T. E. (Mechanical) Sandwich 2008 Course Structure
(w.e.f. July – 2010)

Semester I

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME				
		Lect.	Pract / Dwg	Paper	TW	Oral	Pr	Total
302061	Elective I (Self Study)	-	-	100	-	-	-	100
302062	Seminar	-	-	-	-	50	-	50
302063	Industrial In-plant Training	-	30	-	150	100	-	250
Total of First Term		**-**	**30**	**100**	**150**	**150**	**-**	**400**

SECOND TERM

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME				
		Lect.	Pract/ Dwg	Paper	TW	Oral	Pr	Total
302042	Heat Transfer*	4	2	100	-	-	50	150
302064	Theory of Machine & Machine Design –II**	4	2	100	25	50	-	175
302045	Turbo machines*	4	2	100	25	25	-	150
302065	Mechatronics	4	2	100	25	50	-	175
302066	Tribology	4	-	100	-	-	-	100
302067	Metrology & Quality Control	-	2	-	50	-	-	50
Total of Second Term		**20**	**10**	**500**	**125**	**125**	**50**	**800**

*Common to T.E. Mechanical Course
** Theory Paper of 4 Hours Duration

Code	Elective
302061 A	Production Management
302061 B	Behavioural Science
302061 C	Welding Technology

University of Pune, Pune
T. E. (Mechanical) Sandwich Part I 2008 Course
302061 (A): Production Management
(Elective I) (Self study)

Examination Scheme:
Paper : 100 Marks

Section I

Unit I

Evolution of Management Practices: Characteristics, Objectives, Functions, Principles & Types of Management, Scientific. Management - Contribution of F.W. Taylor & H. Fayol & others to the Management thoughts.

Organization: Definition, Principles, Functions & Types of Organization.

Group dynamics: Definition, Types, Characteristics, Functions & Objectives, Groups & Group Dynamics. Objectives of Business Enterprise, Concept of Firm & Industry, Different forms of Business Ownership - Proprietor, Partnership Firm, Private & Public Limited Company, Cooperatives, Private & Public Trusts.

Unit II

Production Management

The Production function, Operations Concept, Productivity, Objective of Production, Management, Elements of Production function. Industrial Engineering- History, Development, Definitions, Functioning & Application of Industrial Engineering, Contribution of various persons to the field of Industrial Engineering. Types of Production (Job, batch etc,) & their characteristics, Degree of repetitiveness & Volume of Production. Facilities (Plant) Location & Layout, Equipments & Principals of Material handling. Introduction to Production Planning & Control. Process Planning, Maintenance Function.

Unit III

Method Study: Steps, Tools & Techniques used in the Method Study, Process Chart, Symbols, Flow Diagrams, Two Hand Chart, Multiple Activity Chart, 5W & 1H, Use of Motion Pictures & its analysis. SIMO chart, Chronocylograph. Developing, Presentation, Installation & Maintenance of new Methods. Meaning, Definition & Importance of Ergonomics in Industry.

Work Measurement

Time Study: Aim & Objectives, Terminology & Tools, Use of stopwatch procedure in making Time Study. Time Study Forms, Performance rating, allowances and its types. Calculations of standard Time. Time study for indirect functions such as Maintenance & Marketing. Criticism of Time Study.

Synthetic & Standard data Methods: Concepts, Introduction to PMTS, MTM1, WFS, & Basic Motion Time Study. MTM2 & Other second Generation Methods, MOST.

Section II

Unit - IV

Quality Control: Definition of Quality, Quality Characteristics, Introduction to Quality Control, Study of control chart -control chart for variables, control chart for attributes. Acceptance Sampling - Sampling inspection v/s 100 percent inspection, Basic concepts, operating

characteristics curves, conflicting interests of consumer and producers, producer's and consumer's risks, AQL, LTPD, AOQL, Single and Double Sampling Plans, Standard Sampling tables. Theory of Work Sampling

Unit - V

World Class Manufacturing-I: Deming's and Juran's Approach, Deming's PDCA, PDSA cycle, 7 QC Tools, 5'S, TPM, Kaizen, Quality Circle, Concurrent Engineering, JIT, Kanban, Quality Function Deployment, House of Quality, Six Sigma, Poka Yoke

Unit - VI

World Class Manufacturing-II: ISO, QS and CMM Standards, Introduction to Reliability, FMEA, FTA. Introduction to Taguchi method, Design of Experiments. Concept of Hypothesis Testing.

Text Books:

1. Banga & Sharma, "Industrial Organisation & Engineering Economics", Khanna Publishers.
2. Jhamb L. C., "Production (Operations) Management", Everest Publishing House.
3. M. Mahajan, "Industrial Engineering & Production Management", Dhanpat Rai & Company.

Reference Books:

1. "Introduction to Work Study", ILO Publication. Mansoor Ali & Dalela, "Industrial Engineering and Management Systems", Standard Publisher Distributor.
2. Zaidi, SPC, "Concepts, Methodologies & Tools", PHI
3. J P Saxena, "Production and Operations Management" Tata McGraw Hill.
4. Elwood S. Buffa, Rakesh K.Sarin, "Modern Production/Operations Management" WILEY Publication.
5. Starr, "Production and Operations Management" Cengage Learning Publication.

University of Pune, Pune
T. E. (Mechanical) Sandwich Part I 2008 Course
302061(B): Behavioural Science
(Elective I) (Self study)

Examination Scheme:
Paper : 100 Marks

Section I

Unit I

Factors affecting the operations of Enterprise: The purpose of an industrial enterprise in different industrial sectors- public, private, co-operative and small scale. External factors influencing and governing the enterprise- economic, political, technological and social. Statutory control- licensing, price control, wage legislation's and other industrial laws, trade union's role. Environment in the urban and rural laws.

Unit II

Organisation: Organisational structure, organisational theories, Planning and design. Typical industrial organisation and main functions of management-Production, Sales Finance and Personal management of work through committees, Systems and procedure. The influence of people on the performance of the enterprise.

Unit III

Industrial Behavior: Theories of motivation- Stimulus response, achievement, Affiliation and Maslaw, Personality Traits, learning theories and self-improvement, effect on social and political environment.

Section II

Unit IV

Organizational and group behavior: Small group behavior, formal and informal groups- Group dynamics. Organizational culture- Nature and causes of conflict- Interpersonal and inter-group conflicts- Resolution of conflicts. Role playing exercise- Transitional Analysis.

Unit V

Leadership: Leadership process and styles- Theory X and theory Y- Managerial Grid, continuous versus breakthrough improvements, Management of change, Quality awards models and role of self assessment.

Unit VI

Communication and inverting skills: Written communication- Oral and Nonverbal Communication. Different types of interview- Conducting an interview.

Reference books:

1. The Enterprises and Factors Affecting its operation, ILO Publication.
2. Fred Luthans, Organisational Behavior, McGraw Hill.
3. Davies and Newstrom, "Organisational Behavior".
4. R.L.Sharma and Krishna Mohan, "Business Correspondence and Report writing" Tata McGraw Hill.
5. Peter Druncker, "The Practice of management".

University of Pune, Pune
T. E. (Mechanical) Sandwich Part I 2008 Course
302061 (C): Welding Technology
(Elective I) (Self study)

Examination Scheme:
Paper : 100 Marks

Section I

Unit I

Gas welding processes and Equipments

Definition, Oxy-acetylene welding, Principle of operation, Types of welding flames, Chemistry of oxy-acetylene flame, Lighting the torch, Flame adjustment, Gas welding technique, Base metal preparation, Welding techniques-Leftward and Rightward, Welding filler metal rods and fluxes, Gas welding equipment, Oxygen and acetylene cylinders, Acetylene generator, Manifold system and its advantages, Single stage and two-stage oxygen and acetylene pressure regulators, Oxygen and acetylene gas hoses and hose connections, Welding torches or blowpipes –low and high pressure type, Welding nozzles or tips, Gas lighter, Gas cylinder trolleys, Advantages of gas welding, Disadvantages of gas welding, Applications of gas welding, Oxy-hydrogen and other fuel-gas welding, Hydrogen, Propane, Butane and natural gas used for gas welding purposes, Air-acetylene welding, definition, principle of
operation and Applications.

Unit II

Arc welding processes and Equipments

Definition, Principle of the process, Principle of operation, Welding equipment, Joint design, Welding variables and parameters, Advantages, Limitations, and Applications for the processes like- Carbon Arc Welding ,Flux Shielded Metal Arc Welding, Submerged Arc Welding, TIG (or GTAW) Welding, MIG (or GMAW) Welding, Flux Cored Arc Welding (FCAW), Electro slag Welding, Plasma Arc Welding, Arc Spot Welding,

Welding Electrodes- Types of welding electrodes, Electrode details, Non-consumable or refractory electrodes, Consumable electrodes, Light, Medium and heavily coated electrodes, Categories of covered electrodes, Electrode coating ingredients and their functions, Manufacture of electrodes, Selection of electrodes, Care and storage of electrodes, Classification and coding of mild steel and low alloy steel electrodes, American system, British system and Indian system, Typical applications of covered electrodes.

Unit III

Resistance welding

Definition, Fundamentals of electric resistance welding, Principle of operation Equipment used, metal to be used Variables in resistance welding. Advantages of resistance welding, Disadvantages of resistance welding, and applications of resistance welding for the processes like- Spot Welding, Seam Welding, Projection Welding, Resistance (Upset) Butt Welding, Flash butt Welding, Percussion Welding.

Section II

Unit IV

Solid-state welding processes

Definition, concept, Principle of operation Equipment used, metal to be used Variables in solid state welding. Advantages of solid state welding, Disadvantages of solid state welding, and

applications for the processes like -Cold (Pressure) Welding, Diffusion (Bonding) Welding, Ultrasonic Welding, Explosive Welding, Friction Welding and Inertia Welding, Forge Welding**.**

Special welding processes: Definition, concept, Principle of operation Equipment used, metal to be used Variables in special welding. Advantages of special welding, Disadvantages of special welding, and applications for the processes like - Thermit Welding, Atomic Hydrogen Welding, Electron Beam Welding, Laser Beam Welding

Unit V

Brazing and Soldering

Definition, Principle of operation, Brazing procedure, Surface cleaning, Brazing joint design, Base metals brazed, Brazing filler alloys, Brazing fluxes and atmospheres, Functions and Constituents of fluxes, Advantages, Limitations and Applications of brazing, Brazing processes: Torch, Furnace, Vacuum, Induction, Dip, Resistance, Infrared, Carbon arc, Flow and Block brazing, Silver brazing, alloys, flux, brazing methods, Advantages, Disadvantages and Applications.

Introduction, Comparison of soldering, brazing and welding, Definition of soldering. Principles of good soldering process, Soldering joint design, Soldering alloys, Selection of a soldering alloy, Soldering fluxes, cleaning the base metal surface, Soldering methods.

Adhesive bonding: Definition, Concept, Procedure. Testing of adhesive bonded joints, Types of adhesive bonded joints, Sandwich construction, its Advantages. Disadvantages and Applications. Selection and types of adhesives, Advantages, Disadvantages and Applications of adhesive bonding.

Unit VI

Defects in welds

Introduction, Cracks, Distortion, Incomplete penetration, Inclusions, Porosity and blowholes or gas pockets, Poor fusion, Poor weld bead appearance, Spatter, Under-cutting and over lapping, causes and remedies of defects.

Quality control in welding

Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes and remedies and Quality conflicts.

Estimation of welding costs

Introduction, Main component costs of welding processes, Factors involved in welding costs, Basic costing procedure for arc welding, Solved and unsolved examples, Basic costing procedure for gas welding, Factors affecting welding cost, Solved and unsolved examples.

References:

1. Welding and welding Technology – Richard L. Little, 1973
2. Welding Technology – S.W. Nadkarni
3. Metallurgy of Welding, Solderind and Brazing – J.F. Lacaster, Pergamon press
4. Physics of Arc – Ed. J.F. Lancaster; Pergamon press
5. Welding Handbooks – American Welding Society
6. Metal Hand Books – American Society of Metals
7. CO_2 Welding – British Welding Society
8. Rational Welding Design – Gray, Spence and Phillips
9. Modern Arc welding Technology – S.C. Nadkarni, Admioerlikon Ltd. Oxffrd, PBH pub. Co. 1992
10. Text book of welding technology, O.P. Khanna, Dhanpat Rai & Sons
11 Modern Welding Technology, Carry, Prientice Hall

University of Pune, Pune
T. E. (Mechanical) Sandwich Part I 2008 Course
302062: Seminar

Examination Scheme:
Oral: 50 Marks

A Seminar is expected to be on a state-of-the-art technical topic related to Mechanical Engineering but outside syllabus. The Seminar report and its presentation is to be based on material, mainly collected and analyzed from the latest papers in technical Journals, Manuals, Manufacturers catalogue, Technical magazines, Reference books etc.

(Minimum 3 references are to be submitted along with seminar report).

Report	Number of pages 15 to 20 (Soft copy and 1 hardcopy) Excluding a) Title b) Certificate c) Acknowledgement d) Abstract e) Index f) References. (Web site names should not be mentioned)
Text	Font size – 12 Font type – Times New Roman Spacing – 1.5
Binding	Spiral Binding
Page size	A 4
Internal assessment	One mid term presentation by the student on the topic
Examination	Two examiners, one internal and one external examiner. Marks are equally divided between Report and Presentation/ Oral. Presentation – Maximum 10 minutes, Question/Answer- Maximum 5 minutes

University of Pune, Pune
T. E. (Mechanical) Sandwich Part I 2008 Course
302063: Industrial In-Plant Training

Teaching Scheme:
½, Hours /Week/Student

Examination Scheme:
Term work : 150 Marks
Oral : 100 Marks

Duration of training in industry: 6 Months

GENERAL GUIDELINES
TO THE INSTITUTIONS RUNNING MECHANICAL ENGINEERING (SANDWICH) DEGREE COURSE
AND
TO THE STUDENTS OPTED FOR SANDWICH COURSE

Students are expected to learn following things during the Industrial In-plant Training of six months. He shall be given training in large or medium size manufacturing unit in various departments.

1. Orientation / Rotational Training: Organizational structure of the Company, scale and type of production, types of products, functional departments, like Manufacturing Process, Planning and Control, Quality Assurance, Assembly, Testing, Maintenance, Stores, Purchase, Marketing. Human resources Department, Design and Drawing Department, General Administration, Packing and Dispatching, Tool Engineering, Materials and Material Handling etc.

2. Industrial Design and Drawing Practice: Design and Drawing standards, study of mechanical components and component design such as gears, gear boxes, chain and belt drives, electric motor selection, couplings, shaft, keys, bearings, brackets, bolted and welded connections. Sub-assembly and assembly drawings. Simple assignments based on the above items, selection of material specification, heat treatment, and properties of materials.

3. Study of Manufacturing Processes: Study of processes such as casting, forging, sheet metal working, plastic moulding, extrusion, rolling, and machining operations on various machines, study of finishing processes like grinding, lapping, honing, burnishing, buffing, etc. Chipless manufacturing processes.

4. Study of Various Manufacturing Machine Tools such as lathes, capstan and turret lathes planer, shaper, and milling. Mechanical and Hydraulic presses, Gear hobbing, shaping and grinding machines.

5. Study of special purpose machines, Jig boring machines, NC/CNC machines, work centers, and transfer lines and automatic machines.

6. Study of single point cutting tools and multipoint tools form tools, Jig and fixtures, special purpose machine tools. Tool material and tool selection, Study of cutting parameters.

7. Study of material handling methods and equipment.
8. Study of various inspection gauge, selection of type of gauge, comparators, calibration of gauges, standards room etc. Product performance test procedures.

9. Study of processes and operation planning.

10. Study of safety gadgets used on machines, personal safety equipment, plant safety.

The students shall be asked to do simple assignments in various departments where he is taking training. Industries shall be required to prepare training program beforehand, covering as much as possible from above mentioned topics depending upon the types of industry.

Term work

Term work shall consist of a comprehensive report based on his observations, training received and assignments completed during 6 months of training. The report shall also include good drawings, figures, process sheets and machine and product specifications. Sandwich students shall obtain a certificate of successful completion of his training and his attendance from concerned industry and attach it to his report

Examination:

Oral examination shall be conducted after training by appointing one internal examiner and one external examiner from industry.

University of Pune, Pune
T. E. (Mechanical) Sandwich Part II 2008 Course
302064: Theory of Machine & Machine Design - II

Teaching Scheme:		**Examination Scheme:**	
Lectures	: 4 Hours/Week	Paper	: 100 Marks
Drawing	: 2 Hours/Week	Term Work	: 25 Marks
		Oral	: 50 Marks

Section I (A) THEORY OF MACHINE

Unit I

Synthesis of Mechanisms

Type, number & dimensional synthesis, Freudenstines equation, precision points, function generation, path generation. Analytical and graphical synthesis of four bar mechanism and slider crank mechanism. Body guidance, coupler curves.

Cams and Followers

Types, kinematic equivalent systems, follower motions, kinematic analysis and profile construction of radial cams. Introduction to specified contour cams.

Unit II

Spur and Helical Gears

Spur gear - terminology, involute and cycloidal profile, conjugate action, interference, undercutting. Friction between gear teeth.Helical gears - Normal and transverse module, virtual number of teeth, force analysis, torque transmitted by helical gears.

Gear Trains

Types, velocity ratio, torque transmitted, holding torque.

Unit III

Gyroscope

Principles of gyroscopic action , precession , gyroscopic couple, effect of gyroscopic couple on ships, airplane and vehicles etc.

Brakes and Dynamometers

Different types of brakes – shoe brakes, external and internal shoe brakes, band brakes, bandand block brakes, braking torque. Dynamometers – absorption and transmission type, construction, working principle, torque measurement.

Section II (B) MACHINE DESIGN

Unit IV

Design of Spur and Helical Gears

Gear tooth loads, formative number of teeth, effective load, estimation of module based on different equations. Types of gear teeth failures, gear materials and constructional details.

Design of Bevel and Worm Gears

Design of bevel & worm and worm gears- terminology, applications, torque transmitted and efficiency

Unit V

Friction and Friction Clutches

Pivot and collar friction, plate clutches, cone clutches, centrifugal clutches, torque transmitting capacity. Design requirements of friction clutches, selection criteria, materials. Design of single plate and multi plate clutches and cone clutches. Energy consideration and temperature rise.

Rolling Contact Bearings

Types, static and dynamic load capacity, stribeck's equation, load life relationship, selection of bearings. Design for variable loads and speeds. Lubrication, oil seal and packing, preloading, failure causes and remedies.

Unit VI

Design for Fluctuating Loads

Stress concentration-causes and remedies, Fluctuating stresses, Fatigue failure, S-N curve,Endurance limit ,notch sensitivity, Endurance strength modifying factors, Reserved stresses, design for finite and infinite life, Cumulative damage in fatigue failure, Soderberg and Goodman diagram, Modified Goodman diagram, Fatigue design of components under combined stresses such as shafts, bolts, springs.

Term Work:

The term work shall consist of:

A – Three assignments on Theory of Machine part

B – Experiment on Gyroscope

C – ONE design project.

The design project shall consist of two full imperial size sheets - one involving assembly drawing with a part list and overall dimensions and the 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. (Preference should be given to Autocad)

Reference Books:

1. Hannah and Stephans, "Mechanics of Machines", Edward Arnold Publication.
2. Bevan T., "Theory of Machines", Longman Publication.
3. Shigley J.E. and Uicker.J.J, "Theory of Machines and Mechanisms", McGraw Hill
4. Ballaney P.L., "Theory of Machines", Khanna Publications.
5. Jagdish Lal, "Theory of Machines", Metropolitian Book.
6. Khurmi R.S. and Gupta J.K., "Theory of Machines" Eurasia Publishing House.
7. Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill.
8. Spotts M.F. and Shoup T.E., "Design of Machine Elements"- Prentice Hall.
9. Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill.
10. Black P.H. and O. Eugence Adams, "Machine Design", McGraw Hill.
11. Denavit & Hartenberg, "Kinematic Analysis and Synthesis", Tata McGraw Hill
12. A. S. Hall, "Kinematic Linkage Design", Pretice Hall Publication

University of Pune, Pune
T. E. (Mechanical) Sandwich Part II 2008 Course
302065: Mechatronics

Teaching Scheme:		**Examination Scheme:**	
Lectures	: 4 Hours/Week	Paper	: 100 Marks
Drawing	: 2 Hours/Week	Term Work	: 25 Marks
		Oral	: 50 Marks

Section I

Unit I

Introduction to Sensors and Transducers

Introduction to Mechatronics, Measurement systems, Static characteristics, Classification of Transducers and Sensors,

Basic Divider Circuits, Bridge Circuits, filters

Level measurement, strain measurement: Strain Gauge Principles, types, strain gauge circuits, Load Cells, Temperature Compensation,.

Temperature measurement : Thermister, RTD, Thermocouples

Unit II

Mechanical Sensors

Displacement & Position Sensors: Potentiometric Sensor, Capacitive and Inductive Sensors, Variable Reluctance Sensors, Linear Variable Differential Transformers

Motion Sensors: Translational and Rotary Optical Encoders, Tachometers with output signal as electrical quantity

Unit III

Converters and Controller Fundamentals

Data Acquisition system: concept of sampling, sample & hold operation, analog to digital converters, digital to analog converters.

Introduction to SCADA & its application

System Models: Mathematical models, introduction to mechanical, electrical, fluid and thermal systems. Rotational and transnational systems, Basic concepts of transfer function.

Section II

Unit IV

Controller Principles

Control Systems: Types of control system, Open loop, closed loop systems, transfer functions, feed back and feed forward control systems and their applications

Process Characteristics: Process equation, Process load, Error, Variable range, Control Parameter Range, Dead time.

Unit V

Controller Modes

Continuous Controller Modes: Proportional Controller, Integral Controller, Derivative Controller, with mathematical equations, advantages, disadvantages and applications.

Composite Controller Modes: Proportional, Proportional + Integral (PI), Proportional + Derivative (PD), Proportional + Integral + Derivative (PID) Controllers, with simple numerical treatment.

Unit VI

Discrete State Process Control

Relay Controllers and Ladder Diagrams: Ladder Diagram Elements, and Ladder Diagram Examples.

Programmable Logic Controllers : Relay sequencers, PLC Programming Concepts, logic, basic structure, input/ output processing, timers, internal relays and counters, shift resisters, ladder diagram and programming, selection of PLCs,

Case studies of Mechatronics with different applications like washing machine, dish washer, bottle filling plant, elevator, building automation.

List of Experiments

Minimum of 10 experiments from the following; out of which experiment no. 12 is compulsory, four shall be from serial no. 1 to 5, three from serial no. 6 to 11 and two from 13 to 17. Record of experiments and assignments shall be submitted in the form of journal.

1. Calibration of flow meters.
2. Calibration of Thermocouples/ RTD.
3. Study of Load Cells.
4. Study of various types of actuators.
5. Displacement measurement/ level measurement.
6. Verification of P, P+I, P+D, P+I+D control actions.
7. Study of XY position control systems.
8. Study of linear conveyor control system.
9. Study of rotary table positioning systems.
10. Development of ladder diagram/programming PLC for level control, position control or any other mechanical engineering application.
11. Study of A/D and D/A converters.
12. Study of Flip Flops and Timers.
13. Study of Application of Op – Amp circuits.
14. Study of Data acquisition system.
15. Study of switches & relays

Text Book

1. Johnson C. D., Process Control Instrumentation Technology, Prentice Hall of India Pvt Ltd., New Delhi.

Reference Books

1. Doebelin E. O., Measurement System – Application and Design, Tata McGraw Hill Publications Ltd, New Delhi.
2. Bolton W. , Mechatronics – Electronics Control Systems in Mechanical and Electrical Engineering, Pearson – Education (Singapore) Pte. Ltd.
3. Rangan C. S., Sarma G. R., Mani V. S., Instrumentation – Devices and Systems, Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Histand B. H., Alciatore D. G., Introduction to Mechatronics and Measurement Systems.
5. HMT, Mechatronics, HMT.
6. Mahalik N. P., Mechatronics – Principles, concepts and applications, Tata McGraw Hill Publishing Company Ltd, New Delhi.
7. Kolk R. A., Shetty D., Mechatronics Systems Design, Vikas Publishing Manual Delhi.

University of Pune, Pune
T. E. (Mechanical) Sandwich Part II 2008 Course
302066: Tribology

Teaching Scheme:
Lectures : 4 Hours/Week

Examination Scheme:
Paper : 100 Marks

Section I

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, Viscosity standards, 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.

Section II

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.
Lubrication of Plain Bearings: Ring oil Lubrication, Oil Circulation Systems, Maintenance of oil quality, contamination, Lubricant degradation, foaming, Warning and protective devices, Gears: Gear Surface finish, crankcase explosions, Reciprocating Compressors, Lubrication System

Unit VI

Hydrodynamic Thrust bearing: Introduction, flat plate thrust bearing, pressure equation, load, centre of pressure, Raleigh Bearing. Elastohydrodynamic Lubrication: Principle and Application
Bearing Materials and bearing constructions. Oil seals : Clearance seals, Labyrinth Seals, Throttling bush seals, O-rings and Automatic packing, Mechanical seals & shields , Gaskets.

References:

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 “, Butterworth’s.
5. B. C. Majumdar “Introduction to Tribology and Bearings”, H. Wheeler and Company.
6. D.Summers Smith, “An Introduction to Tribology in Industry”, The Machinery Publishing Co.
7. O. P. Orlov, “Fundamentals of Machine Design”, Vol. IV, MIR.
8. Bhandari V.B., “Design of Machine Elements”, Tata-Mc Graw Hill Publication.
9. Handbook of Tribology by Bharat Bhushan.

University of Pune, Pune
T. E. (Mechanical) Sandwich Part II 2008 Course
302067: Metrology & Quality Control

Teaching Scheme:
Practical : 2 Hours/Week

Examination Scheme:
Term Work : 50 Marks

Students have to carry out <u>Any Eight</u> Experiments from 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. (any one)
3. Machine tool Alignment Test on any two machine like- Lathe, Milling, Drilling.(any 5 test one one machine)
4. Measurement of gear tooth thickness by gear tooth Vernier Caliper/Constant chord/ Span micrometer.
5. Measurement of circularity/Roundness using mechanical comparator.
6. Study & applications of profile projector.
7. Inspection of Production job by Statistical process control.
8. Design of GO and NOGO gauges by tailors principle
9. Quality control case study assignment poka- yoke /kaizen
10. Quality control case study assignment 5s /TPM /,TQM/pareto analysis

Reference Books:

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.
5. Narayana K.L. Engineering Metrology
6. Galyer J.F & Shotbolt C.R. Metrology for engineers.
7. Francis T. Farago, Mark A. Curtis- Handbook of dimensional measurement.
8. Rajput R.K.- Engineering Metrology & instrumentation.