## SYLLABUS FOR GROUP-4

## [Mechanical Engineering/Metallurgy Engineering/ Production Engineering/ Mechatronics Engineering]

### 1. Mathematics- I

**UNIT - I: Trigonometry**

Concept of angles, measurement of angles in degrees, grades and radians and their conversions, T-Ratios of Allied angles (without proof), Sum, difference formulae and their applications (without proof). Product formulae (Transformation of product to sum, difference and vice versa). T- Ratios of multiple angles, sub-multiple angles (2A, 3A, A/2). Graphs of sin x, cos x, tan x and $e^x$ .

**Differential Calculus**

Definition of function; Concept of limits. Four standard limits $\lim_{x \to a} \frac{x^n - a^n}{x-a}$, $\lim_{x \to 0} \frac{\sin x}{x}$, $\lim_{x \to a} \left(\frac{a^x - 1}{x}\right)$ and $\lim_{x \to a} (1+x)^{\frac{1}{x}}$.

Differentiation by definition of $x^n$, $\sin x$ $\cos x$, $\tan x$, $e^x$ and $\log_a x$. Differentiation of sum, product and quotient of functions. Differentiation of function of a function. Differentiation of trigonometric and inverse trigonometric functions, Logarithmic differentiation, Exponential functions.

**UNIT - III: Algebra**

**Complex Numbers:** Definition, real and imaginary parts of a Complex number, polar and Cartesian, representation of a complex number and its conversion from one form to other, conjugate of a com- plex number, modulus and amplitude of a complex number Addition, Subtraction, Multiplication and Division of a complex number. Demovier's theorem, its application.

**Partial fractions:** Definition of polynomial fraction proper & improper fractions and definition of partial fractions. To resolve proper fraction into partial fraction with denominator containing non-repeated linear factors, repeated linear factors and irreducible non-repeated quadratic factors. To resolve improper fraction into partial fraction.

**Permutations and Combinations:** Value of ${}^nP_r$ and ${}^nC_r$.

**Binomial theorem:** Binomial theorem (without proof) for positive integral index (expansion and general form); binomial theorem for any index (expansion without proof) first and second binomial approximation with applications to engineering problems.

### 2. Applied Physics –I

**Unit 1**: **Physical world, Units and Measurements**

Physical quantities; fundamental and derived, Units and systems of units (FPS, CGS and SI units),

Dimensions and dimensional formulae of physical quantities, Principle of homogeneity of dimensions, Dimensional equations and their applications (conversion from one system of units to other, checking of dimensional equations and derivation of simple equations), Limitations of dimensional analysis. Measurements: Need, measuring instruments, least count, types of measurement (direct, indirect), Errors in measurements (systematic and random), absolute error, relative error, error propagation, error estimation and significant figures.

**Unit 2: Force and Motion**
Scalar and Vector quantities – examples, representation of vector, types of vectors. Addition and Subtraction of Vectors, Triangle and Parallelogram law (Statement only), Scalar and Vec- tor Product, Resolution of a Vector and its application to inclined plane and lawn roller.

Force, Momentum, Statement and derivation of conservation of linear momentum, its applications such as recoil of gun, rockets, Impulse and its applications.

Circular motion, definition of angular displacement, angular velocity, angular acceleration, frequency, time period, Relation between linear and angular velocity, linear acceleration and angular acceleration (related numerical), Centripetal and Centrifugal forces with live examples, Expression and applications such as banking of roads and bending of cyclist.

**Unit 3: Work, Power and Energy**
Work: Concept and units, examples of zero work, positive work and negative work
Friction: concept, types, laws of limiting friction, coefficient of friction, reducing friction and its engineering applications, Work done in moving an object on horizontal and inclined plane for rough and plane surfaces and related applications.

Energy and its units, kinetic energy, gravitational potential energy with examples and derivations, mechanical energy, conservation of mechanical energy for freely falling bodies, trans- formation of energy (examples).

Power and its units, power and work relationship, calculation of power (numerical problems).

**Unit 4**: **Rotational Motion**
Translational and rotational motions with examples, Definition of torque and angular momentum and their examples, Conservation of angular momentum (quantitative) and its applications.

Moment of inertia and its physical significance, radius of gyration for rigid body, Theorems of parallel and perpendicular axes (statements only), Moment of inertia of rod, disc, ring and sphere (hollow and solid); (Formulae only).

**Unit 5**: **Properties of Matter**
Elasticity: definition of stress and strain, moduli of elasticity, Hooke's law, significance of stress-strain curve.

Pressure: definition, units, atmospheric pressure, gauge pressure, absolute pressure, Fortin's Barometer and its applications.

Surface tension: concept, units, cohesive and adhesive forces, angle of contact, Ascent Formula (No derivation), applications of surface tension, effect of temperature and impurity on surface tension.
Viscosity and coefficient of viscosity: Terminal velocity, Stoke's law and effect of temperature on viscosity, application in hydraulic systems.

Hydrodynamics: Fluid motion, stream line and turbulent flow, Reynold's number Equation of continuity, Bernoulli's Theorem (only formula and numericals ) and its applications.

**Unit 6: Heat and Thermometry**
Concept of heat and temperature, modes of heat transfer (conduction, convection and radiation with examples), specific heats, scales of temperature and their relationship, Types of

Thermometer (Mercury thermometer, Bimetallic thermometer, Platinum resistance thermometer, Pyrometer) and their uses.

Expansion of solids, liquids and gases, coefficient of linear, surface and cubical expansions and relation amongst them, Co-efficient of thermal conductivity, engineering applications.

## 3. Applied Chemistry

### Unit 1: Atomic Structure, Chemical Bonding and Solutions

Rutherford model of atom, Bohr's theory (expression of energy and radius to be omitted), and hydrogen spectrum explanation based on Bohr's model of atom, Heisenberg uncertainty principle, Quantum numbers – orbital concept. Shapes of s, p and d orbitals, Pauli's exclusion principle, Hund's rule of maximum multiplicity Aufbau rule, electronic configuration.

Concept of chemical bonding – cause of chemical bonding, types of bonds: ionic bonding (NaCl example), covalent bond ($H_2$, $F_2$, HF hybridization in Be $Cl_2$, $BF_3$, $CH_4$, $NH_3$, $H_2O$), coordination bond in $NH_4^+$, and

anomalous properties of $NH_3$, $H_2O$ due to hydrogen bonding, and metallic bonding.

Solution – idea of solute, solvent and solution, methods to express the concentration of solution molarity (*M* = mole per liter), ppm, mass percentage, volume percentage and mole fraction.

### Unit 2: Water

Graphical presentation of water distribution on Earth (pie or bar diagram). Classification of soft and hard water based on soap test, salts causing water hardness, unit of hardness and simple numerical on water hardness.

Cause of poor lathering of soap in hard water, problems caused by the use of hard water in boiler (scale and sludge, foaming and priming, corrosion etc ), and quantitative measurement of water hardness by ETDA method, total dissolved solids (TDS) alkalinity estimation.

i). Water softening techniques – soda lime process, zeolite process and ion exchange process.

ii). Municipal water treatment (in brief only) – sedimentation, coagulation, filtration, sterilization.

Water for human consumption for drinking and cooking purposes from any water sources and enlist Indian standard specification of drinking water (collect data and understand standards).

### Unit 3: Engineering Materials

Natural occurrence of metals – minerals, ores of iron, aluminium and copper, gangue (matrix), flux, slag, metallurgy – brief account of general principles of metallurgy.

Extraction of - iron from haematite ore using blast furnace, aluminium from bauxite along with reactions. Alloys – definition, purposes of alloying, ferrous alloys and non-ferrous with suitable examples, properties and applications.

General chemical composition, composition based applications (elementary idea only details omitted):

Port land cement and hardening, Glasses Refractory and Composite materials.

Polymers – monomer, homo and co polymers, degree of polymerization, simple reactions involved in preparation and their application of thermoplastics and thermosetting plastics (using PVC, PS, PTFE, nylon – 6, nylon-6,6 and Bakelite), rubber and vulcanization of rubber.

### Unit 4: Chemistry of Fuels and Lubricants

Definition of fuel and combustion of fuel, classification of fuels, calorific values (HCV and

LCV), calculation of HCV and LCV using Dulong's formula.

Proximate analysis of coal solid fuel

petrol and diesel - fuel rating (octane and cetane numbers),

Chemical composition, calorific values and applications of LPG, CNG, water gas, coal gas, producer gas and biogas.

Lubrication – function and characteristic properties of good lubricant, classification with examples, lubrication mechanism – hydrodynamic and boundary lubrication, physical properties (viscosity and viscosity index, oiliness, flash and fire point, could and pour point only) and chemical properties (coke number, total acid number saponification value) of lubricants.

**Unit 5: Electro Chemistry**

Electronic concept of oxidation, reduction and redox reactions.

Definition of terms: electrolytes, non-electrolytes with suitable examples, Faradays laws of electrolysis and simple numerical problems. Industrial Application of Electrolysis –

- Electrometallurgy
- Electroplating
- Electrolytic refining.

Application of redox reactions in electrochemical cells –

- Primary cells – dry cell,
- Secondary cell - commercially used lead storage battery, fuel and Solar cells.

Introduction to Corrosion of metals –

- definition, types of corrosion (chemical and electrochemical), $H_2$ liberation and $O_2$ absorption mechanism of electrochemical corrosion, factors affecting rate of corrosion.

Internal corrosion preventive measures –

- Purification, alloying and heat treatment and

External corrosion preventive measures: a) metal (anodic, cathodic) coatings, b) organic inhibitors.

**4. Communication Skills in English**

**Unit-1 Communication: Theory and Practice**

- Basics of communication: Introduction, meaning and definition, process of communication etc.
- Types of communication: formal and informal, verbal, non-verbal and written Barriers to effective communication.
- **7** Cs for effective communication (considerate, concrete, concise, clear, complete, correct, courteous).
- Art of Effective communication,
    - Choosing words
    - Voice
    - Modulation
    - Clarity
    - Time
    - Simplification of words
- Technical Communication.

**Unit-2 Soft Skills for Professional Excellence**

- Introduction: Soft Skills and Hard Skills.
- Importance of soft skills.
- Life skills: Self-awareness and Self-analysis, adaptability, resilience, emotional intelligence and empathy etc.
- Applying soft skills across cultures.
- Case Studies.

**Unit-3: Reading Comprehension**
Comprehension, vocabulary enhancement and grammar exercises based on reading of the following texts:
**Section-1**
*Malgudi Days*: R.K. Narayan
*The Room on Roof*: Ruskin Bond "The Gift of the Magi" by O. Henry
"Uncle Podger Hangs a Picture" Jerome K. Jerome

**Section-2**
Night of the Scorpion by Nissim Ezekiel,
Stopping by Woods on a Snowy Evening by Robert Frost, Where the Mind is Without Fear by Rabindranath Tagore, Ode to Tomatoes by Pablo Neruda,

**Unit-4: Professional Writing**
The art of précis writing, Letters: business and personnel,
Drafting e-mail, notices, minutes of a meeting etc.
Filling-up different forms such as banks and on-line forms for placement etc.

**Unit-5: Vocabulary and Grammar**
Vocabulary of commonly used words
Glossary of administrative terms (English and Hindi) One-word substitution, Idioms and phrases etc.
Parts of speech, active and passive voice, tenses etc., Punctuation

**5. Engineering Graphics**

**Unit – I Basic elements of Drawing**
Drawing Instruments and supporting materials: method to use them with applications.

Convention of lines and their applications.

Representative Fractions – reduced, enlarged and full size scales; Engineering Scales such as plain and diagonal scale.

Dimensioning techniques as per SP-46:2003 – types and applications of chain, parallel and coordinate dimensioning.

Geometrical and Tangency constructions. (Redraw the figure)

**Unit – II Orthographic projections**
Introduction of projections-orthographic, perspective, isometric and oblique: concept and applications. (No question to be asked in examination).

Introduction to orthographic projection, First angle and Third angle method, their symbols.

Conversion of pictorial view into Orthographic Views – object containing plain surfaces, slanting surfaces, slots, ribs, cylindrical surfaces. (use First Angle Projection method only)

**Unit – III Isometric Projections**

Introduction to isometric projections. Isometric scale and Natural scale.

Isometric view and isometric projection.

Illustrative problems related to objects containing lines, circles and arcs shape only. Conversion

of orthographic views into isometric view/projection.

**Unit – IV Free Hand Sketches of engineering elements**
Free hand sketches of machine elements: Thread profiles, nuts, bolts, studs, set screws, wash- er, Locking arrangements. (For branches other than mechanical Engineering, the teacher should select branch specific elements for free hand sketching)

Free hand sketches of orthographic view (on squared graph paper) and isometric view (on isometric grid paper)

**Unit – V Computer aided drafting interface**
Computer Aided Drafting: concept.

Hardware and various CAD software available.

System requirements and Understanding the interface.

Components of AutoCAD software window: Title bar, standard tool bar, menu bar, object properties tool bar, draw tool bar, modify tool bar, cursor cross hair. Command window, status bar, drawing area, UCS icon.

File features: New file, Saving the file, Opening an existing drawing file, Creating templates, Quit.

Setting up new drawing: Units, Limits, Grid, Snap. Undoing and redoing action.

**Unit – VI Computer aided drafting**
Draw basic entities like Line, Circle, Arc, Polygon, Ellipse, Rectangle, Multiline, Poly Line.

Method of Specifying points: Absolute coordinates, Relative Cartesian and Polar coordinates.

Modify and edit commands like trim, extend, delete, copy, offset, array, block, layers.

Dimensioning: Linear, Horizontal Vertical, Aligned, Rotated, Baseline, Continuous, Diameter, Radius, Angular Dimensions.

Dim scale variable. Editing dimensions.

Text: Single line Text, Multiline text.

Standard sizes of sheet. Selecting Various plotting parameters such as Paper size, paper units, Drawing orientation, plot scale, plot offset, plot area, print preview.

**6. Engineering Workshop Practice**

| S.No. | Details Of Practical Content |
|---|---|
| I | **Carpentry:** i) Demonstration of different wood working tools / machines. ii) Demonstration of different wood working processes, like plaining, marking, chiseling, grooving, turning of wood etc. iii) One simple job involving any one joint like mortise and tenon dovetail, bridle, half lap etc. |
| II | **Fitting:** i) Demonstration of different fitting tools and drilling machines and power tools ii) Demonstration of different operations like chipping, filing, drilling, tapping, sawing, cutting etc. iii) One simple fitting job involving practice of chipping, filing, drilling, tapping, cutting etc |

| | |
|---|---|
| **III** | **Welding:** i) Demonstration of different welding tools / machines. ii) Demonstration on Arc Welding, Gas Welding, MIG, MAG welding, gas cutting and rebuilding of broken parts with welding. iii) One simple job involving butt and lap joint |
| **IV** | **Sheet Metal Working:** i) Demonstration of different sheet metal tools / machines. ii) Demonstration of different sheet metal operations like sheet cutting, bending, edging, end curling, lancing, soldering, brazing, and riveting. iii) One simple job involving sheet metal operations and soldering and riveting. |
| **V** | **Electrical House Wiring:** Practice on simple lamp circuits (i) one lamp controlled by one switch by surface conduit wiring, (ii) Lamp circuits- connection of lamp and socket by separate switches, (iii) Connection of Fluorescent lamp/tube light, (iv) simple lamp circuits-in- stall bedroom lighting. And (v) Simple lamp circuits- install stair case wiring. |
| **VI** | **Demonstration:** i) Demonstration of measurement of Current, Voltage, Power and Energy.<br>ii) Demonstration of advance power tools, pneumatic tools, electrical wiring tools and accessories. iii) Tools for Cutting and drilling |

## 7. Applied Physics-I Labs

1. To measure length, radius of a given cylinder, a test tube and a beaker using a Vernier caliper and find volume of each object.
2. To determine diameter of a wire, a solid ball and thickness of cardboard using a screw gauge.
3. To determine radius of curvature of a convex and a concave mirror/surface using a spherometer.
4. To verify triangle and parallelogram law of forces.
5. To find the co-efficient of friction between wood and glass using a horizontal board.
6. To determine force constant of a spring using Hook's Law.
7. To verify law of conservation of mechanical energy (PE to KE).
8. To find the moment of inertia of a flywheel.
9. To find the viscosity of a given liquid (Glycerin) by Stoke's law.
10. To find the coefficient of linear expansion of the material of a rod.
11. To determine atmospheric pressure at a place using Fortin's barometer.
12. To measure room temperature and temperature of a hot bath using mercury thermometer and convert it into different scales.

## 8. Applied Chemistry Lab

**Volumetric and Gravimetric analysis:**

1 Preparation of standard solution of oxalic acid or potassium permanganate.

2 To determine strength of given sodium hydroxide solution by titrating against standard oxalic
acid solution using phenolphthalein indicator.

3 Standardization of $KMnO_4$ solution using standard oxalic acid and Determine the percentage of
iron present in given Hematite ore by $KMnO_4$ solution.

4 Iodometric estimation of copper in the copper pyrite ore.

5 Volumetric estimation of total acid number (TAN) of given oil.

6 Volumetric estimation of

a) Total hardness of given water sample using standard EDTA solution.
b) Alkalinity of given water sample using 0.01M sulphuric acid

7 Proximate analysis of coal
a) Gravimetric estimation moisture in given coal sample
b) Gravimetric estimation ash in given coal sample

**Instrumental analysis**

8. Determine the conductivity of given water sample.
9. Determination of the Iron content in given cement sample using colorimeter.
10. Determination of calorific value of solid or liquid fuel using bomb calorimeter.
11. Determination of viscosity of lubricating oil using Redwood viscometer.
12. Determination of flash and fire point of lubricating oil using Able's flash point apparatus.
13. To verify the first law of electrolysis of copper sulfate using copper electrode.
14. Construction and measurement of emf of elector chemical cell (Daniel cell).
15. To study the effect of dissimilar metal combination.

**9. Sports and Yoga**

- **Introduction to Physical Education**
  - Meaning & definition of Physical Education
  - Aims & Objectives of Physical Education
  - Changing trends in Physical Education
- **Olympic Movement**
  - Ancient & Modern Olympics (Summer & Winter)
  - Olympic Symbols, Ideals, Objectives & Values
  - Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award,
    Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.)
- **Physical Fitness, Wellness & Lifestyle**
  - Meaning & Importance of Physical Fitness & Wellness
  - Components of Physical fitness
  - Components of Health related fitness
  - Components of wellness
  - Preventing Health Threats through Lifestyle Change
  - Concept of Positive Lifestyle
- **Fundamentals of Anatomy & Physiology in Physical Education, Sports and Yoga**
  - Define Anatomy, Physiology & Its Importance
  - Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

- **Kinesiology, Biomechanics & Sports**
  - Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports
  - Newton's Law of Motion & its application in sports.
  - Friction and its effects in Sports.
- **Postures**
  - Meaning and Concept of Postures.
  - Causes of Bad Posture.
  - Advantages & disadvantages of weight training.
  - Concept & advantages of Correct Posture.
  - Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis.
  - Corrective Measures for Postural Deformities
- **Yoga**
  - Meaning & Importance of Yoga
  - Elements of Yoga
  - Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas
  - Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Sha-shankasana)
  - Relaxation Techniques for improving concentration - Yog-nidra
- **Yoga & Lifestyle**
  - Asanas as preventive measures.
  - Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana.
  - Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana.
  - Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana.
  - Diabetes: Procedure, Benefits & contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana.
  - Asthema: Procedure, Benefits & contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.
- **Training and Planning in Sports**
  - Meaning of Training
  - Warming up and limbering down
  - Skill, Technique & Style

- Meaning and Objectives of Planning.
- Tournament – Knock-Out, League/Round Robin & Combination.

- **Psychology & Sports**
  - Definition & Importance of Psychology in Physical Edu. & Sports
  - Define & Differentiate Between Growth & Development
  - Adolescent Problems & Their Management
  - Emotion: Concept, Type & Controlling of emotions
  - Meaning, Concept & Types of Aggressions in Sports.
  - Psychological benefits of exercise.
  - Anxiety & Fear and its effects on Sports Performance.
  - Motivation, its type & techniques.
  - Understanding Stress & Coping Strategies.

- **Doping**
  - Meaning and Concept of Doping
  - Prohibited Substances & Methods
  - Side Effects of Prohibited Substances
- **Sports Medicine**
  - First Aid – Definition, Aims & Objectives.
  - Sports injuries: Classification, Causes & Prevention.
  - Management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries
- **Sports / Games**

  Following sub topics related to any one Game/Sport of choice of student out of: Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, Yoga etc.
  - History of the Game/Sport.
  - Latest General Rules of the Game/Sport.
  - Specifications of Play Fields and Related Sports Equipment.
  - Important Tournaments and Venues.
  - Sports Personalities.
  - Proper Sports Gear and its Importance.

**10. Communication Skills in English - Lab**

**Unit 1 Listening Skills**

Listening Process and Practice: Introduction to recorded lectures, poems, interviews and speeches, listening tests.

**Unit II Introduction to Phonetics**
Sounds: consonant, vowel, diphthongs, etc. transcription of words (IPA), weak forms, syllable division, word stress, intonation, voice etc.

**Unit III Speaking Skills**
Standard and formal speech: Group discussion, oral presentations, public speaking, business presentations etc. Conversation practice and role playing, mock interviews etc.

**Unit IV Building vocabulary**
Etymological study of words and construction of words, phrasal verbs, foreign phrases, idioms and phrases. Jargon/ Register related to organizational set up, word exercises and word games to en- hance self-expression and vocabulary of participants.

**11. Mathematics - II**

**UNIT - I: Determinants and Matrices**

Elementary properties of determinants up to 3rd order, consistency of equations, Crammer's rule. Algebra of matrices, Inverse of a matrix, matrix inverse method to solve a system of linear equations in 3 variables.

**UNIT - II: Integral Calculus**

Integration as inverse operation of differentiation. Simple integration by substitution, by parts

and by partial fractions (for linear factors only). Use of formulas $\int_0^{\frac{\pi}{2}} \sin^n x\, dx$, $\int_0^{\frac{\pi}{2}} \cos^n x\, dx$ and $\int_0^{\frac{\pi}{2}} \sin^m x \cos^n x\, dx$ for solving problems Where m and n are positive integers.

Applications of integration for i. Simple problem on evaluation of area bounded by a curve and axes.
ii. Calculation of Volume of a solid formed by revolution of an area about axes. (Simple problems).

**UNIT - III: Co-Ordinate Geometry**

Equation of straight line in various standard forms (without proof), inter section of two straight lines, angle between two lines. Parallel and perpendicular lines, perpendicular distance formula.

General equation of a circle and its characteristics. To find the equation of a circle, given:

i. Centre and radius,

ii. Three points lying on it and

iii. Coordinates of end points of a diameter;

Definition of conics (Parabola, Ellipse, Hyperbola) their standard equations without proof. Problems
on conics when their foci, directories or vertices are given.

**UNIT - IV: Vector Algebra**

Definition notation and rectangular resolution of a vector. Addition and subtraction of vectors. Scalar
and vector products of 2 vectors. Simple problems related to work, moment and angular velocity.

**UNIT-V: Differential Equations**

Solution of first order and first degree differential equation by variable separation method (simple
problems). MATLAB – Simple Introduction.

## 13. Applied Physics -II

**UNIT - 1: Wave motion and its applications**

Wave motion, transverse and longitudinal waves with examples, definitions of wave velocity, frequency and wave length and their relationship, Sound and light waves and their properties, wave equation ($y = r \sin\omega t$) amplitude, phase, phase difference, principle of superposition of waves and beat formation.

Simple Harmonic Motion (SHM): definition, expression for displacement, velocity,

acceleration, time period, frequency etc. Simple harmonic progressive wave and energy transfer, study of vibration of cantilever and determination of its time period, Free, forced and resonant vibrations with examples.

Acoustics of buildings – reverberation, reverberation time, echo, noise, coefficient of absorption of sound, methods to control reverberation time and their applications, Ultrasonic waves – Introduction and properties, engineering and medical applications of ultrasonic.

**UNIT - 2: Optics**

Basic optical laws; reflection and refraction, refractive index, Images and image formation by mirrors, lens and thin lenses, lens formula, power of lens, magnification and defects. Total internal reflection, Critical angle and conditions for total internal reflection, applications of total internal reflection in optical fiber.

Optical Instruments; simple and compound microscope, astronomical telescope in normal adjustment, magnifying power, resolving power, uses of microscope and telescope, optical projection systems.

**UNIT - 3: Electrostatics**

Coulombs law, unit of charge, Electric field, Electric lines of force and their properties, Electric flux, Electric potential and potential difference, Gauss law: Application of Gauss law to find electric field intensity of straight charged conductor, plane charged sheet and charged sphere.

Capacitor and its working, Types of capacitors, Capacitance and its units. Capacitance of a parallel plate capacitor, Series and parallel combination of capacitors (related numerical), dielectric and its effect on capacitance, dielectric break down.

**UNIT - 4: Current Electricity**

Electric Current and its units, Direct and alternating current, Resistance and its units, Specific resistance, Conductance, Specific conductance, Series and parallel combination of resistances. Factors affecting resistance of a wire, carbon resistances and colour coding.

Ohm's law and its verification, Kirchhoff's laws, Wheatstone bridge and its applications (slide wire
bridge only), Concept of terminal potential difference and Electro motive force (EMF)

Heating effect of current, Electric power, Electric energy and its units (related numerical problems), Advantages of Electric Energy over other forms of energy.

**UNIT - 5: Electromagnetism**

Types of magnetic materials; dia, para and ferromagnetic with their properties, Magnetic field and its units, magnetic intensity, magnetic lines of force, magnetic flux and units, magnetization.

Concept of electromagnetic induction, Faraday's Laws, Lorentz force (force on moving charge in magnetic field). Force on current carrying conductor, force on rectangular coil placed in magnetic field.

Moving coil galvanometer; principle, construction and working, Conversion of a galvanometer into ammeter and voltmeter.

**UNIT - 6: Semiconductor Physics**

Energy bands in solids, Types of materials (insulator, semi-conductor, conductor), intrinsic and extrinsic semiconductors, p-n junction, junction diode and V-I characteristics, types of junction diodes. Diode as rectifier – half wave and full wave rectifier (centre taped).

Transistor; description and three terminals, Types- pnp and npn, some electronic applications (list only).

Photocells, Solar cells; working principle and engineering applications.

**UNIT - 7: Modern Physics**

Lasers: Energy levels, ionization and excitation potentials; spontaneous and stimulated emission; population inversion, pumping methods, optical feedback, Types of lasers; Ruby, He-Ne and semiconductor, laser characteristics, engineering and medical applications of lasers.

Fiber Optics: Introduction to optical fibers, light propagation, acceptance angle and numerical aperture, fiber types, applications in; telecommunication, medical and sensors.

Nanoscience and Nanotechnology: Introduction, nanoparticles and nanomaterials, properties at nanoscale, nanotechnology, nanotechnology based devices and applications.

**14. Introduction to IT Systems**

**UNIT 1:**

Basic Internet skills: Understanding browser, efficient use of search engines, awareness about Digital
India portals (state and national portals) and college portals.

General understanding of various computer hardware components – CPU, Memory, Display, Key- board, Mouse, HDD and other Peripheral Devices.

**UNIT 2:**

OS Installation (Linux and MS Windows), Unix Shell and Commands, vi editor.

**UNIT 3:**

HTML4, CSS, making basic personal webpage.

**UNIT 4:**

Office Tools: OpenOffice Writer, OpenOffice Spreadsheet (Calc), OpenOffice Impress.

**UNIT 5:** Information security best practices.

Class lectures will only introduce the topic or demonstrate the tool, actual learning will take place in the Lab by practicing regularly.

## 15. Fundamentals of Electrical and Electronics Engineering

**UNIT I** Overview of Electronic Components & Signals:

Passive Active Components: Resistances, Capacitors, Inductors, Diodes, Transistors, FET, MOS and CMOS and their Applications. Signals: DC/AC, voltage/current, periodic/non-periodic signals, aver- age, rms, peak values, different types of signal waveforms, Ideal/non-ideal voltage/current sources, independent/dependent voltage current sources.

**UNIT II** Overview of Analog Circuits:

Operational Amplifiers-Ideal Op-Amp, Practical op amp, Open loop and closed loop configurations, Application of Op-Amp as amplifier, adder, differentiator and integrator.

**UNIT III** Overview of Digital Electronics: Introduction to Boolean Algebra, Electronic Implementation of Boolean Operations, Gates-Functional Block Approach, Storage elements-Flip Flops-A Functional block approach, Counters: Ripple, Up/down and decade, Introduction to digital IC Gates (of TTL Type).

**Unit IV** Electric and Magnetic Circuits:

EMF, Current, Potential Difference, Power and Energy; M.M.F, magnetic force, permeability, hysteresis loop, reluctance, leakage factor and BH curve; Electromagnetic induction, Faraday's laws of electromagnetic induction, Lenz's law; Dynamically induced emf; Statically induced emf; Equations of self and mutual inductance; Analogy between electric and magnetic circuits.

**Unit V** A.C. Circuits:

Cycle, Frequency, Periodic time, Amplitude, Angular velocity, RMS value, Average value, Form Factor Peak Factor, impedance, phase angle, and power factor; Mathematical and phasor representation of alternating emf and current; Voltage and Current relationship in Star and Delta connections; A.C in resistors, inductors and capacitors; A.C in R-L series, R-C series, R-L-C series and parallel circuits; Power in A. C. Circuits, power triangle.

**Unit VI** Transformer and Machines: General construction and principle of different type of trans- formers; Emf equation and transformation ratio of transformers; Auto transformers; Construction and Working principle of motors; Basic equations and characteristic of motors.

## 16. Engineering Mechanics

**Unit – I Basics of mechanics and force system**

Significance and relevance of Mechanics, Applied mechanics, Statics, Dynamics. Space, time, mass, particle, flexible body and rigid body.

Scalar and vector quantity, Units of measurement (SI units) - Fundamental units and derived units. Force – unit, representation as a vector and by Bow's notation, characteristics and effects of a force, Principle of transmissibility of force, Force system and its classification.

Resolution of a force - Orthogonal components of a force, moment of a force, Varignon's Theorem.

Composition of forces – Resultant, analytical method for determination of resultant for concur-rent, non-concurrent and parallel co-planar force systems – Law of triangle, parallelogram and polygon of forces.

**Unit– II Equilibrium**

Equilibrium and Equilibrant, Free body and Free body diagram, Analytical and graphical methods of analysing equilibrium

Lami's Theorem – statement and explanation, Application for various engineering problems.

Types of beam, supports (simple, hinged, roller and fixed) and loads acting on beam (vertical and inclined point load, uniformly distributed load, couple),

Beam reaction for cantilever, simply supported beam with or without overhang – subjected to combination of Point load and uniformly distributed load.

Beam reaction graphically for simply supported beam subjected to vertical point loads only.

**Unit– III Friction**

Friction and its relevance in engineering, types and laws of friction, limiting equilibrium, limiting friction, co-efficient of friction, angle of friction, angle of repose, relation between co-efficient of friction and angle of friction.

Equilibrium of bodies on level surface subjected to force parallel and inclined to plane.

Equilibrium of bodies on inclined plane subjected to force parallel to the plane only.

**Unit– IV Centroid and centre of gravity**

Centroid of geometrical plane figures (square, rectangle, triangle, circle, semi-circle, quarter circle) Centroid of composite figures composed of not more than three geometrical figures

Centre of Gravity of simple solids (Cube, cuboid, cone, cylinder, sphere, hemisphere) Centre of Gravity of composite solids composed of not more than two simple solids.

**Unit – V Simple lifting machine**

Simple lifting machine, load, effort, mechanical advantage, applications and advantages. Velocity ratio, efficiency of machines, law of machine.

Ideal machine, friction in machine, maximum Mechanical advantage and efficiency, reversible and non-reversible machines, conditions for reversibility

Velocity ratios of Simple axle and wheel, Differential axle and wheel, Worm and worm wheel, Single purchase and double purchase crab winch, Simple screw jack, Weston's differential pulley block, geared pulley block.

**17. Applied Physics II Lab**

1. To determine and verify the time period of a cantilever.
2. To determine velocity of ultrasonic in different liquids using ultrasonic interferometer.
3. To verify laws of reflection from a plane mirror/ interface.
4. To verify laws of refraction (Snell's law) using a glass slab.
5. To determine focal length and magnifying power of a convex lens.
6. To verify Ohm's law by plotting graph between current and potential difference.
7. To verify laws of resistances in series and parallel combination.
8. To find the frequency of AC main using electrical vibrator.
9. To verify Kirchhoff's law using electric circuits.
10. To study the dependence of capacitance of a parallel plate capacitor on various factors and determines permittivity of air at a place.
11. To find resistance of a galvanometer by half deflection method.

12. To convert a galvanometer into an ammeter.
13. To convert a galvanometer into a voltmeter.
14. To draw V-I characteristics of a semiconductor diode (Ge, Si) and determine its knee voltage.
15. To verify inverse square law of radiations using a photo-electric cell.
16. To measure wavelength of a He-Ne/diode laser using a diffraction grating.
17. To measure numerical aperture (NA) of an optical fiber.

**17. Introduction to IT Systems Lab**

| S.No. | Topics for Practice |
|---|---|
| 1 | Browser features, browsing, using various search engines, writing search queries |
| 2 | Visit various e-governance/Digital India portals, understand their features, services of- fered |
| 3 | Read Wikipedia pages on computer hardware components, look at those components in lab, identify them, recognise various ports/interfaces and related cables, etc. |
| 4 | Install Linux and Windows operating system on identified lab machines, explore various<br>options, do it multiple times |
| 5 | Connect various peripherals (printer, scanner, etc.) to computer, explore various features<br>of peripheral and their device driver software. |
| 6 | Practice HTML commands, try them with various values, make your own Webpage |
| 7 | Explore features of Open Office tools, create documents using these features, do it multiple times |
| 8 | Explore security features of Operating Systems and Tools, try using them and see what happens. |

**18. Fundamentals of Electrical and Electronics Engineering Lab**

| **S. No.** | **Practical Outcomes (PrOs)** |
|---|---|
| 1. | Determine the permeability of magnetic material by plotting its B-H curve. |
| 2. | Measure voltage, current and power in 1-phase circuit with resistive load. |
| 3. | Measure voltage, current and power in R-L series circuit. |
| 4. | Determine the transformation ratio (K) of 1-phase transformer. |
| 5. | Connect single phase transformer and measure input and output quantities. |
| 6. | Make Star and Delta connection in induction motor starters and measure the line and phase values. |
| 7. | Identify various passive electronic components in the given circuit |
| 8. | Connect resistors in series and parallel combination on bread board and measure its value using digital multimeter. |
| 9. | Connect capacitors in series and parallel combination on bread board and measure its value using multimeter. |
| 10. | Identify various active electronic components in the given circuit. |
| 11. | Use multimeter to measure the value of given resistor. |
| 12. | Use LCR-Q tester to measure the value of given capacitor and inductor. |

| | |
|---|---|
| 13. | Determine the value of given resistor using digital multimeter to confirm with colour code. |
| 14. | Test the PN-junction diodes using digital multimeter. |
| 15. | Test the performance of PN-junction diode. |
| 16. | Test the performance of Zener diode. |
| 17. | Test the performance of LED. |
| 18. | Identify three terminals of a transistor using digital multimeter. |
| 19. | Test the performance of NPN transistor. |
| 20. | Determine the current gain of CE transistor configuration. |
| 21. | Test the performance of transistor switch circuit. |
| 22. | Test the performance of transistor amplifier circuit. |
| 23. | Test Op-Amp as amplifier and Integrator |

**19. Engineering Mechanics Lab.**

1. To study various equipments related to Engineering Mechanics.
2. To find the M.A., V.R., Efficiency and law of machine for Differential Axle and Wheel.
3. To find the M.A., V.R., Efficiency and law of machine for Simple Screw Jack.
4. Derive Law of machine using Worm and worm wheel.
5. Derive Law of machine using Single purchase crab.
6. Derive Law of machine using double purchase crab.
7. Derive Law of machine using Weston's differential or wormed geared pulley block.
8. Determine resultant of concurrent force system applying Law of Polygon of forces using force table.
9. Determine resultant of concurrent force system graphically.
10. Determine resultant of parallel force system graphically.
11. Verify Lami's theorem.
12. Study forces in various members of Jib crane.
13. Determine support reactions for simply supported beam.
14. Obtain support reactions of beam using graphical method.
15. Determine coefficient of friction for motion on horizontal and inclined plane.
16. Determine centroid of geometrical plane figures.

**20. Environmental Science**

**Pre requisite: -** High School Chemistry

**Unit-1 Ecosystem**

Structure of ecosystem, Biotic & Abiotic components Food chain and food web

Aquatic (Lentic and Lotic) and terrestrial ecosystem Carbon, Nitrogen, Sulphur, Phosphorus cycle. Global warming -Causes, effects, process, Green House Effect, Ozone depletion

**Unit– 2 Air and, Noise Pollution**

Definition of pollution and pollutant, Natural and manmade sources of air pollution (Refrigerants, I.C., Boiler) Air Pollutants: Types, Particulate Pollutants: Effects and control (Bag filter, Cyclone separator, Electrostatic Precipitator)

Gaseous Pollution Control: Absorber, Catalytic Converter, Effects of air pollution due to Refrigerants, I.C., Boiler Noise pollution: sources of pollution, measurement of pollution level, Effects of Noise pollu- tion, Noise pollution (Regulation and Control) Rules, 2000

**Unit- 3 Water and Soil Pollution**

Sources of water pollution, Types of water pollutants, Characteristics of water pollutants Turbidity, pH, total suspended solids, total solids BOD and COD: Definition, calculation

Waste Water Treatment: Primary methods: sedimentation, froth floatation, Secondary methods: Activated sludge treatment, Trickling filter, Bioreactor, Tertiary Method: Membrane separation technology, RO (reverse osmosis).

Causes, Effects and Preventive measures of Soil Pollution: Causes-Excessive use of Fertilizers, Pesticides and Insecticides, Irrigation, E-Waste.

**Unit– 4 Renewable sources of Energy**

Solar Energy: Basics of Solar energy. Flat plate collector (Liquid & Air). Theory of flat plate collector. Importance of coating. Advanced collector. Solar pond. Solar water heater, solar dryer. Solar stills.

Biomass: Overview of biomass as energy source. Thermal characteristics of biomass as fuel. Anaerobic digestion. Biogas production mechanism. Utilization and storage of biogas.

Wind energy: Current status and future prospects of wind energy. Wind energy in India. Environmental benefits and problem of wind energy.

New Energy Sources: Need of new sources. Different types new energy sources. Applications of (Hydrogen energy, Ocean energy resources, Tidal energy conversion.) Concept, origin and power plants of geothermal energy

**Unit-5 Solid Waste Management, ISO 14000 & Environmental Management 06 hours**

Solid waste generation- Sources and characteristics of : Municipal solid waste, E- waste, biomedical waste.

Metallic wastes and Non-Metallic wastes (lubricants, plastics, rubber) from industries.

Collection and disposal: MSW (3R, principles, energy recovery, sanitary landfill), Hazardous waste

Air quality act 2004, air pollution control act 1981 and water pollution and control act1996.

Structure and role of Central and state pollution control board.

Concept of Carbon Credit, Carbon Footprint. Environmental management in fabrication industry. ISO14000: Implementation in industries, Benefits.

**21. BASIC MECHANICAL ENGINEERING**

**UNIT-I: Introduction to Thermodynamics** - Role of Thermodynamics in Engineering and Science, Types of Systems, Thermodynamic Equilibrium, Properties, State, Process and Cycle, Elementary introduction to Zeroth, First and Second laws of thermodynamics, Heat and Work

Interactions for various non-flow and flow processes; Concept of Heat Engine, Heat Pump & Refrigerator, Efficiency/ COP; Kelvin-Planck and Clausius Statements, Carnot Cycle, Carnot Efficiency, T-S and P-V Diagrams, Concept of Entropy (Definition only).

**Unit-II: Heat transfer & Thermal Power Plant:** Modes of Heat Transfer; Conduction: Composite Walls and Cylinders, Combined Conduction and Convection: Overall Heat Transfer Co-efficient, Sim- ple Numerical Problems: Thermal Power Plant Layout; Rankine Cycle; Fire Tube and Water Tube boilers, Babcock & Wilcox, Cochran Boilers;

**Unit-III: Steam Turbines:** Impulse and Reaction Turbines; Condensers: Jet & Surface Condensers, Cooling Towers; **Internal Combustion Engines and Refrigeration:** Otto, Diesel and Dual cycles; P-V and T-S Diagrams; IC Engines: 2 - Stroke and 4 - Stroke I.C. Engines, S.I. and C.I. Engines.

**Unit-IV: Materials and Manufacturing Processes:** Engineering Materials, Classification and their Properties; Metal Casting, Moulding, Patterns, Metal Working: Hot Working and Cold Working, Metal Forming: Extrusion, Forging, Rolling, Drawing, Gas Welding, Arc Welding, Soldering, and Brazing.

**Unit-V: Machine Tools and Machining Processes:** Machine Tools: Lathe Machine and types, Lathe Operations, Milling Machine and types, Milling Operations, Shaper and Planer Machines: Differences, Quick-Return Motion Mechanism, Drilling Machine: Operations, Grinding Machine: Operations

## 22. COMPUTER AIDED MACHINE DRAWING PRACTICE

| S.No. | Topics for practice |
|---|---|
| I | Introduction to CAD software. |
| II | Drawing aids and editing commands. |
| III | Basic dimensioning, hatching, blocks and views. |
| IV | Isometric drawing, printing and plotting |
| V | Machine Drawing practice using Auto CAD: Detailed drawings of following machine parts are to be given to the students to assemble and draw the sectional or plain elevations, plans and side views with dimensioning and bill of materials using cad software (12 exrcises).<br>1) Sleeve & Cotter Joint 2) Spigot & Cotter Joint 3) Knuckle Joint 4) Stuffing Box 5) Screw<br>Jack 6) Foot Step Bearing 7) Universal Coupling 8) Plummer Block 9) Simple Eccentric<br>10) Machine Vice 11) Connecting Rod 12) Protected Type Flanged Coupling. |

## 23. MATERIAL SCIENCE & ENGINEERING

**UNIT-I: Crystal structures and Bonds:** Unit cell and space lattice: Crystal system: The seven

basic crystal systems; Crystal structure for metallic elements: BCC, FCC and HCP; Coordination number for Simple Cubic, BCC and FCC; Atomic radius: definition, atomic radius for Simple Cubic, BCC and FCC; Atomic Packing Factor for Simple Cubic, BCC, FCC and HCP; Simple problems on finding number of atoms for a unit cell.

**Bonds in solids:** Classification - primary or chemical bond, secondary or molecular bond; Types of primary bonds: Ionic, Covalent and Metallic Bonds; Types of secondary bonds: Dispersion bond, Dipole bond and Hydrogen bond.

**Unit-II: Phase diagrams, Ferrous metals and its Alloys:** Isomorphs, eutectic and eutectoid sys- tems; Iron-Carbon binary diagram; Iron and Carbon Steels; flow sheet for production of iron and steel; Iron ores – Pig iron: classification, composition and effects of impurities on iron; Cast Iron: clas- sification, composition, properties and uses; Wrought Iron: properties, uses/applications of wrought Iron; comparison of cast iron, wrought iron and mild steel and high carbon steel; standard com- mercial grades of steel as per BIS and AISI; Alloy Steels – purpose of alloying; effects of alloying ele- ments – Important alloy steels: Silicon steel, High Speed Steel (HSS), heat resisting steel, spring steel, Stainless Steel (SS): types of SS, applications of SS – magnet steel – composition, properties and uses

**Unit-III: Non-ferrous metals and its Alloys:** Properties and uses of aluminium, copper, tin, lead, zinc, magnesium and nickel; Copper alloys: Brasses, bronzes – composition, properties and uses; Aluminium alloys: Duralumin, hindalium, magnelium – composition, properties and uses; Nickel al- loys: Inconel, monel, nicPerome – composition, properties and uses. Anti-friction/Bearing alloys: Various types of bearing bronzes - Standard commercial grades as per BIS/ASME.

**Unit-IV: Failure analysis & Testing of Materials:** Introduction to failure analysis; Fracture: ductile fracture, brittle fracture; cleavage; notch sensitivity; fatigue; endurance limit; characteristics of fa- tigue fracture; variables affecting fatigue life; creep; creep curve; creep fracture; Destructive testing: Tensile testing; compression testing; Hardness testing: Brinell, Rockwell; bend test; torsion test; fa- tigue test; creep test. Non-destructive testing: Visual Inspection; magnetic particle inspection; liquid penetrant test; ultrasonic inspection; radiography.

**Unit-V: Corrosion & Surface Engineering:** Nature of corrosion and its causes; Electrochemical re- actions; Electrolytes; Factors affecting corrosion: Environment, Material properties and physical con- ditions; Types of corrosion; Corrosion control: Material selection, environment control and design; Surface engineering processes: Coatings and surface treatments; Cleaning and mechanical finishing of surfaces; Organic coatings; Electroplating and Special metallic plating; Electro polishing and pho- to-etching ;– Conversion coatings: Oxide, phosphate and chromate coatings; Thin film coatings: PVD and CVD; Surface analysis; Hard-facing, thermal spraying and high-energy processes; Process/mate- rial selection. Pollution norms for treating effluents as per standards.

## 24. 24. FLUID MECHANICS & HYDRAULIC MACHINERY

**UNIT-I: Properties of fluid:** Density, Specific gravity, Specific Weight, Specific Volume, Dynamic Vis- cosity, Kinematic Viscosity, Surface tension, Capillarity, Vapour Pressure, Compressibility.

**Fluid Pressure & Pressure Measurement:** Fluid pressure, Pressure head, Pressure intensity, Concept of vacuum and gauge pressures, atmospheric pressure, absolute pressure, Simple and differential manometers, Bourdan pressure gauge, Concept of Total pressure on immersed bodies, center of pressure, Simple problems on Manometers.

**Unit-II: Fluid Flow:** Types of fluid flows, Path line and Stream line, Continuity equation, Bernoulli's theorem, Principle of operation of Venturimeter, Orifice meter and Pitot tube, Derivations for dis- charge, coefficient of discharge and numerical problems.

**Flow Through Pipes:** Laminar and turbulent flows; Darcy's equation and Chezy's equation for frictional losses, Minor losses in pipes, Hydraulic gradient and total gradient line, Numerical problems to estimate major and minor losses

**Unit-III: Impact of jets:** Impact of jet on fixed vertical, moving vertical flat plates, Impact of jet on curved vanes with special reference to turbines & pumps, Simple Numericals on work done and efficiency.

**Unit-IV: Hydraulic Turbines:** Layout of hydroelectric power plant, Features of Hydroelectric power plant, Classification of hydraulic turbines, Selection of turbine on the basis of head and discharge available, Construction and working principle of Pelton wheel, Francis and Kaplan turbines, Draft tubes – types and construction, Concept of cavitation in turbines, Calculation of Work done, Power, efficiency of turbines, Unit quantities and simple numericals.

**Unit-V: Centrifugal Pumps:** Principle of working and applications, Types of casings and impellers, Concept of multistage, Priming and its methods, Cavitation, Manometric head, Work done, Manomet- ric efficiency, Overall efficiency. Numericals on calculations of overall efficiency and power required to drive pumps.

**Reciprocating Pumps:** Construction, working principle and applications of single and double acting reciprocating pumps, Concept of Slip, Negative slip, Cavitation and separation.

## 25. MANUFACTURING ENGINEERING

**UNIT-I: Cutting Fluids & Lubricants:** Introduction; Types of cutting fluids, Fluids and coolants re- quired in turning, drilling, shaping, sawing & broaching; Selection of cutting fluids, methods of appli- cation of cutting fluid; Classification of lubricants (solid, liquid, gaseous), Properties and applications of lubricants.

**Lathe Operations:** Types of lathes – light duty, Medium duty and heavy duty geared lathe, CNC lathe; Specifications; Basic parts and their functions; Operations and tools – Turning, parting off, Knurling, facing, Boring, drilling, threading, step turning, taper turning.

**Unit-II: Broaching Machines:** Introduction to broaching; Types of broaching machines – Horizontal type (Single ram & duplex ram), Vertical type, Pull up, pull down, and push down; Elements of broach tool; broach teeth details; Nomenclature; Tool materials.

**Drilling:** Classification; Basic parts and their functions; Radial drilling machine; Types of operations; Specifications of drilling machine; Types of drills and reamers.

**Unit-III: Welding:** Classification; Gas welding techniques; Types of welding flames; Arc Welding – Principle, Equipment, Applications; Shielded metal arc welding; Submerged arc welding; TIG / MIG welding; Resistance welding - Spot welding, Seam welding, Projection welding; Welding defects; Brazing and soldering: Types, Principles, Applications.

**Milling:** Introduction; Types of milling machines: plain, Universal, vertical; constructional details – specifications; Milling operations: simple, compound and differential indexing; Milling cutters – types; Nomenclature of teeth; Teeth materials; Tool signature of milling cutter; Tool & work holding devices.

**Unit-IV: Gear Making:** Manufacture of gears – by Casting, Moulding, Stamping, Coining Extruding, Rolling, Machining; Gear generating methods: Gear Shaping with pinion cutter & rack cutter; Gear hobbing; Description of gear hob; Operation of gear hobbing machine; Gear finishing processes; Gear materials and specification; Heat treatment processes applied to gears.

**Press working:** Types of presses and Specifications, Press working operations - Cutting, bending, drawing, punching, blanking, notching, lancing; Die set components- punch and die shoe, guide pin, bolster plate, stripper, stock guide, feed stock, pilot; Punch and die clearances for blanking and piercing, effect of clearance.

**Unit-V: Grinding and finishing processes:** Principles of metal removal by Grinding; Abrasives – Natural & Artificial; Bonds and binding processes: Vitrified, silicate, shellac, rubber, bakelite; Factors affecting the selection of grind wheels: size and shape of wheel, kind of abrasive, grain size, grade and strength of bond, structure of grain, spacing, kinds of bind material; Standard marking systems: Meaning of letters & numbers sequence of marking, Grades of letters; Grinding machines classification: Cylindrical, Surface, Tool & Cutter grinding machines; Construction details; Principle of cen- treless grinding; Advantages &

limitations of centre less grinding; Finishing by grinding: Honing, Lapping, Super finishing; Electroplating: Basic principles, Plating metals, applications; Hot dipping: Galvanizing, Tin coating, Parkerising, Anodizing; Metal spraying: wire process, powder process and applications; Organic coatings: Oil base Paint, Lacquer base, Enamels, Bituminous paints, rubber base coating; Finishing specifications.

**26.** THERMAL ENGINEERING - I

**UNIT-I: Sources of Energy:** Brief description of energy Sources: Classification of energy sources- Renewable, Non-Renewable; Fossil fuels, including CNG, LPG; Solar Energy: Flat plate and concentrating collectors & its applications (Solar Water Heater, Photovoltaic Cell, Solar Distillation); Wind Energy; Tidal Energy; Ocean Thermal Energy; Geothermal Energy; Biogas, Biomass, Bio-diesel; Hydraulic Energy, Nuclear Energy; Fuel cell.

**Unit-II: Internal Combustion Engines:** Assumptions made in air standard cycle analysis; Brief de- scription of Carnot, Otto and Diesel cycles with P-V and T-S diagrams; Internal and external com- bustion engines; advantages of I.C. engines over external combustion engines; classification of I.C. engines; neat sketch of I.C. engine indicating component parts; Function of each part and materials used for the component parts - Cylinder, crank case, crank pin, crank, crank shaft, connecting rod, wrist pin, piston, cooling pins cylinder heads, exhaust valve, inlet valve; Working of four-stroke and two-stroke petrol and diesel engines; Comparison of two stroke and four stroke engines; Comparison of C.I. and S.I. engines; Valve timing and port timing diagrams for four stroke and two stroke engines.

**Unit-III: I.C. Engine Systems:** Fuel system of Petrol engines; Principle of operation of simple and Zenith carburettors; Fuel system of Diesel engines; Types of injectors and fuel pumps; Cooling system air cooling, water cooling system with thermo siphon method of circulation and water cooling system with radiator and forced circulation (description with line diagram). Comparison of air cooling and water cooling system; Ignition systems – Battery coil ignition and magneto ignition (description and working). Comparison of two systems; Types of lubricating systems used in I.C. engines with line diagram; Types of governing of I.C. engines – hit and miss method, quantitative method, qualitative method and combination methods of governing; their applications; Objective of super charging.

**Unit-IV: Performance of I.C. Engines:** Brake power; Indicated power; Frictional power; Brake and Indicated mean effective pressures; Brake and Indicated thermal efficiencies; Mechanical efficiency; Relative efficiency; Performance test; Morse test; Heat balance sheet; Methods of determination of B,P., I.P. and F.P.; Simple numerical problems on performance of I.C. engines.

**Unit-V: Air Compressors:** Functions of air compressor; Uses of compressed air; Types of air

com- pressors; Single stage reciprocating air compressor - its construction and working (with line dia- gram) using P-V diagram; Multi stage compressors – Advantages over single stage compressors; Ro- tary compressors: Centrifugal compressor, axial flow type compressor and vane type compressors.

**Refrigeration & Air-conditioning:** Refrigeration; Refrigerant; COP; Air Refrigeration system: com- ponents, working & applications; Vapour Compression system: components, working & applications; Air conditioning; Classification of Air-conditioning systems; Comfort and Industrial Air-Condition- ing; Window Air-Conditioner; Summer Air-Conditioning system, Winter Air-Conditioning system, Year-round Air-Conditioning system.

## 27. MANUFACTURING ENGINEERING LAB-I

| S.No. | Topics for practice |
|---|---|
| I | Moulding & casting of (i) Connecting rod (ii) Solid bearing (iii) V-Pulley/Gear Pulley |
| II | Arc welding (i) Lap Joint (ii) Butt Joint (iii) T- Joint |
| III | Gas welding (i) Lap Joint (ii) Butt Joint |
| IV | Spot welding (i) Lap Joint |
| V | Turning Exercise (i) Facing, Step Turning & Chamfering (ii) Step Turning & Taper Turning<br>(iii) Step Turning & Groove Cutting (iv) Step Turning & & Knurling (v) Step Turning & Thread Cutting (vi) Turning and Drilling |
| VI | Grinding the Lathe Cutting tools to the required angles |
| VII | Study of Lathe, Drilling machine, shaping machine and slotting machine |
| VIII | The dismantling some of the components of lathe and then assemble the same |
| IX | List the faults associated with lathe and its remedies |
| X | The routine and preventive maintenance procedure for lathe |

## 28. FLUID MECHANICS & HYDRAULIC MACHINERY LAB

| S.No. | Topics for practice |
|---|---|
| I | Verification of Bernoulli's theorem. |
| II | Determination of Coefficient of Discharge of Venturimeter. |
| III | Determination of Coefficient of Discharge, coefficient of contraction and coefficient of velocity of Orificemeter. |
| IV | Determination of coefficient of friction of flow through pipes. |
| V | Determination of force exerted by the jet of water on the given vane. |
| VI | Determination of minor losses of flow through pipes. |
| VII | Calibration of pressure gauge using dead weight pressure gauge tester. |
| VIII | Trial on centrifugal pump to determine overall efficiency. |
| IX | Trial on reciprocating pump to determine overall efficiency. |
| X | Trial on Pelton wheel to determine overall efficiency. |
| XI | Trial on Francis/Kaplan turbine to determine overall efficiency. |

## 29. Thermal Engineering Lab – I

| S.No. | Topics for practice |
|---|---|
| I | Flash & Fire point tests using Able's/Cleveland/Pensky Martin Apparatus |
| II | Viscosity measurement usi/Saybolt viscometer |

| | |
|---|---|
| III | Calorific value tests using Bomb Calorimeter (Solid and Liquid fuels) and Junkers Gas<br>Calorimeter (Gaseous fuels) |
| IV | Carbon residue test using Conradson's apparatus. |
| V | Assembling and disassembling of I.C. Engines |
| VI | Port timing diagram of Petrol engine |
| VII | Port timing diagram of Diesel engine |
| VIII | Valve timing diagram of Petrol engine |
| IX | Valve timing diagram of Diesel engine |
| X | Study of petrol and diesel engine components and Models |

## 30. MEASUREMENTS & METROLOGY

**UNIT-I: Introduction to measurements**: Definition of measurement; Significance of measurement; Methods of measurements: Direct & Indirect; Generalized measuring system; Standards of mea- surements: Primary & Secondary; Factors influencing selection of measuring instruments; Terms applicable to measuring instruments: Precision and Accuracy, Sensitivity and Repeatability, Range, Threshold, Hysteresis, calibration; Errors in Measurements: Classification of errors, Systematic and Random error.

**Measuring instruments:** Introduction; Thread measurements: Thread gauge micrometre; Angle measurements: Bevel protractor, Sine Bar; Gauges: plain plug gauge, ring Gauge, snap gauge, limit gauge; Comparators: Characteristics of comparators, Types of comparators; Surface finish: Definition, Terminology of surface finish, Tal surf surface roughness tester; Co-ordinating measuring machine.

**Unit-II: Transducers and Strain gauges:** Introduction; Transducers: Characteristics, classification of transducers, two coil self-inductance transducer, Piezoelectric transducer; Strain Measurements: Strain gauge, Classification, mounting of strain gauges, Strain gauge rosettes-two and three elements.

**Measurement of force, torque, and pressure:** Introduction; Force measurement: Spring Balance, Proving ring, Load cell; Torque measurement: Prony brake, Eddy current, Hydraulic dynamometer; Pressure measurement: Mcloed gauge.

**Unit-III: Applied mechanical measurements:** Speed measurement: Classification of tachometers, Revolution counters, Eddy current tachometers; Displacement measurement: Linear variable Differential transformers (LVDT); Flow measurement: Rotometers, Turbine meter; Temperature measurement: Resistance thermometers, Optical Pyrometer.

**Miscellaneous measurements**: Humidity measurement: hair hygrometer; Density measurement: hydrometer; Liquid level measurement: sight glass, Float gauge; Biomedical measurement: Sphygmo monometer.

**Unit-IV: Limits, Fits & Tolerances:** Concept of Limits, Fits, and Tolerances; Selective Assembly; Interchangeability; Hole And Shaft Basis System; Taylor's Principle; Design of Plug; Ring Gauges; IS 919-1993 (Limits, Fits & Tolerances, Gauges} IS 3477-1973; concept of multi gauging and inspection.

**Angular Measurement**: Concept; Instruments For Angular Measurements; Working and Use of Uni- versal Bevel Protractor, Sine Bar, Spirit Level; Principle of Working of Clinometers; Angle Gauges (With Numerical on Setting of Angle Gauges).

**Screw thread Measurements**: ISO grade and fits of thread; Errors in threads; Pitch errors; Measurement of different elements such as major diameter, minor diameter, effective

diameter, pitch;
Two wire method; Thread gauge micrometer; Working principle of floating carriage dial micrometer.

**Unit-V: Gear Measurement and Testing**: Analytical and functional inspection; Rolling test; Measurement of tooth thickness (constant chord method); Gear tooth vernier; Errors in gears such as backlash, runout, composite.

**Machine tool testing**: Parallelism; Straightness; Squareness; Coaxiallity; roundness; run out; alignment testing of machine tools as per IS standard procedure.

## 31. STRENGTH OF MATERIALS

**UNIT-I: Simple Stresses and Strains:** Types of forces; Stress, Strain and their nature; Mechanical properties of common engineering materials; Significance of various points on stress – strain dia- gram for M.S. and C.I. specimens; Significance of factor of safety; Relation between elastic constants; Stress and strain values in bodies of uniform section and of composite section under the influence of normal forces; Thermal stresses in bodies of uniform section and composite sections; Related nu- merical problems on the above topics.

**Strain Energy:** Strain energy or resilience, proof resilience and modulus of resilience; Derivation of strain energy for the following cases: i) Gradually applied load, ii) Suddenly applied load, iii) Impact/ shock load; Related numerical problems.

**Unit-II: Shear Force & Bending Moment Diagrams:** Types of beams with examples: a) Cantilever beam, b) Simply supported beam, c) Over hanging beam, d) Continuous beam, e) Fixed beam; Types of Loads – Point load, UDL and UVL; Definition and explanation of shear force and bending moment; Calculation of shear force and bending moment and drawing the S.F and B.M. diagrams by the analyt- ical method only for the following cases: a) Cantilever with point loads, b) Cantilever with uniformly distributed load, c) Simply supported beam with point loads, d) Simply supported beam with UDL, e) Over hanging beam with point loads, at the centre and at free ends, f) Over hanging beam with UDL throughout, g) Combination of point and UDL for the above; Related numerical problems.

**Unit-III: Theory of Simple Bending and Deflection of Beams:** Explanation of terms: Neutral layer, Neutral Axis, Modulus of Section, Moment of Resistance, Bending stress, Radius of curvature; As- sumptions in theory of simple bending; Bending Equation $M/I = \sigma/Y = E/R$ with derivation; Problems involving calculations of bending stress, modulus of section and moment of resistance; Calculation of safe loads and safe span and dimensions of cross- section; Definition and explanation of deflection as applied to beams; Deflection formulae without proof for cantilever and simply supported beams with point load and UDL only (Standard cases only); Related numerical problems.

**Unit-IV: Torsion in Shafts and Springs:** Definition and function of shaft; Calculation of polar M.I. for solid and hollow shafts; Assumptions in simple torsion; Derivation of the equation $T/J=f_s/R=G\theta/L$; Problems on design of shaft based on strength and rigidity; Numerical Problems related to com- parison of strength and weight of solid and hollow shafts; Classification of springs; Nomenclature of closed coil helical spring; Deflection formula for closed coil helical spring (without derivation); stiffness of spring; Numerical problems on closed coil helical spring to find safe load, deflection, size of coil and number of coils.

**Unit-V: Thin Cylindrical Shells:** Explanation of longitudinal and hoop stresses in the light of cir- cumferential and longitudinal failure of shell; Derivation of expressions for the longitudinal and hoop stress for seamless and seam shells; Related numerical Problems for safe thickness and safe working pressure.

## 32. THERMAL ENGINEERING - II

**UNIT-I: Gas Turbines:** Air-standard Brayton cycle; Description with p-v and T-S diagrams; Gas tur- bines Classification: open cycle gas turbines and closed cycle gas turbines; comparison of gas turbine with reciprocating I.C. engines and steam turbines. Applications and limitations of gas turbines; Gen- eral lay-out of Open cycle constant pressure gas turbine; P-V and T-S diagrams and working; General lay-out of Closed cycle gas turbine; P-V and T-S diagrams and working.

**Jet Propulsion:** Principle of jet propulsion; Fuels used for jet propulsion; Applications of jet propul- sion; Working of a turbojet engine; Principle of Ram effect; Working of a Ram jet engine; Principle of Rocket propulsion; Working principle of a rocket engine; Applications of rocket propulsion; Comparison of jet and rocket propulsions.

**Unit-II: Properties of Steam:** Formation of steam under constant pressure; Industrial uses of steam; Basic definitions: saturated liquid line, saturated vapour line, liquid region, vapour region, wet region, superheat region, critical point, saturated liquid, saturated vapour, saturation temperature, sensible heat, latent heat, wet steam, dryness fraction, wetness fraction, saturated steam, superheated steam, degree of superheat; Determination of enthalpy, internal energy, internal latent heat, entropy of wet, dry and superheated steam at a given pressure using steam tables and Mollier chart for the following processes: Isochoric process, Isobaric process, Hyperbolic process, Isothermal process, Isentropic process, Throttling process, Polytropic process; Simple direct problems on the above using tables and charts; Steam calorimeters: Separating, throttling, Combined Separating and throttling calorim- eters – problems.

**Unit-III: Steam Generators:** Function and use of steam boilers; Classification of steam boilers with examples; Brief explanation with line sketches of Cochran, Babcock and Wilcox Boilers; Compari- son of water tube and fire tube boilers; Description with line sketches and working of modern high pressure boilers Lamont and Benson boilers; Boiler mountings: Pressure gauge, water level indi- cator, fusible plug, blow down cock, stop valve, safety valve, (dead weight type, spring loaded type, high pressure and low water safety alarm); Boiler accessories: feed pump, economiser, super heater and air pre-heater; Study of steam traps & separators; Explanation of the terms: Actual evaporation, equivalent evaporation, factor of evaporation, boiler horse power and boiler efficiency; Formula for the above terms without proof; Simple direct problems on the above; Draught systems (Natural, forced & induced).

**Unit-IV: Steam Nozzles:** Flow of steam through nozzle; Velocity of steam at the exit of nozzle in terms of heat drop using analytical method and Mollier chart; Discharge of steam through nozzles; Critical pressure ratio; Methods of calculation of cross-sectional areas at throat and exit for maxi- mum discharge; Effect of friction in nozzles and Super saturated flow in nozzles; Working steam jet injector; Simple numerical problems.

**Unit-V: Steam Turbines:** Classification of steam turbines with examples; Difference between im- pulse & reaction turbines; Principle of working of a simple Delavel turbine with line diagrams- Velocity diagrams; Expression for work done, axial thrust, tangential thrust, blade and diagram efficiency, stage efficiency, nozzle efficiency; Methods of reducing rotor speed; compounding for velocity, for pressure or both pressure and velocity; Working principle with line diagram of a Parson's Reaction turbine–velocity diagrams; Simple problems on single stage impulse turbines (without blade friction) and reaction turbine including data on blade height. Bleeding, re-heating and re-heating factors (Problems omitted); Governing of steam turbines: Throttle, By-pass & Nozzle control governing.

## 33. MATERIAL TESTING LAB

| S.No. | Topics for practice |
|---|---|
| I | Prepare a specimen and examine the microstructure of the Ferrous and Non- ferrous metals using the Metallurgical Microscope. |
| II | Detect the cracks in the specimen using (i) Visual inspection and ring test (ii) Die penetration test (iii) Magnetic particle test. |
| III | Determination of Rockwell's Hardness Number for various materials like mild steel, high carbon steel, brass, copper and aluminium. |
| IV | Finding the resistance of materials to impact loads by Izod test and Charpy test. |
| V | Torsion test on mild steel – relation between torque and angle of twist determination of shear modulus and shear stress. |
| VI | Finding Young's Modulus of Elasticity, yield points, percentage elongation and percentage reduction in area, stress strain diagram plotting, tests on mild steel. |
| VII | Determination of modulus of rigidity, strain energy, shear stress and stiffness by load deflection method (Open & Closed coil spring) |
| VIII | Single or double Shear test on M.S. bar to finding the resistance of material to shear load. |

## 34. MEASUREMENTS & METROLOGY LAB

| S.No. | Topics for practice |
|---|---|
| I | Measure the diameter of a wire using micrometre and compare the result with digital micrometre |
| II | Measure the angle of the machined surface using sine bar with slip gauges. |
| III | Measure the angle of a V-block / Taper Shank of Drill / Dovetail using universal bevel protractor. |
| IV | Measure the dimensions of ground MS flat/cylindrical bush using Vernier Caliper com- pare with Digital/Dial Vernier Caliper. |
| V | Measure the geometrical dimensions of V-Thread using thread Vernier gauge. |
| VI | Measure the thickness of ground MS plates using slip gauges |

## 35. THERMAL ENGINEERING LAB-II

| S.No. | Topics for practice |
|---|---|
| I | Study of high pressure boiler with model |
| II | Study of boiler mountings and accessories |
| III | Conduct performance test on VCR test rig to determine COP of the refrigerator |
| IV | Conduct performance test on multi stage reciprocating compressor |
| V | Conduct Morse test to determine the indicated power of individual cylinders |
| VI | Conduct Performance test on 2-S CI/SI engine. |

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|---|---|
| **VII** | Conduct Performance test on 4-S CI/SI engine. |
| **VIII** | Conduct Heat balance test on CI/SI engine.. |
| **IX** | Conduct Economical speed test on 4-S CI/SI engine. |
| **X** | Thermal conductivity test on 1) Thick slab 2) Composite wall 3) Thick cylinder |
| **XI** | Leak detection of refrigeration equipment |
| **XII** | Conduct performance test on A/C test rig to determine COP of the refrigerator |

## 36. ADVANCED MANUFACTURING PROCESSES

**UNIT-I: Jigs & Fixtures:** Definition of jig; Types of jigs: Leaf jig, Box and Handle jig, Template jig, Plate jig, Indexing jig, Universal jig, Vice jigs - constructional details of the above jigs; General consid- eration in the design of drill jigs; Drill bush; Types of fixtures: Vice fixtures, Milling fixtures, Boring fixtures, Grinding fixtures - constructional details of the above fixtures; Basic principles of location; Locating methods and devices; Basic principles of the clamping; Types of clamps: Strap clamps, Cam clamps, Screw clamps, Toggle clamps, Hydraulic and Pneumatic clamps.

**Unit-II: Jig Boring**: Introduction; Jig boring on vertical milling machine; Types jig boring machines: Open front machine, Cross rail type machine - constructional details & their working; System of location of holes.

**Plastic Processing:** Processing of plastics; Moulding processes: Injection moulding, Compression moulding, Transfer moulding; Extruding; Casting; Calendering; Fabrication methods-Sheet forming, Blow moulding, Laminating plastics (sheets, rods & tubes), Reinforcing; Applications of Plastics.

**Unit-III: Modern Machining Processes:** Introduction – comparison with traditional machining; Ul- trasonic Machining: principle, Description of equipment, applications; Electric Discharge Machining: Principle, Description of equipment, Dielectric fluid, tools (electrodes), Process parameters, Output characteristics, applications; Wire cut EDM: Principle, Description of equipment, Controlling param- eters; applications; Abrasive Jet Machining: principle, description of equipment, application; Laser Beam Machining: principle, description of equipment, application; Electro Chemical Machining: de- scription of equipment, application.

**Unit-IV: CNC Milling Machines:** Vertical and horizontal machining center: Constructional features, Axis identification, Electronic control system. Automatic tool changer and tool magazine. CNC pro- gramming: Preparatory functions (G code), miscellaneous functions (M code), Part programming including subroutines and canned cycles. Principles of computer aided part programming.

**Machine Tool Automation:** Introduction and Need; (A) Single spindle automates, transfer lines.

(B) Elements of control system, Limit switches, Proximity switches, Block diagram for feedback and servo control system, Introduction to PLC, Block diagram of PLC.

**Unit-V: Special Purpose Machines (SPM)**: Concept, General elements of SPM, Productivity im- provement by SPM, Principles of SPM design.

**Maintenance of Machine Tools:** Types of maintenance, Repair cycle analysis, Repair complexity, Maintenance manual, Maintenance records, Housekeeping. Introduction to Total Productive Mainte- nance (TPM).

## 37. THEORY OF MACHINES & MECHANISMS

**UNIT I: Cams and Followers:** Concept; Definition and application of Cams and Followers; Classi- fication of Cams and Followers; Different follower motions and their displacement diagrams like uniform velocity, SHM, uniform acceleration and Retardation; Drawing of profile of radial cam with knife-edge and roller follower with and without offset with reciprocating motion (graphical method).

**UNIT II: Power Transmission**: Types of Drives – Belt, Chain, Rope, Gear drives & their comparison; Belt Drives - flat belt, V– belt & its applications; Material for flat and V-belt; Angle of lap, Belt length. Slip and Creep; Determination of Velocity Ratio, Ratio of tight side and slack side tension; Centrifugal tension and Initial tension; Condition for maximum power transmission (Simple numericals); Chain Drives – Advantages & Disadvantages; Selection of Chain & Sprocket wheels; Methods of lubrication; Gear Drives – Spur gear terminology; Types of gears and gear trains, their selection for different applications; Train value & Velocity ratio for compound, reverted and simple epicyclic gear train; Methods of lubrication; Law of gearing; Rope Drives – Types, applications, advantages & limitations of Steel ropes.

**UNIT III: Flywheel and Governors:** Flywheel - Concept, function and application of flywheel with the help of turning moment diagram for single cylinder 4-Stroke I.C. Engine (no Numericals); Co- efficient of fluctuation of energy, Coefficient of fluctuation of speed and its significance; Governors
- Types and explanation with neat sketches (Centrifugal, Watt and Porter); Concept, function and
applications & Terminology of Governors; Comparison between Flywheel and Governor.

**UNIT IV: Brakes, Dynamometers, Clutches & Bearings**: Function of brakes and dynamometers; Types of brakes and Dynamometers; Comparison between brakes and dynamometers; Construction and working of i) shoe brake, ii) Band Brake, iii) Internal expanding shoe brake iv) Disc Brake; Con- cept of Self Locking & Self energizing brakes; Numerical problems to find braking force and braking torque for shoe & band brakes; Construction and working of i) Rope Brake Dynamometer, ii) Hydrau- lic Dynamometer, iii) Eddy current Dynamometers; Clutches- Uniform pressure and Uniform Wear theories; Function of Clutch and its application; Construction and working of i) Single plate clutch,
ii) Multiplate clutch, iii) Centrifugal Clutch iv) Cone clutch and v) Diaphragm clutch. (Simple numer- icals on single and Multiplate clutch); Bearings – i) Simple Pivot, ii) Collar Bearing, iii) Conical pivot. Torque & power lost in friction (no derivation). Simple numericals.

**UNIT V: Balancing & Vibrations**: Concept of balancing; Balancing of single rotating mass; Graphical method for balancing of several masses revolving in same plane; Concept and terminology used in vibrations, Causes of vibrations in machines; their harmful effects and remedies.

## 38. INDUSTRIAL ENGINEERING & MANAGEMENT

**UNIT-I: Plant Engineering:** Plant; Selection of site of industry; Plant layout; Principles of a good layout; Types; Process; Product and Fixed position; Techniques to improve Layout; Principles of Material handling equipment; Plant maintenance; Importance; Break down maintenance; Preventive maintenance and Scheduled maintenance.

**Plant Safety:** Importance; Accident: Causes and Cost of an Accident, Accident Proneness, Prevention of Accidents; Industrial disputes; Settlement of Industrial disputes; Collective bargaining; Conciliation; Mediation; Arbitration; Indian Factories Act 1948 and its provisions related to health, welfare and safety.

**UNIT-II: Work Study:** Productivity; Standard of living; Method of improving Productivity; Objectives; Importance of good working conditions.

**Method Study:** Definition; Objectives; Selection of a job for method study; Basic procedure for con- duct of Method study; Tools used; Operation process chart; Flow process chart; Two handed process chart; Man Machine chart; String diagram and flow diagram.

**Work Measurement:** Definition; Basic procedure in making a time study; Employees rating fac- tor; Application of time allowances: Rest, Personal, Process, Special and Policy allowances; Calculation of standard time; Numerical Problems; Basic concept of production study; Techniques of Work Measurement; Ratio delay study; Synthesis from standard data; Analytical estimating and Pre deter- mined Motion Time System (PMTS).

**UNIT-III: Production Planning and Control:** Introduction; Major functions of Production Planning and Control; Pre planning; Methods of forecasting; Routing and Scheduling; Dispatching and Con- trolling; Concept of Critical Path Method (CPM); Types of Production: Mass Production, Batch Production and Job Order Production; Characteristics; Economic Batch Quantity (EBQ); Principles of Product and Process Planning; Make or Buy decision; Numerical problems.

**Quality Control:** Definition; Objectives; Types of Inspection: First piece, Floor and Centralized Inspection; Advantages and Disadvantages; Statistical Quality Control; Types of Measurements; Method of Variables; Method of Attributes; Uses of X, R, p and c charts; Operating Characteristics curve (O.C curve); Sampling Inspection; Single and Double Sampling plan; Concept of ISO 9001:2008 Quality Management System Registration/Certification procedure; Benefits of ISO to the organization.

**UNIT-IV: Principles of Management:** Definition of Management; Administration; Organization; F.W. Taylor's and Henry Fayol's Principles of Management; Functions of Manager; Types of Organization: Line, Staff, Taylor's Pure functional types; Line and staff and committee type; Directing; Leadership; Styles of Leadership; Qualities of a good leader; Motivation; Positive and Negative Motivation; Mod- ern Management Techniques; Just In Time; Total Quality Management (TQM); Quality circle; Zero defect concept; 5S Concept; Management Information Systems. **Personnel Management:** Responsibility of Human Resource Management; Selection Procedure; Training of Workers; Apprentice Training; On the Job training and Vestibule School Training; Job Evaluation and Merit Rating; Objectives and Importance; Wages and Salary Administration; Components of Wages; Wage Fixation; Type of Wage Payment: Halsey's 50% Plan, Rowan's Plan and Emerson's efficiency plan; Numerial Problems.

**UNIT-V: Financial Management:** Fixed and Working Capital; Resources of Capital; Shares Prefer- ence and Equity Shares; Debentures; Type of debentures; Public Deposits; Factory Costing: Direct Cost; Indirect Cost; Factory Overhead; Selling Price of a product; Profit; Numerical Problems; Depre- ciation; Causes; Methods: Straight line, sinking fund and percentage on Diminishing Value Method; Numerical Problems.

**Material Management:** Objectives of good stock control system; ABC analysis of Inventory; Pro- curement and Consumption cycle; Minimum Stock, Lead Time, Reorder Level-Economic Order Quan- tity problems; Supply Chain.

## 39. CAD/CAM LAB

| S.No. | Topics for practice |
|---|---|
| PART-A | **Introduction:** Part modelling; Datum Plane; constraint; sketch; dimensioning; extrude; revolve; sweep; blend; protrusion; extrusion; rib; shell; hole; round; chamfer; copy; mirror; assembly; align; orient. |
| | Exercises: 3D Drawings of<br>1). Geneva Wheel; 2). Bearing Block; 3). Bushed bearing: 4). Gib and Cotter joint; 5). Screw Jack; 6). Connecting Rod:<br>Note: Print the orthographic view and sectional view from the above assembled 3D<br>drawing. |
| PART-B | **CNC Programming and Machining:**<br>Introduction; 1). Study of CNC lathe, milling; 2). Study of international standard codes: G-Codes and M-Codes; 3). Format – Dimensioning methods;<br>4). Program writing – Turning simulator – Milling simulator, IS practice – commands menus; 5). Editing the program in the CNC machines; 6). Execute the program in the CNC machines;<br>Exercises:<br>Note: Print the Program from the Simulation Software and make the Component in the CNC Machine. |
| | **CNC Turning Machine:** (Material: Aluminium/Acrylic/Plastic rod)<br>1. Using Linear and Circular interpolation - Create a part program and produce com- ponent in the Machine.<br>2. Using Stock removal cycle – Create a part program for multiple turning operations and produce component in the Machine.<br>3. Using canned cycle - Create a part program for thread cutting, grooving and pro- duce component in the Machine. |
| | **CNC Milling Machine** (Material: Aluminium/ Acrylic/ Plastic)<br>1. Using Linear interpolation and Circular interpolation – Create a part program for grooving and produce component in the Machine.<br>2. Using canned cycle - Create a part program for drilling, tapping, counter sinking and produce component in the Machine.<br>3. Using subprogram - Create a part program for mirroring and produce component in the Machine. |

## 40. MANUFACTURING ENGINEERING LAB-II

| S.No. | Topics for practice |
|---|---|
| I | Drilling Exercise (Three different sized holes for different materials maintaining uniform<br>distance between them) |
| II | Milling-square-hexagon from round bars with indexing and without indexing |
| III | Generation of spur gear teeth on a round bar |
| IV | Simple planning exercise cutting 'T' slots (one model) |
| V | Shaping a Hexagon on a round bar, key ways, grooves splines |
| VI | Shaping step block cut dovetail to angles 60, 90, 120 degrees |

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| VII | Cylindrical grinding of external surface and internal surface using universal grinding machines |
| VIII | Grinding Cutting tools to the required angles |
| IX | Grinding of milling cutters etc, on a tool and cutter grinder |
| X | Grinding flat surface on a surface grinder using magnetic chuck and clamping devices |
| XI | Dismantling some of the components of drilling machine and service, assemble the same |
| XII | Dismantling some of the components of shaper head and then assemble the same |
| XIII | Dismantling some of the components of Milling machines and service, assemble the same |
| XIV | Servicing of universal grinding machine |

**41. Design of Machine Elements**

**UNIT-I: Introduction to Design**: Machine Design philosophy and Procedures; General Consider- ations in Machine Design; Fundamentals: Types of loads, concepts of stress, Strain, Stress – Strain Diagram for Ductile and Brittle Materials, Types of Stresses; Bearing pressure Intensity; Crushing; Bending and Torsion; Principal Stresses; Simple Numericals; Creep strain and Creep Curve; Fatigue; S-N curve; Endurance Limit; Factor of Safety and Factors governing selection of factor of Safety; Stress Concentration: Causes & Remedies; Converting actual load or torque into design load or torque using design factors like velocity factor, factor of safety & service factor; Properties of Engineering materi- als; Designation of materials as per IS and introduction to International standards & advantages of standardization; Use of design data book; Use of standards in design and preferred numbers series; Theories of Elastic Failures; Principal normal stress theory; Maximum shear stress theory & Maxi- mum distortion energy theory.

**UNIT-II: Design of simple machine parts**: Cotter Joint; Knuckle Joint; Turnbuckle; Design of Levers: Hand/Foot Lever & Bell Crank Lever; Design of C–Clamp; Off-set links; Overhang Crank; Arm of Pul- ley.

**Antifriction Bearings**: Classification of Bearings; Sliding contact & Rolling contact; Terminology of Ball bearings: Life Load relationship, Basic static load rating and Basic dynamic load rating, limiting speed; Selection of ball bearings using manufacturer's catalogue.

**UNIT-III: Design of Shafts, Keys, Couplings and Spur Gears:** Types of Shafts; Shaft materials; Stan- dard Sizes; Design of Shafts (Hollow and Solid) using strength and rigidity criteria; ASME code of design for line shafts supported between bearings with one or two pulleys in between or one over- hung pulley; Design of Sunk Keys; Effect of Keyways on strength of shaft; Design of Couplings – Muff Coupling, Protected type Flange Coupling, Bush-pin type flexible coupling; Spur gear design consid- erations; Lewis equation for static beam strength of spur gear teeth; Power transmission capacity of spur gears in bending.

**UNIT-IV: Design of Power Screws**: Thread Profiles used for power Screws - Relative merits and de- merits of each; Torque required to overcome thread friction; Self-locking and overhauling property;

Efficiency of power screws; Types of stresses induced; Design of Screw Jack; Toggle Jack.

Design of springs: Classification and Applications of Springs; Spring terminology; Materials

and Specifications; Stresses in springs; Wahl's correction factor; Deflection of springs; Energy stored in springs; Design of Helical, Tension and Compression springs subjected to uniform applied loads like
I.C. engine valves, Weighing balance, Railway buffers and Governor springs; Leaf springs: Construc- tion and Application.

**UNIT-V:** Design of Fasteners: Stresses in Screwed fasteners; Bolts of Uniform Strength; Design of Bolted Joints subjected to eccentric loading; Design of Parallel and Transverse fillet welds; Axially loaded symmetrical section; Merits and demerits of screwed and welded joints.

Ergonomics & Aesthetic consideration in design: Ergonomics of Design: Man–Machine relation- ship; Design of Equipment for control, environment & safety; Aesthetic considerations regarding shape, size, color & surface finish.

## 42. PRODUCTION & OPERATIONS MANAGEMENT

**UNIT-I: Process Planning and Process Engineering:** Process Planning: Introduction, Function, Pre-requisites and steps in process planning, Factors affecting process planning, Make or buy de- cision, plant capacity and machine capacity. Process Engineering: Preliminary Part Print Analysis: Introduction, Establishing the General Characteristics of work piece, determining the principal Pro- cess, Functional surfaces of the work piece, Nature of the work to be Performed, Finishing and identi- fying operations. Dimensional Analysis: Introduction, types of dimensions, measuring the Geometry of form, Baselines, Direction of specific dimensions. Tolerance Analysis: Causes of work piece varia- tion, Terms used in work piece dimensions, Tolerance stacks. Work piece Control: Introduction, Equi- librium Theories, Concept of location, Geometric Control, Dimensional control, Mechanical control.

**UNIT-II: Production Forecasting:** Introduction of production forecasting, The strategic role of fore- casting in supply chain, Time frame, Demand behavior, Forecasting methods- Qualitative and Quan- titative, Forecast accuracy.

**Scheduling:**

Introduction, Objectives in scheduling, Loading, Sequencing, Monitoring, Advanced Planning and Scheduling Systems, Theory of Constraints, Employee scheduling.

**UNIT-III: Break-Even Analysis:** Introduction, Break-even analysis charts, Breakeven analysis for process, plant and equipment selection.

**Aggregate Operations Planning:** Aggregate production planning, Adjusting capacity to meet the demand, Demand management, Hierarchical and collaborative planning, Aggregate planning for ser- vices.

**UNIT-IV: Assembly Line Balancing:** Assembly lines, Assembly line balancing, Splitting tasks, Flexi- ble and U-shaped line layouts, Mixed model line balancing, Current thoughts on assembly lines, Com- puterized assembly line balancing.

**UNIT-V: Material Management:** Introduction, Importance and objectives, Purchasing and Stores: policies and procedures, Vendor development, selection, analysis and rating.

## 43. BASIC MECHANICAL ENGINEERING

**UNIT-I: Introduction to Thermodynamics** - Role of Thermodynamics in Engineering and Science, Types of Systems, Thermodynamic Equilibrium, Properties, State, Process and

Cycle, Elementary introduction to Zeroth, First and Second laws of thermodynamics, Heat and Work Interactions for various non-flow and flow processes; Concept of Heat Engine, Heat Pump & Refrigerator, Efficiency/ COP; Kelvin-Planck and Clausius Statements, Carnot Cycle, Carnot Efficiency, T-S and P-V Diagrams,Concept of Entropy (Definition only).

**Unit-II: Heat transfer & Thermal Power Plant:** Modes of Heat Transfer; Conduction: Composite Walls and Cylinders, Combined Conduction and Convection: Overall Heat Transfer Co-efficient, Sim-ple Numerical Problems: Thermal Power Plant Layout; Rankine Cycle; Fire Tube and Water Tube boilers, Babcock & Wilcox, Cochran Boilers;

**Unit-III: Steam Turbines:** Impulse and Reaction Turbines; Condensers: Jet & Surface Condensers, Cooling Towers; **Internal Combustion Engines and Refrigeration:** Otto, Diesel and Dual cycles; P-Vand T-S Diagrams; IC Engines: 2 - Stroke and 4 - Stroke I.C. Engines, S.I. and C.I. Engines.

**Unit-IV: Materials and Manufacturing Processes:** Engineering Materials, Classification and their Properties; Metal Casting, Moulding, Patterns, Metal Working: Hot Working and Cold Working, Metal Forming: Extrusion, Forging, Rolling, Drawing, Gas Welding, Arc Welding, Soldering, and Brazing.

**Unit-V: Machine Tools and Machining Processes:** Machine Tools: Lathe Machine and types, LatheOperations, Milling Machine and types, Milling Operations, Shaper and Planer Machines: Differences, Quick-Return Motion Mechanism, Drilling Machine: Operations, Grinding Machine: Operations

## 44. COMPUTER AIDED MACHINE DRAWING PRACTICAL

1. Introduction to CAD software
2. Drawing aids and editing commands
3. Basic dimensioning, hatching, blocks and views
4. Isometric drawing, printing and plotting
5. CAD drawing practice detailed drawings of following machine parts are given to students toassemble and draw the sectional or plain elevations / plans / and side views with dimension-ing and bill of materials using cad software – 12 exercises: sleeve & cotter joint, spigot & cot-ter joint, knuckle joint, stuffing box, screw jack, foot step bearing, universal coupling, plum- mer block, simple eccentric, machine vice, connecting rod, protected type flanged coupling.

## 45. METROLOGY & MEASUREMENTS

**UNIT-I: Introduction to measurements**: Definition of measurement; Significance of measurement;Methods of measurements: Direct & Indirect; Generalized measuring system; Standards of mea- surements: Primary & Secondary; Factors influencing selection of measuring instruments; Terms applicable to measuring instruments: Precision and Accuracy, Sensitivity and Repeatability, Range, Threshold, Hysteresis, calibration; Errors in Measurements: Classification of errors, Systematic andRandom error.

**Measuring instruments:** Introduction; Thread measurements: Thread gauge micrometer; Angle measurements: Bevel protractor, Sine Bar; Gauges: plain plug gauge, ring Gauge, snap gauge, limit gauge; Comparators: Characteristics of comparators, Types of comparators; Surface finish: Defini- tion, Terminology of surface finish, Talysurf surface roughness tester; Co-ordinating measuring ma-chine.

**Unit-II: Transducers and Strain gauges:** Introduction; Transducers: Characteristics, classificationof transducers, two coil self-inductance transducer, Piezoelectric transducer;

Strain Measurements:Strain gauge, Classification, mounting of strain gauges, Strain gauge rosettes-two and three elements.

**Measurement of force, torque, and pressure:** Introduction; Force measurement: Spring Balance, Proving ring, Load cell; Torque measurement: Prony brake, Eddy current, Hydraulic dynamometer;Pressure measurement: Mcloed gauge.

**Unit-III: Applied mechanical measurements:** Speed measurement: Classification of tachometers,Revolution counters, Eddy current tachometers; Displacement measurement: Linear variable Differ-ential transformers (LVDT); Flow measurement: Rotometers, Turbine meter; Temperature measure-ment: Resistance thermometers, Optical Pyrometer.

**Miscellaneous measurements**: Humidity measurement: hair hygrometer; Density measurement: hydrometer; Liquid level measurement: sight glass, Float gauge; Biomedical measurement: Sphygmomonometer.

**Unit-IV: Limits, Fits & Tolerances:** Concept of Limits, Fits, and Tolerances; Selective Assembly; Interchangeability; Hole And Shaft Basis System; Taylor's Principle; Design of Plug; Ring Gauges; IS 919-1993 (Limits, Fits & Tolerances, Gauges} IS 3477-1973; concept of multi gauging and inspection.

**Angular Measurement**: Concept; Instruments For Angular Measurements; Working and Use of Uni- versal Bevel Protractor, Sine Bar, Spirit Level; Principle of Working of Clinometers; Angle Gauges (With Numerical on Setting of Angle Gauges).

**Screw thread Measurements**: ISO grade and fits of thread; Errors in threads; Pitch errors; Mea- surement of different elements such as major diameter, minor diameter, effective diameter, pitch; Two wire method; Thread gauge micrometer; Working principle of floating carriage dial micrometer.

**Unit-V: Gear Measurement and Testing**: Analytical and functional inspection; Rolling test; Mea- surement of tooth thickness (constant chord method); Gear tooth vernier; Errors in gears such as backlash, runout, composite.

**Machine tool testing**: Parallelism; Straightness; Squareness; Coaxiallity; roundness; run out; align-ment testing of machine tools as per IS standard procedure.

**46. FLUID MECHANICS & HYDRAULIC MACHINERY**

**UNIT-I: Properties of fluid:** Density, Specific gravity, Specific Weight, Specific Volume, Dynamic Vis- cosity, Kinematic Viscosity, Surface tension, Capillarity, Vapour Pressure, Compressibility.

**Fluid Pressure & Pressure Measurement:** Fluid pressure, Pressure head, Pressure intensity, Con- cept of vacuum and gauge pressures, atmospheric pressure, absolute pressure, Simple and differen-tial manometers, Bourdan pressure gauge, Concept of Total pressure on immersed bodies, center ofpressure, Simple problems on Manometers.

**Unit-II: Fluid Flow:** Types of fluid flows, Path line and Stream line, Continuity equation, Bernoulli'stheorem, Principle of operation of Venturimeter, Orifice meter and Pitot tube, Derivations for dis- charge, coefficient of discharge and numerical problems.

**Flow Through Pipes:** Laminar and turbulent flows; Darcy's equation and Chezy's equation for fric- tional losses, Minor losses in pipes, Hydraulic gradient and total gradient line, Numerical problems to estimate major and minor losses

**Unit-III: Impact of jets:** Impact of jet on fixed vertical, moving vertical flat plates, Impact of jet on curved vanes with special reference to turbines & pumps, Simple Numericals on work done and efficiency.

**Unit-IV: Hydraulic Turbines:** Layout of hydroelectric power plant, Features of Hydroelectric powerplant, Classification of hydraulic turbines, Selection of turbine on the basis of head and discharge available, Construction and working principle of Pelton wheel, Francis and Kaplan turbines, Draft tubes – types and construction, Concept of cavitation in turbines, Calculation of Work done, Power, efficiency of turbines, Unit quantities and simple numericals.

**Unit-V: Centrifugal Pumps:** Principle of working and applications, Types of casings and impellers, Concept of multistage, Priming and its methods, Cavitation, Manometric head, Work done, Manometric efficiency, Overall efficiency. Numericals on calculations of overall efficiency and power requiredto drive pumps.

**Reciprocating Pumps:** Construction, working principle and applications of single and double actingreciprocating pumps, Concept of Slip, Negative slip, Cavitation and separation.

## 47. INDUSTRIAL PRODUCTION TECHNOLOGY-I

### UNIT-I: Foundry Technology

Patterns: Definition – types of pattern – solid piece – split piece – loose piece – match plate – sweep
– skeleton – segmental – shell – pattern materials – pattern allowances.

Moulding: Moulding sand – constituents – types – properties of moulding sand – moulding sand preparation – moulding tools – moulding boxes – types of moulds – green sand mould – dry sand mould – loam sand mould – methods of moulding – Moulding machines – Jolting – Squeezing – sandslinger Construction and working principle. Cores: Essential qualities of core – materials – core sandpreparation – core binders – core boxes – CO2 process core making – types of core. Metallurgy: Intro- duction – Iron-carbon diagram. Melting furnaces: Blast furnace – Cupola furnace – Crucible furnace
– types – Pit furnace – Coke fired – Oil fired – Electric furnace – types – Direct arc – Indirect arc – In-duction furnace –working principles.

**UNIT-II: Casting:** Shell mould casting – Investment casting – Pressure die casting – Hot chamber diecasting – Cold chamber die casting – Gravity die casting – Centrifugal casting – Continuous casting –Defects in casting – causes and remedies.

### UNIT-III: Welding Technology

Arc Welding: Definition – arc welding equipment – electrode types – filler and flux materials – arc welding methods – Metal arc – Metal Inert gas (MIG) – Tungsten inert gas (TIG) - Submerged arc - Electro slag welding – Resistance welding – Spot welding – Butt welding – Seam welding – Plasma arc welding – Thermit welding – Electron beam welding – Laser beam welding – Friction welding
– Ultrasonic welding – Induction welding – working principle – applications – Advantages and dis- advantages. Gas welding: Oxy-acetylene welding – advantages – limitations – gas welding equipment –three types of flames – welding techniques – filler rods. – Flame cutting – soldering – brazing – difference between soldering and brazing. Types of welded joints –Selection of

welding rod and type of flame for gas welding of ferrous metals- merits and demerits of welded joints – Inspection and testing of welded joints – destructive and non-destructive types of tests – magnetic particle test – radiographic and ultrasonic test - defects in welding – causes and remedies.

**UNIT-IV: Forming Technology**

Forging: Hot working, cold working – advantages of hot working and cold working – hot working operations – rolling, forging, smith forging, drop forging, upset forging, press forging – roll forging. Press Working: Types of presses – mechanical and hydraulic presses – press tools and accessories –press working operations – bending operations – angle bending – channel bending – curling – draw-ing – shearing operations – blanking, piercing, trimming – notching – lancing.

**UNIT-V: Powder Metallurgy**: Methods of manufacturing metal powders – atomization, reduction and electrolysis deposition – compacting – sintering – sizing – infiltration – mechanical properties ofparts made by powder metallurgy – design rules for the power metallurgy process.

**48. HEAT POWER ENGINEERING**

**UNIT-I: Basics of Thermodynamics and Thermodynamic Processes of Perfect Gases:** Introduction – definitions and units of mass, weight, volume, density, specific weight, specific gravity and specific volume – pressure – units of pressure – temperature - absolute temperature – S.T.P and N.T.Pconditions – heat - specific heat capacity at constant volume and at constant pressure – work – power

– energy – types - law of conservation of energy – thermodynamic system – types – thermodynamic

equilibrium - properties of systems – intensive and extensive properties –State of System-process

– cycle – point and path functions - zeroth , first and second laws of thermodynamics – problems Per-fect gases – laws of perfect gases – Boyle's, Charles' , Joule's, Regnault's and Avogadro's laws –GeneralGas Equation- characteristic gas equation – relation between specific heats and gas constant – uni- versal gas constant - problems –Thermodynamic Processes- Change in Internal Energy- enthalpy – change in enthalpy – entropy – change in entropy – general equations for change in entropy. Constant volume, constant pressure, isothermal(hyperbolic) , isentropic ( reversible adiabatic ), polytropic,

– p-V and T-s diagrams, work done , change in internal energy , heat transfer , change in enthalpy ,

change in entropy for various processes – problems - Free expansion and throttling processes.

**UNIT-II: Thermodynamic Air Cycles and Steady Flow Energy Equation & Applications:** Air cy- cles – air standard efficiency – reversible and irreversible processes – assumptions in deriving air standard efficiency – Carnot cycle – Otto cycle – Joule cycle – Diesel cycle – comparison of Otto cycleand Diesel cycle - Comparison of ideal and actual p-V diagrams of Otto and Diesel cycles – problems -dual combustion cycle (description only). Steady flow system – control volume – steady flow energyequation – assumptions –Engineering applications – steam boiler – condenser – nozzles – steam and gas turbines – reciprocating and rotary compressors –Centrifugal pump – non flow energy equation problems.

**UNIT-III: Air Compressors**: Uses of compressed air – classifications of Air compressor – reciprocat-ing compressor - single stage reciprocating compressor – compression processes – power required to drive the compressor ( Neglecting clearance Volume)– problems – clearance volume and its effects

– volumetric efficiency – power required to drive the compressor with clearance volume – problems

– multi stage compression –merits and demerits –Two stage compressor with imperfect cooling- with perfect inter cooling - work input – condition for minimum work input in multi stage com- pressor with perfect inter cooling – ratio of cylinder diameters for minimum work input - problems

– rotary compressors – Roots blower - vane blowers – centrifugal and axial flow air compressors. Gas turbines –uses - classifications – merits and demerits of gas turbines - constant pressure com- bustion gas turbine – gas turbine with – intercooler – reheater - regenerator -effects – closed cycle gas turbines - merits and demerits of open and closed cycle gas turbines – jet propulsion -turbojet engines – merits and demerits – turbo propeller engines – merits and demerits - ramjet– merits anddemerits –Rocket engines – applications of rockets.

**UNIT-IV: Fuels & Combustion of Fuels and Internal Combustion Engines:** Classifications of fu- els - merits and demerits – requirements of a good fuel – combustion equations – stoichiometric air required for complete combustion of fuels – excess air – products of combustion – problems – anal-ysis of exhaust gases- Orsat apparatus - calorific value of fuels – higher and lower calorific values

– Dulong's formula – problems – determination of calorific value – Bomb and Junker's calorimeter

– problems -Internal combustion engines. Classifications of I.C Engines – components of I.C Enginesand functions material and method of manufacturing - four stroke cycle petrol and diesel engines – two stroke cycle petrol and diesel engines - comparison of four stroke and two stroke engines – Com-parison of petrol and diesel engines - valve timing diagram for four stroke petrol and diesel engines

– port timing diagram for two stroke petrol and diesel engines.

**UNIT-V: Refrigeration and Air- Conditioning:** Introduction - COP of Heat Pump and refrigerator, Tonnes of Refrigeration. Vapour compression system - Vapour compression refrigeration cycle, components of Vapour Compression Cycle. Applications- Water Cooler Domestic refrigerator, Ice plant &cold storage. Psychrometry - Properties of air, psychrometric chart & processes (No Numerical) Airconditioning systems - Definition of Air conditioning and classification of Air Conditioning Systems.

## 49. PRODUCTION DRAWING LAB

1. Representation Materials & Machine Components
2. Limits and Fits
3. Form and Positional Tolerances
4. Surface Roughness and its Indication & Heat and Surface Treatment Symbols
5. Detailed and Part Drawings
   a. Stuffing Box
   b. Crosshead
   c. Eccentric
   d. Connecting rod
   e. Screw jack
   f. Pipe vice
   g. Plummer block
   h. Lathe tool post
   i. Oldham coupling

j. Universal coupling
k. Spring
l. loaded relief valve
m. Air cock valve

**50. INDUSTRIAL PRODUCTION TECHNOLOGY LAB-I**

- **Prepare the green sand mould using the following patterns.**
  - **Solid pattern**

    1. Stepped pulley
    2. Bearing top
  - **Split pattern**

    3. Bent Pipe with core print
    4. T-pipes with core print
    5. Tumbles
  - **Loose Piece Pattern**

    6.Dovetail
- **Core preparation**

  6. Core preparation for Bent pipe/T-pipe
- **Make the following welding joint/cutting.**
- **Arc welding (Raw Material: 25 mmx6mm MS flat)**

  1. Lap joint
  2. Butt joint
  3. T-joint
- **Gas Welding (Raw Material: 25mmx3mm Ms flat)**

  4. Lap joint
  5. Butt joint
- **Gas cutting: (GI/MSSheet-3mm thickness)**

  6. Profile cutting–circular profile
- **Spot welding: (GI/MS Sheet)**

  7. Lap joint

**51. PRECISION METROLOGY LAB**

**I. LINEAR MEASUREMENTS:**

1. Determine the thickness of ground MS flat to an accuracy of 0.02mm using Vernier caliper.

2. Determine the diameter and length of cylindrical objects to an accuracy of 0.02mm usingvernier caliper.

3. Determine the inside diameter of a bush component to an accuracy of 0.02 using Verniercaliper.

4. Determine the diameter of a cylindrical component to an accuracy of 0.01mm using mi-crometer and check the result with digital micrometer

5. Determine the height of gauge block or parallel bars to an accuracy of 0.02mm using

Ver-nier height gauge.

6. Determine the depth of a blind bore component to an accuracy of 0.02mm using vernierdepth gauge.

7. Determine the thickness of ground MS plates using slip gauges.

**II. ANGULAR MEASUREMENTS:**

8. Determine the angle of V-block, Taper Shank of Drill and Dovetails in mechanical compo-nents using universal bevel protractor.

9. Determine the angle of machined surfaces of components using sine bar with slip gauges.

**III. GEOMETRIC MEASUREMENT**

10. Measure the geometrical dimensions of V-Thread

11. Measure the geometrical dimensions of spur gear.

**IV. MACHINE TOOL TESTING**

Geometrical Test: Position of machine tool components and displacement of machine toolcomponents relative to one another is checked.

The instruments required for Geometrical tests are Dial Gauge, test mandrel, Straight edge,Squareness, sprit level.

- Test for level of installation of machine tool in Horizontal and Vertical Planes.
- Test for Flatness of machine bed and for straightness and parallelism of bed ways onbearing surface.
- Test for perpendicular of guide ways to other guide ways or bearing surface.
- Test for true running of the main spindle and its axial movements.
- Test for parallelism of spindle axis to guide ways or bearing surfaces.
- Test for line of movements of various members like spindle and table cross slides.
- Practical test in which some test pieces are done and their accuracy and finish is checked.

## 52. HEAT POWER ENGINEERING LAB

List of Experiments:

**PART-A**

1. Determine flash and fire point of the given oil using open cup apparatus.
2. Determine flash and fire point of the given oil using closed cup apparatus.
3. Determine the absolute viscosity of the given lubricating oil using Redwood viscometer.
4. Determine the absolute viscosity of the given lubricating oil using Say bolt viscometer.
5. Port timing diagram of two stroke petrol Engine
6. Valve time diagram for four stroke petrol Engine.
7. Valve time diagram for four stroke diesel engines.

**PART-B**

8. Load test (Performance test) on Four Stroke Petrol Engine.
9. Load test (Performance test) on Four Stroke diesel Engine.
10. Morse test on Multi-cylinder petrol engine.
11. Heat balance test on Four Stroke Petrol engine.
12. Heat balance test on Four Stroke Diesel engine.

13. Volumetric efficiency of Air Compressor.
14. Thermal Conductivity measurement using guarded plate apparatus
15. Determination of COP of Refrigeration System

**PART-C**

16. Study of high-pressure boiler.
17. Study of boiler mountings and Accessories.

## 53. INDUSTRIAL PRODUCTION TECHNOLOGY-II

**UNIT-I: Theory of Metal Cutting:** Theory of Metal Cutting: Cutting tool material-High carbon Steel-High Speed Steel-Stellites-Cemented carbides-ceramics-Composition and applications for the above-Single point cutting tool-nomenclature-tool life- Chip Breakers.

**Drilling Machines:** Drills-Flat drills-Twist drills-Nomenclature-Types of drilling machines-Bench type-Floor type-Radial type-Gang drill-Multi-spindle type-Principle of operation in drilling-Speeds and feeds for various materials-drilling holes-methods of holding drill bit-drill chucks-socket and sleeve-drilling-operation-reaming-counter sinking-counter boring-spot facing-tapping-deep hole drilling.

**Boring Machines:** Boring machines-horizontal and vertical types-fine boring machines-boring tools

**UNIT-II: Reciprocating Machines: Planer:** Types of planers-description of double housing planer specifications- principles of operation-drives-quick return mechanism-feed mechanism- work hold-ing devices and special fixtures-types of tools various operation.

**Shaper:** Types of shapers-specifications-standard-plain-universal principles of opera- tions-drives-quick return mechanism-crank and slotted link-feed mechanism-work holding devic-es-Special fixture-various operations.

**Slotter:** Types of slotters-specifications-method of Operation-Whitworth quick return mecha-nism-feed mechanism-work holding devices-types of tools.

**UNIT-III: Milling Machines:** Types-column and knee type-plain-universal milling machine-verticalmilling machine-specification of milling machines principles of operation-work and tool holding de- vices-arbor-stub arbor spring collet-adapter-milling cutters-cylindrical milling cutter-slitting cutter- side milling cutter-angle milling cutter-T-slot milling cutter-woodruff milling cutter-fly cutter-no- menclature of cylindrical milling cutter-milling process conventional milling-climb milling-milling operations-straddle milling-gang milling-vertical milling attachment.

**Gear Generating Processes:** Gear shaper-Gear hobbing-Principle of operation only-Gear finishing processes-Burnishing-Shaving-Grinding and Lapping; Gear materials-Cast iron, Steel, Alloy steels, Brass, Bronze, Aluminum and Nylon

**UNIT-IV: Abrasive Process and Broaching:** Abrasive Process: Types and classification-specifica- tions-rough grinding – pedestal grinders- portable grinders- belt grinders-precision grinding cy- lindrical grinder- centerless grinders – surface grinder- tool and cutter grinder - planetory grind- ers-principles of operations-grinding wheels abrasives- natural and artificial diamond wheels-typesof bonds-grit, grade and structure of wheels-wheel shapes and sizes-standard marking systems ofgrinding wheels-selection of grinding wheel-mounting of grinding wheels-Dressing and Truing of wheels-Balancing of grinding wheels.

Broaching: Types of broaching machine-horizontal, vertical and continuous broaching-principles ofoperation-types of broaches classification- broach tool nomenclature-broaching operations-simple examples

**UNIT-V: Jigs & Fixtures:** Definitions and concept of Jig and fixture-Advantages of jigs and fixtures-el- ements of jigs and fixtures-locating devices-'V' locators-fixed stop locators-adjustable stop loca- tors-clamping devices strap clamp, screw clamp-cam action clamp-types of jigs-box drill jig indexing drill jig-types of fixtures-keyway milling fixture-string milling fixture.

**Press Working:** Types of presses-mechanical and hydraulic presses press tools and accessories-press working operations-bending operations angle bending-channel bending -curling-Drawing-shearingoperations - blanking, piercing, trimming-notching-lancing-shaving-parting off.

**Non-Conventional Machining Processes:** Construction, working and applications of Ultrasonic machining-chemical machining-electro chemical grinding-electrical discharge machining-plasma arc machining-LASER machining-Advantages – Disadvantages.

## 54. STRENGTH OF MATERIALS

**UNIT-I: Simple Stresses and Strains:** Types of forces; Stress, Strain and their nature; Mechanical properties of common engineering materials; Significance of various points on stress – strain dia- gram for M.S. and C.I. specimens; Significance of factor of safety; Relation between elastic constants; Stress and strain values in bodies of uniform section and of composite section under the influence of normal forces; Thermal stresses in bodies of uniform section and composite sections; Related nu-merical problems on the above topics.

**Strain Energy:** Strain energy or resilience, proof resilience and modulus of resilience; Derivation ofstrain energy for the following cases: i) Gradually applied load, ii) Suddenly applied load, iii) Impact/ shock load; Related numerical problems.

**Unit-II: Shear Force & Bending Moment Diagrams:** Types of beams with examples: a) Cantilever beam, b) Simply supported beam, c) Over hanging beam, d) Continuous beam, e) Fixed beam; Typesof Loads – Point load, UDL and UVL; Definition and explanation of shear force and bending moment;Calculation of shear force and bending moment and drawing the S.F and B.M. diagrams by the analyt-ical method only for the following cases: a) Cantilever with point loads, b) Cantilever with uniformly distributed load, c) Simply supported beam with point loads, d) Simply supported beam with UDL, e)Over hanging beam with point loads, at the centre and at free ends, f) Over hanging beam with UDL throughout, g) Combination of point and UDL for the above; Related numerical problems.

**Unit-III: Theory of Simple Bending and Deflection of Beams:** Explanation of terms: Neutral layer, Neutral Axis, Modulus of Section, Moment of Resistance, Bending stress, Radius of curvature; As- sumptions in theory of simple bending; Bending Equation $M/I = \sigma/Y = E/R$ with derivation; Problems involving calculations of bending stress, modulus of section and moment of resistance; Calculation of safe loads and safe span and dimensions of cross- section; Definition and explanation of deflectionas applied to beams; Deflection formulae without proof for cantilever and simply supported beams with point load and UDL only (Standard cases only); Related numerical problems.

**Unit-IV: Torsion in Shafts and Springs:** Definition and function of shaft; Calculation of polar M.I. for solid and hollow shafts; Assumptions in simple torsion; Derivation of the equation $T/J=f_s/R=G\theta/L$; Problems on design of shaft based on strength and rigidity; Numerical Problems related to com- parison of strength and weight of solid and hollow shafts; Classification of springs; Nomenclatureof closed coil helical spring; Deflection formula for closed coil helical spring (without derivation); stiffness of spring; Numerical problems on closed coil helical spring to find safe load, deflection, sizeof coil and number of coils.

**Unit-V: Thin Cylindrical Shells:** Explanation of longitudinal and hoop stresses in the light of cir- cumferential and longitudinal failure of shell; Derivation of expressions for the longitudinal and hoop stress for seamless and seam shells; Related numerical Problems for safe thickness and safe workingpressure.

## 55. THEORY OF MACHINES AND MECHANISMS

**UNIT I: Cams and Followers:** Concept; Definition and application of Cams and Followers; Classi- fication of Cams and Followers; Different follower motions and their displacement diagrams like uniform velocity, SHM, uniform acceleration and Retardation; Drawing of profile of radial cam with knife-edge and roller follower with and without offset with reciprocating motion (graphical method).

**UNIT II: Power Transmission:** Types of Drives – Belt, Chain, Rope, Gear drives & their comparison;Belt Drives - flat belt, V– belt & its applications; Material for flat and V-belt; Angle of lap, Belt length.Slip and Creep; Determination of Velocity Ratio, Ratio of tight side and slack side tension; Centrifugal tension and Initial tension; Condition for maximum power transmission (Simple numericals);Chain Drives – Advantages & Disadvantages; Selection of Chain & Sprocket wheels; Methods of lubri-cation; Gear Drives – Spur gear terminology; Types of gears and gear trains, their selection for differ-ent applications; Train value & Velocity ratio for compound, reverted and simple epicyclic gear train;Methods of lubrication; Law of gearing; Rope Drives – Types, applications, advantages & limitationsof Steel ropes.

**UNIT III: Flywheel and Governors:** Flywheel - Concept, function and application of flywheel with the help of turning moment diagram for single cylinder 4-Stroke I.C. Engine (no Numericals); Co- efficient of fluctuation of energy, Coefficient of fluctuation of speed and its significance; Governors
- Types and explanation with neat sketches (Centrifugal, Watt and Porter); Concept, function and
applications & Terminology of Governors; Comparison between Flywheel and Governor.

**UNIT IV: Brakes, Dynamometers, Clutches & Bearings:** Function of brakes and dynamometers; Types of brakes and Dynamometers; Comparison between brakes and dynamometers; Construction and working of i) shoe brake, ii) Band Brake, iii) Internal expanding shoe brake iv) Disc Brake; Con- cept of Self Locking & Self energizing brakes; Numerical problems to find braking force and braking torque for shoe & band brakes; Construction and working of i) Rope Brake Dynamometer, ii) Hydrau- lic Dynamometer, iii) Eddy current Dynamometers; Clutches- Uniform pressure and Uniform Wear theories; Function of Clutch and its application; Construction and working of i) Single plate clutch,
ii) Multiplate clutch, iii) Centrifugal Clutch iv) Cone clutch and v) Diaphragm clutch. (Simple numer-icals on single and Multiplate clutch); Bearings – i) Simple Pivot, ii) Collar Bearing, iii) Conical pivot.Torque & power lost in friction (no derivation). Simple numericals.

**UNIT V: Balancing & Vibrations:** Concept of balancing; Balancing of single rotating mass; Graphical method for balancing of several masses revolving in same plane; Concept and terminology used in vibrations, Causes of vibrations in machines; their harmful effects and remedies.

**56. INDUSTRIAL PRODUCTION TECHNOLOGY LAB-II**

**1.0 DRILLING EXERCISE (Three models)**

**1.1** Preparation of model with two or three different sizes holes for different materials

**1.2** Preparation models of different holes by maintain minimum distance between them

**2.0 SHAPING SQUARE (Three models)**

**2.1** Hexagon on a round bar, key ways, grooves splines,

**2.2** Shaping step block cut dovetail to angles 60, 90, 120 degrees.

**3.0 SIMPLE PLANNING EXERCISE CUTTING 'T' SLOTS (One model)**

**4.0 PRACTICES ON MILLING MACHINE (Three models)**

**4.1** Milling-square-hexagon from round bars with indexing and without indexing

**4.2** Milling key ways of different types

**4.3** Generation of spur gear teeth on a round bar.

**4.4** Milling flutes of a twist drill

**4.5** Milling splines and T-slots

**5.0 MOUNTING BALANCING AND DRESSING OF GRINDING WHEELS**

**5.1** Grinding flat surface on a surface grinder using magnetic chuck and clamping devices

**5.2** Cylindrical grinding of external surface and internal surface using universal grinding ma-chines

**5.3** Grinding Cutting tools to the required angles

**5.4** Grinding of milling cutters etc, on a tool and cutter grinder

**6.0 LATHE OPERATIONS**

**6.1** Facing, Step turning & Chamfering

**6.2** Step turning & Groove cutting

**6.3** Step turning & Taper turning

**6.4** Step turning & Knurling

**6.5** Step turning &Thread cutting (L.H)

**6.6** Bush: Turning & Drilling

**57. CAD/CAM LAB**

**PART A: Solid modelling**

Introduction

Part modelling - Datum Plane – constraint – sketch – dimensioning – extrude – revolve – sweep – blend – protrusion – extrusion – rib – shell – hole – round – chamfer – copy – mirror – assembly – align – orient.

Exercises

3D Drawing

1. Geneva Wheel
2. Bearing Block
3. Bushed bearing
4. Gib and Cotter joint
5. Screw Jack

6. Connecting Rod

Note: Print the orthographic view and sectional view from the above assembled 3D drawing.

**PART B: CNC Programming and Machining**

Introduction:

1. Study of CNC lathe, milling.
2. Study of international standard codes: G-Codes and M-Codes
3. Format – Dimensioning methods.
4. Program writing – Turning simulator – Milling simulator, IS practice – commands menus.
5. Editing the program in the CNC machines.
6. Execute the program in the CNC machines.Exercises

Note: Print the Program from the Simulation Software and make the Component in the CNCMachine.

**PART C: CNC Turning Machine Material: Aluminium/Acrylic /Plastic rod**

1. Using Linear and Circular interpolation - Create a part program and produce component inthe Machine.
2. Using Stock removal cycle – Create a part program for multiple turning operations and pro-duce component in the Machine.
3. Using canned cycle - Create a part program for thread cutting, grooving and produce compo-nent in the Machine.

**PART D: CNC Milling Machine Material: Aluminium/ Acrylic/ Plastic**

1. Using Linear interpolation and Circular interpolation – Create a part program for groovingand produce component in the Machine.
2. Using canned cycle - Create a part program for drilling, tapping, counter sinking and producecomponent in the Machine.
3. Using subprogram - Create a part program for mirroring and produce component in the Ma-chine.

## 58. STRENGTH OF MATERIALS & HYDRAULIC MACHINERY LAB

**Strength of Materials Laboratory Exercises**

**1. Test on Ductile Materials:**

Finding Young's Modulus of Elasticity, yield points, percentage elongation and percentage reduction in area, stress strain diagram plotting, tests on mild steel.

**2. Hardness Test:**

Determination of Rockwell's Hardness Number for various materials like mild steel, high car-bon steel, brass, copper and aluminum

**3. Torsion test**:

Torsion test on mild steel – relation between torque and angle of twist-determination of shear modulus and shear stress

**4. Impact test:**

Finding the resistance of materials to impact loads by Izod test and Charpy test

**5. Tests on springs of circular section:**

Determination of modulus of rigidity, strain energy, shear stress and stiffness by load deflec-tion

method (Open / Closed coil spring)

**6. Shear test:**

Single or double shear test on M.S. bar to finding the resistance of material to shear load

**Fluid Mechanics Laboratory Exercises**

1. Verify the Bernoulli's Theorem.
2. Determination of co-efficient of discharge of a mouth piece / orifice by variable head meth-od.
3. Determination of co-efficient of discharge of a venturimeter / orifice meter.
4. Determination of the friction factor in a pipe.
5. Performance test on reciprocating pump / centrifugal pump and to draw the characteris-tics curves.
6. Performance test on impulse turbine / reaction turbine and to find out the Efficiency.

## 59. Introduction MECHATRONICS

**UNIT-I: Introduction**: Mechatronic systems, closed and open loop measurement systems, The Mechatronics approach, Sensors microprocessors and transducers, displacement, position and prox- imity pickups. Mechanical and Electrical activation systems.

**Measurement Systems:** Measurement errors, modelling measurement systems, system, Reliability,signal conditioning & processing, Data acquisition and processing systems, Data presentation.

**Applied Instrumentation:** Measurement of mechanical and process parameters. Measurement of force, torque, temperature, pressure and flow. Measurement of displacement velocity and accelera-tion. Measurement of noise and vibration

**UNIT-II: Programmable Logic Controller (PLC):** Definition – Basic block diagram and structure of PLC – Input/Output processing – PLC Programming: Ladder diagram, its logic functions, latching andsequencing – PLC mnemonics – Timers, internal relays and counters – Shift registers – Master and jump controls – Data handling – Analog input/output – Selection of PLC.

**UNIT-III: Fundamentals of Robot:** Robot – Definition – Co-ordinate Systems, Work Envelope, typesand classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Basic robot motions - Point to point control, Continuous path control. Robot Parts and Their Func- tions – Need for Robots – Different Applications. Robot drive systems and end effectors: Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor,
A.C. Servo Motors – Salient Features, Applications and Comparison of all these Drives. End Effectors
– Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Se- lection and Design Considerations

**UNIT-IV: Sensors and Machine Vision:** Requirements of a sensor, Principles and Applications of the following types of sensors – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Opti- cal Encoders), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Laser Range Meters), Proximity Sensors (Inductive, Capacitive, and Ultrasonic), Touch Sensors, (Binary Sensors,Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors. Camera, Frame Grabber, Sensingand Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques.

**UNIT-V: Robot kinematics and Robot Programming:** Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two Degrees of Free- dom (In 2 Dimensional) – Deviations and Problems. Teach Pendant Programming, Lead through pro- gramming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Com- mands, End effecter commands, and Simple Programs Industrial Applications: Application of robotsin machining, welding, assembly, and material handling.

## 60. INDUSTRIAL ENGINEERING & MANAGEMENT

**UNIT-I: Plant Engineering:** Plant; Selection of site of industry; Plant layout; Principles of a good
layout; Types; Process; Product and Fixed position; Techniques to improve Layout; Principles of Material handling equipment; Plant maintenance; Importance; Break down maintenance; Preventive maintenance and Scheduled maintenance.

**Plant Safety:** Importance; Accident: Causes and Cost of an Accident, Accident Proneness, Prevention of Accidents; Industrial disputes; Settlement of Industrial disputes; Collective bargaining; Concilia- tion; Mediation; Arbitration; Indian Factories Act 1948 and its provisions related to health, welfare and safety.

**UNIT-II: Work Study:** Productivity; Standard of living; Method of improving Productivity; Objec- tives; Importance of good working conditions.

**Method Study:** Definition; Objectives; Selection of a job for method study; Basic procedure for con-duct of Method study; Tools used; Operation process chart; Flow process chart; Two handed processchart; Man Machine chart; String diagram and flow diagram.

**Work Measurement:** Definition; Basic procedure in making a time study; Employees rating fac-tor; Application of time allowances: Rest, Personal, Process, Special and Policy allowances; Calcula- tion of standard time; Numerical Problems; Basic concept of production study; Techniques of WorkMeasurement; Ratio delay study; Synthesis from standard data; Analytical estimating and Pre deter-mined Motion Time System (PMTS).

**UNIT-III: Production Planning and Control:** Introduction; Major functions of Production Planningand Control; Pre planning; Methods of forecasting; Routing and Scheduling; Dispatching and Con- trolling; Concept of Critical Path Method (CPM); Types of Production: Mass Production, Batch Pro- duction and Job Order Production; Characteristics; Economic Batch Quantity (EBQ); Principles of Product and Process Planning; Make or Buy decision; Numerical problems.

**Quality Control:** Definition; Objectives; Types of Inspection: First piece, Floor and Centralized In- spection; Advantages and Disadvantages; Statistical Quality Control; Types of Measurements; Meth-od of Variables; Method of Attributes; Uses of X, R, p and c charts; Operating Characteristics curve (O.C curve); Sampling Inspection; Single and Double Sampling plan; Concept of ISO 9001:2008 Qual- ity Management System Registration/Certification procedure; Benefits of ISO to the organization.

**UNIT-IV: Principles of Management:** Definition of Management; Administration; Organization;
F.W. Taylor's and Henry Fayol's Principles of Management; Functions of Manager; Types of Organiza-tion: Line, Staff, Taylor's Pure functional types; Line and staff and committee type; Directing; Leader-ship; Styles of Leadership; Qualities of a good leader; Motivation; Positive and Negative Motivation;Modern Management Techniques; Just In Time; Total Quality Management (TQM); Quality circle; Zero defect concept; 5S Concept; Management Information Systems.

**Personnel Management:** Responsibility of Human Resource Management; Selection Procedure; Training of Workers; Apprentice Training; On the Job training and Vestibule School Training; Job Evaluation and Merit Rating; Objectives and Importance; Wages and Salary Administration; Compo- nents of Wages; Wage Fixation; Type of Wage Payment: Halsey's 50% Plan, Rowan's Plan and Emer-son's efficiency plan; Numerical Problems.

**UNIT-V: Financial Management:** Fixed and Working Capital; Resources of Capital; Shares Prefer- ence and Equity Shares; Debentures; Type of debentures; Public Deposits; Factory Costing: Direct Cost; Indirect Cost; Factory Overhead; Selling Price of a product; Profit; Numerical Problems; Depre- ciation; Causes; Methods: Straight line, sinking fund and percentage on Diminishing Value Method; Numerical Problems.

**Material Management:** Objectives of good stock control system; ABC analysis of Inventory; Pro-curement and Consumption cycle; Minimum Stock, Lead Time, Reorder Level-Economic Order Quan-tity problems; Supply Chain.

## 61. AUTOMATION & CNC MACHINES

**UNIT-I: Introduction:** Basic concept of Automation, Types of Automation, Feasibility etc, Industrial Hydraulics: Introduction, basic concepts, Hydraulic fluids, Classification and properties of hydraulic fluids, Contaminates in hydraulic system, control and cleanliness standards, Fluid power generators,
i.e. Gear, Vane, Piston pumps, linear and Rotary Actuators, Direction Control Valves, types, actuation methods, pressure control valves; pressure reducing valves, pressure relief valve, Unloading valve, Sequence valve, Counterbalance valve, Flow control valves simple and pressure compensated type.

**UNIT-II: Pneumatics:** Introduction, Basic components, Source, storage and distribution, treatment of compressed air, linear and Rotary actuators, Direction control valves – types, actuation methods,pressure control valves, logic devices – twin pressure valve, shutter valve, time delay valve, Pneu- matic circuit design and analysis, conventional as well as computer aided design. Robotics: Basic concepts, classification based on Geometry, programming, drives, work volume of robots world andjoint coordinates various joints, DOF, end effectors – Types and uses, Sensors in Robots, program- ming – Teach pendant and Computer programming

**UNIT-III: Automatic Assembly System:** Development of Automatic Assembly process, Transfer devices – continuous, Intermittent, synchronous and asynchronous, Vibratory feeders – Mechanics, ef-fect of frequency, acceleration, track angle, friction, load sensitivity, orientation of parts – active andpassive devices, Mechanical feeders – computation and operational details, feed tracks, Escapementdevices. Product design for high-speed automatic assembly, examples of design modifications.

**UNIT-IV: CNC Machine and Components:** CNC Machines: Numerical control – definition – compo- nents of NC systems – development of NC – DNC – Adaptive control systems – working principle of aCNC system – Features of CNC machines - advantage of CNC machines – difference between NC and CNC – Construction and working principle of turning centre – Construction and working principle of machining centers – machine axes conventions turning centre and machining centre – design con- siderations of NC machine tools. CNC EDM machine – Working principle of die sinking and wire EDM machines - Coordinate Measuring Machines: construction and working principles.

Drives: spindle drive – dc motor – Feed drives – dc servo motor and stepper motor – hydraulic sys- tems – Slide ways – requirement – types – friction slide ways and anti-friction slide ways -

linear mo-tion bearings – recirculation ball screw – ATC – tool magazine – feedback devices – linear and rotarytransducers – Encoders - in process probing.

**UNIT-V: Part Programming:** NC part programming – methods – manual programming – conversa- tional programming – APT programming - Format: sequential and word address formats - sequence number – coordinate system – types of motion control: point-to-point, paraxial and contouring – Da-tum points: machine zero, work zero, tool zero NC dimensioning – reference points – tool material
– tool inserts - tool offsets and compensation - NC dimensioning – preparatory functions and G codes,miscellaneous functions and M codes – interpolation: linear interpolation and circular interpolation
- CNC program procedure. Part Program – macro – sub-program – canned cycles: stock – mirror im-ages – thread cutting – Sample programs for lathe: Linear and circular interpolation - Stock removalturning – Peck drilling – Thread cutting and Sample programs for milling: Linear and circular inter-polation – mirroring – sub program – drilling

## 62. TOOL ENGINEERING

**UNIT-I: Jigs and fixtures**: – Necessity for jigs and fixtures - Elements of fixtures, design consider-ations, locators, types of locators, clamping and guiding devices, swarf disposal methods

**UNIT-II: Work holding devices for flat, round and irregular surface**: Design of drill jigs, bush specifications. Fixture for lathe operations, milling, broaching and welding fixtures, fixtures for CNCmachines, modular fixtures.

**UNIT-III: Press working:** tools, blanking and piercing tools, load variation during blanking- Calcula- tion of press tonnage for blanking and piercing. Types of dies, simple, compound, combination and progressive dies- Design of compound and progressive dies. Bending and drawing dies: Bending al-lowances, bending methods. Bending pressure-calculation of blank size and press tonnage for draw- ing, metal flow during drawing operations - Fine blanking, Embossing and Coining.

**UNIT-IV: Tool for forging, Design of drop forging dies:** - Rolling, strip rolling theory, stress distri- bution in rolling, Roll separation force and torque. Forces acting on single point and multiple point cutting tools

**UNIT-V: CAD for tooling:** Turret press FMS-Computer applications (CAD / CAM) in short metal press work – Quick die change method – Single minute exchange of dies- group tooling –Design of single point tools – Plastic as a tooling materials – Fluidized bed fixturing.

1. Metal Hand Book- ASM

## 63. INDUSTRIAL EQUIPMENT MAINTENANCE

**UNIT-I: Introduction:** Maintenance, Need of Maintenance Management, Maintenance Policies, Strat- egies and options in Maintenance management. Maintenance forms/actions and their inter relation-ships, Brief descriptions of various Maintenance actions.

**UNIT-II: Maintenance Organizations:** Prerequisities, factors determining effectiveness of a Main- tenance organization, objectives of organization design, types of organization. Maintenance Plan- ning and Control: Establishing a Maintenance Plan-Preliminary consideration, Systematic method ofMaintenance Plan and schedule planning and schedule of Plant shut downs

**UNIT-III: Maintenance practices on production machines**: Lathe, Drilling, Milling, Welding, Shaper. Use of computer in maintenance, Machine Reconditioning. Evaluation of Maintenance Man-agement: Need for evaluation a to z objectives, criterion of evaluation.

**UNIT-IV: Spare Parts Management:** Capacity utilization, cost reduction approach to spares, reliabil- ity and quality of spares, spare parts procurement, inventory control of spare parts.

**UNIT-V: Introduction:** friction, wear and lubrication, Historical background, Purpose of lubrication,
Lubrication regimes, Characteristics of lubricants - viscosity, viscosity index, oxidation stability, flash point and fire point, pour point and cloud point, carbon residue, ash content, iodine value, neutral- ization number, dielectric strength, Composition and classification of lubricants, Lubricating oils – oil refining, types, categories, grading, Grease - composition, function, characteristics, thickeners and additives, soap and its complexes, selection and its practices, solid lubricants, Functional additives – surface, performance enhancing, lubricant protective , Lubricants applications – tribological compo- nents and industrial machinery, Lubricants testing and test methods, Organization and management of lubrication, lubricant storage and handling, Safety and health hazards, Environmental regulations.

**64. CAD/CAM**

**UNIT-I: Fundamentals of CAD/CAM:** Automation; Design process; Application of computers for de- sign; Benefits of CAD; Computer configuration for CAD applications; Design workstation; Graphic terminal; CAD Software: Definition of system software and application software; CAD database and structure.

**65. MECHATRONICS**

**UNIT-I: Introduction to Mechatronics:** Mechatronics; Importance of Mechatronics; Systems: Mea-surement systems; Control systems and their types; Closed-loop control System; Automatic water level controller; Sequential controllers-washing machine

**Measurement System terminology**: Displacement, Position & Proximity Sensors; Velocity and Mo-tion Sensors; Force Sensors; Fluid Pressure Sensors; Flow Sensors; Liquid Level Sensors; Tempera- ture Sensors; Light Sensors; Selection of Sensors.

**Unit-II:Mechanical Actuation Systems**: Types of motion; Freedom and constraints; Loading; Gear Trains; Pawl & Ratchet; Belt & Chain drives; Bearings: Selection, Ball & Roller bearings; Mechanical aspects of motor selection.

**Electrical Actuation Systems**: Switches & Relays; Solenoids; D.C Motors; A.C.Motors; Stepper Mo- tors: Specifications and Control of stepper motors; Servomotors: D.C Servomotor and A.C Servomo-tor.

**Pneumatic & Hydraulic Systems:** Power supplies; DCV; PCV; Cylinders; Rotary actuators.

**Unit-III:Mathematical Model**: Introduction to Mathematical model; Mechanical System building blocks; Electrical System building blocks; Fluid System building blocks; Thermal System building blocks.

**System Model**: Engineering.Systems: Rotational, Translational Systems; Electro-Mechanical System; Hydro-Mechanical System.

**Input/Output Systems:** Interfacing; Input/output ports; Interface requirements: Buffers, Hand-shaking, Polling and interrupts, Serial interfacing; Introduction to PIA; Serial communications inter-face; Example of interfacing of a seven-segment display with a decoder.

**Unit-IV: Programmable Logic Controller (PLC):** Definition; Basic block diagram and structure of PLC; Input/Output processing; PLC Programming: Ladder diagram, its logic functions, Latching andSequencing; PLC mnemonics; Timers; Internal relays and Counters; Shift registers; Master and JumpControls; Data handling; Analog input/output; Selection of PLC.

**Unit-V: Design Examples & Advanced Applications in Mechatronics:** Design process stages;Traditional Vs Mechatronics designs; Possible design solutions: Timed switch, Wind-screen wiper motion, Bath room scale; Case studies of Mechatronics systems: A pick-and-place robot, Car park barrier, Car engine management system, Automatic Camera and Automatic Washing Machine only.

**Sensors for Condition Monitoring Systems of Production Systems**: Examples of Monitoring methods: Vibration monitoring, Temperature monitoring, Wear behavior monitoring; Mechatronicscontrol in automated manufacturing: Monitoring of Manufacturing processes, On-line quality moni-toring, Model based systems, Hardware in-the-loop simulation, Supervisory control in manufactur- ing inspection, Integration of heterogeneous systems.