SYLLABUS FOR GROUP-7

[Mechatronics Engineering / Mechanical Engineering/ Instrumentation Engineering / Electrical 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 ap- plications.

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. 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.

12. 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.

13. 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.

14. 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.

15. 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.

16. 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 options, do it multiple times
5	Connect various peripherals (printer, scanner, etc.) to computer, explore various features 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 (Refriger- ants, 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 Refrig- erants, 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 Tur-
bidity, pH, total suspended solids, total solids BOD and COD: Definition, calculation

Waste Water Treatment: Primary methods: sedimentation, froth floatation, Secondary meth- ods: Activated sludge treatment, Trickling filter, Bioreactor, Tertiary Method: Membrane sepa- ration 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 col- lector. 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, bio- medical 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). 1) Sleeve & Cotter Joint 2) Spigot & Cotter Joint 3) Knuckle Joint 4) Stuffing Box 5) Screw Jack 6) Foot Step Bearing 7) Universal Coupling 8) Plummer Block 9) Simple Eccentric 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. 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 (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 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 de- flection 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 compare 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.
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; Ultrasonic 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; ex- trude; revolve; sweep; blend; protrusion; extrusion; rib; shell; hole; round; chamfer; copy; mirror; assembly; align; orient.
	Exercises: 3D Drawings of 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 CNC Machine.
	CNC Turning Machine: (Material: Aluminium/Acrylic/Plastic rod) 1. Using Linear and Circular interpolation - Create a part program and produce component in the Machine. 2. Using Stock removal cycle – Create a part program for multiple turning operations and produce component in the Machine. 3. Using canned cycle - Create a part program for thread cutting, grooving and produce component in the Machine.
	CNC Milling Machine (Material: Aluminium/ Acrylic/ Plastic) 1. Using Linear interpolation and Circular interpolation – Create a part program for grooving and produce component in the Machine. 2. Using canned cycle - Create a part program for drilling, tapping, counter sinking and produce component in the Machine. 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 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
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. Introduction to 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.

44. INTRODUCTION TO ELECTRIC GENERATION SYSTEMS

Unit – I Thermal Power Plants: Coal, Gas/ Diesel and Nuclear-based

Layout and working of a typical thermal power plant with steam turbines and electricgenerators.

Properties of conventional fuels used in the energy conversion equipment used in thermal power plants: Coal, Gas/ diesel, Nuclear fuels –fusion and fission action Safe Practices and working of various thermal power plants: coal-based, gas-based,diesel-based, nuclear-based.

Functions of the following types of thermal power plants and their major auxiliaries: Coal fired boilers: fire tube and water tube.

Gas/diesel based combustion engines

Types of nuclear reactors: Disposal of nuclear waste and nuclear shielding.Thermal power plants in Maharashtra.

Unit – II Large and Micro-Hydro Power Plants

Energy conversion process of hydro power plant.

Classification of hydro power plant: High, medium and low head.

Construction and working of hydro turbines used in different types of hydro powerplant:

a. High head – Pelton turbine
b. Medium head – Francis turbine
c. Low head – Kaplan turbine.

Safe Practices for hydro power plants.

Different types of micro- hydro turbines for different heads: Pelton, Francis and Kaplan turbines Locations of these different types of large and micro-hydro power plants in Maharashtra Potential locations of micro-hydro power plants in Maharashtra.

Unit– III Solar and Biomass based Power Plants

Solar Map of India: Global solar power radiation.

Solar Power Technology

a. Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors
b. Solar Photovoltaic (PV) power plant: layout, construction, working.

Biomass-based Power Plants

a. Layout of a Bio-chemical based (e.g. biogas) power plant:
b. Layout of a Thermo-chemical based (e.g. Municipal waste) power plant
c. Layout of an Agro-chemical based (e.g. bio-diesel) power plant

Features of the solid, liquid and gas biomasses as fuel for biomass power plant.

Unit– IV Wind Power Plants

Wind Map of India**:** Wind power density in watts per square meter

Layout of Horizontal axis large wind power plant:

Geared wind power plant. Direct-drive wind power plant.

Salient Features of electric generators used in large wind power plants: Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG), Wound Rotor Induction Generator (WRIG)

Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronousgenerator (PMSG)

Unit– V Economics of Power Generation and Interconnected Power System Related terms: connected load, firm power, cold reserve, hot reserve, spinning reserve. Base load and peak load plants; Load curve, load duration curve, integratedduration curve

Cost of generation: Average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor. Choice of size and number of generator units, combined operation of power station.Causes and Impact and reasons of Grid system fault: State grid, national grid, brownout and black out; sample blackouts at national and

international level

45. INTRODUCTION TO ELECTRIC GENERATION SYSTEMSLABORATORY

1. Identify the routine maintenance parts of the coal fired thermal power plant after watching a video programme
2. Identify the routine maintenance parts of the gas fired thermal power plant after watching a video programme
3. Assemble and dismantle a small diesel generator power plant.
4. Identify the routine maintenance parts of the nuclear fired thermal power plant after watching a video programme.
5. Identify the routine maintenance parts of the large hydro power plant after watching a video programme
6. Identify the routine maintenance parts of the micro hydro power plant after watching a video programme.
7. Assemble a micro hydro power plant and then dismantle it.
8. Assemble the parabolic trough or parabolic dish Concentrated Solar Power (CSP) plant.
9. Dismantle the parabolic trough or parabolic dish CSP plant.
10. Assemble the solar PV plant to produce electric power and then dismantle it.
11. Assemble a small biogas plant to generate electric power
12. Dismantle the biogas plant.
13. Identify the routine maintenance parts of the large wind power plant after watching a video programme.
14. Assemble a horizontal axis small wind turbine to produce electric power
15. Dismantle a horizontal axis small wind turbine.
16. Assemble a vertical axis small wind turbine to produce electric power and then dismantle it.
17. Identify the routine maintenance parts of the horizontal axis small wind turbine after watching a video programme.
18. Identify the routine maintenance parts of the vertical axis small wind turbine after watching a video programme.

46. ELECTRIC CIRCUITS

Unit – I Single Phase A.C Series Circuits

Generation of alternating voltage, Phasor representation of sinusoidal quantities R, L, C circuit elements its voltage and current response

R-L, R-C, R-L-C combination of A.C series circuit, impedance, reactance, impedance triangle, Power factor, active power, reactive power, apparent power, power triangle and vector diagram

Resonance, Bandwidth, Quality factor and voltage magnification in series R-L, R-C, R-L-C circuit

Unit – II Single Phase A.C Parallel Circuits

R-L, R-C and R-L-C parallel combination of A.C. circuits. Impedance, reactance, phasor

diagram, impedance triangle

R-L, R-C, R-L-C parallel A.C. circuits power factor, active power, apparent power, reactive power, power triangle

Resonance in parallel R-L, R-C, R-L-C circuit, Bandwidth, Quality factor and voltage magnification

Unit– III Three Phase Circuits

Phasor and complex representation of three phase supply

Phase sequence and polarity

Types of three-phase connections, Phase and line quantities in three phase star anddelta system

Balanced and unbalanced load, neutral shift in unbalanced load

Three phase power, active, reactive and apparent power in star and delta system.

Unit– IV Network Reduction and Principles of Circuit Analysis

Source transformation

Star/delta and delta/star transformationMesh Analysis

Node Analysis

Unit– V Network Theorems Superposition theorem.Thevenin's theorem.

Norton's theorem

Maximum power transfer theorem

Reciprocity theorem Duality in electric circuits

47. ELECTRIC CIRCUITS LABORATORY

1. Use dual trace oscilloscope to determine A.C voltage and current response in given R, L, Ccircuit.
2. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power con-sumed in given R-L series circuit. Draw phasor diagram.
3. Use voltmeter, ammeter to determine active, reactive and apparent power consumed in givenR-C series circuit. Draw phasor diagram.
4. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power con-sumed in given R-L-C series circuit. Draw phasor diagram.
5. Use variable frequency supply to create resonance in given series R-L-C circuit or by usingvariable inductor or variable capacitor.
6. Use voltmeter, ammeter, wattmeter to determine current, p.f. , active, reactive and apparentpower in R-C parallel A.C. circuit.
7. Use voltmeter, ammeter, wattmeter, p.f meter to determine current, p.f., active, reactive and apparent power for given R-L-C parallel circuit with series connection of resistor and induc-tor in parallel with capacitor.
8. Use variable frequency supply create resonance in given parallel R-L-C circuit or by using variable inductor or capacitor.
9. Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of volt- age and current for balanced three phase star and delta connected load and calculate active,reactive, and apparent power. Draw phasor diagram.
10. Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase

quantities of volt-age and current for unbalanced three phase star and delta connected load and calculate ac- tive, reactive, and apparent power. Draw phasor diagram.

11. Use voltmeter, ammeter to determine current through the given branch of a electric networkby applying mesh analysis.
12. Use voltmeter, ammeter to determine current through the given branch of a electric networkby applying node analysis.
13. Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem.
14. Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by apply-ing Thevenin's theorem
15. Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by ap- plying Norton's theorem
16. Use voltmeter, ammeter to determine load resistance for maximum power transfer for a giv-en circuit by applying maximum power transfer theorem.

48. ELECTRICAL AND ELECTRONIC MEASUREMENTS

Unit – I Fundamentals of Measurements

Measurement: Significance, units, fundamental quantities and standards Classification of Instrument Systems:

Null and deflection type instrumentsAbsolute and secondary instrumentsAnalog and digital instruments

Static and dynamic characteristics, types of errorsCalibration: need and procedure

Classification of measuring instruments: indicating, recording and integrating instruments.

Essential requirements of an indicating instruments

Unit – II Measurement of voltage and current

DC Ammeter: Basic, Multi range, Universal shunt,

DC Voltmeter: Basic, Multi-range, concept of loading effect and sensitivity

AC voltmeter: Rectifier type (half wave and full wave)

CT and PT: construction, working and applications.Clamp-on meter.

Unit– III Measurement of Electric Power

Analog meters: Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter, their construction, working, salient features, merits and demerits

Dynamometer type wattmeter: Construction and working Range: Multiplying factor and extension of range using CT and PTErrors and compensations.

Active and reactive power measurement: One, two and three wattmetermethod.

Effect of Power factor on wattmeter reading in two wattmeter method.

Maximum Demand indicator

Unit– IV Measurement of Electric Energy

Single and three phase electronic energy meter: Constructional features andworking principle.

Errors and their compensations.

Calibration of single phase electronic energy meter using direct loading.

Unit– V Circuit Parameter Measurement, CRO and Other Meters

Measurement of resistance:

Low resistance: Kelvin's double bridge,

Medium Resistance: Voltmeter and ammeter method

High resistance: Megger and Ohm meter: Series and shunt

Measurement of inductance using Anderson bridge (no derivation and phasor diagram)

Measurement of capacitance using Schering bridge (no derivation and phasor diagram) Single beam/single trace CRO, Digital storage Oscilloscope**:** Basic block diagram, working,
Cathode ray tube, electrostatic deflection, vertical amplifier, time base generator, horizontal amplifier, measurement of voltage/ amplitude/ time period/ frequency/ phase angle delay line, specifications.

Other meters: Earth tester, Digital Multimeter; L-C-R meter, Frequency meter (ferromagnet-ic and Weston type), Phase sequence indicator, power factor meter (single phase and three phase dynamometer type), Synchro scope, Tri-vector meter

Signal generator: need, working and basic block diagram.

Function generator: need, working and basic block diagram, function of symmetry.

49. ELECTRICAL AND ELECTRONIC MEASUREMENTS LABORATORY

1. Identify measuring instruments on the basis of symbols on dial, type, accuracy, class positionand scale.
2. Identify the components of PMMC and MI instruments.
3. Troubleshoot PMMC and MI instruments.
4. Measure AC and DC quantities in a working circuit.
5. Extend range of ammeter and voltmeter by using (i) shunt and multiplier (ii) CT and PT.
6. Use Clamp-on meter for measurement of AC/DC current, AC/DC voltage.
7. Use electro-dynamic watt-meter for measurement of power in a single phase circuit
8. Troubleshoot electrodynamic watt-meter for measurement of power in a single phase circuit
9. Use single wattmeter for measurement of active and reactive power of three phase balanced load.
10. Use two watt-meters for measuring active power of three-phase balanced load.
11. Calibrate single phase electronic energy meter by direct loading.
12. Troubleshoot single phase electronic energy meter.
13. Use digital multi-meter for measurement of AC/DC current, AC/DC voltage.
14. Use Kelvin's double bridge for measurement of low resistance.
15. Use voltmeter and ammeter method for measurement of medium resistance.
16. Use Megger for insulation resistance measurements.
17. Use earth tester for measurement of earth resistance.

18. Use CRO for the Measurement of supply frequency in single-phase circuit.
19. Use Tri-vector meter for measuring kW, kVAr and kVA of a power line.

50. ELECTRIC MOTORS AND TRANSFORMERS

Unit – I DC Generators

DC generator: construction, parts, materials and their functions.

Principle of operation of DC generator: Fleming's right hand rule, schematicdiagrams, e.m.f. equation of generator, armature reaction, commutation and.

Applications of DC generators. Classification of measuring instruments: indicating, recording and integrating instruments.

Unit – II D.C. Motors

DC motor: Types of DC motors. Fleming's left hand rule, Principle of operation of, Back e.m.f. and its significance, Voltage equation of DC motor.

Torque and Speed; Armature torque, Shaft torque, BHP, Brake test, losses, efficiency.

DC motor starters: Necessity, two point and three point starters.

Speed control of DC shunt and series motor: Flux and Armature control.

Brushless DC Motor: Construction and working.

Unit– III Single Phase Transformers

Types of transformers: Shell type and core type; Construction: Parts and functions, materialsused for different parts: CRGO, CRNGO, HRGO, amorphous cores,

Transformer: Principle of operation, EMF equation of transformer: Derivation, Voltage transformation ratio,

Significance of transformer ratings

Transformer No-load and on-load phasor diagram, Leakage reactance, Equivalent circuit of transformer: Equivalent resistance and reactance.

Voltage regulation and Efficiency: Direct loading, OC/SC method, All day efficiency.

Unit– IV Three Phase Transformers

Bank of three single phase transformers, Single unit of three phase transformer Distribution and Power transformers.

Construction, cooling, Three phase transformers connections as per IS:2026 (part IV)-1977, Three phase to two phase conversion (Scott Connection), Selection of transformer as per IS: 10028 (Part I)-1985, Criteria for selectionof distribution transformer, and power transformer, Amorphous Core type Distribution Transformer, Specifications of three-phase distribution transformers as per IS:1180 (part I)-1989

Need of parallel operation of three phase transformer, Conditions forparallel operation.

Polarity tests on mutually inductive coils and single phase transformers;Polarity test, Phasing out test on Three-phase transformer.

Unit– V Special Purpose Transformers

Single phase and three phase auto transformers: Construction, working and applications.

Instrument Transformers: Construction, working and applications of Current transformer and Potential transformer.

Isolation transformer: Constructional Features and applications.

Single phase welding transformer: constructional features and applications.Pulse transformer: constructional features and applications.

'K' factor of transformers: overheating due to non-linear loads and harmonics.

51. ELECTRIC MOTORS AND TRANSFORMERS LABORATORY

1. Dismantle a DC machine.
2. Reverse the direction of rotation of the DC shunt motor.
3. Perform brake test on DC shunt motor.
4. Control the speed of DC shunt motor by different methods.
5. Control the speed of DC series motor by different methods.
6. Perform the brake test on DC series motor.
7. Check the functioning of single phase transformer.
8. Determine regulation and efficiency of single phase transformer by direct loading.
9. Perform open circuit and short circuit test on single phase transformer to determine equiva-
   lent circuit constants, voltage regulation and efficiency.
10. Perform parallel operation of two single phase transformers to determine the load currentsharing.
11. Perform parallel operation of two single phase transformers and determine the apparent andreal power load sharing.
12. Perform polarity test on a single phase transformer whose polarity markings are masked.
13. Perform phasing out test on a three phase transformer whose phase markings are masked.
14. Connect the auto-transformer in step-up and step-down modes noting the input/output read-ings.
15. Check the functioning of the CT, PT and isolation transformer.
16. Test the pulse transformer.

52. Renewable Energy Power Plants

Unit – I Solar PV and Concentrated Solar Power Plants

Solar Map of India: Global solar power radiation, Solar PV

Concentrated Solar Power (CSP) plants, construction and working of: Power Tower,

Parabolic Trough, Parabolic Dish, Fresnel Reflectors

Solar Photovoltaic (PV) power plant: components layout, construction, working.Rooftop solar PV power system

Unit – II Large Wind Power Plants

Wind Map of India: Wind power density in watts per square meterLift and drag principle; long path theory.

Geared type wind power plants: components, layout and working. Direct drive type wind power plants: components, layout and working.

Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG),

Wound Rotor Induction Generator (WRIG); Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent mag- net

synchronous generator (PMSG).

Unit– III Small Wind Turbines

Horizontal axis small wind turbine: direct drive type, components and workingHorizontal axis small wind turbine: geared type, components and working

Vertical axis small wind turbine: direct drive and geared, components and working Types of towers and installation of small wind turbines on roof tops and open fields.Electric generators used in small wind power plants

Unit– IV Micro-hydro Power Plants

Energy conversion process of hydro power plant.

Classification of hydro power plant: High, medium and low head.

Layouts of micro-hydro power plants

Construction and working of hydro turbines used in different types of hydro power plant:

- High head – Pelton turbine
- Medium head – Francis turbine
- Low head – Kaplan turbine.

Safe Practices for micro hydro power plants.

Unit– V Biomass-based Power Plants

Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk,municipal waste

Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-dieselgobar gas

Layout of a Bio-chemical based (e.g. biogas) power plant:

Layout of a Thermo-chemical based (e.g. Municipal waste) power plantLayout of a Agro-chemical based (e.g. bio-diesel) power plant

53. Renewable Energy Power Plants Laboratory

1. Dismantle the parabolic trough CSP plant.
2. Assemble the parabolic trough Concentrated Solar Power (CSP) plant.
3. Assemble the parabolic dish CSP plant.
4. Dismantle the parabolic dish CSP plant.
5. Assemble the solar PV plant to produce electric power.
6. Dismantle the solar PV plant.
7. Identify the routine maintenance parts of the large wind power plant after watching a videoprogramme.
8. Assemble a horizontal axis small wind turbine to produce electric power
9. Dismantle a horizontal axis small wind turbine.
10. Assemble a vertical axis small wind turbine to produce electric power
11. Dismantle a vertical axis small wind turbine.
12. Identify the routine maintenance parts of the micro hydro power plant after watching a videoprogramme.
13. Assemble a micro hydro power plant.
14. Dismantle a micro hydro power plant.
15. Assemble a small biogas plant to generate electric power

16. Dismantle the biogas plant.

54. Fundamentals of Power Electronics

Unit – I Power Electronic Devices

Power electronic devices

Power transistor: construction, working principle, V-I characteristics and uses. IGBT: Construction, working principle, V-I characteristics and uses.

Concept of single electron transistor (SET) - aspects of Nano- technology.

Unit – II Thyristor Family Devices

SCR: construction, two transistor analogy, types, working and characteristics.SCR mounting and cooling.

Types of Thyristors: SCR, LASCR, SCS, GTO, UJT, PUT, DIAC and TRIAC

Thyristor family devices: symbol, construction, operating principle and V-I characteristics. Protection circuits: over-voltage, over-current, Snubber, Crowbar.

Unit– III Turn-on and Turn-off Methods of Thyristors

SCR Turn-On methods: High Voltage thermal triggering, Illumination triggering, dv/dt triggering, Gate triggering.

Gate trigger circuits – Resistance and Resistance-Capacitance circuits.

SCR triggering using UJT, PUT: Relaxation Oscillator and Synchronized UJT circuit.

Pulse transformer and opto-coupler based triggering.

SCR Turn-Off methods: Class A- Series resonant commutation circuit, Class B-Shunt Resonant commutation circuit, Class C-Complimentary Symmetry commutation circuit, Class D –Auxiliary commutation, Class E- External pulse commutation, Class F- Line or natural commutation.

Unit– IV Phase Controlled Rectifiers

Phase control: firing angle, conduction angle.

Single phase half controlled, full controlled and midpoint controlled rectifier with R, RL load: Circuit diagram, working, input- output waveforms, equations for DC output and effectof freewheeling diode.

Different configurations of bridge controlled rectifiers: Full bridge, half bridge with common anode, common cathode, SCRs in one arm and diodes in another arm.

Unit– V Industrial Control Circuits

Applications: Burglar's alarm system, Battery charger using SCR, Emergency light system, Temperature controller using SCR and; Illumination control / fan speed control TRIAC.

SMPS.

UPS: Offline and Online

SCR based AC and DC circuit breakers.

55. FUNDAMENTALS OF POWER ELECTRONICS LABORATORY

1. Test the proper functioning of power transistor.

2. Test the proper functioning of IGBT.
3. Test the proper functioning of DIAC to determine the break over voltage.
4. Determine the latching current andholding current using V-I characteristics of SCR.
5. Test the variation of R, C in R and RC triggering circuits onfiring angle of SCR.
6. Test the effect of variation of R, C in UJT triggering technique.
7. Perform the operation of Class – A, B, C, turn off circuits.
8. Perform the operation of Class –D, E, F turn off circuits.
9. Use CRO to observe the output waveform of half wave controlled rectifier with resistive load and determine the load voltage.
10. Draw the output waveform of Full wave controlled rectifier with R load, RL load, free wheeling diode and determine the load voltage.
11. Determine the firing angle using DIAC and TRIAC phase controlled circuit on output power under different loads such as lamp, motor or heater
12. Simulate above firing angle control on SCILAB software
13. Test the performance of given SMPS, UPS.
14. Troubleshoot the Burglar's alarm, Emergency light system, Speed control system, Temperaturecontrol system.

56. ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

Unit – I Basics of Transmission and Distribution

Single line diagrams with components of the electric supply transmission and distribution systems.

Classification of transmission lines: Primary and secondary transmission; standard voltage level used in India.

Classification of transmission lines: based on type of voltage, voltage level, length and others

Characteristics of high voltage for power transmission.

Method of construction of electric supply transmission system – 110 kV, 220 kV, 400 kV. Method of construction of electric supply distribution systems – 220 V, 400V, 11 kV, 33 kV

Unit – II Transmission Line Parameters and Performance

Line Parameters: Concepts of R, L and C of line parameters and types of lines.Performance of short line: Efficiency, regulation and its derivation, effect of power factor, vector diagram for different power factor.

Performance of medium line: representation, nominal 'T', nominal 'π' and end

condenser methods.

Transposition of conductors and its necessity.

Skin effect and proximity effect.

Unit– III Extra High Voltage Transmission

Extra High Voltage AC (EHVAC) transmission line**:** Necessity, high voltage substation components such as transformers and other switchgears, advantages, limitations and applications and lines in India. Ferranti and Corona effect.

High Voltage DC (HVDC) Transmission Line**:** Necessity, components, advantages,limitations and

applications. Layout of monopolar, bi-Polar and homo-polar transmission lines. Lines in India.

Features of EHVAC and HVDC transmission line.

Flexible AC Transmission line: Features, d types of FACTS controller.

New trends in wireless transmission of electrical power.

Unit– IV A.C Distribution System

AC distribution: Components classification, requirements of an ideal distribution system, primary and secondary distribution system.

Feeder and distributor, factors to be considered in design of feeder anddistributor.

Types of different distribution schemes: radial, ring, and grid, layout, advantages, disadvantages and applications.

Voltage drop, sending end and receiving end voltage.

Distribution Sub-Station: Classification, site selection, advantages, disadvantages and applications.

Single Line diagram (layout) of 33/11KV Sub-Station, 11KV/400V sub-station,Symbols and functions of their components.

Unit– V Components of Transmission and Distribution Line

Overhead Conductors**:** Properties of material, types of conductor with trade names, significance of sag.

Line supports: Requirements, types of line structures and their specifications, methods of erection.

Line Insulators**:** Properties of insulating material, selection of material, types of insulators and their applications, causes of insulator failure, derivation of equation of string efficiency for string of three suspension insulator, methods of improving string efficiency.

Underground Cables**:** Requirements, classification, construction, comparison with overhead lines, cable laying and cable jointing.

57. ELECTRIC POWER TRANSMISSION AND DISTRIBUTION LABORATORY

Laboratory work is not applicable for this course.

Following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare a report based on transmission line network in Maharashtra.
b. Collect the information on components of transmission line.
c. Evaluate transmission line performance parameters of a given line.
d. Library/Internet survey of electrical high voltage line and HVDC lines.
e. Visit to 33/11 KV and 11KV/400V Distribution Substation and write a report

Also one micro-project can be assigned to the student. A suggestive list of micro-projects is givenhere. Similar micro-projects could be added by the concerned faculty:

a. Prepare a model showing:

i. Single line diagram of electric supply system.
ii. Single line diagram of a given distribution system.
iii. Short line and medium transmission line.
iv. Write a report on the same by giving the details of lines in Maharashtra State.

b. Collect different samples of Overhead Conductors, Underground Cables, Line supports and LineInsulators.

c. Prepare a power point presentation:
i. Extra High Voltage AC Transmission line.
ii. High Voltage DC Transmission line.
iii. Flexible AC Transmission line.
iv. New trends in wireless transmission of electrical power.

d. Collect information on:
i. A.C Distribution System adjacent to your institute.

ii. Draw a layout diagram of 11KV/400 V substation in your campus/ adjacent substation.

58. INDUCTION, SYNCHRONOUS AND SPECIAL ELECTRIC MACHINES

Unit – I Three Phase Induction Motor

Working principle: production of rotating magnetic field, Synchronous speed, rotor speed and slip.

Constructional details of 3 phase induction motors: Squirrel cage induction motor and Slip ring induction motor.

Rotor quantities: frequency, induced emf, power factor at starting and running condition.

Characteristics of torque versus slip (speed), Torques: starting, full load and maximum with relations among them.

Induction motor as a generalized transformer with phasor diagram.

Four quadrant operation, Power flow diagram

Starters: need and types; stator resistance, auto transformer, star delta, rotor resistance and soft starters.

Speed control methods: stator voltage, pole changing, rotor resistance and VVVF. Motor selection for different applications as per the load torque-speed requirements.Maintenance of three phase induction motors

Unit – II Single phase induction motors

Double field revolving theory, principle of making these motors self-start.

Construction and working: Resistance start induction run, capacitor start induction run, capacitor start capacitor run, shaded pole, repulsion type, series motor, universal motor, hysteresis motor.

Torque-speed characteristics for all of the above motors.

Motor selection for different applications as per the load torque-speed requirements. Maintenance of single phase induction motors

Unit– III Three phase Alternators

Principle of working, moving and stationary armatures.

Constructional details: parts and their functions, rotor constructions. Windings: Single and Double layer.

E.M.F. equation of an Alternator with numerical by considering short pitch factor and distribution factor.

Alternator loading: Factors affecting the terminal voltage of alternator; Armature resistance and leakage reactance drops.

Armature reaction at various power factors and synchronous impedance.Voltage regulation: direct loading and synchronous impedance methods. Maintenance of alternators

Unit– IV Synchronous motors

Principle of working /operation, significance of load angle.

Torques: starting torque, running torque, pull in torque, pull out torque. Synchronous motor on load with constant excitation (numerical), effect of excitationat constant load (numerical).

V-Curves and Inverted V-Curves.Hunting and Phase swinging.

Methods of Starting of Synchronous Motor.

Losses in synchronous motors and efficiency (no numerical).

Applications areas

Unit– V Fractional horse power (FHP) Motors

Construction and working: Synchronous Reluctance Motor, Switched Reluctance Motor, BLDC, Permanent Magnet Synchronous Motors, stepper motors, AC and DCservomotors.

Torque speed characteristics of above motors.Applications of above motors.

59. INDUCTION, SYNCHRONOUS AND SPECIAL ELECTRIC MA-CHINES LABORATORY

1. Identify the different parts (along with function and materials) for the given single phaseand three phase induction motor.
2. Connect and run the three phase squirrel cage induction motors (in both directions) usingthe DOL, star-delta, auto-transformer starters (any two)
3. Perform the direct load test on the three phase squirrel cage induction motor and plot the
   i) efficiency versus output, ii) power factor versus output, iii) power factor versus motor
   current and iv) torque – slip/speed characteristics.
4. Conduct the No-load and Blocked-rotor tests on given 3-ϕ squirrel cage induction motorand determine the equivalent circuit parameters.
5. Conduct the No-load and Blocked-rotor tests on given 3-ϕ squirrel cage induction motorand plot the Circle diagram.
6. Control the speed of the given three phase squirrel cage/slip ring induction motor using theapplicable methods: i) auto-transformer, ii) VVVF.
7. Measure the open circuit voltage ratio of the three phase slip ring induction motor.
8. Conduct the direct load test to determine the efficiency and speed regulation for

different loads on the given single phase induction motor; plot the efficiency and speed regulation curves with respect to the output power.

9. Perform the direct loading test on the given three phase alternator and determine the reg-
ulation and efficiency.
10. Determine the regulation and efficiency of the given three phase alternator from OC and SC
tests (Synchronous impedance method)
11. Conduct the test on load or no load to plot the 'V' curves and inverted 'V' curves (at no-load)of 3-ϕ synchronous motor.
12. Dismantling and reassembling of single phase motors used for ceiling fans, universal motor
for mixer.
13. Control the speed and reverse the direction of stepper motor
14. Control the speed and reverse the direction of the AC servo motor
15. Control the speed and reverse the direction of the DC servo motor

60. MICROCONTROLLER APPLICATIONS

Unit – I Introduction to Microcontrollers

Evolution of Microcontrollers Block diagram of Microcomputer, elements of Microcomputer, types of buses Von Neuman and Harward Architecture Compare Microprocessor and MicrocontrollersNeed of Microcontroller Family of Microcontrollers and their specifications Versions of Microcontroller 8951, 89C1051, 89C2051, 89C4051 with their specifications and comparison

Unit – II Architecture of Microcontroller8051 Block diagram of 8051, function of each blockPin diagram, function of each pin

Concept of Internal memory and External memory (RAM and ROM)

Internal RAM structureReset and clock circuit

Various registers and SFRs of 8051

Unit– III 8051 Instruction Set and Programs Overview of 8051 instruction set Various addressing modes Classification of instructions

Data transfer instructionsArithmetic instructions Logical instructions Branching instructions

Bit manipulation instructions

Stack, subroutine and interrupt related instructionsPrograms based on above instructions.

Unit– IV Assembly Language Programming

Software development steps

Software development tools like Editor, Assembler, Linker, Loader and Hex

converters.

Role of various files created at various levels in running a Assembly program using

simulators like RIDE or KEIL.

Various directives of Assembly language programmingPrograms using directives.

Unit– V 8051 Internal Peripherals and Related Programs

I/O ports- List, diagram, read write operation, instructions and related SFRs Timers/counters – list, related SFRs, programming modes, operations with diagram.

Serial communication- Basics of serial communication, baud rate, related SFRs, programming modes, operations with diagram.

Interrupts- related SFRs, types, operations with diagram. Power saving operation- modes, related SFR.

61. MICROCONTROLLER APPLICATIONS LABORATORY

1. Interpret details of Hardware kit for Microcontroller and practice to write and execute pro-grams.
2. Identify different menus available in a simulator software RIDE/KEIL and demonstrate theiruse.
3. Develop and execute Assembly language programs using Arithmetic Instructions and demon-strate outcome for a given input data
4. Develop and execute Assembly language programs using Logical Instructions and demonstrate outcome for a given input
5. Develop and execute an Assembly language program for Addition of series of 8 bit nos, 16 bit result and demonstrate outcome for a given input data
6. Develop and execute Assembly language program for addition/subtraction of 16 bit no/multi- byte nos. and demonstrate outcome for a given input data
7. Develop and execute Assembly language program for Block transfer from and to Internal/Ex-ternal memory using directives and demonstrate outcome for a given input data.
8. Develop and execute Assembly language program Largest/smallest of given series of no. fromInternal/External memory and demonstrate outcome for a given input data.
9. Develop and execute Assembly language program arrange no in ascending/descending order from Internal/External memory and demonstrate outcome for a given input data.
10. Develop and execute Assembly language program for LED blinking/LED sequences using de-lay/timer mode.
11. Develop and execute Assembly language program to interface LED with microcontroller.

62. ENERGY CONSERVATION AND AUDIT

Unit – I Energy Conservation Basics

Energy Scenario: Primary and Secondary Energy, Energy demand and supply,National scenario.

Energy conservation and Energy audit; concepts and difference Indian Electricity Act 2001; relevant clauses of energy conservationBEE and its Roles

MEDA and its Roles

Star Labelling: Need and its benefits.

Unit – II Energy Conservation in Electrical Machines

Need for energy conservation in induction motor and transformer. Energy conservation techniques in induction motor by:

Improving Power quality.Motor survey

Matching motor with loading.

Minimizing the idle and redundant running of motor.Operating in star mode.

Rewinding of motor.

Replacement by energy efficient motor

Periodic maintenance

Energy conservation techniques in Transformer.Loading sharing

Parallel operation Isolating techniques.

Replacement by energy efficient transformers. Periodic maintenance.

Energy Conservation Equipment: Soft starters, Automatic star delta convertor, Variable Frequency Drives, Automatic p. f. controller (APFC), Intelligent p. f. controller (IPFC)

Energy efficient motor; significant features, advantages, applications and limitations.

Energy efficient transformers, amorphous transformers; epoxy Resin cast transformer / Dry type of transformer.

Unit– III Energy conservation in Electrical Installation systems

Aggregated Technical and commercial losses (ATC); Power system at state, regional, nationaland global level.

Technical losses; causes and measures to reduce by.

a) Controlling I^2R losses.

b) Optimizing distribution voltage

c) Balancing phase currents

d) Compensating reactive power flow

Commercial losses: pilferage, causes and remedies

Energy conservation equipment: Maximum Demand Controller , kVAR Controller, Automatic Power Factor controller(APFC)

Energy Conservation in Lighting System

a) Replacing Lamp sources.

b) Using energy efficient luminaries.

c) Using light controlled gears.

d) Installation of separate transformer / servo stabilizer for lighting.

e) Periodic survey and adequate maintenance programs.Energy Conservation techniques in fans, Electronic regulators.

Unit– IV Energy conservation through Cogeneration and Tariff

Co-generation and Tariff; concept, significance for energy conservation

Co-generation

Types of cogeneration on basis of sequence of energy use (Topping cycle, Bottoming cycle)

Types of cogeneration basis of technology (Steam turbine cogeneration, Gas turbine cogeneration, Reciprocating engine cogeneration).

Factors governing the selection of cogeneration system.Advantages of cogeneration.

Tariff: Types of tariff structure: Special tariffs; Time-off-day tariff, Peak-off-day tariff, Power factor tariff, Maximum Demand tariff, Load factor tariff.

Application of tariff system to reduce energy bill.

Unit– V Energy Audit of Electrical System

Energy audit (definition as per Energy Conservation Act)

Energy audit instruments and their use. Questionnaire for energy audit projects. Energy flow diagram (Sankey diagram)

Simple payback period, Energy Audit procedure (walk through audit and detailed audit). Energy Audit report format.

63. ENERGY CONSERVATION AND AUDIT LABORATORY

1. Compare power consumption of different types of TL with choke, electronic ballast and LEDlamps by direct measurements.
2. Determine the reduction in power consumption by replacement of lamps in a class room /laboratory.
3. Determine the reduction in power consumption by replacement of Fans and regulators in aclass room / laboratory.
4. Collect electricity bill of an industrial consumer and suggest suitable tariff for energy conser-vation and its impact on energy bill.
5. Collect electricity bill of a commercial consumer and suggest suitable tariff for conservationand reduction of its energy bill.
6. Collect electricity bill of a residential consumer and suggest suitable means for conservationand reduction of the energy bill.
7. Estimate energy saving by improving power factor and load factor for given cases.
8. Prepare a sample energy audit questionnaire for the given industrial facility.
9. Prepare an energy audit report (Phase-I)
10. Prepare an energy audit report (Phase-II)
11. Prepare an energy audit report (Phase-III)

64. BUILDING ELECTRIFICATION

Unit – I Wiring Tools and Accessories

Various tools required for wiring- screwdrivers, pliers, Try square, saws, hacksaw, chisel, hammers, mallet, rawl punch, hand drill machine, portable drilling machine, files, plumb bob, line thread, electricians knife, test lamp, tester and their BIS specifications, application, care & maintenance of tools.

Classification of electrical accessories- controlling, holding, safety, outlet

BIS symbols of following electrical accessories.

Switch – Their types according to construction such as surface switch, flush switch, and pull switch, rotary switch, knife switch, pendent switch, Main-switch (ICDP, ICTP). Their types according to working such as single pole, double pole, two-way, two-way centre off, intermediate, series parallel switch

Holders- Their types such as bayonet cap lamp holder, pendent holder, batten lamp holder,angle holder, bracket holder, tube light holder, screw type Edison and goliath Edison lamp holder, swivel lamp holder.

Socket outlets and plugs- two pin, three-pin, multi pin sockets, two-pin and three-pin plug.

Others- Iron connector, adaptor, and ceiling rose, distribution box, neutral link, bus-bar chamber.

Wooden/ mica boards, Moulded/ MS Concealed boxes of different sizes. Modular accessories.

Unit – II Electrical Wires and Underground Cables

Conductors: - wire, cable, bus bar, stranded conductor, cable, armoured cable, flexible cable, solid conductor, PVC wires, CTS wire, LC wire, FR (Fire retardant) wire,Size of wire according to BIS. Tools used for measurement of wire size, Wire jointing methods.

Classification of cables, low tension, high tension, and extra high tension cables,solid, oil filled and gas filled type

Cable insulation materials –vulcanized rubber (VIR), polyvinyl chloride (PVC), cross linked polythene (XLPE), impregnated paper, Selection of suitable cable size and typefrom standard data

Cable jointing methodsCable laying methods.

Factors determining selection of electric cables

Unit– III Wiring Methods and wiring layout

Factors determining the selection of wiring methods.

Classification of wiring methods.

PVC casing-capping wiring- wiring rules according to IS: 732-1983

Conduit wiring- Types of conduit, comparison between Metal and PVC conduit, types of con-duit wiring (Surface/Concealed). Conduit wiring accessories, BIS rules for Metal and PVC conduit wiring.

Comparison of various wiring systems. General BIS rules for domestic installations.

Design, working and drawing of following electrical circuits: Simple light and fan circuits, Stair case wiring, Go-down wiring circuit, Bedroom lighting circuit, Corridor lighting circuit,Series parallel circuit, Master switch control circuit, Different lighting circuit using - Interme- diate switch, Call bell circuit using bell indicator, Design of wiring circuits according to user's requirement

Unit– IV Residential Building Electrification

Domestic Dwellings/Residential Buildings: reading of Civil Engineering building drawing, In-terpretation of electrical installation plan and electrical diagrams, electrical symbols as per IS: 732.

Electrical installation for residential building as per part I section 9 of NEC-2011

Difference between residential and industrial load, rules/requirements related to lighting load followed in electrical installations, Positioning of equipment.

Lighting and power circuits: Light and fan circuit, Power circuit

Wiring and circuit Schematic diagram according to IS: 2042(Part-I)-1962: multiline and sin-gle line representation

Load assessment: Selection of size of conducto, Selection of rating of main switch and protec-tive switch gear.

Design and drawing, estimation and costing of a residential installation having maximum 5 KW load; Sequence to be followed for preparing estimate; Calculation of length of wire and other materials, labour cost

Testing of wiring installation as per IS: 732-1982: Insulation resistance - between earth and conductors, between conductors, polarity test of single pole switches. Testing of earth conti-nuity path.

Residential building Service Connection- types Underground and overhead. Calculation of Material required for service connection

Unit– V Protection of Electrical Installation

Fuse in electric circuit: fuse element, fuse current rating, minimum fusing current, cut-off current, fusing factor, Fuse material

Types of fuses –Re-wirable, cartridge fuses (HRC and LRC), Fuse material Selection of fuse.

Miniature circuit Breaker (MCB)-Construction, Principle rating and uses, Earth Leakage Cir-cuit Breaker (ELCB)-Construction, Principle rating and uses.

System and equipment earthing and its requirements, Earth, earth electrode, earth current, earth terminal, earthing wire, earthing lead, fault current, leakage current, Measurement of earth resistance using earth tester, Methods of reducing earth resistance, Methods of earthing as per IS 3043: 1987 and their procedure- Driven pipe, pipe and plate earthing, modern methods of earthing,

Unit– V Illumination in Residential Installation

Concept of Luminous flux, Luminous intensity, Lumen, Illumination or illuminance, Lux, Space-height ratio, utilization factor, depreciation factor, luminous efficiency- values for dif-ferent luminaries.

Laws of Illumination-Inverse Square Law, Cosine Law, illumination received directly under-neath, horizontal screen and screen moved horizontally at certain distance

Factors affecting the illumination. Different types of lighting arrangements,

Luminous flux of different types of light sources, Lux level required for different places as per SP 72: 2010.

65. BUILDING ELECTRIFICATION LABORATORY

1. Prepare series testing board.
2. Select the electric wire using measuring and testing instruments for particular applications.
3. Identify cables of different current ratings.
4. Prepare wiring installation on a board showing control of one lamp, one fan and one socket from one switch board in PVC surface conduit wiring system.
5. Prepare wiring installation on a board.
6. Control one lamp from two different places using PVC surface conduit wiring system.
7. Prepare wiring installation on a board. Control one lamp from three different places using PVC surface conduit wiring system.
8. Prepare wiring installation on a board.
9. Perform go-down wiring for three blocks using PVC casing capping.
10. Design 2 BHK residential installation scheme and estimate the material required. And draw the details required for installation on A4 size sheet.
11. Test wiring installation using megger.

66. INDUSTRIAL INSTRUMENTATION AND CONDITION MONITORING

Unit – I Fundamentals of instrumentation

Basic purpose of instrumentation.

Basic block diagram (transduction, signal conditioning, signal presentation) and their func-tion.

Construction, working and application of switching devices- Push button, limit switch, float

switch, pressure switch, thermostat, electromagnetic relay.

Unit – II Transducers

Distinguish between Primary and Secondary, Electrical and Mechanical, Analog and Digital, Active and Passive. Mechanical devices pry. And sec. transducers

Advantages of electric transducers Required characteristics of transducers. Factors affecting the

choice of transducers

Construction and principle of resistive transducer-Potentiometer –variac and strain gauges -No derivation. Only definition and formula for gauge factor

Types of strain gauges like unbonded, bonded and semiconductor.

Construction and principle of Inductive transducers-L.V.D.T. and R.V.D.T, their applications.

Construction, principle and applications of transducers – Piezo-Electric transducer, photo-conductive cells, photo voltaic cells.

Unit– III Measurement of Non-Electrical Quantities

Temperature measurement - Construction and Working of RTD, Thermistor and Thermocou-ple, radiation pyrometer, technical specifications and ranges.

Pressure measurement – Construction and working of bourdon tube, bellow diaphragm and strain gauge, Combination of diaphragm and inductive transducer, Bourdon tube and LVDT, bellow and LVDT, diaphragm capacitance and bridge Circuit.

Construction and Working of Speed Measurement by contacting and non-Contact Type- DC tachometer, photo- electric tachometer, toothed rotor tachometer Generator - magnetic pick-up and Stroboscope.

Construction and Working of Vibration measurement by accelerometer-LVDT accelerometer, Piezo electric type.

Construction and Working of Flow measurement by electromagnetic and Turbine Flow me-ter.

Construction and Working of Liquid level measurement by resistive, inductive, Capacitive gamma rays and Ultrasonic methods.

Construction and Working of Thickness measurement by resistive, inductive, capacitive, ul-trasonic and Nuclear methods.

Unit– IV Signal Conditioning

Basic Concept of signal conditioning System.

Draw pin configuration of IC 741.

Define Ideal OP-AMPand Electrical Characteristics of OP-AMP.

Different Parameters of op-amp:-Input offset voltage, Input offset current, Input bias current, Differential input resistance, CMMR, SVRR, voltage gain, output voltage, slew rate, gain band-width. Output, short circuit current.

Use of op-amp as inverting, non- inverting mode, adder, subtractor, and Working of Differen-tial amplifier and instrumentation amplifier.

Filters: Types of RC filters and frequency response -no derivation.

Sample and hold circuits - operation and its application.

Unit– V Data Acquisition System

Generalized DAS- Block diagram and description of Transducer, signal conditioner, multiplex-er, converter and recorder

Draw Single Channel and Multi-channel DAS- Block diagram only. Difference between Signal

Channel and Multi-Channel DAS.

Data conversion- Construction and Working of Analog to digital conversion- successive approximation method, ramp type method.

Digital to Analog conversion- Construction and Working of binary weighted resistance meth-od.

Concept and methods of data transmission of electrical and electronic transmission. Construction and principle of telemetry system and its type - Electrical telemetering system-

Digital display device- operation and its application of seven segment display, dot matrix dis-play and concept of 3½, 4½ digits, LED and LCD applications

Unit– VI Condition Monitoring and Diagnostic Analysis

Definition of condition monitoring

Insulation deterioration Mechanism- factors affecting occurrence and rate of deterioration,types of stresses responsible for deterioration

Different tests on transformer, their purpose, and the necessary condition of machine.Tests on Circuit breaker, purpose and required condition of machine

Tests on CT, purpose, item to be tested and required condition of machine. Power factor, capacitance /tan delta test

Insulation and Polarization index, DC winding resistance test, Turns Ratio test

Tools and equipment used in Condition monitoring

67. INDUSTRIAL INSTRUMENTATION AND CONDITION MONITORINGLABORATORY

1. Identify different switches used in instrumentation system.
2. Measure linear displacement by L.V.D.T.
3. Measure the strain with the help of strain gauge
4. Measure temperature by PT-100, thermistor, thermocouple along with simple resistance bridge.
5. Use Thermocouple to control the temperature of a furnace/machine.
6. Measure pressure using pressure sensor kit.
7. Measure angular speed using stroboscope and tachometer.
8. Measure the flow using flow meter.
9. Use op-amp as inverter, non-inverting mode, adder, differentiator and integrator.
10. Convert digital data into analog data by using analog to digital converters and analog data into digital data by digital to analog converter.
11. Visit to testing center of electrical testing lab for tan delta and diagnostic tests and determine polarization index
12. Prepare a Report on various tools and equipment used for condition monitoring of electrical machines]I9KYI

68. INDUSTRIAL AUTOMATION AND CONTROL

Unit – I Introduction to Industrial Automation

Automation: Need and benefits.

Types of automation system: Fixed, Programmable, Flexible

Different systems used for Industrial automation: PLC, HMI, SCADA, DCS, Drives.Evolution of PLC.

Unit – II PLC Fundamentals

Building blocks of PLC**:** CPU, Memory organization, Input- output modules (discrete and ana- log), Specialty I/O Modules, Power supply

Fixed and Modular PLC and their types, Redundancy in PLC module

I/O module selection criteria

Interfacing different I/O devices with appropriate I/O modules

Unit– III PLC Programming and Applications

PLC I/O addressing

PLC programming Instructions**:** Relay type instructions, Timer instructions: On delay, off de-lay, retentive, Counter instructions: Up, Down, High speed, Logical instructions, Comparison Instructions, Data handling Instructions, Arithmetic instructions.

PLC programming language**:** Functional Block Diagram (FBD), Instruction List. Structured text, Sequential Function Chart (SFC), Ladder Programming.

Simple Programming examples using ladder logic**:** Language based on relay, timer counter, logical, comparison, arithmetic and data handling instructions.

PLC Based Applications: Motor sequence control, Traffic light control, Elevator control, Tank Level control, Conveyor system, Stepper motor control, Reactor Control Gate trigger circuits – Resistance and Resistance-Capacitance circuits.

Unit– IV Electric Drives and special machines

Electric drives: Types, functions, characteristics, four quadrant operation. DC and AC drive controls: V/F control, Parameters, direct torque control. Drives: Specifications, Applications- Speed control of AC motor /DC Motor.

Unit– V Supervisory Control and Data Acquisition System (SCADA)

Introduction to SCADA: Typical SCADA architecture/block diagram, Benefits of SCADA

Various editors of SCADA

Interfacing SCADA system with PLC: Typical connection diagram, Object Linking & embed- ding for Process Control(OPC) architecture, Steps in Creating SCADA Screen for simple ob- ject, Steps for Linking SCADA object (defining Tags and Items) with PLC ladder program us- ing OPC.

Applications of SCADA: Traffic light control, water distribution, pipeline control.

69. INDUSTRIAL AUTOMATION AND CONTROL LABORATORY

1. Identify various automation systems available in different appliances/ devices/ machines inday to day use.
2. Identify various parts of the given PLC and front panel status indicators.
3. Use PLC to test the START STOP logic using two inputs and one output.
4. Develop/Execute a ladder program for the given application using following: - timer, counter,
   comparison, logical, arithmetic instructions.
5. Use PLC to control the following devices like lamp, motor, push button switches, proximity sensor
6. Measure the temperature of the given liquid using RTD or Thermocouple and PLC.
7. Develop/test ladder program to blink the LED/lamp.
8. Develop / test the Ladder program for sequential control application of lamps/ DC motors.

9. Develop ladder program for Traffic light control system.
10. Develop and test ladder program for pulse counting using limit switch /Proximity sensor.
11. Develop /test ladder program for Automated car parking system.
12. Develop / test ladder program for Automated elevator control.
13. Develop / test ladder program for rotating stepper motor in forward and reverse direction at constant speed.
14. Develop /test ladder program for tank water level control.
15. Develop / test ladder program for control of speed of stepper motor with suitable drivers.
16. Identify various front panel controls of VFD (smart drive).
17. Control speed of AC/DC motor using VFD. (VFD-Variable Frequency Drive)
18. Use various functions of SCADA simulation editors to develop simple project.
19. Develop a SCADA mimic diagram for Tank level control.
20. Develop SCADA mimic diagram for Flow control in a given system.
21. Simulate Tank level control using available SCADA system.

70. INDUSTRIAL DRIVES

Unit – I Electric Drives

Need of Electric Drives, Functional Block diagrams of an electric drives.

DC Motors, Motor Rating

a. Series, Shunt and compound DC motors.
b. Universal motor
c. Permanent magnet motor
d. DC servo motor
e. Moving coil motor
f. Torque motor.

Starting and Braking of DC Motors

Brushless DC Motors for servo applications.Maintenance procedure.

Unit – II AC Motors

Single phase AC Motors

a) Resistance split phase motors
b) Capacitor run motors
c) Capacitor start motors
d) Shaded pole motors Three phase Induction Motors
a) Squirrel cage Induction motor
b) Slip ring Induction Motor
c) Starting methods of Induction Motor
d) Braking methods of Induction Motor Determination of Motor Rating Maintenance procedure.

Unit– III DC Drives

Single phase SCR Drives

a) Half wave converter

b) Full wave converter
c) Semi converter
d) Dual converter Three Phase SCR Drives
a) Half wave converter
b) Full wave converter
c) Semi converter
d) Dual converterReversible SCR Drives.

Speed control methods of DC series MotorChopper Controlled DC Drives

Solar and battery powered vehiclesMaintenance procedure.

Unit– IV AC Drives

Starting and Braking of Induction motors.Stator voltage control

Variable Frequency Control Voltage Source Inverter ControlCurrent Source Inverter Control Rotor Resistance Control

Slip Power Recovery

Solar powered pump drives Maintenance procedure for AC drives

Sequences of stages & drives required in each stage for following applications:

a) Textile mills
b) Steel rolling mills
c) Paper mills
d) Sugar mills

Unit– V Advanced Techniques of Motor Control Microcontroller/ Microprocessor based control for drivesPhase locked loop control of DC motor.

AC/DC motor drive using Microcomputer control AC/DC motor drive using Microcontroller control.Synchronous Motor drives.

Ratings & specifications of stepper motor.

Stepper motor drives employing microcontroller (No programming)

71. INDUSTRIAL DRIVES LABORATORY

1. Dismantle the given DC motor and identify its different parts
2. Dismantle the given AC motor and identify its different parts
3. Control the speed of DC Motor using armature voltage control method
4. Control the speed of DC Motor using field current control method
5. Measure the output voltage of chopper for resistive load by varying the frequency and /or dutycycle of chopper.
6. Control the speed of three phase squirrel cage induction motor using stator voltage controlmethod.
7. Effect on speed of given D.C. series motor by varying armature voltage using step down chop-per.
8. Observe the effect on speed of the given D.C. separately excited motor by varying voltage using
   step down chopper.
9. Control the speed of the given separately excited motor by changing the firing angle of

SCR
using single phase semi converter and measure the speed.

10. Control the speed of the given separately exited motor by changing the firing angle of SCR us-ing single phase full converter and measure the speed
11. Control the speed of the given three phase induction motor by using constant V/f method andplot the graph between speed and frequency.
12. Control the speed of the given three phase induction motor by varying frequency and plot thegraph between speed and frequency
13. Control the speed of the given synchronous motor drives using microcontroller.
14. Demonstrate High power SCR/power device and Heat sink and write their specifications and
rating.
15. Control the speed of single phase capacitor split phase induction motor using DIAC –TRIACcircuit.
16. Control the speed of DC motor drives using microcontroller.
17. Identify different parts and assemble the given DC motor.
18. Identify different parts and assemble the given AC motor.

72. COMMUNICATION TECHNOLOGIES

Unit – I Data Communication and Modulation

Block diagram of communication system

Types of communication system: synchronous and asynchronous, simplex, half-duplex, Full duplex, serial and parallel communication

Classification of communication technique: AM, FM, & PM on the basis of definition, wave-form, bandwidth, modulation index

Modulation and demodulation: Block diagram of AM, FM and PM

Pulse Modulation: Block diagram for waveform generation of PAM,PWM& PPM, working principle, advantages, disadvantages and applications.

Advantages of pulse modulation over AM and FM.

Unit – II Digital Modulation Techniques

Digital Communication: Block diagram and working principle, waveforms, strength and limitations Sampling process Nyquist sampling theorem, quantization process, quantization error, quan-tization noise

PCM: Block diagram, working principle, waveforms, advantages, disadvantages, applicationof PCM.

Principle of ASK, PSK, FSK. Application of ASK, PSK, FSK

Unit– III Data Communication Media

Baud rate, Bit rate, types of errors in data communication and error correction techniques.Types

of communication media and frequency band of operation

Guided media: Types of cable-twisted pair cable, co-axial cable, fiber optic cable.

Unguided media: Microwave communication, Infrared communication.

Unit– IV Fibre Optics

Introduction to Fiber optic communication.

Strength and limitations of fiber optic system

Light propagation : reflection, refraction, Snell's law

Light propagation through cable: Mode of propagation, index profile

Fibre optic cables: cable construction, fibre optics cable modes, single mode, step index fibre, multimode index fibre, multimode graded index fibre, fibre cable losses.

Light source and Detector: Light emitting diode (LED), Photo Transistor, Laser diode, opto-coupler.

Unit– V Data Communication Protocols and Interfacing Standard OSI (Open Systems Interconnection) Reference model Introduction to protocol, FTP, SMTP, TCP/IP, UDP

LAN standards.

Introduction to IEEE Standards for LAN and GPIB

RS-232 standard: Introduction, and working principle

Network topologies, introduction star, ring, tree, bus, mesh, hybrid

Basic functions of networking devices: modem, switches, routers, repeaters, hubs, bridges, gateway.

Unit– VI Advanced Data Communication Introduction to Wi-Fi and Wi- Max Bluetooth architecture and its layers, Universal serial bus (USB) architecture.Bluetooth and USB

73. COMMUNICATION TECHNOLOGIES LABORATORY

1. Measure the modulation index of amplitude modulated wave and observe the effect of mod-ulating signal voltage on it.
2. Measure the modulation index of the frequency modulated wave and observe the effect of
   modulating and Carrier signal voltage on Frequency Modulation.
3. Test Pulse Amplitude Modulation (PAM)signal.
4. Test Pulse Width Modulation signal.
5. Test Pulse Position Modulation Signal.
6. Test Pulse Code Modulation Signal.
7. Test Amplitude Shift Keying Signal
8. Test Frequency Shift Keying Signal
9. Test Phase shift Keying Signal.
10. Plot the V-I Characteristics of given Infra-Red Light Source(IR-LED)
11. Test UTP/STP cable in straight and crossover mode and by line tester.
12. Plot the V-I Characteristics of given Light Source(LED) and detector(photo transistor)
13. Use OFT trainer Kit given 1mm. diameter Plastic optical fibre at 650 nm to determine the
    Numerical Aperture (NA).
14. Create the scenario and study the performance of token ring LAN protocol through simula-tion and using trainer kit.
15. Install and configure TCP/IP protocol.

16. Perform the transfer of files from PC to PC using Windows
17. Perform the transfer of a file from PC to another PC using Serial port RS-232
18. Establish star topology using transmission media and network control device.
19. Establish Wireless Communication between five computers using wireless LAN.
20. Establish Bluetooth communication using 4G mobile and laptop.

74. ELECTRICAL TESTING AND COMMISIONING

Unit – I Electrical Safety and Insulation

Do's and don'ts regarding safety in domestic electrical appliances as well for substation/ power station operators

Electrical safety in industry/power stations/ substations at the time of operation/ control/ maintenance. Fire detection alarm, fire-fighting equipments

Factors affecting life of insulating materials, classifications of insulating materials as per IS:1271-1958

Measuring insulation resistance by different methods such as i) Polarization, ii) Dielectric absorption, iii) Megger and to predict the condition of insulation

Reconditioning of insulation,

Insulating oil - properties of insulating oil, causes of deterioration of oil,testing of transformer oil as per IS 1866-1961

Unit – II Installation and Erection

Concept of foundation for installation of machinery. Requirements of foundation for staticand rotating electrical machinery.

Concept of leveling and aligning Procedure for leveling and aligning alignment of direct cou-pled drive, effects of mis-alignment

Installation of transformer as per I.S.-1886-1967 and procedure of installation of transform-er, Requirements of installation of pole mounted transformer

Requirements of installation of rotating electrical machines as per I.S. 900 - 1965

Devices and tools required for loading, unloading, lifting, and carrying heavy equipment and precautions to be taken while handling them.

Unit– III Testing and Commissioning

Concept of testing, Objectives of testing. Roles of I.S.S. in testing of electrical equipment, Typesof tests and concepts, Routine tests, type tests, supplementary test, special tests, Methods oftesting - Direct/Indirect/Regenerative testing.

Tolerances for the various items for equipment –transformer, induction motor, dc motor, syn-chronous machines

Commissioning, Tests before Commissioning for transformer, induction motor, alternatorTesting of transformer as per I.S.1886- 1967 and I.S.2026- 1962

Testing of three-phase Induction motor as per I.S.325 - 1970.Testing of single-phase induction motor as per I.S.990-1965.Testing of synchronous machines as per ISS

Testing of D.C. machines

Unit– IV Troubleshooting Plans

Internal and external causes for failure / abnormal operation of equipment.

List of mechanical faults, electrical faults and magnetic faults in the electrical equipment

remedies, applications

Use of tools like bearing puller filler gauges, dial indicator, spirit level, megger, earth tester, and growler. Common troubles in electrical equipments and machines.

Preparation of trouble shooting charts for D.C. Machines, AC Machines and transformers.

Unit– V Maintenance

Concept of maintenance, types of maintenance, Routine, preventive and breakdown maintenance.

Causes of failure of electrical machines

Preventive maintenance-procedure or developing maintenance schedules for electrical machines.

Factors affecting preventive maintenance schedules, Concept of TPM, Pillars of TPM

Identification of different types of faults developed such as mechanical/ electrical/ magnetic faults

Maintenance schedules of the following as per I.S.S.

a) Distribution transformer as per I.S.1886-1967
b) Single phase and three phase Induction motors as per I.S.900-1965.
c) Batteries

75. ELECTRICAL TESTING AND COMMISIONING LABORA-TORY

1. Determine breakdown strength of transformer oil.
2. Perform insulation resistance test on any one motor/transformer.
3. Prepare trouble shooting charts for electrical machines such as Transformer, D.C. machines,Induction motor, and Synchronous machines
4. Measure impedance voltage and load losses of three-phase transformer.
5. Find regulation and efficiency of single-phase transformer by direct loading and back-to-back connection method and compare the results.
6. Determine efficiency of D.C. machine by Swinburne's test.
7. Determine efficiency of D.C. machine by Hopkinson's test.
8. Perform reduced voltage running up test on three-phase Induction motor as per I.S.325 - 1967.
9. Measure no load losses and no load current of a transformer as per IS.
10. Perform no load test on single phase Induction motor for the measurements of no load current,power input, and speed at rated voltage as per I.S.
11. Perform temperature rise test on single-phase transformer.
12. Find efficiency of M.G. set

76. ELECTRICAL ESTIMATION AND CONTRACTING

Unit – I Electric Installation and Safety

Scope and features of National electric code 2011Types of electrical installation

Fundamental principles for electrical installation Permit to work, safety instructions and safety practicesPurpose of estimating and costing.

Unit – II Estimation and Costing

Meaning and purpose of- Rough estimate, detailed estimate, supplementary estimate, annual maintenance estimate and revised estimate

Factors to be considered while preparation of detailed estimate and economical execution of work

Contracts- Concepts of contracts, types of contracts, contractor, role of contractor

Tenders and Quotations- Type of tender, tender notice, preparation of tender document, and method of opening of tender

Quotation, quotation format, comparison between tender and quotation

Comparative statement, format comparative statement. Order format, placing of purchasing order.

Principles of execution of works, planning, organizing and completion of work, Billing of work

Unit– III Non-Industrial Installations

Types of Non-industrial installations-- Office buildings, shopping and commercial centre, residential installation, Electric service and supply

Design consideration of electrical installation in commercial buildings.

Design procedure of installation- steps involved in detail, Estimating and costing of unit

Earthing of commercial installation.

Design electrical installation scheme of commercial complex.

Erection, Inspection and testing of installation as per NEC

Unit– IV Industrial Installation

Classification of industrial buildings Classification based on power consumption,

Drawing of wiring diagram and singleline diagram for single phase and three phaseMotors.
Design consideration in industrial installations Design procedure of installation-detailed steps

Design electrical installation scheme of factory/ small industrial unit, Preparation of material schedule and detailed estimation

Installation and estimation of agricultural pump and flourmill

Unit– V Public Lighting Installation

Classification of outdoor installations streetlight/ public lighting installation

Street light pole structures. Selection of equipments, sources used in street light installations.

Cables, recommended types and sizes of cable. Control of street light installation.

Design, estimation and costing of streetlightPreparation of tenders and abstracts.

Unit– VI Distribution Lines and LT Substation

Introduction to overhead and underground distribution line.Materials used for distribution line HT and LV

Cables used for distribution line, factors determining selection of LT/ HT power Cables, cable laying and cable termination method according to IS

Design, estimation and costing of HT LT overhead line and underground cabling.

Types of 11 KV Distribution substations their line diagram, Estimation of load, Load factor, diversity factor and determination of rating of distribution.

Transformer. Design, estimation and costing of outdoor and indoor 11 KV substation.

77. ELECTRICAL ESTIMATION AND CONTRACTING LABORATORY

1. Prepare a tender notice for purchasing a transformer of 200 KVA for commercial installation.
2. Prepare a quotation for purchasing different electrical material required.
3. Prepare a comparative statement for above material Prepare purchase order for the same.
4. Design drawing, estimating and costing of hall / cinema theater / commercial installation Pre-pare report and draw sheet.
5. Design electrical installation scheme for any one factory / small industrial unit. Draw detailedwiring diagram. Prepare material schedule and detailed estimate. Prepare report and draw sheet.
6. Estimate with a proposal of the electrical Installation of streetlight scheme for small premisesafter designing.
7. Estimate with a proposal of the L.T. line installation. Prepare report and draw sheet.
8. Estimate with a proposal of the 500 KVA, 11/0.433 KV outdoor substation and prepare a report

78. INTRODUCTION TO ELECTRIC GENERATION SYSTEM

Unit – I Fundamentals of illumination

Basic illumination, Terminology, Laws of illumination

Polar curves, polar curve: its meaning and applications for designing the lamp. Concept of Photometry, Measurement of illumination

Lighting calculation methods, Watt /m^2 method, Lumens or light flux method, Point to point method

Standards for illumination

Unit – II Types of lamps

Incandescent lamp, ARC lamps – AC and DC arc lamps, Fluorescent lamp

Types of other lamps: Mercury vapour lamp, HPMV lamp, Mercury iodide lamp, Sodium va- pour lamp, Halogen Lamps, Ultraviolet Lamps, Neon Lamps. Neon Sign Tubes. Metal halides,HID and Arc lamps

LED lamps, CFL, Lasers Selection Criteria for lamps

Unit– III Illumination Control and Control Circuits

Purpose of lighting control, and Dimmer, Resistance type Salt water DimmerWorking principle and operation of Dimmer

Transformer and their types, Dimmer Transformer, Auto transformer dimmer, Two winding transformer dimmer

Electronic Dimmer: working principle and operation

a. Thyristor operated dimmer
b. Triac operated dimmer

Control of Enhance Lighting, Methods used for light control, Control circuits for lamps (re-fer): ON/OFF control

Control circuits for lamps: single lamp controlled by single switch, two switches. Single Lamp

control by two point method, three point method and four point method,

Unit– IV Illumination for Interior Applications

Standard for various locations of Interior Illumination

Design considerations for Interior location of residences (1/2/3/4 BHK), Commercial, Indus-trial premises

Illumination scheme for different Interior locations of Residential, Commercial, industrialunit

Unit– V Illumination for Interior Applications

Factory Lighting

Street Lighting (Latest Technology), Flood LightingRailway Lighting

Lighting for advertisement /Hoardings/sports lighting, Agriculture and Horticulture lighting, Health Care Centres / Hospitals, Decorating Purposes, Stage Lighting, Aquariums and Ship- yards

Special purpose lamps used in photography video films.

79. ILLUMINATION PRACTICES LABORATORY

1. Conduct illumination level assessment in workplace using lux meter.
2. Fit the given lamp in the selected mounting
3. Interpret the polar curves of the given type of lamp and verify it using the lux meter
4. Measure the illumination output of different lamps (Incandescent, Fluorescent, CFL,LED, HPSV, HPMV) and compare it with their wattage.
6. Measure illumination level with and without reflectors used in the various Luminaries.
7. Estimate and compare luminous efficiency of incandescent and compact fluorescent lamp.
8. Prepare light dimmer arrangement using the relevant dimmer type of transformer
9. Identify the given types of dimmer transformer and their parts
10. Build an electronic dimmer – Part I
11. Build another type of electronic dimmer – Part II
12. Build a single lamp control by single switch
13. Build a single lamp control by two switches
14. Build a single lamp control circuit for two-point method
15. Build a lamp control circuit for three-point method
16. Build a lamp control circuit for four-point method.

80. SWITCHGEAR AND PROTECTION

Unit – I Basics of Protection

Necessity, functions of protective system.Normal and abnormal conditions.

Types of faults and their causes. Protection zones and backup protection

Short circuit fault calculations in lines fed by generators through transformersNeed of current limiting reactors and their arrangements.

Unit – II Circuit Interruption Devices

Isolators- Vertical break, Horizontal break and Pantograph type. HRC fuses – Construction, working, characteristics and applications.

Arc formation process, methods of arc extinction (High resistance and Low resistance), Arc voltage, Recovery voltage, Re-striking voltage, RRRV.

HT circuit breakers (Sulphur-hexa Fluoride (SF6), Vacuum circuit breaker) - Working, construction, specifications and applications.

L.T. circuit breaker (Air circuit breakers (ACB), Miniature circuit breakers (MCB), Moulded case circuit breakers (MCCB) and Earth leakage circuit breaker (ELCB)) - Working and appli-cations.

Selection of LT and HT circuit breakers (ratings), Selection of MCCB for motors.Gas insulated switchgear.

Unit– III Protective Relays

Fundamental quality requirements: Selectivity, Speed, Sensitivity, Reliability, Simplicity, Economy.

Basic relay terminology- Protective relay, Relay time, Pick up, Reset current, current setting,Plug setting multiplier, Time setting multiplier.

Protective relays: Classification, principle of working, construction and operation of – Electromagnetic (Attracted armature type, Solenoid type, Watt-hour meter type) relay, Thermal relay. Block diagram and working of Static relay.

Overcurrent relay-Time current characteristics.

Microprocessor based over current relays: Block diagram, working.Distance relaying- Principle, operation of Definite distance relays. Directional relay: Need and operation.

Operation of current and voltage differential relay.

Unit– IV Protection of Alternator and Transformer Alternator Protection

Faults, Differential protection Over current, earth fault, overheating and field failure, protec-tion.

Reverse power protection.

Transformer Protection

Faults, Differential, over current, earth fault, over heating protection, Limitations of differen-tial protection.

Buchholz relay: Construction, operation, merits and demerits.

Unit– V Protection of Motors, Bus-bar and Transmission Line Motor

Faults. Short circuit protection, Overload protection, Single phase preventer**.**

Bus bar and Transmission line

Faults on Bus bar and Transmission Lines.

Bus bar protection: Differential and Fault bus protection. Transmission line: Over current, Distance and Pilot wire protection.

81. SWITCHGEAR AND PROTECTION LABORATORY

1. Identify various switchgears in the laboratory and write their specifications.
2. Test HRC fuse by performing the load test.
3. Test MCB by performing the load test
4. Dismantle MCCB/ELCB and identify various parts.
5. Dismantle ACB/VCB and identify different parts.

6. Set the plug and time (with PSM, TSM) of induction type electromagnetic relay.
7. Test electromagnetic over-current relay by performing load test.
8. Simulate differential protection scheme for transformer with power system simulation kit.
9. Test the working of the single phasing preventer using a three phase induction motor.
10. Simulate transmission line protection by using the impedance relay/over current relay for var-ious faults. (On transmission line protection simulation Kit).
11. Dismantle Thyrite type arrester and identify different parts.
12. Perform neutral earthing at different substations / locations.

82. SOLAR POWER TECHNOLOGIES

Unit – I Solar Energy

Solar Map of India: Global solar power radiation

Different types of Solar water heaters: Construction, working, specifications and installation

Solar Heating systems

Solar drying and different types of Solar cookersSolar lighting.

Preventive maintenance of all of the above.

Unit – II Concentrated Solar Power (CSP)

Concentrated Solar Power (CSP) plants or solar thermal electric systems

Parabolic Trough: Construction, working and specifications Parabolic Dish: Construction, working and specifications

Power Tower, Fresnel Reflectors: Construction, working and specifications

Solar Stirling engines

Preventive maintenance of all of the above

Unit– III Solar PV Systems

Solar PV cell: Types construction, working, Typical specifications of solar cellsSolar PV working principle: Series and parallel connections of solar modules Solar Photovoltaic (PV) system: components layout and working.

Solar modules, arrays and their standard specifications

Roof top and streetlight solar PV systems and typical specifications

Maintenance of these systems

Unit– IV Solar PV Electronics

Solar Charge controllers: working and specifications, switchgear and cables Batteries: Different types for solar PV systems, maintenance and specifications Solar Inverters: working and specifications

Signal conditioning systems: working and specifications

Solar Power tracking: construction, working, tilt angle, solar radiation, I-V, P-V characteris-tics, maximum power point tracking (MPPT) Maintenance of these systems.

Unit– V Solar PV Off-grid and Grid Tied Systems

Solar off grid systems: layout and specifications

Solar Grid tied (on grid) systems: Working principle of grid-tied dc-ac inverter, grid synchronization and active power export

Net metering: main features and working

Solar-wind Hybrid systems: Layout and specifications.

83. SOLAR POWER TECHNOLOGIES LABORATORY

1. Dismantle solar power heaters
2. Assemble solar power heaters
3. Assemble the parabolic dish CSP plant.
4. Dismantle the parabolic dish CSP plant.
5. Troubleshoot a CSP plant
6. Assemble the solar PV system.
7. Dismantle the solar PV system
8. Troubleshoot a solar PV system
9. Troubleshoot a solar PV panels and arrays
10. Troubleshoot solar inverters
11. Troubleshoot solar signal conditioners
12. Troubleshoot solar PV MPPT systems
13. Troubleshoot solar off-grid systems
14. Troubleshoot solar net metering systems
15. Troubleshoot solar-wind hybrid systems.

84. WIND POWER TECHNOLOGIES

Unit – I Wind Energy and Wind Power Plants

Wind power scenario in the world and India

Characteristics of Wind Energy: Wind movement, wind profile, roughness, effects of obstacles in wind path.

Types of Wind Power Plants (WPPs): Small and large wind turbines; Horizontal and Vertical axis; Upwind and Downwind, One, Two and Three blades; constant and variable Speed; Geared, Direct-Drive and Semi-Geared (Hybrid) WPPs; WECS, WEGs, WTs, WPPs,

WPP Tower Types: Lattice; tubular: steel, concrete, hybrid, ladders, cables.

WPP substation: Switchgear, transformers, inside layouts of Electric electronic panels at block level.

Unit – II Construction and Working of Large Wind Power Plants.

Wind Turbine Terminologies: Cut-in, cut-out and survival wind speeds, Threshold wind speeds, rated power, nominal power, Wind Power Curve,

Major parts and Functions of WPP: Rotor blades, hub, nacelle, tower, electric sub-station, nacelle layouts of Geared, Direct-Drive and Semi-Geared WPPs, Main shaft, gearbox, electric generator, electronic control panels

Rotation principles: Drag and Lift principle, thrust and torque of wind turbine rotor.

Different types of Sensors: Anemometer, wind vane, rpm sensors of main shaft and generator, temperature sensors of nacelle, gearbox and generator; cable untwisting and vibration sensors.

Different types of Actuators: Electric and hydraulic pitching and yawing mechanisms, cable untwisting and braking mechanisms

Unit– III Aerodynamic Control, Electric Generators and Grid Connection

Aerodynamic Control of WPPs: Stall Pitch and Active

Stall.Braking mechanisms of large WPPs.

Electric Generator Types: Working of Squirrel-Cage rotor Induction Generator (SCIG), Wound-Rotor Induction Generator (WRIG), Doubly-Fed Induction Generator (DFIG), wound rotor and permanent magnet synchronous generators.

Electric grid connection of WPPs: Local Impacts and system wide impact

Unit– IV Maintenance of Large Wind Power Plants

General maintenance of WPPs: preventive maintenance schedule of actuators such as yaw control, pitch control, braking mechanisms and sensors; oiling and greasing; electric and electronic equipment related; tower related; minor repairs, some tips,

Scheduled Maintenance: of Stall and Pitch and Active Pitch controlled WPPs

Unscheduled maintenance: operational factors, design faults, wear and tear of components, spurious trip, Major repairs.

Software related, warranty and insurance related issues

Unit– V Construction and Working Small Wind Turbines

Types and working of different type of small wind turbines (SWT): Classification: Horizontal and Vertical axis, Upwind and Downwind, One, Two and Three blades; Constant and Variable Speed; Direct-Drive and Geared; braking of SWTs

Parts of SWTs: Rotor, generator, gearbox, tower, electric control panel, tale vane, anemometer, wind vane, temperature and rpm

sensors. Working SWTs: Direct-drive

and Geared.

Electrical generators in SWTs: permanent magnet synchronous generators, induction gener-ators

SWT towers: Lattice tubular type, hydraulic towers, ladders, cables,

Unit– VI Maintenance of Small Wind Turbines

Small wind turbine assembly.

Installation of different types of small wind turbines (SWT): tubular and

latticetypes.

SWT Routine maintenance: Tips; Preventive maintenance schedule of: braking

mechanisms, sensors; oiling and greasing related; electric and electronic

equipmentrelated; tower related; software related, minor repairs

Power electronic devices and converters in different types of SWTs:

thyristors,power transistors

Common electrical and mechanical faults in SWTs

85. WIND POWER TECHNOLOGIES LABORATORY

1. Identify the specified items of a wind farm after watching the video clip.
2. Identify the specified parts inside the nacelle of a large wind power plant after watching the
   video clips.
3. Check the performance of the temperature and vibration sensor used in 125/150 kW WPPs.
4. Check the performance of the SCIG
5. Check the performance of the PMSG
6. Check the performance of the hydraulic and electric pitch actuator and yaw actuator used in125/150 kW WPPs.
7. Check the performance of the contactless RPM sensors used in WPPs
8. Troubleshoot the anemometer and wind vane
9. Check the generator performance of SWTs.
10. Identify the parts of a direct-drive SWT
11. Identify the parts of a geared SWT
12. Assemble/Dismantle a direct-drive SWT
13. Assemble/Dismantle a geared SWT
14. Check the performance of direct-drive SWT
15. Check the performance of geared SWT
16. Simulate faults in the small wind turbine trainer
17. Troubleshoot direct-drive SWT
18. Troubleshoot geared SWT
19. Interpret the wiring of a SWT electric-electronic control panel

86. BIOMASS AND MICRO-HYDRO POWER PLANTS

Unit– I Basics of Biomass-based Power Plants

Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk, municipal waste

Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-diesel gobar gas

Layout of a Bio-chemical based (e.g. biogas) power plant:

Layout of a Thermo-chemical based (e.g. Municipal waste) power plantLayout of a Agro-chemical based (e.g. bio-diesel) power plant

Selection of biomass power plants.

Unit– II Biomass Gasification Power Plants

The basic principle to convert Agriculture and forestry products and wood processing re- mains (including rick husks, wood powder, branches, offcuts, corn straws, rice straws, wheatstraws, cotton straws, fruit shells, coconut shells, palm shells, bagasse, corncobs) into com- bustible gas

General Construction and working of a typical gasifier

Power generating in gas engine:

Strengths and limitations of Agriculture and forestry products gasifier

Preventive maintenance steps different types of biomass gasifiers.

Unit– III Different Types of Gasifiers

Construction and working of the following types of gasifiers:Rice Husk Gasification Power Plant and their specifications Straw Gasification Power Plant and their specifications

Bamboo Waste, Bamboo Chips Gasification Power Plantand their specifications
Coconut shell, coconut peat, coconut husk, Gasification Power Plantand their specifications

Bagasse/Sugar Cane Trash Gasification Power Plantand their specifications
Gobar gas plant and its specifications
Breakdown maintenance of biomass power plant at the module level.

Unit– IV Micro-hydro Power Plants

Locations of microhydro power plant
Energy conversion process of hydro power plant.
Classification of hydro power plant: High, medium and low head.
General Layouts of typical micro-hydro power plant. Strengths and limitations of microhydro power plants

Unit– V Different types of Microhydopower plants

Construction and working of High head – Pelton turbineand their specifications Construction and working of Medium head – Francis turbineand their specificationsConstruction and working of Low head – Kaplan turbineand their specifications Preventive and breakdown maintenance of microhydro power plants
Safe Practices for microhydro power plants.

87. BIOMASS AND MICRO-HYDRO POWER PLANTS LABORA-TORY

1. Identify different components of a typical Biomass power plant.
2. Identify different biomass resources and evaluate their energy potential.
3. Determine the carbon content of solid biomass.
4. Assemble the Biogas power plant.
5. Dismantle the Biogas power plant
6. Identify the components of the high head micro hydro power plant
7. Identify the components of the medium head micro hydro power plant
8. Identify the components of the low head micro hydro power plant
9. Assemble a high head micro hydro power plant
10. Assemble a medium head micro hydro power plant
11. Assemble a low head micro hydro power plant
12. Undertake preventive maintenance of the high head micro hydro power plant
13. Undertake preventive maintenance of the medium head micro hydro power plant
14. Undertake preventive maintenance of the low head micro hydro power plant
15. Check the performance of Pelton wheel micro hydro power plant

88. ELECTRIC VEHICLES

Unit – I Introduction to Hybrid Electric Vehicles

Evolution of Electric vehicles

Advanced Electric drive vehicle technology Vehicles-Electric vehicles (EV), Hybrid Electricdrive (HEV), Plug in Electric vehicle (PIEV),

Components used Hybrid Electric Vehicle

Economic and environmental impacts of Electric hybrid vehicle Parameters affecting Environmental and economic analysis Comparative study of vehicles for economic, environmental aspects

Unit – II Dynamics of hybrid and Electric vehicles

General description of vehicle movement

Factors affecting vehicle motion- Vehicle resistance, tyre ground adhesion, rolling resistance, aerodynamic drag, equation of grading resistance, dynamic equation

Drive train configuration, Automobile power train, classification of vehicle power plant Performance characteristics of IC engine, electric motor, need of gear box Classification of motors used in Electric vehicles

Basic architecture of hybrid drive trains, types of HEVsEnergy saving potential of hybrid drive trains

HEV Configurations-Series, parallel, Series-parallel, complex.

Unit– III DC-DC Converters for EV and HEV Applications

EV and HEV configuration based on power converters Classification of converters – unidirectional and bidirectionalPrinciple of step down operation

Boost and Buck- Boost convertersPrinciple of Step-Up operation

Two quadrant converters; multi quadrant converters

Unit– IV DC-AC Inverter & Motors for EV and HEVs

DC-AC Converters

Principle of operation of half bridge DC-AC inverter (R load, R-L load)Single phase Bridge DC-AC inverter with R load, R-L load

Electric Machines used in EVs and HEVs, principle of operation, working & controlPermanent magnet motors, their drives, switched reluctance motor Characteristics and applications of above motors

Unit– V Batteries

Overview of batteries

Battery Parameters, types of batteries

Battery Charging, alternative novel energy sources-solar photovoltaic cells, fuel cells, super capacitors, flywheels

Control system for EVs and HEVs, overview, Electronic control unit ECUSchematics of hybrid drive train, control architecture

Regenerative braking in EVs

89. ELECTRIC VEHICLES LABORATORY

1. Develop block diagram of Electric vehicle and identify parts
2. Case study- Compare minimum four vehicles for economic and environmental analysis
3. Develop schematic diagram of hybrid electric vehicle and identify the components

fluores-cent lamp.

4. Prepare report on Plug in Electric vehicle by visiting a charging station
5. Inspect and install inverter of given lead acid battery
6. Prepare a report on batteries used from market survey
7. Collect specifications of converters and inverters used for Electric vehicles a single lamp con-trol by two switches
8. Diagnose, repair and maintain battery used in electric vehicle
9. Prepare test procedure for equipment used in Electric vehicle
10. List safety procedures and schedule for handling HEVs and EVs.

90. ELECTRIC TRACTION

Unit – I Basics of Traction

General description of Electrical Traction system in India.

Advantages and Disadvantages of Electric Drive, Diesel Electric Drive, Battery DriveProblems associated with AC traction System and remedies for it.

Voltage balance, current balance, production of harmonics, induction effects.Metro rail system, features

Unit – II Power Supply Arrangements

Constituents of supply system:-

- Substation: layout, list of equipment and their functions
- Feeding post: list of equipment and their functions
- Feeding and sectioning Arrangements
- Sectioning and paralleling post
- Sub sectioning and Paralleling post
- Sub sectioning post
- Elementary section

Major equipment at substation, Miscellaneous equipment at control post or Switching station Protection system for traction transformer and 25 kV centenary construction

Unit– III Overhead Equipment

Different types of overhead equipments Pentagonal OHE Centenary Construction

Different Types of Centenary according to speed Limit OHE Supporting Structure, Cantilever assembly diagram

Overhead system- Trolley collector, Bow collector, Pantograph CollectorTypes and construction of pantograph

Unit– IV Electric Locomotive

Classification and Nomenclature of Electric Locomotive

Block diagram of AC locomotivePower Circuit of AC Locomotive

Equipment (List and Function only) used in auxiliary circuit of AC Locomotive Loco bogie classification according to wheel arrangements

Maintenance of AC systems

Unit– V Traction Motors and Train Lighting

Desirable characteristics of traction motor.

Types of motors used for traction with their characteristics and featuresControl of motors used for traction and methods to control Requirements of braking, types of braking

Electric braking, Regenerative braking

Systems of train lighting, Single battery, double battery parallel block systemSG, HOG, End on generation

Unit VI. Signalling and Supervisory Control Requirements of signaling systems Types of signals, track circuits Advantages of remote control

Systems of remote control, equipment and network Metro rail-supply systems, advantages, schemes in India

91. ELECTRIC TRACTION LABORATORY

1. Dismantle a traction motor
2. Assemble a traction motor
3. Troubleshoot a traction motor
4. Visit electric-traction train lighting system installation, identify components of system and prepare report
5. Visit electric-traction loco shed, investigate working of each section & prepare report
6. Visit to Traction Substation or feeding post (for layout and OHE) and write a report
7. Visit to Railway Station (for signalling and train lighting) and writing a report on visit
8. Draw traction substation Layout on drawing sheet and prepare report
9. Draw Pentagonal OHE Catenary, different Catenaries according to speed limit, OHE support ing structure on drawing sheet and prepare report
10. Draw Power Circuit of AC Locomotive on drawing sheet and prepare report.