T. Y. B. Tech (Production Engineering) – Semester V.

METALLURGY

Course Code: PCC-PE 301

Teaching Scheme:                             Examination Scheme:
Lectures: 3 Hrs. / Week Theory Paper (3 Hrs)   ESE: 70 Marks
Practical: 2 Hrs. / Week/ Batch               CIE: 30 Marks
Credits : 4                                    Term Work: 25

Pre-requisite: Fundamental knowledge of crystals structure and meaning of materials, chemistry of Metals and alloys.

Course Objectives:
1) To select proper ferrous or nonferrous metal material as per given application by considering metallurgical and mechanical properties in accordance with its phase diagram with proper justification.
2) To explain cooing of any given alloy schematically.
3) To calculate percentage of various phases present in solid solution at given temp and composition by using lever rule analytically.
4) To draw various types of equilibrium diagrams of Ferrous and Non Ferrous materials, TTT and CCT diagram graphically.
5) To clearly distinguish between various types of heat treatment process.
6) To understand processing of Powder Metallurgy parts.

Course Outcomes: At the end of successful completion of course, the students will be able to

1. Understand basic concept of metal structure.
2. Understand fundamental knowledge of Ferrous and Non Ferrous Metal.
3. Selection of Metals and Alloys for different engineering application.
4. Understand need of Heat treatment and various heat treatment processes.
5. Understand and distinguish between various types of heat treatment process

Unit 1: Introduction to Composite Materials, Metals and alloy system

Introduction to Advanced & Composite materials for manufacturing Industrial Application/s, phases, components, degree of freedom, Construction of phase diagram using cooling curves, Isomorphous systems, Eutectic system, Eutectoid, Peritectic. Solid solutions and its types, Intermediate phases
Unit 2: Study of ferrous equilibrium diagrams, with respect to compositions, properties and applications for following alloys  

Unit 3: Study of non-ferrous equilibrium diagrams, compositions, properties, and applications of important alloys and material testing  
Copper-based alloys, Aluminum-based alloys, modification treatment, Titanium- and Mg based, Non-ferrous equilibrium diagrams - Pb-Sn : solders, Sn-Sb : Babbit
Material testing- Tensile test, Izod and charpy impact test, Fatigue test, Hardness measurement methods.

Unit 4: Introduction and Principles of Heat Treatment Processes of Steels  
Heat treatment furnaces, atmospheres, defects and energy economy

Unit 5: Heat treatment process of steels, cast iron and Non-ferrous alloys.
Annealing, Hardening, Normalizing - Classification comparison and application of processes, hardenability, factors affecting hardenability, determination of hardenability, hardening methods, Tempering- Purposes, types, structural changes during tempering, temper brittleness. Heat treatment process of Cast Irons-Stress relief annealing, normalizing, hardening, surface, hardening and malleablising. Surface and case hardening processes: Case Hardening, Carburizing, Nitriding, Surface Hardening: Flame hardening, induction hardening, electron beam hardening and laser hardening, Case depth measurement - hardness method, chemical method, microstructure method.

Unit 6: Powder Metallurgy
Importance of process as a manufacturing technique, advantages and limitations of powder metallurgy, Methods of powder manufacture, powder conditioning, blending and mixing, Powder compaction - Methods of compaction, Sintering - Types of sintering, structure and property changes during sintering, sintering atmospheres and their importance. Finishing operations - Sizing, heat treatment, surface treatment, electroplating and impregnation treatments, Applications as Self-lubricating (porous) bearings, electric contact materials, filters, magnets, sintered friction materials, cutting tools and cermets, flow charts for
Term Work: Study should conduct following experiments

**Experiment No.1** Study of Metallurgical microscope and Metallography

**Experiment No.2** Study of microstructure of hypo eutectoid, Eutectoid steel and Hypereutectoid

**Experiment No.3** Study of microstructure of cast iron as SG, Gray, White, Chilled, Malleable Cast Irons

**Experiment No.4** Study of microstructure of Non-ferrous alloys as Brass, Bronze, Babbits

**Experiment No.5** Tensile test of MS, Al and Brass material

**Experiment No.6** Izod and charpy impact test of MS, Al and Brass material

**Experiment No.8** Study of Hardenability of steel

**Experiment No.9** Study of heat treatment processes and furnaces

**Experiment No.09** Hardness measurement by Brinell and Rockwell method.

**Textbooks:**

2. V.D. Kodgire, Material science and metallurgy, Everest Publishers Pune
4. Material science and Metallurgy, C. Daniel Yesudin, D. G. Harris Samuel Scitech
5. A.K. Sinha, Powder Metallurgy
7. V.K. Agarwal, Material Science, Mcgraw hill publications

**Reference Books:**

9. Material science and Metallurgy, C. Daniel Yesudin, D. G. Harris Samuel Scitech
[15] ASM Handbooks, American Society of Metals
[16] ASM Handbooks, American Society of Metals
T. Y. B. Tech (Production Engineering) – Semester V

THEORY OF MACHINE II

Course Code: PCC-PE302

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hrs. / Week/ Batch
Credits : 4

Examination Scheme:
Theory Paper: 3 Hrs
ESE: 70 Marks, CIE: 30 Marks
Term Work: 25 Marks

Pre-requisites: Theory of machines - I

Course Learning Objectives:
1) To understand the basics of gear, motion analysis and selection of gears for various applications.
2) To demonstrate different types of gear trains and its applications.
3) To acquaint with working principles and applications of gyroscope and governors
4) To evaluate the effect of static and dynamic balancing of rotary and reciprocating masses.
5) To aware the students about the phenomenon of vibrations and its effects.

Course Outcomes: At the end of this course, student will be able to
1. Understand the need of gear, gear train, governors, gyroscope etc.
2. Analyze different types of gear trains.
3. To solve the problems on static and dynamic balancing using graphical and analytical method.
4. Understand the concept of basics of vibrations from application point of view.

Unit-1

Gear: Introduction, law of gearing, gear terminology, involute and cycloidal profiles, length of path of contact, arc of contact, contact ratio, interference of involute gear teeth,
helical and double helical gears
(5)

**Unit-2**

**Gear Trains:** Types of gear trains, analysis of gear trains, analysis of differential gear box, torques in epicyclic gear train.
(4)

**Unit-3**

**Balancing:** Static and dynamic balancing, Balancing of rotary masses: masses rotating in the same plane and masses rotating in different planes, Balancing of reciprocating masses: primary and secondary balancing, Balancing of locomotives, Balancing of multi-cylinder inline engines, balancing of V-engines.
(6)

**Unit-4**

**Gyroscope:** Introduction, Gyroscopic couple, Effect of gyroscopic couple on motion of aero plane, naval ship, two and four wheelers, Gyroscopic stabilization
(5)

**Unit-5**

**5.1 Governors:** Functions of governor, types of governors, characteristics of governor, effort and power of governor.
(5)

**Flywheel:** Crank effort, turning moment on crankshaft, turning moment diagram, fluctuations of energy and speed.
(4)

**Unit-6**

**Vibrations:**

**6.1 Longitudinal and transverse vibrations:** Simple Harmonic Motion vibration of single degree freedom system: Undamped, damped and forced vibration systems, Two degrees of freedom systems.
(4)

**6.2 Torsional vibrations:** Introduction, natural frequency for single, two and three rotor system, bifilar, trifler suspension system, torsionally equivalent shafts, free torsional vibrations of a geared system.
(5)

**Term Work:**

Minimum 8 experiments out of first 10 experiments from the following list.
1) Generation of involute gear tooth profile.
2) Study and analysis of differential gear box.
3) Experiment on verification of static and dynamic balancing principle.
4) Experimental verification of gyroscopic principle.
5) Determination of the governor characteristics of Porter and/or Hartnell governor.
6) Experiment on free longitudinal vibrations
7) Experiment on trifler suspension system.
8) Experiment on two rotor system.
9) Experiment on forced vibration
10) Measurement of vibrations by using vibration-measuring instrument.

11) At least one industrial visit to study applications related to the subject and submission of the relevant report.

Text Books:
1) Theory of Machines and Mechanisms, by P. L. Ballaney, (Khanna Publishers, Delhi)
2) Theory of Machines, by S. S. Ratan, (TMH)
3) Theory of Mechanism and Machines by Ghosh and Mallik (EWP)
4) Theory of machines, by Dr. R.K.Bansal, Laxmi Publication
5) Theory of Machines by R.S. Khurmi, S.Chand and co.
6) Theory of Machines, by Thomas Bevan, (CBS Publishers, Delhi)

Reference Books:
2) Theory of Machines, by W.Green
3) Mechanical vibrations, G.K.Grover
4) Mechanical Vibration Analysis, P.Srineevasan- Tata McGraw Hill
8) Theory of vibrations with applications, W.T.Thompson, Prentice Hall of India
9) Mechanical Vibrations, Schaum’s outline series, McGraw Hill

Shivaji University, Kolhapur.
T. Y. B. Tech (Production Engineering) – Semester V.

DESIGN OF MACHINE ELEMENTS

Course Code: PCC-PE303

Teaching Scheme:
Lectures: 3 Hrs. / Week Theory Paper (3 Hrs.)
Practical: 2 Hrs. / Week/ Batch
Credits : 4

Examination Scheme:
ESE: 70 Marks
CIE: 30 Marks
Term Work: 25

Pre-requisites: Machine Drawing, Theory of Machine-I

Course Learning Objectives:

1) To study the different types load considerations and design aspects of various machine members.
2) To study the different types of joints and design.
3) To study the different types of Gear design

Course Outcome: At the end of this course, student will be able to

1) Different types load considerations and design aspects of various machine members.
2) Different types of joints and design.
3) Design the shaft, keys, spline and coupling.
4) Design of springs and power screw.
5) Different types of Gear design.

Unit-1

Introduction: Concept of machine design, general design considerations, design procedure; factor of safety for different types of loading its significance and selection; theories of failures, Selection of engineering materials for a component considering functionality, raw material generating process, strength, cost, quantity and aesthetics, use of IS codes.

Unit-2

a). Design for static loading: Knuckle joint, turnbuckle, cotter joint, levers.

b). Design for fluctuating loads: Fatigue phenomena, concept of stress vs. number of cycles diagram and endurance limit, stress concentration and remedies, use of Goodman and Soderberg diagram in design of machine elements like shafts, springs and couplings.
Unit-3
Design of shafts, keys, splines and couplings: Design of solid and hollow shafts for strength and rigidity against pure torsion, pure bending, combined bending, torsion and axial loads; design of keys and splines; design of rigid and flexible couplings. (6)

Unit-4
a) Design of pressure vessels: Classification and design of thick a thin pressure vessels and cylinders. (2)
b) Design of joints: Design of bolted, riveted, and welded joints subjected under transverse and eccentric loading, materials for bolts, initial tightening loads on bolts, effect of washer and gasket, uniform strength bolts. (3)

Unit-5
a). Design of springs: Types, applications, spring materials, stress deflection equation of helical spring, Whal’s stress factor, style of ends, design of springs for valves, clutches, buffers etc., design considerations for leaf spring. (4)
b). Design of power screw: Types, materials used, thread forms and their applications. Types of stresses induced, overhauling and self-locking properties, re-circulating ball screw, design of nuts, methods of pitch error compensation for machine tools. (4)

Unit-6
a). Design of gears: a) Spur gears- materials, gear tooth loads, number of teeth, face width, strength of gear teeth, static beam strength (Lewis equation), dynamic tooth load, Wear strength (Buckingham’s equation), estimation of module based on beam strength and wear strength, gear design for maximum power. (4)
b) Helical gears- No. of teeth, force analysis, beam and wear strength, effective load and design procedure. (2)
c) Construction details of gears i.e. hub, web, arms, rim, gear Lubrication, gear tooth failures and remedies. (1)
Term Work:
Any Six of the following exercises.

(Note: Standard components shall be selected from relevant I.S. codes and Design Data Hand Books for the exercises given below.)

1) Study of Engineering Materials, their applications and selection as per different standards used in practice.
2) Design, stress analysis and working drawing of components and assembly of Cotter Joint, Knuckle Joint and Turnbuckle.
3) Design of Coupling and Detailed Working drawings with assembly.
4) Design of bolted, riveted and welded joints for transverse and eccentric loading.
5) Design of Gear Drive involving Gears, Shafts, and Keys with working drawings.
6) One assignment using CAD package on any one of the exercises 2, 3, or 5 above.
7) Two computer programs (or use of spreadsheet) on any of the above exercise.

Reference Books:
5) Design of Machine Elements, Dbrovalsky( MIR Publisher )
7) Design of Machine Elements by M. F. Spoots, T.E.Shoup (PHI)
11) CMTI Machine Tool Design Handbook (TMH)
T. Y. B. Tech (Production Engineering) –Semester V.

METROLOGY

Course Code: PCC-PE304

Teaching Scheme:\nLectures: 3 Hrs. / Week Theory Paper (3 Hrs): 363 Hrs.
Practical: 2 Hrs. / Week/ Batch
Credits : 4

Examination Scheme:
ESE: 70 Marks
CIE: 30 Marks
Term Work: 25
Practical Oral Examination: 25 Marks

Pre-requisites: Machine Drawing, Workshop Practice

Course Learning Objectives: A Student should be -
1) Able to explain the principles of measurement and its techniques.
2) Able to demonstrate the design, construction and accuracy features of various instruments.
3) Able to acquire hands-on skills of measurement by using different instruments and gauges.

Course Outcomes: A Student should have-
1) Ability to describe measurement aspects.
2) Ability to design a measuring instrument.
3) Ability to maintain and service measuring instruments.
4) Develop the hands on skill in solving problems encountered during inspection.
5) Ability to use all types of measuring instruments.

Unit-1 Fundamental Principles of Metrology and Basic Measuring Instruments
Definition and scope of metrology, definition of measurement, primary, secondary, tertiary and working standards, line and end standards, advantages of optical standard precautions to minimize errors, measurement system and its characteristics, Vernier calipers, micrometers, height and depth gauges, - types, design considerations, specifications, applications, sources of errors and handling precautions, selection and general care of measuring instruments. Slip gauge box - Grades, materials, wringing, setting to sizes, precautions while use and storage
Accessories - Bench centers, surface plates, V-blocks, angle plates.

(8)

Unit-2 Comparators and Advance Measuring Instruments

Need for comparators, comparison of principles, mechanical, pneumatic, optical and electrical and electronic instruments, dial indicator, bore gauges and master rings, optical profile projector, tool makers microscope, electrical and electronic comparators, differential pneumatic comparator, and applications of pneumatic gauging.

(5)

Unit-3 Gauges and Gauge Design

Concept of limit gauging, Taylor's principle, various types of plug, ring and snap gauges for plain and taper dimensions, gauge design for a given dimension for workshop, inspection and general grade gauges, fixtures and gauges for measurement of pitch circle diameter, center distance between holes, positioning of holes and surfaces. (IS:919, Part 1, 1993-ISO system for limits, fits and tolerances, is to be used for gauge design)

(4)

Unit-4 Measurement of Angles and Geometric Features

Bevel protractor, clinometers, sine bar, angle dekor, angle slip gauges, measurement of taper, angle and radius with the help of simple inspection set-ups using standard pins and balls Measurement of straightness, flatness, parallelism, squareness, circularity, roundness, concentricity, symmetry, distance between axes and other geometrical features Straightedge, level beam comparator, autocollimator.

(5)

Unit-5 Gear, Thread and Surface Finish Measurement

a) Measurement of Screw Threads

Basic terminology, measurement of major, minor and effective diameter, Screw thread micrometer, floating carriage diameter measuring machine, two wire and three wire method, measurement of pitch and pitch error, thread pitch gauges, limit gauges for thread measurements

b) Measurement of gears

Basic terminology, measurement of pitch, lead, run out, back lash and tooth thickness, constant chord and base tangent method, Gear tooth Vernier caliper, David Brown tangent comparator, errors in gear geometry, measurement of composite error, Parkinson gear tester

(5)

c) Measurement of surface properties

Waviness and roughness, causes of variation in surface quality, different parameters for assessment of surface roughness, methods of calculation, instruments for surface roughness
measurement.

(10)

Unit-6 Advances in Industrial Metrology

Types, applications, Principle of digital measurement instruments and examples, Instrument-computer interface, Co-ordinate Measuring Machines (CMM), construction, working principle and applications, Objectives, Non Contact inspection methods, equipment; contact type inspection, Inspection robots.

(4)

Term Work:

The term work shall consist of the following.

A) All the experiments listed below-

1. Measurement of linear dimensions using vernier, micrometer and bore gauge
2. Measurement of angle by using bevel protractor and sine bar
3. Dimensional measurement by using pneumatic comparator
4. Measurement of effective diameter of a screw thread by using floating carriage diameter measuring machine
6. a) Measurement of roundness and concentricity by using dial indicator
    b) Measurement of radius by using inspection setup like rollers and pins
7. Measurement of roughness of machined surface
8. Assessment of profile of a component by using profile projector.

B) One assignment on Gauge design problem

C) One industrial visit to study inspection practices and submission of the report

Practical Examination: Each student shall perform individually, one assigned experiment from the above list and submit the result, followed by an oral examination.

Reference Books:

1. Engineering Metrology, -K. J. Hume, McDonald London
2. Engineering Metrology, -D. M. Anthony, Oxford University Press (I)
8. Testing of Machine Tools, -Dr. George Schlesinger, Pergamon Press
10. A Text Book of Metrology, -M. Mahajan, DhanpatRai and Co.
T. Y. B. Tech (Production Engineering) –Semester V.
MANUFACTURING TECHNOLOGY
Course Code: PCC-PE305

Teaching Scheme: Examination Scheme:
Lectures: 3 Hrs. / Week Theory Paper (3 Hrs) ESE: 70 Marks
Practical: 2 Hrs. / Week/ Batch CIE: 30 Marks
Credits : 4 Term Work: 25

Pre-requisites: Foundry Technology, Machine Tools and Processes

Course Learning Objectives: A Student should be -

1) To Understand principles of rolling & forging processes.
2) To demonstrate the fundamental of principles of metal forming processes.
3) To Understand principles in metal removal process.
4) To develop knowledge & importance of metal cutting parameters.
5) To study the metal cutting technology including the process, measurements, design and selection of various cutting tools and their industrial specifications.

Course Outcomes: At the end of this course ,student will be able to

1) Understand function & application of metal forming process.
2) Ability to describe plastic manufacturing processes.
3) Apply cutting mechanics to metal machining based on cutting force & power consumption.
4) To Select cutting materials & tool geometries for different materials
5) To solve problems on Single point cutting tool & Broach tool Design

Unit-1: Rolling and Forging: Rolling process, types of rolling mills, production of seamless pipes by rolling process, rolling defects. Forging process, types of forging, forging equipment’s, forging defects.

Unit-3: Plastic Manufacturing: Thermoplastics and thermosetting plastics, injection molding, plastic extrusion, blow molding, rotational molding, thermoforming, compression molding, calendaring.

Unit-4: Theory of Metal Cutting: Speed, Feed, Depth of Cut, Orthogonal Cutting and Oblique Cutting, Geometry of single point cutting tool, Mechanism of chip formation, Chip Breaker, Strain in Chip, Shear plane angle, Cutting ratio, Force relationship, Velocity relationship, Merchant circle, Ernst Merchant theory, dynamometer. Design of Single point cutting tool.

Unit-5 Machinability: Concept of Machinability,
i) Cutting force: Effect of speed, feed, depth of cut, tool materials, angles and work material on cutting forces, specific cutting force, specific power consumption.
ii) Tool life: Flank and Crater wear, Mechanism of wear, effect of cutting parameter on tool life, Taylor’s tool life equation.
iii) Surface Roughness: Effect of speed, feed, depth of cut, tool materials, angles and work material on surface roughness, built up edge, chatter and its elimination.

Unit-6 Design of Form Tool: Design of flat form tool and circular form tool. Geometry, nomenclature, types, selection and applications of drills, reamers, milling cutters and broach.

Term Work:
1) Machining of minimum two jobs of different materials such as C.I., Steel, Aluminium etc. and measurement of surface roughness to study the effect of parameters such as feed, tool nose radius, depth of cut on the surface roughness.
2) Design of form tool and broach for given components
3) Industrial visit to study applications of tools for different metal cutting processes.
4) Study of Rolling Process
5) Study of Forging Process
6) Study of extrusion Process.

Reference Books:
1. Manufacturing Processes – Begman, Amstead etc. (John Wiley)
2. Forging and Forging Die Design - Sharan, Prasad, Saxena.
3. Rolling of Metals: Ivankove and Chaturvedi (Yantrik Publications, Mumbai)
4. Extrusion - Pearson (McGraw Hill)
5. Manufacturing Technology: Foundry, Forming and Welding by P.N. Rao (TMH)
8. Production Technology - HMT Handbook (TMH)
14. Tool Engineering handbook - ASTM, Frank Wilson (Editor) (TMH)