. Study of installation/operation/maintenance practices for refrigeration systems
9. Determination of refrigeration loas in cold storage (case study/visit).
10. Visit to any refrigeration or air conditioning plant.

Reference Books:

1. Arrora and Domkundwar: Refrigeration and airconditioning, Dhanpatrai and Company.
2. C P Arrora: Refrigeration and Airconditioning, Tata McGraw Hill.
3. Dossat Ray J.," Principal of refrigeration"S.I. Version,Wiley Eastern Limited, 2000
4. Manohar Prasad,"Refrigeration and Air-conditioning",Wiley Eastern Limited, 1983
5. Ballaney P.L." Refrigeration and Air-conditioning'Khanna Publishers, New Delhi, 1992.
6. Khurmi R.S. and Gupta J.K., "Refrigeration and Air-conditioning"Eurasia publishing house (P) Ltd.,New Delhi, 1994
7. Stocker W.F. and Jones J.W." Refrigeration and Air-conditioning', mcgraw Hill international editions 1982
8. Threlkeld J.L."Thermal environmental engineering",Prentice hall Inc. New Delhi.
9. ISHRAE Handbook.

302052 Technical Paper Presentation

Teaching scheme : (hrs/week)	Examination scheme
Practical : 2	Term work : 50 Marks

Technical Paper Presentation is a seminar which is expected to be on a state – of – the – art technical topic, related to Mechanical Engineering discipline but outside syllabus. The seminar report and its presentation is to be based on material, mainly collected and analysed from the latest papers in technical journals. The report is expected to be of about 15 A4 size pages, including figures and plates, in addition to certificate, synopsis and reference pages. The presentation is expected to be in front of the audience which must include at least two internal examiners one of them being a guide and both being university approved teachers. The marks distribution is equally divided between the report and presentation/oral examination.