

6751 GENERATION OF ELECTRICAL ENERGY

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AIMS

To provide the student with an opportunity to acquire knowledge, skill and attitude in the area of generation of electrical energy with special emphasis on ;

- Main features of power generation.
- Power plant economics.
- Authorities responsible for generation of electrical energy in Bangladesh.
- Non-conventional renewable energy sources.

SHORT DESCRIPTION

Sources of energy; Power plants: Types & working principle; Selection of power plants & site; Power plant economics; Authority for generating power and Renewable energy sources.

DETAIL DESCRIPTION

Theory:

SOURCES OF ENERGY

1 Understand types of energy.

- 1.1 List at least ten common sources of energy.
- 1.2 Describe the different types of energy.
- 1.3 Mention the conventional sources of energy available in Bangladesh with their locations.

POWER PLANTS: TYPES & WORKING PRINCIPLE

2 Understand the types and characteristics of power plants.

- 2.1 Describe basic operation of a power plant.
- 2.2 Describe the importance of power plants.
- 2.3 Describe the uses of power plants.
- 2.4 Name the different types of power plants.
- 2.5 Mention the names of power plants of Bangladesh with their location and rating.

3 Understand the principle of operation of a steam power plant.

- 3.1 Define Boiler.
- 3.2 Explain the different type of Boiler.
- 3.3 Describe the Construction and working principle of water tube boiler.
- 3.4 Describe the Construction and working principle of fire tube boiler.
- 3.5 Explain the working principle of a steam power plant.
- 3.6 Explain the different types of vapor cycle with P-V diagram.
- 3.7 Explain the different types of steam generator.
- 3.8 Explain the working principle of steam generator.
- 3.9 Explain working principle of boiler auxiliaries and accessories.
- 3.10 Describe the feed water treatment process.
- 3.11 Describe the working principle of different types of steam turbine including starting and shutdown procedure.
- 3.12 Sketch a schematic diagram of a steam power plant and label its different sections.

4 Understand the principle of operation of a diesel power plant.

- 4.1 Explain the working principle of a diesel power plant.
- 4.2 Identify the areas of application of diesel power plant.
- 4.3 Describe the constructional features of a modern diesel engine used for a diesel generating station.
- 4.4 Explain starting and stopping procedure of a diesel generator.
- 4.5 Describe the fuel storage and handling method for large diesel power plant.

5 Understand the principle of operation of gas turbine power plant.

- 5.1 Explain working principle of simple open and closed cycle gas turbine with P-V diagram.
- 5.2 Identify the applications of a gas turbine power plant in Bangladesh.
- 5.3 List the advantages and disadvantages of a gas turbine power plant.

6 Understand the operation of a hydro-electric power plant.

- 6.1 Explain the working principle of a hydro-electric power plant.
- 6.2 Describe different types of hydro-electric power plants with sketches.
- 6.3 Define catchment area.
- 6.4 Describe different sections of a hydro-electric power plant with schematic diagram.
- 6.5 Explain different types of water turbine generally used in hydro-electric plant.
- 6.6 Explain the governing principle of a water turbine with a schematic diagram.
- 6.7 Solve problems related to hydro-electric power plant.

7 Understand the principle of operation of a nuclear power plant.

- 7.1 Explain the elements of a nuclear power station with schematic diagram.
- 7.2 Explain the chain reaction.
- 7.3 List the name of four types of reactor used in a nuclear power station.
- 7.4 Explain the constructional features of each type of reactor.
- 7.5 Explain the working principle of each type of reactor.
- 7.6 Identify the advantages & disadvantages of nuclear power plant.
- 7.7 List large nuclear power plants in the world.

SELECTION OF POWER PLANT & ITS SITE

8 Understand the process of selection of a power plant and its site.

- 8.1 List the different factors to be considered for selecting a steam, diesel, hydro-electric, gas and nuclear power plant.
- 8.2 List the factors to be considered for selecting the site for a steam, diesel, hydro-electric, gas and nuclear power plant.
- 8.3 Sketch the different power plants of Bangladesh with their types, capacities and location in a map.

POWER PLANT ECONOMICS

9 Understand the concept of power plant economics.

- 9.1 Describe plant depreciation.
- 9.2 List the factors influencing the rate or tariff designing of electrical energy.
- 9.3 Describe the operating costs of a hydro-electric, steam and nuclear power plant.
- 9.4 Outline the effects of variable loads on power generation economy.
- 9.5 Describe the advantages of interconnection of different power plants.
- 9.6 Discuss the following terms -
Ideal and actual load curve, annual load curve, peak load, load factor, maximum demand, demand factor, capacity factor, use factor and diversity factor.
- 9.7 Explain load despatch, centre-capacity and load scheduling.
- 9.8 Describe peak-hour.
- 9.9 Explain load management.
- 9.10 Solve problems related to power plant economics.

AUTHORITY FOR GENERATING ELECTRICAL POWER

10 Recognize authority for generating bulk and consumer supply of electrical power.

- 10.1 Identify the authorities for power supply in Bangladesh.
- 10.2 Explain grid system.
- 10.3 List the functions of public & private sector in the field of power generation in Bangladesh.
- 10.4 Draw the organization of Rural Electrification Board with its consumers.
- 10.5 Describe the operation of Dhaka Electric Supply Authority (DESA).
- 10.6 Identify the jurisdiction of Dhaka Electric Supply Company (DESCO).
- 10.7 Identify the function and jurisdiction of Power Grid Company of Bangladesh (PGCB).
- 10.8 Describe the existing private sector power station in Bangladesh and their future growth.

RENEWABLE ENERGY SOURCES

11 Understand the concept of non conventional renewable energy sources.

- 11.1 List global energy scenario and energy scenario of Bangladesh.
- 11.2 List non conventional renewable energy sources.
- 11.3 Discuss potential renewable energy sources of Bangladesh.
- 11.4 Describe measurement of solar radiation and solar radiation at earth surface.
- 11.5 List the uses of solar radiation (eg. solar P-V submersible water pumping, solar cooker, solar P-V home lighting for rural application, solar P-V charging station, solar P-V powered Refrigerator, solar dryer and commercially used generation of electrical energy).
- 12 Understand the concept of solar power generation.**
 - 12.1 List four types of solar electric application.
 - 12.2 Describe operating principle of solar cell.
 - 12.3 Describe different types of solar cell.
 - 12.4 Describe the principle of solar thermal power generation.
 - 12.5 Describe the photo voltaic energy conversion system.
 - 12.6 Describe the application of photo voltaic energy conversion system – Residential, Community and central station.
 - 12.7 Describe storage for solar thermal power generation.
- 13 Understand wind energy generation.**
 - 13.1 Discuss wind energy conversion system.
 - 13.2 Discuss small scale system, intermeditate scale system and large scale system of wind energy generation.
 - 13.3 Describe the different components of wind machine.
 - 13.4 Describe different types of wind machines.
 - 13.5 Discuss different types of wind energy conversion system.
 - 13.6 Discuss wind energy prospects of Bangladesh (coastal regions).
- 14 Understand non conventional sources of energy.**
 - 14.1 Discuss the generation of electrical energy by municipal waste.
 - 14.2 Describe wave energy generation.
 - 14.3 Describe tidal energy generation.
 - 14.4 Describe Ocean thermal energy conversion (OTEC).

Practical:

- 1 Select a particular type of power plant in an area.**
 - 1.1 Assess the probable load of the proposed locality for which the power station is supposed to be installed.
 - 1.2 List the existing communication system of the area.
 - 1.3 Assess the cost of land in the area.
 - 1.4 Make a topographic survey of the area.
 - 1.5 Find the location of the sources and nature of energy available for the area.
 - 1.6 Select the type of power plant for the area.
 - 1.7 Justify the reasons for selecting the power plant.
- 2 Select size, type and rating of a generator for a particular power plant.**
 - 2.1 Survey the electrical load of the area to be electrified by the power plant.
 - 2.2 Select a power plant on the basis of economy of the power sources available.
 - 2.3 Select the size of the power plant on the basis of load survey.
 - 2.4 Select the voltage rating of the power plant on the basis of distribution.
 - 2.5 Justify the reasons for the selection made.
- 3 Locate the main power plants of Bangladesh with sources of natural energy by tracing a map of Bangladesh.**
 - 3.1 Trace a map of Bangladesh showing important places.
 - 3.2 Locate the power plants and power sources symbolically in the map.
 - 3.3 Write the name of the places where the power plants and power sources are located.
 - 3.4 Indicate the rivers adjacent to the power plants.
 - 3.5 Show the legends demonstrating the symbols.

- 4 Reassemble a boiler.**
 - 4.1 Collect the tools required to open the boiler.
 - 4.2 Read the manual carefully.
 - 4.3 Open the boiler.
 - 4.4 Identify the different parts.
 - 4.5 Clean the tubes with steel brush.
 - 4.6 Clean inside of the boiler with cotton waste.
 - 4.7 Reassemble carefully the dismantled parts.
 - 4.8 Sketch a neat diagram showing all parts of the boiler.
- 5 Start a diesel electric power plant.**
 - 5.1 Collect the tools required for starting a diesel electric power plant.
 - 5.2 Check all accessories.
 - 5.3 Check fuel level and cooling water.
 - 5.4 Check the specific gravity of the electrolyte of the storage battery.
 - 5.5 Start the engine coupled with generator.
 - 5.6 Check the metering panel and gauges.
 - 5.7 Run the generator at no load.
 - 5.8 Increase engine speed and gradually apply electrical load.
 - 5.9 Record all meters and gauge readings.
 - 5.10 Record voltmeter reading at rated speed.
- 6 Operate a turbine.**
 - 6.1 Identify the different components of the turbine.
 - 6.2 Follow all instructions and precautions for starting the turbine and make it ready for starting.
 - 6.3 Start and operate the turbine for warming up and gradually increase the speed to rated RPM.
 - 6.4 Couple the turbine with load.
 - 6.5 Record the relevant data.
 - 6.6 Observe all precautions and shut down the turbine.
 - 6.7 Deduce the BHP of the turbine.
- 7 Plot the load curve and load duration curve of a power plant.**
 - 7.1 Process the supplied data of a particular power plant for a given period.
 - 7.2 Plot a load curve according to the processed data on a graph with suitable scale.
 - 7.3 Plot a load duration curve from the processed data on a graph with suitable scale.
- 8 Find load factor and average load from the load curve.**
 - 8.1 Observe the load curves and load duration curves plotted before.
 - 8.2 Deduce the load factor of the plant using relevant formula and proper information from the curves.
 - 8.3 Find the average load of the plant using relevant formula and proper information from the curves.
- 9 Sketch the layout diagram of a known power plant.**
 - 9.1 Visit a nearby power station.
 - 9.2 Identify the different sections of the power plant.
 - 9.3 Sketch the layout diagram of different sections of the plant visited.
 - 9.4 Prepare a neat integrated sketch of the layout diagram of the plant visited.
- 10 Sketch the layout diagram of a solar power plant.**
 - 10.1 Visit a nearby solar plant.
 - 10.2 Identify the different sections of the plant.
 - 10.3 Prepare a neat integrated sketch of the layout diagram of the plant visited.
- 11 Design a photovoltaic system.**
 - 11.1 Calculate the electrical load of a nearby area.
 - 11.2 Select the appropriate rating of cell, Battery, Cable etc.
 - 11.3 Sketch the layout diagram.
 - 11.4 Connect the components properly.

- 11.5 Draw the current-voltage curve and power-voltage curve.
- 12 Sketch the layout diagram of a wind power plant.**
- 12.1 Visit a nearby wind plant.
- 12.2 Identify the different sections of the plant.
- 12.3 Prepare a neat integrated sketch of the layout diagram of the plant visited.

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– G R Nagpal Thirteenth Edition 1994
2. Power Plant Engineering
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4. Principle of Power System
– V K Mehta
5. Renewable Engineering Sources and Conversion Technology
– NK Bansal, Manufred klee mann Michel (Megam Hill)
6. Hand Book of Energy Technology, Trends and Perspection
– V Daniel Hunt
7. Energy Technology – Alternative, Renewable and Conventional
Dr. B. B Parulkar, Dr. K G Naratan
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8. Photovoltaic Technology For Bangladesh
– Editors: AKM Sadral Islam, D G Infield

AIMS

- To develop knowledge and skill on cell and battery and the process of electroplating.
- To provide understanding on DC generator.
- To develop knowledge and skill on DC motor.
- To provide knowledge on characteristics of DC generator.
- To develop knowledge on electric traction.

SHORT DESCRIPTION

Cell and battery : Principle, construction, uses and maintenance; Electroplating; DC Generator : Principle, construction, winding, losses, efficiency, characteristics and parallel operation; DC Motor : Principle, construction, torque/speed curves, efficiency, speed control, starting and tests; Electric traction.

DETAIL DESCRIPTION**Theory :****CELL AND BATTERY**

- 1 Understand the construction of different types of cell and battery.**
 - 1.1 Describe the construction of dry cell and its chemical reaction.
 - 1.2 Describe the construction of alkaline batteries.
 - 1.3 Describe the construction of lead acid battery and its chemical reaction.
- 2 Understand the features of battery charging.**
 - 2.1 Name the types of battery charging system.
 - 2.2 Describe the charging procedure of battery by 220-230VAC source.
 - 2.3 Describe the procedure of slow charging.
 - 2.4 Describe the procedure of quick charging.
 - 2.5 Describe the procedure of preparing electrolyte.
 - 2.6 Describe the construction of dry charged battery.
 - 2.7 Explain the charging procedure of sulfated battery.
 - 2.8 Describe the process of charging more than one battery at a time.
- 3 Understand the efficiency and testing of batteries.**
 - 3.1 Describe the internal resistance and efficiency of a battery.
 - 3.2 Explain ampere – hour (A - H) rating of battery.
 - 3.3 Solve problems related with internal resistance affecting terminal voltage.
 - 3.4 List at least three factors on which the capacity of a battery depends.
 - 3.5 Describe the procedures of testing a storage battery by hydrometer, voltmeter and ammeter.
 - 3.6 State the maintenance and routine inspection procedure of a battery.
- 4 Understand the process of electroplating.**
 - 4.1 State fundamental principles of electroplating.
 - 4.2 State Faraday's laws of electrolysis.
 - 4.3 Describe briefly the process of extraction and refining of metals.
 - 4.4 State a simple method of producing copper plating upon a carbon brush.
 - 4.5 Describe electro-deposition process.
 - 4.6 Identify power supply for electrolytic process adopted in electroplating.

DC GENERATOR

5 Understand the working principle of DC generator.

- 5.1 State generator principle.
- 5.2 Mention the conditions for generation of emf in a single coil generator.
- 5.3 Describe the constructional details of a DC generator.
- 5.4 Explain the functions of different parts/components of a DC generator.
- 5.5 Sketch the magnetic circuit of a DC generator.
- 5.6 Express the deduction of the emf equation of a DC generator.
- 5.7 List the various losses in a DC generator.
- 5.8 Explain power stages of a DC generator.
- 5.9 Express the condition for maximum efficiency.
- 5.10 Solve problems relating to DC generator.

6 Understand the principle of winding of DC generator.

- 6.1 Define the terms pole pitch, coil pitch, front pitch, back pitch, average pitch and commutation pitch.
- 6.2 Describe lap and wave winding.
- 6.3 Sketch the developed diagram of simplex and duplex (lap and wave) winding.
- 6.4 Name at least four major differences between the lap and wave windings.

7 Understand the armature reaction and commutation of DC generator.

- 7.1 Explain armature reaction.
- 7.2 Describe the effect of armature reaction.
- 7.3 State de-magnetizing and cross magnetizing.
- 7.4 Explain the action of commutation.
- 7.5 Identify the value of reactance voltage.
- 7.6 Express the deduction of Hobart's formula for coefficient of self-induction.
- 7.7 Mention the methods of improving commutation.
- 7.8 Explain the necessity of interpoles and compensating winding.
- 7.9 State the need for equalizing bar and rings.

8 Understand the principle of excitation.

- 8.1 Explain the excitation of DC generator.
- 8.2 Explain the necessity of excitation.
- 8.3 Identify self excited and separately excited generator.
- 8.4 Describe the condition for excitation.

9 Understand the characteristics of DC generator.

- 9.1 Explain the process of building up voltage of shunt generator.
- 9.2 State the critical resistance and critical speed for shunt generator.
- 9.3 Plot the terminal voltage Vs load current characteristic curve of shunt generator.
- 9.4 State the reasons for decreasing terminal voltage with increasing load.
- 9.5 Solve related problems relating to shunt generator.
- 9.6 Plot the internal and external characteristic curve of DC shunt, series and compound generator.

10 Understand the concept of voltage regulation and efficiency of a DC generator.

- 10.1 Explain the formula for voltage regulation of a DC generator.
- 10.2 Discuss the importance of voltage regulation of DC generator.
- 10.3 Solve problems relating to voltage regulation of DC generator.
- 10.4 Express the formula for efficiency of a DC generator.
- 10.5 Solve problems relating to efficiency of a DC generator.

11 Understand the principle of parallel operation of DC generator.

- 11.1 State the need for parallel operation of DC generator (shunt, series and compound)
- 11.2 List the conditions for parallel operation of DC generator.
- 11.3 Discuss the condition of sharing loads in DC generators operating in parallel.
- 11.4 Draw the circuit diagram of two long shunt compound generators connected in parallel.
- 11.5 Calculate the load shared by individual machine at the time of parallel operation.

DC MOTOR

12 Understand the working principle of DC motor.

- 12.1 Explain the working principle of DC motor.
- 12.2 Explain generator action of motor.
- 12.3 Explain the significance of the back emf.
- 12.4 Express the deduction of voltage equation of motor.
- 12.5 Define the term torque (mentioning its unit), running torque and break down torque.
- 12.6 Express the deduction of equation for speed of DC motor (for series and shunt motors).
- 12.7 Plot the torque/speed curve of series, shunt and compound motors.

13 Understand losses and efficiency.

- 13.1 State the losses in DC motor.
- 13.2 Calculate the efficiency of DC motor from a given data.
- 13.3 Explain the power stages of DC motor.

14 Understand the starting methods and speed control of DC motor.

- 14.1 Describe the factors controlling the speed of DC motor.
- 14.2 Discuss the general methods of speed control of DC motor.
- 14.3 Explain speed control of shunt, series and compound motor.
- 14.4 Mention the merits and demerits of reostat control method.
- 14.5 Describe electric braking of shunt and series motor.
- 14.6 Explain the necessity of a starter for DC motor.
- 14.7 Describe three point and four point starter used in DC motor.
- 14.8 Explain the heating and cooling of DC machine.
- 14.9 Explain brake test and no-load test of DC motor.

ELECTRIC TRACTION

15 Understand the system of electric traction.

- 15.1 State the meaning of electric traction.
- 15.2 Describe the system of electric traction.
- 15.3 List the characteristics of an ideal traction system.
- 15.4 Describe the feeding and distribution system for tram ways and trolley buses.
- 15.5 Explain the diesel electric drive, battery electric drive and electric drive of locomotives.
- 15.6 Explain the working principle of tram ways and trolley buses.
- 15.7 Explain the DC system used in traction.
- 15.8 Explain the reasons for using DC series motor for traction purpose.

16 Understand the concept of speed control of traction motors.

- 16.1 Explain different methods of speed control of DC traction motors.
- 16.2 Explain starting methods and speed control of 1-phase AC series motor.
- 16.3 Explain starting method of 3-phase induction motor used in traction.
- 16.4 Explain speed control system of 3-phase induction motor used in traction.
- 16.5 Explain different braking systems.
- 16.6 Explain the systems of supplying power in electric traction.

Practical :

1 Charge a lead acid battery.

- 1.1 Sketch the connection diagram for constant potential/Constant current method of charging.
- 1.2 Identify the equipment and materials required for charging a lead acid battery.
- 1.3 Record the readings by measuring the terminal voltage of the discharged battery and specific gravity of electrolytes.
- 1.4 Connect the positive and negative terminal of the battery to the positive and negative terminals of the charger respectively.
- 1.5 Set the charging voltage and switch on the charger.
- 1.6 Record the readings by measuring the specific gravity of electrolyte and the terminal voltage of the battery.

2 Measure the internal resistance of a battery.

- 2.1 Sketch necessary circuit diagram.
- 2.2 Connect a resistance (known value) with the battery.
- 2.3 Record the readings by measuring the voltage and current of the battery.
- 2.4 Calculate the internal resistance using the formula.

$$I = \frac{V}{R_i R_i}$$

3 Test of Battery

3.1 Discharge test

4 Dis-assemble and re-assemble the parts of a DC generator/ DC motor.

- 4.1 Select the necessary tools required for dis-assembling and re-assembling the parts of DC generator/ DC motor.
- 4.2 Identify at least ten main parts of the generator/motor.
- 4.3 Sketch at least ten main parts of the generator/motor.
- 4.4 Re-assemble the parts of the generator/motor.
- 4.5 Connect the generator/motor to the proper power source.
- 4.6 Start the generator/motor.

5 Develop a 4 poles, 24 slots, double layer lap winding (simplex & duplex) of a DC generator.

- 5.1 Select pole pitch, back pitch, front pitch and commutator pitch for the generator.
- 5.2 Sketch the developed winding diagram (simplex and duplex) showing the position of carbon brushes.
- 5.3 Select the coil turns, coil number and coil grouping for the winding.
- 5.4 Select the sizes and types of wires required for the winding.
- 5.5 Construct required number of coils.
- 5.6 Insert the coils into the slot using the proper insulation.
- 5.7 Connect the coils in proper way.
- 5.8 Test the winding step by step.
- 5.9 Note down the observations.

6 Develop a 4 poles, 16 slots, double layer wave winding (simplex & duplex) of a DC generator.

- 6.1 Identify pole pitch, back pitch, front pitch, commutator pitch.
- 6.2 Sketch the developed winding diagram (simplex & duplex) showing the position of carbon brushes.
- 6.3 Determine the number of turns required on the basis of coil grouping and layer of winding.
- 6.4 Determine the size and type of wires required for the winding.
- 6.5 Perform winding.

7 Determine generated emf of a DC shunt generator.

- 7.1 Sketch the required diagram of the shunt generator.
- 7.2 Set the experiment as per diagram.
- 7.3 Start the generating set and build up the voltage.
- 7.4 Measure the developed emf by starting the generator.
- 7.5 Record the required data.
- 7.6 Plot the I_f versus V_g curve from the data.

8 Plot the V_L - I_L characteristic curves of a shunt generator.

- 8.1 Sketch the required diagram for the experiment.
- 8.2 List the materials, meters and equipment required for the experiment.
- 8.3 Connect all the meters and equipment as per diagram.
- 8.4 Record the necessary readings from the meters.
- 8.5 Plot the V_L - I_L curve from the data.

9 Plot the V_L - I_L characteristic curve of a series generator.

- 9.1 Sketch the required diagram for the experiment.
- 9.2 List the required instruments & materials.

- 9.3 Connect all the meters and equipment as per diagram.
- 9.4 Record the necessary readings from the meters.
- 9.5 Plot the V_L - I_L curve from the data.
- 10 Plot the V_L - I_L characteristic curve of a compound generator.**
 - 9.1 Sketch the required diagram for the experiment.
 - 9.2 List the required instruments & materials.
 - 9.3 Connect all the meters and equipment as per diagram.
 - 9.4 Record the necessary readings from the meters.
 - 9.5 Plot the V_L - I_L curve from the data.
- 11 Run the two DC shunt generators in parallel.**
 - 11.1 Sketch the required diagram.
 - 11.2 List tools and materials required for the experiment.
 - 11.3 Connect the machines as per diagram.
 - 11.4 Check connection and start incoming machine.
 - 11.5 Observe the voltage of incoming machine and compare this with bus bar voltage.
 - 11.6 Switch on the incoming machine with the bus bar when it is ready.
- 12 Run a small size DC shunt motor and control its speed.**
 - 12.1 Sketch the required diagram.
 - 12.2 List tools and materials required.
 - 12.3 Connect the machine as per diagram.
 - 12.4 Start the machine.
 - 12.5 Regulate speed of the motor.
- 13 Start a DC shunt motor by a three-point starter.**
 - 13.1 Sketch the required diagram for the experiment.
 - 13.2 List tools, equipment and materials required.
 - 13.3 Connect the machine as per diagram.
 - 13.4 Start the motor with the help of three point starter.
- 14 Start a DC compound motor by a four point starter.**
 - 14.1 Sketch the required diagram for the experiment.
 - 14.2 List the tools and materials required.
 - 14.3 Connect the machine as per diagram.
 - 14.4 Start the motor with the help of four point starter.

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– Samadder & Gongopadhya
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– J. B. Gupta
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– B. L. Theraja
- 4 Automotive Electrical Equipment
– H.W. Crouse, P.L. Kohli

AIMS

To provide the student with an opportunity to acquire knowledge, skill and attitude in the area of measurement and measuring instruments of electrical quantities with special emphasis on;

- Accuracy, precision, sensitivity and error in electrical measuring instruments.
- Concept of operation of different types of electrical measuring instruments.
- Selection of correct type of meters for particular measurement.
- Measurement of power of single phase and three phase system.
- Concept of operation of energy meter.

SHORT DESCRIPTION

Fundamentals of measurements; Indicating instruments; Digital instruments; Current & voltage measuring instruments; Measurement of electrical power; Energy meters.

DETAIL DESCRIPTION**Theory:****FUNDAMENTALS OF MEASUREMENTS****1 Understand the basic concept of measurements.**

- 1.1 Define measurements of electrical quantities.
- 1.2 Discuss significance of measurements.
- 1.3 Describe the terms accuracy, precision, sensitivity and resolution or discrimination.
- 1.4 Distinguish between accuracy and precision.
- 1.5 Describe errors in measurements.
- 1.6 State true value, static error or absolute error, relative error, static correction, limiting error and percentage limiting error.
- 1.7 Define the loading effect.
- 1.8 Describe the loading effects due to shunt connected instruments.
- 1.9 Describe the loading effects due to series connected instruments.
- 1.10 Solve problems related to errors in measurement.

2 Understand the classification of measuring instrument.

- 2.1 Describe measuring instrument.
- 2.2 Name two main types of measuring instruments.
- 2.3 Describe absolute and secondary instruments.
- 2.4 List two types of secondary instruments according to their mode of operation.
- 2.5 List three types of secondary instruments according to their functions.
- 2.6 Describe indicating, recording and integrating instruments.
- 2.7 Discuss the various effects of current or voltage utilized in measuring instrument upon which their operation depends.

INDICATING INSTRUMENTS**3 Understand the principle of operation of indicating instruments.**

- 3.1 Name the three torque applied in indicating instrument which act upon their moving system.
- 3.2 Discuss deflecting torque and controlling torque.
- 3.3 Discuss spring control and gravity control system.
- 3.4 Compare between spring control and gravity control system.
- 3.5 Solve problems related to spring control and gravity control system.
- 3.6 Explain damping torque.

- 3.7 Name the three systems of damping.
- 3.8 Compare air friction damping, fluid friction damping and eddy current damping.

4 Understand the constructional features of measuring instruments.

- 4.1 Name the essential parts of measuring instruments.
- 4.2 Describe the parts of the instrument such as supporting, moving system, balancing, permanent magnets, pointer, scale, zero-adjuster, cases, etc.
- 4.3 Discuss the torque weight ratio.

CURRENT & VOLTAGE MEASURING INSTRUMENTS

5 Understand the concepts of ammeters and voltmeters.

- 5.1 Explain the principle of operation of ammeter and voltmeter.
- 5.2 Distinguish between the working principle of ammeter and voltmeter.
- 5.3 List the various types of ammeter and voltmeter.

6 Understand the principle of operation of moving iron instruments.

- 6.1 Describe the construction and working principle of moving iron attraction type instruments.
- 6.2 Express the deduction of the torque equation of the moving iron attraction type instruments.
- 6.3 Describe the construction and working principle of repulsion type moving iron instrument.
- 6.4 Express the deduction of the torque equation.
- 6.5 List the advantages and disadvantages of moving iron instruments.
- 6.6 Discuss errors in moving iron instruments.
- 6.7 Solve problems related to of moving iron instruments.

7 Understand the principle of operation of moving coil instruments.

- 7.1 Describe the construction and working principle of permanent magnet moving coil instruments.
- 7.2 Express the deduction of the torque equation of the moving coil instrument.
- 7.3 Mention the advantages and disadvantages of permanent magnet moving coil instruments.
- 7.4 Describe the construction and working principle of dynamometer type moving coil instruments.
- 7.5 Indicate the arrangement of coils of dynamometer type instruments for measurements of current and voltage.
- 7.6 Discuss the errors of moving coil instruments.
- 7.7 Solve problems related to torque equation of moving coil instruments.

8 Understand the principle of operation of electrostatic voltmeter.

- 8.1 Describe the construction and working principle of a quadrant type voltmeter.
- 8.2 Describe the construction and working principle of attracted disc type voltmeter.
- 8.3 Mention the advantages of electrostatic voltmeter.
- 8.4 List the limitations of electrostatic voltmeter.
- 8.5 Mention the uses of electrostatic voltmeter.

9 Understand the operation of dynamometer type wattmeter.

- 9.1 Describe the construction and principle of operation of dynamometer type wattmeter.
- 9.2 List the advantages of dynamometer type wattmeter.
- 9.3 List the disadvantages of dynamometer type wattmeter.
- 9.4 Compare induction type wattmeter with dynamometer wattmeter.

10 Understand the operation of induction type wattmeter.

- 10.1 Describe the construction of induction type wattmeter.
- 10.2 Describe the principle of operation of induction type wattmeter.
- 10.3 List the advantages of induction type wattmeter.
- 10.4 List the disadvantages of induction type wattmeter.

11 Understand the concept of measurement of single phase power.

- 11.1 Express the deduction of the equation $P = EI \cos \theta$.
- 11.2 Explain the circuit diagram connecting wattmeter in a single phase circuit.
- 11.3 Explain the errors involved in connecting wattmeter in a single phase circuit.

- 11.4 Explain the function of compensating coil in wattmeter connection.
- 11.5 Solve problems on error calculation in single phase power measurement.

WATT METER

12 Understand the principle of power measurement in three phase circuit.

- 12.1 List the method for the measurement of power in three phase circuit.
- 12.2 Describe the method for measurement of three phase power by two wattmeter.
- 12.3 Express the deduction of the equation for power and power factor in two wattmeter method.
- 12.4 Solve problems for the calculation of power and power factor.
- 12.5 Describe the method of three phase power measurement by one watt meter.

13 Apply the principle of reactive power measurement.

- 13.1 Describe the method of 1- Φ reactive power measurement by single phase VAR meter.
- 13.2 Describe the method of 3- Φ reactive power measurement.

ENERGY METER

14 Understand the operation of energy meter.

- 14.1 Describe the principle of operation of energy meter.
- 14.2 List the different types of energy meter.
- 14.3 List the different types of motor meter.
- 14.4 Explain the working principle of motor meter.
- 14.5 Describe the construction and working principle of mercury motor meter.
- 14.6 Explain mercury meter modified as watt hour meter.
- 14.7 List the errors in mercury motor meter.
- 14.8 Explain the friction compensation in mercury motor meter.
- 14.9 Describe the construction and working principle of induction motor meter.
- 14.10 Explain errors in induction motor meter.
- 14.11 Describe working principle of poly phase induction type energy meter.
- 14.12 Sketch the connection diagram of poly phase induction type energy meter.
- 14.13 Basic information about prepaid metering system.

15 Understand the concept of testing of energy meter.

- 15.1 Explain the necessity of testing of energy meter.
- 15.2 List the apparatus required for testing of energy meter.
- 15.3 List the methods of testing of energy meter..
- 15.4 Explain the short period testing using a standard wattmeter.
- 15.5 Solve problems related to energy meter testing.

DIGITAL INSTRUMENTS

16 Understand the concept of digital instrument.

- 16.1 Explain the principle of operation of digital instruments.
- 16.2 Describe the advantages of digital instruments.
- 16.3 Compare digital instruments with the analog instruments.

17 Understand the concept of digital display system.

- 17.1 Mention the different types of digital display system.
- 17.2 Describe seven segment display and 3 \times 5 dot matrix display.
- 17.3 Describe the construction of liquid crystal display.
- 17.4 Describe the operation of gas discharge plasma display.
- 17.5 Explain resolution in digital meter and sensitivity of digital meters.

18 Understand the concept of digital voltmeter.

- 18.1 Describe the operation of transistor voltmeter (TVM).
- 18.2 Describe the operation of ramp type digital voltmeter (DVM).
- 18.3 Describe the operation of successive approximation digital voltmeter.

19. Understand the principle of operation of digital single phase energy meter.

Describe the principle of operation of digital single phase energy meter

Draw the block diagram of a digital single phase energy meter
Describe each block of a digital single phase energy meter

20. Understand the principle of operation of digital three phase energy meter.

Describe the principle of operation of digital three phase energy meter
Draw the block diagram of a digital three phase energy meter
Describe each block of a digital three phase energy meter

Practical:

- 1 Study the various types of measuring instruments.**
 - 1.1 Select at least eight different measuring instruments.
 - 1.2 Identify the types of given instruments for measuring electrical quantities.
 - 1.3 Observe the ranges of instruments.
- 2 Study the operation of indicating, integrating, recording and digital instruments.**
 - 2.1 Choose one indicating, one integrating, one recording and one digital instrument.
 - 2.2 Select the tools and materials required.
 - 2.3 Connect each instrument to the supply system with proper load, if necessary.
 - 2.4 Observe the operation of moving system of each instrument.
- 3 Study the parts of different types of measuring instruments.**
 - 3.1 Select two types of measuring instruments.
 - 3.2 Disassemble the magnet, moving iron parts, controlling and damping parts, pointer, scale and case.
 - 3.3 Observe the balancing system of the moving parts.
 - 3.4 Assemble the parts as original.
- 4 Select the correct type of ammeter and voltmeter.**
 - 4.1 Collect some ammeters and voltmeters.
 - 4.2 Collect required numbers of tools to open ammeters and voltmeter.
 - 4.3 Disassemble the parts of the instrument.
 - 4.4 Identify the controlling and damping system.
 - 4.5 Identify the parts of the meter.
 - 4.6 Identify the types of meter.
- 5 Study the wattmeter.**
 - 5.1 Select proper tools and wattmeter.
 - 5.2 Disassemble the different parts of the wattmeter.
 - 5.3 Identify the different parts of the wattmeter.
 - 5.4 Identify the type of meter.
- 6 Measure the single phase power by ammeter, voltmeter and wattmeter.**
 - 6.1 Sketch the circuit diagram for measuring single phase power by ammeter, voltmeter and wattmeter.
 - 6.2 List tools, equipment and materials required.
 - 6.3 Prepare the circuit according to the circuit diagram using necessary equipment.
 - 6.4 Check the circuit before energizing.
 - 6.5 Record the meter readings.
 - 6.6 Calculate the power and power factor from the data obtained.
 - 6.7 Determine error from calculation.
 - 6.8 Draw vector diagram from the data obtained.
- 7 Measure the three phase power by two wattmeter method.**
 - 7.1 Draw the circuit diagram for measuring power by two wattmeter of a three phase system.
 - 7.2 List tools, equipment and materials for the experiment.
 - 7.3 Prepare the circuit according to the circuit diagram using required equipment.
 - 7.4 Check the circuit before energizing.
 - 7.5 Record the reading from the meters.
 - 7.6 Calculate the power and power factor.
 - 7.7 Determine error from calculation.
 - 7.8 Draw vector diagram using relevant data as obtained.

- 8 Measure the three phase power by one wattmeter method.**
 - 8.1 Sketch the circuit diagram for measuring power by one wattmeter of a three phase system.
 - 8.2 List tools, equipment and materials for the experiment.
 - 8.3 Prepare the circuit according to the circuit diagram using proper equipment.
 - 8.4 Check the circuit before energizing it.
 - 8.5 Record the reading from the meter.
 - 8.6 Calculate the power.
 - 8.7 Draw vector diagram using relevant data as obtained.
- 9 Study the different parts of a energy meter.**
 - 9.1 Select one energy meter and tools required.
 - 9.2 Disassemble the different parts of the energy meter.
 - 9.3 Identify the parts of the meter.
 - 9.4 Identify the type of the energy meter.
 - 9.5 Reassemble the meter.
- 10 Measure the energy of a single phase circuit by energy meter.**
 - 10.1 Sketch the circuit diagram for measuring energy in a single phase circuit by energy member..
 - 10.2 Select tools, equipment, materials and a load.
 - 10.3 Connect the equipment as per the circuit diagram.
 - 10.4 Record reading from the meter.
- 11 Measure the energy of a three phase circuit by a three phase energy meter.**
 - 11.1 Sketch the circuit diagram.
 - 11.2 Select tools, equipment, materials and a three phase load.
 - 11.3 Connect the equipment according to the circuit diagram.
 - 11.4 Record reading from the meter.
- 12 Test an energy meter for finding its error.**
 - 12.1 Draw the circuit diagram for testing an energy meter.
 - 12.2 Select an energy meter and one wattmeter.
 - 12.3 Select tools, equipment and materials for the experiment.
 - 12.4 Prepare the circuit according to the circuit diagram.
 - 12.5 Record reading from the meter.
 - 12.6 Calculate the error from the reading.
- 13 Measure the energy of a single phase circuit by single phase digital energy meter.**
 - 13.1 Sketch the circuit diagram.
 - 13.2 Connect the equipment as per the circuit diagram.
 - 13.3 Record the reading from the meter.
- 14 Measure the energy of a three phase circuit by single phase digital energy meter.**
 - 14.1 Sketch the circuit diagram.
 - 14.2 Connect the equipment as per the circuit diagram.
 - 14.3 Record the reading from the meter.

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– A. K. Sawhrey.
3. A Text Book of Electrical Technology
– B.L. Theraja
4. Electric Instrumentation
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AIMS

- To provide understanding and skill on SCR and TRIAC.
- To provide understanding and skill on phase controlled rectifier.
- To provide understanding and skill on wave shaping circuits.
- To familiarize with integrated circuits.
- To give an understanding on the Operational Amplifier.
- To develop comprehensive knowledge and skill on power switching device.
- To provide understanding and skill on optoelectronic device and security system.
- To provide understanding and skill on special electronic equipment.
- To familiarize with the programmable logic controller.

SHORT DESCRIPTION

UJT, SCR, PUT, DIAC, TRIAC, controlled rectifier, wave shaping circuits, integrated circuit, Operational amplifier, Power switching devices; Optoelectronic device; Security system; Special electronic equipment and Programmable logic controller.

DETAIL DESCRIPTION**Theory:**

1. Understand the Concept of Unijunction Transistor (UJT).
 - 1.1 Describe the structure and operation of UJT.
 - 1.2 Identify the UJT by its equivalent circuit.
 - 1.3 Define standoff ratio.
 - 1.4 Explain why UJT is not a thyristor.
 - 1.5 Analyze the operation of a UJT relaxation oscillator.
 - 1.6 Analyze the operation of UJT controlled SCR dc operated time-delay circuit.

2. Understand the Concept of Silicon Control Rectifier (SCR)
 - 2.1 Define Thyristors.
 - 2.2 Mention the types of Thyristors.
 - 2.3 Describe the construction and operation of SCR.
 - 2.4 Describe the I-V characteristics of SCR.
 - 2.5 Explain the operation of SCR using two-transistor Equivalent circuit.
 - 2.6 Derive the equation for anode current.
 - 2.7 Explain how to turn an SCR on and off.
 - 2.8 Define various parameters and mention the ratings of SCR.
 - 2.9 Explain the operation of automatic battery charger, emergency lighting.

- 2.10 System, heater control, and over voltage protection circuits.
- 2.11 Mention the advantages of SCR as a switch.
- 2.12 Describe the construction and operation of light activated SCR (LASCR).

3 Understand the Concept of Controlled Rectifier.

- 3.1 Define Controlled Rectifier.
- 3.2 Mention the types of control rectifier.
- 3.3 Describe the operation of half wave controlled rectifier using SCR for resistive and inductive load with wave shapes.
- 3.4 Drive the equation for load current and voltage of half wave controlled rectifier for resistive and inductive load.
- 3.5 Analyze the operation of single-phase full-wave mid-point controlled rectifier, Half controlled and full controlled bridge rectifier with wave shapes.
- 3.6 Drive the equation for load current and voltage of full wave rectifier.
- 3.7 Explain the effect of freewheeling diode in rectifier circuit with inductive load.
- 3.8 Describe the operation of poly-phase controlled rectifier.
- 3.9 Mention the operation of (a) Illumination circuit (b) Speed control of dc and ac motors.

4 Understand the Concept of Programmable Unijunction Transistor (PUT)

- 4.1 Describe the structure and operation of the PUT.
- 4.2 State how to set the trigger voltage of PUT.
- 4.3 Explain the difference between a PUT and UJT.
- 4.4 Analyze the operation of a PUT relaxation oscillator.

5. Understand the Concept of DIAC and TRIAC

- 5.1 Describe the structure and operation of DIAC.
- 5.2 Explain the I-V characteristics curve of DIAC.
- 5.3 Describe the structure of TRIAC.
- 5.4 Discuss the SCR equivalent circuit of TRIAC.
- 5.5 Explain the triggering modes of TRIAC.
- 5.6 Describe the characteristics curve of TRIAC.
- 5.7 State the commutation of TRIAC.
- 5.8 Analyze the operation of TRIAC firing circuits using (i) DIAC (ii) UJT.
- 5.9 Analyze the operation of a TRIAC phase control, lamp dimmer and Heat control circuit.

6. Understand the features of wave shaping circuits.

- 6.1 Mention the types of wave shaping circuit.

- 6.2 Discuss the principles of RC and RL differentiating and integrating circuits.
 - 6.3 Analyze the output waves for various input wave shapes of differentiating and integrating circuit.
 - 6.4 Explain the operation of various clippers by PN junction diode, zener diode and transistor.
 - 6.5 Describe the operation of diode clamping circuit for different input wave shape.
7. Understand the Features of Integrated Circuit (IC).
- 7.1 Define IC
 - 7.2 List the advantages and limitation of IC's.
 - 7.3 Mention the scale of integration.
 - 7.4 Identify the types of integrated circuits.
 - 7.5 Describe the fabrication monolithic integrated circuits.
 - 7.6 Describe the fabrication of integrated circuit components resistor, capacitor BJT and FET.
8. Understand the Features of Operational Amplifier (Op- Amp)
- 8.1 Define operational amplifier.
 - 8.2 Recognize the Op-Amp symbol.
 - 8.3 Identify the terminals on Op-Amp packages.
 - 8.4 State the basic principle of Op-Amp.
 - 8.5 Analyze the equivalent circuit of Op-Amp.
 - 8.6 State the golden rule and virtual ground of Op-Amp.
 - 8.7 List the characteristics of an ideal Op-Amp.
 - 8.8 Describe the input& output impedance, input offset voltage, input bias current, input offset current, common-mode input voltage range, open-loop voltage gain, common-mode rejection ratio, slew rate, frequency response and unity-gain bandwidth.
 - 8.9 Explain the operation of Op-Amp in inverter, scale changer, unity follower, comparator, phase shifter, adder, subtractor, differentiator, integrator, ramp generator, multichannel amplifier and filters.
9. Understand the feature of advance power switching devices
- 9.1 Describe the construction of GTO, IGBT, MCT, SIT and SITH & LASCR.
 - 9.2 Explain the principles of operation of GTO, IGBT, MCT, SIT and SITH & LASCR.
 - 9.3 Mention the v-i characteristics of GTO, IGBT, MCT, SIT and SITH & LASCR devices.
 - 9.4 List the application of various power switching devices.

10. Understand the features of photo resistors, photo diodes and phototransistors.
 - 10.1 Describe the basic structure of photo resistors, photo diodes & photo transistors.
 - 10.2 Explain the operating principles of photo resistors, photo diodes & photo transistors.
 - 10.3 Explain the v-i characteristics curve of photo resistors, photo diodes and photo transistors.
 - 10.4 List typical applications of photo resistors, photo diodes and photo transistors.
 - 10.5 Explain a block diagram showing how photo detectors used in speed measuring system.
 - 10.6 Explain the operation of photo diode switching circuit.
 - 10.7 Explain the operation of photo transistor switching circuit.
11. Understand the features of security system.
 - 11.1 Explain the operation fire (smoke) indication system using ionization detector and photo transistor with block diagram.
 - 11.3 Describe the operation of touch and non-touch type person (thief) detector using Infrared detection system with block diagram.
 - 11.4 Explain the operation of video monitoring system using video camera and video monitor (With multiple monitor switching).
12. Understand the features of special electronic equipment.
 - 12.1 Mention the principles of operation of UPS with block diagram.
 - 12.2 Mention the principles of operation of SMPS with block diagram.
 - 12.3 Mention the principles of operation of multimedia projector with block diagram.
13. Understand the features of programmable logic controllers (PLCs).
 - 13.1 Mention the basic operating and programming principles of PLCs.
 - 13.2 Draw a simplified block diagram showing the main parts of a PLC.
 - 13.3 State the function of main part of PLC.

Practical:

1 Determine the characteristics curve of UJT.

- 1.1 Select an appropriate experiment circuit, required materials, tools and equipments.
- 1.2 Connect the circuit as per diagram with meters.
- 1.3 Check the circuit and switch on the power supply.
- 1.4 Record the data for I-V curve.
- 1.5 Plot the curve.

- 2 **Study the gate control of forward breakdown voltage for an SCR.**
 - 2.1 Select an appropriate circuit, required tools, equipments and materials.
 - 2.2 Connect the circuit as per diagram with meters.
 - 2.3 Switch on the power supply and make proper adjustments.
 - 2.4 Set the gate control at minimum and observe the breakdown voltage for I-V characteristics.
 - 2.5 Increase gate current in steps and observe the breakdown voltage.
 - 2.6 Plot the I-V characteristics curve.
 - 2.7 Compare different curves and breakdown voltage.

- 3 **Study the Operation of a single phase controlled rectifier using SCR.**
 - 3.1 Select an appropriate experiment circuit.
 - 3.2 Select required tools, equipments and materials.
 - 3.3 Connect the circuit as per diagram with Oscilloscope.
 - 3.4 Check the connection and switch on the power supply.
 - 3.5 Observe the wave shapes at relevant points of the circuit.

- 4 **Study the Operation of a Illumination Circuit.**
 - 4.1 Select an appropriate experiment circuit.
 - 4.2 Select required tools, equipments and materials.
 - 4.3 Connect the circuit as per diagram.
 - 4.4 Check the connection and switch on the power supply.
 - 4.5 Adjust the POT and observe the Illumination.

- 5 **Determine the characteristics curve of DIAC.**
 - 5.1 Select an appropriate experiment circuit, required materials, tools and equipments.
 - 5.2 Connect the circuit as per diagram with meters.
 - 5.3 Check the circuit and switch on the power supply.
 - 5.4 Record the data for I-V curve.
 - 5.5 Plot the curve.

- 6 **Study the Operation of a RC differentiating circuit.**
 - 6.1 Select a RC differentiating circuit.
 - 6.2 Select required materials, tools and equipments.
 - 6.3 Connect the circuit as per diagram with CRO.
 - 6.4 Switch on the power supply.
 - 6.5 Adjust the signal frequency for the differentiating circuit.
 - 6.6 Observe the output wave for different input wave shape on CRO screen.

- 7 **Study the Operation of a RC Integrating circuit.**
 - 7.1 Select a RC differentiating circuit.
 - 7.2 Select required materials, tools and equipments.
 - 7.3 Connect the circuit as per diagram with CRO.
 - 7.4 Switch on the power supply.
 - 7.5 Adjust the signal frequency for the differentiating circuit.
 - 7.6 Observe the output wave for different input wave shape on CRO screen.

- 8 **Study the operation of biased and unbiased series and shunt clipping circuits for positive and negative peak and bias clipping of a sine wave using switching diodes.**
 - 8.1 Select a required circuit.

- 8.2 Select the associate equipments and materials.
- 8.3 Buildup the circuit for required wave shapes.
- 8.4 Switch on the power supply.
- 8.5 Observe the output on CRO screen.

9 Study the operation a clamping circuit.

- 9.1 Select a required circuit.
- 9.2 Select the associate equipments and materials.
- 9.3 Buildup the circuit for required wave shapes.
- 9.4 Switch on the power supply.
- 9.5 Observe the output on CRO screen.

10 Study the operation of Op-Amp (for IC 741) as inverting and non inverting amplifier, adder, comparator, buffer and subtractor.

- 10.1 Select a required circuit.
- 10.2 Select the associate equipments and materials.
- 10.3 Buildup the circuit as per function.
- 10.4 Switch on the power supply.
- 10.5 Observe the input and output wave shape on CRO screen.

11 Study the operation and application of SMPS./UPS

- 11.1 Select a SMPS/UPS
- 11.2 Identify different parts of SMPS/UPS
- 11.3 Observe the operation of SMPS/UPS

12 Determine the v-i characteristic curve of photo diode.

- 12.1 Select a required circuit.
- 12.2 Select tools and materials.
- 12.3 Build up the circuit
- 12.4 Check the connection.
- 12.5 Switch on the power supply
- 12.6 Record the data.
- 12.7 Plot the curve.

13 Study the operation of PLC.

- 13.1 Select a PLC trainer.
- 13.2 Identify different parts of turner
- 13.3 Observe the operation of PLC for specific purpose.

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4. Principles of Electronics
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AIMS

- To enable to understand the vector operators and the application in applied mechanics.
- To provide the understanding of the composition and resolution of forces and computing the resultant force.
- To provide the understanding of parallel forces, couple and ability to computing the moment of inertia.
- To provide understanding the centroid and enable to computing the centre of gravity.
- To enable to understand the laws of friction, the coefficient of friction and frictional forces of reactions of surfaces.
- To provide to understanding of driving support reactions and types of loading of beam.
- To facilitate the understanding of mechanical vibration.
- To facilitate the understanding of work, power, energy, projectile lifting machine and gear trains.

SHORT DESCRIPTION

Fundamental of mechanics, vector operators and their applications. Composition and resolution of forces. Moment and their applications. Equilibrium of force. Parallel forces, couples, centre of gravity and moment of inertia, Friction, support reactions, frame, stress and strain mechanical vibration, work, power and energy, lifting machine, gear trains.

DETAIL DESCRIPTION**Theory :****1. Understand the composition and resolution of forces.**

- 1.1. State the effect of forces.
- 1.2. Mention the characteristics of a force.
- 1.3. Define resultant force, composition of forces & regulation of a force.
- 1.4. Find the resultant force graphically and analytically.
- 1.5. Write the laws of forces.
- 1.6. State the principle of resolution of force.
- 1.7. Express the deduction of the formula for finding the resolved part of a component.
- 1.8. Find the magnitude and position of the resultant force graphically and analytically.
- 1.9. Solve problems related to resultant force.

2. Understand the aspects of moment of forces.

- 2.1. Define moment of force.
- 2.2. Identify the clockwise and anticlockwise moment.
- 2.3. State the Varignon's principle of moments.
- 2.4. State the laws of moments.
- 2.5. Identify the types of lever.
- 2.6. Solve problems related to moment of forces.

3. Understand the aspects of equilibrium of forces & parallel forces.

- 3.1. Mention different system of forces.
- 3.2. State the principles of equilibrium of forces.
- 3.3. State the Lami's theorem.
- 3.4. Express the derivation of Lami's theorem.
- 3.5. Describe different methods of the equilibrium of coplanar forces, non-coplanar forces & parallel forces.

- 3.6. Explain the conditions of equilibrium & parallel forces.
- 3.7. Mention the various types of equilibrium and parallel forces
- 3.8. Solve problems related to equilibrium and parallel forces.
- 4. Understand the concept of center of gravity.**
 - 4.1. Define center of gravity and centroid.
 - 4.2. Distinguish between center of gravity and centroid.
 - 4.3. Explain the methods of finding out center of gravity of simple geometrical figure.
 - 4.4. Determine the center of gravity of simple geometrical figure geometrically and by integration.
 - 4.5. Identify the axis of reference and axis of symmetry.
 - 4.6. Calculate the center of gravity of compound geometrical figure or areas by moments.
- 5. Understand the application of moment of inertia.**
 - 5.1. Explain the term moment of inertia.
 - 5.2. Express the derivation of the formulae for moment of inertia of an area.
 - 5.3. Describe the methods for finding out the moment of inertia.
 - 5.4. Find the moment of inertia of simple areas by the method of integration.
 - 5.5. State the theorem of perpendicular axis as applied to moment of inertia.
 - 5.6. State the parallel axis theorem in the determination of moment of inertia of areas.
 - 5.7. Explain the radius of gyration and section modulus.
 - 5.8. Calculate the moment of inertia and section modulus of composite sections and simple solid bodies.
- 6 Understand the principles of friction.**
 - 6.1 Define friction.
 - 6.2 Identify the types of friction.
 - 6.3 State the laws of static and dynamic friction.
 - 6.4 Explain the angle of friction & coefficient of friction.
 - 6.5 Explain free body diagrams of a body lying on horizontal, inclined and vertical surfaces, ladder and wedge.
 - 6.6 Solved the problems the frictional force of a body lying on an horizontal, inclined surfaces, ladder and wedge.
- 7 Understand the fundamentals of support reaction on beams.**
 - 7.1 Identify types of beam.
 - 7.2 Explain support reactions.
 - 7.3 Explain the types of loading on beams.
 - 7.4 Determine the support reactions of simple and cantilever beam with different loading condition.
 - 7.5 Determine the support reactions of roller supported beam.
 - 7.6 Identify the frame with their end supports.
 - 7.7 State the method of finding support reactions and forces on the member of the frame.
 - 7.8 Calculate the support reactions and forces on the member of the frame.
- 8 Understand the aspect of stress and strain.**
 - 8.1 Define stress, strain, modulus of elasticity, Poison's ratio and principle of shear stress.
 - 8.2 Explain the stress in composite bar, stress in nuts and bolts, stress due to change in temperature.
 - 8.3 Describe the linear and lateral strain.
 - 8.4 Explain the stress strain diagram.
 - 8.5 Solve problems on stress and strain.
- 9 Understand the fundamentals of mechanical vibration.**
 - 9.1 Define the mechanical vibration.
 - 9.2 State the dynamics of vibrating body.
 - 9.3 Describe the 3 term relating to SH.M such as (a) Amplitude.

- (b) Oscillation, (c) Beat, (d) Periodic time, (e) Frequency.
- 9.4 Explain the laws of simple Pendulum.
- 9.5 Solve problems related to above.

10 Understand the aspects of work, power and energy.

- 10.1 Define work, power and energy.
- 10.2 Explain the work done in rotation.
- 10.3 Mention the types of engine power.
- 10.4 State the meaning and types of the engine efficiency.
- 10.5 Express the derivation of the equation of kinetic energy.
- 10.6 State the law of conservation of energy.
- 10.7 Solve problems related to work, power and energy.

11 Understand the simple lifting machines.

- 11.1 Define lifting machine.
- 11.2 State Mechanical advantage, velocity ratio, input of machine, output of machine efficiency of machine.
- 11.3 Express the relation between efficiency, mechanical advantage and velocity ration of a lifting machine.
- 11.4 Express the maximum mechanical advantage of a lifting machine by using the equation of law's of machine.
- 11.5 Describe lifting machine such as simple wheel, axel, differential wheel & axel, weston's differential pulley block and geared pulley block.
- 11.6 Solve the problems related to above specific objects.

12 Understand the various aspects of gear trains.

- 12.1 State what is meant by gear.
- 12.2 Identify the types of gears.
- 12.3 Express the derivation of the equation of velocity ratio of simple gear drive.
- 12.4 Identify the compound gear drive and gear train.
- 12.5 Identify the equation of power transmitted by simple and compound train.
- 12.6 Identify the epicyclic gear train.
- 12.7 Express the derivation of the velocity ratio of an epicyclic gear train.
- 12.8 Solve problems related to gear trains.

Practical :

1 Determine the resultant force by using force board.

- 1.1 Set up the force board.
- 1.2 Set up the accessories on the force board.
- 1.3 Find the resultant force.
- 1.4 Calculate the magnitude of resultant force.
- 1.5 Compare the calculated values with experimental values.

2 Determine the compression load using crane boom.

- 2.1 Set up the crane boom.
- 2.2 Set up the accessories on the crane boom.
- 2.3 Find the compression load on the jib.
- 2.4 Calculate the compression analytically.
- 2.5 Compare the experimental values with analytical values.

3 Determine the equilibrium force by using Kennon force table.

- 3.1 Set up the Kennon force table.
- 3.2 Set up the accessories on the Kennon force table.
- 3.3 Find the magnitude and direction of a force establishing equilibrium.

- 3.4 Calculate the magnitude and direction of equilibrium force.
- 3.5 Compare the calculated values with experimental values.
- 4 Determine the center of a triangular lamina.**
 - 4.1 Select a triangular lamina and a plumb bob.
 - 4.2 Set up the plumb bob.
 - 4.3 Find the center point of the triangular lamina.
- 5 Determine the co-efficient of friction.**
 - 5.1 Set up the friction apparatus.
 - 5.2 Select the materials of which coefficient of friction is to be determined.
 - 5.3 Place the materials over each other.
 - 5.4 Raise one end of the body until the other body slides down.
 - 5.5 Find the angle of friction.
 - 5.6 Find the of co-efficient friction.
- 6 Determine the action of load on the member of simple frame or truss.**
 - 6.1 Select two members of which one end roller and other end pin point.
 - 6.2 Select a tension spring.
 - 6.3 Make a unit as a simple frame or truss.
 - 6.4 Apply the load.
 - 6.5 Read the tension load on spring.
- 7 Determine the torque of engine by prony brake.**
 - 7.1 Set up the prony brake with the engine fly wheel .
 - 7.2 Tighten the hand wheel of prony brake.
 - 7.3 Measure the length of torque arm.
 - 7.4 Start the engine.
 - 7.5 Take the reading of spring scale.
 - 7.6 Find the torque of engine.
 - 7.7 Compare the calculated values with the manufacturers' recommended values.
- 8 Determine the BHP of an engine by chassis dynamometer.**
 - 8.1 Place the vehicle on chassis dynamometer.
 - 8.2 Start the vehicle engine.
 - 8.3 Transmit power at different gear position.
 - 8.4 Find the B. H. P. of the engine by chassis dynamometer at different speeds.
 - 8.5 Compare the experimental value with the manufactures' recommended value.
- 9 Determine the velocity ratios among the deriver and driven gears.**
 - 9.1 Set a simple train of gears.
 - 9.2 Compare the velocity ratios of the same.
 - 9.3 Set a compound train of gears.
 - 9.4 Compare the velocity ratios of the same.

REFERENCE BOOKS

- | | | | |
|---|------------------------|---|---------------|
| 1 | Applied Mechanics | – | R. S. Khurmi |
| 2 | Applied Mechanics | – | R. K. Jain |
| 3 | Applied Mechanics | – | Fairries |
| 4 | Analytical Mechanics | – | Faires & Nash |
| 5 | Mechanics of Materials | – | Morgan |

7046 HYDRAULICS AND HYDRAULIC MACHINERY

T	P	C
3	3	4

AIMS

To provide the students with an opportunity to acquire knowledge, skill and attitude in the area of hydraulics and hydraulic machinery with special emphasis on :

- properties of fluids
- fluid pressure measurement
- Bernoulli's equation
- orifice and mouthpieces
- impact of jet
- water pumps & turbines
- hydraulic devices

SHORT DESCRIPTION

Properties of fluid; Fluid pressure measurement; Flow of fluids through pipes; Bernoulli's equation; Flow through orifices; Flow through mouthpieces; Viscous flow; Impact of jets; Water turbine; Reciprocating pumps; Centrifugal pumps; Rotary pumps; Hydraulic devices.

DETAIL DESCRIPTION**Theory :****1 Understand the scope of hydraulics.**

- 1.1 Define hydraulics and hydraulic machines.
- 1.2 Outline the importance of hydraulics and hydraulic machines.
- 1.3 Mention the branches of hydraulics.
- 1.4 Identify different application of hydraulics and hydraulic machines in engineering field.

PROPERTIES OF FLUIDS**2 Understand the fluid properties and fluid pressure.**

- 2.1 Define fluid.
- 2.2 Name the types of fluids.
- 2.3 Compare the liquid, vapor and gas.
- 2.4 List the properties of fluids.
- 2.5 Define density, specific weight, surface tension, capillary, viscosity and fluid pressure.
- 2.6 State Pascal's law of fluid pressure.
- 2.7 Show the proof of the Pascal's law of fluid pressure.
- 2.8 Define atmospheric pressure, gage pressure and absolute pressure.
- 2.9 Mention the relation among atmospheric pressure, gage pressure and absolute pressure.
- 2.10 Express the derivation of the formulae for finding total pressure on immersed surface at horizontal, inclined and vertical position.
- 2.11 Solve problem on static fluid pressure.

3. Buoyancy

- 3.1 Define buoyancy and center of buoyancy.
- 3.2 State the meaning metacentre and metacentric height.
- 3.3 Mention the conditions of equilibrium of a floating body.

4 Understand the features of fluid pressure gages.

- 4.1 State the meaning of pressure gage.
- 4.2 Mention the classification of pressure gages.
- 4.3 Define manometer.
- 4.4 Distinguish between simple manometer and differential manometer.
- 4.5 Mention the working principle of different types of pressure gages.
- 4.6 Mention the specific application of different pressure gages.
- 4.7 Solve problems relating to measurement of fluid pressure by different manometer.

FLOW OF FLUID THROUGH PIPES AND BERNOULLIS EQUATION

5 Understand the concept of fluid flow through pipes and Bernoulli's equation.

- 5.1 State the equation of continuity of flow.
- 5.2 State flow rate or discharge.
- 5.3 Compute the formula of flow rate.
- 5.4 State the equation of continuity of flow.
- 5.5 Define head, pressure head, velocity head, datum head and total head.
- 5.6 State the Bernoulli's equation for flowing liquid.
- 5.7 Show the proof of Bernoulli's equation.
- 5.8 Mention the limitation of Bernoulli's equation.
- 5.9 Mention the function of venturimeter, orificemeter and pitot tube.
- 5.10 Describe the construction and operation of venturimeter, orificemeter and pitot tube.
- 5.11 Express the derivation of formula to measure the quantity of liquid flowing through venturimeter.
- 5.12 Express the derivation of formula to measure the quantity of liquid flowing through orificemeter.
- 5.13 Express the derivation of formula to measure the velocity of flowing liquid by the pitot tube.
- 5.14 Solve the problems on fluid through pipe, Bernoulli's equation and venturimeter, orificemeter and pitot tube.

FLOW THROUGH ORIFICES

6 Understand the concept of flow through orifices.

- 6.1 Define orifice.
- 6.2 Mention the classification of orifices.
- 6.3 State hydraulic coefficients.
- 6.4 Define jet of water, vena contracta, coefficient of contraction (C_c), coefficient of velocity (C_v), coefficient of discharge (C_d) and coefficient of resistance.
- 6.5 Relate the C_c , C_v and C_d .
- 6.6 Calculate different hydraulic coefficients.
- 6.7 Express the deduction of formulae for finding out the discharge of liquid through various orifices
- 6.8 Solve problems relating orifices.

FLOW THROUGH MOUTHPIECES AND NOTCHES

7 Understand the concept of flow through mouthpieces.

- 7.1 State mouthpiece.
- 7.2 Mention the classification of mouthpieces.
- 7.3 Express the deduction of formulae to calculate discharge through different types of mouthpieces.
- 7.4 State head losses of flowing liquid in a pipe.
- 7.5 List the causes of head loss of flowing liquid.
- 7.6 Express the deduction of formulae to calculate loss of head due to friction, sudden enlargement, sudden contraction and obstruction in pipe.

- 7.7 Express the deduction of formulae to calculate loss of head due to friction (Darcy's and Cheay's formulae).
- 7.8 Solve problems relating head losses and discharge through mouthpieces.
- 7.9 Define notches.
- 7.10 Identify different types of notches with sketches such as rectangular notch v-notch trapezoidal notch.
- 7.11 Outline the importance of using notches.

VISCOUS FLOW

8 Understand the concept of viscous flow.

- 8.1 Define viscosity.
- 8.2 Mention the units of viscosity.
- 8.3 Define ideal fluid, real fluid, Newtonian fluid and non-Newtonian fluids.
- 8.4 Distinguish between the laminar flow and turbulent flow.
- 8.5 State Reynold's number.
- 8.6 Solve problems relating to viscosity.

IMPACT OF JETS

9 Understand the aspect of impact of jets.

- 9.1 State impact of jet.
- 9.2 Express the deduction of formula to calculate the force of a jet impinging on a flat fixed vertical plate, inclined plate and hinged plate.
- 9.3 Solve problems on impact of jets relating to flat fixed plate, inclined fixed plate and hinged plate.

WATER TURBINES

10 Understand the features of water turbines.

- 10.1 State the meaning of water turbine.
- 10.2 Mention the classification of water turbine.
- 10.3 Describe the principle of impulse water turbine.
- 10.4 Describe the principle of reaction water turbine.
- 10.5 Compare the impulse and reaction turbines.
- 10.6 Describe the construction of Pelton, Kaplan and Francis water turbine.
- 10.7 Describe the operation of Pelton, Kaplan and Francis water turbine.
- 10.8 State specific speed of turbine.
- 10.9 Describe the governing system of impulse and reaction turbines.
- 10.10 Define draft tube and its classification.

RECIPROCATING PUMPS

11 Understand the features of reciprocating pumps.

- 11.1 State the meaning of reciprocating pump.
- 11.2 Mention the classification of reciprocating pumps.
- 11.3 Describe the construction of various reciprocating pumps.
- 11.4 Describe the operation of different types of reciprocating pumps.
- 11.5 State the meaning of slip of reciprocating pumps.
- 11.6 Mention the function of air vessel in single acting reciprocating pump.
- 11.7 Describe the operation of suction side and discharge side air vessel in a single acting reciprocating pump.
- 11.8 Express the deduction of formula to calculate the discharge of reciprocating pumps.

CENTRIFUGAL PUMPS

12 Understand the features of centrifugal pumps.

- 12.1 State the meaning of centrifugal pump.
- 12.2 Mention the classification of centrifugal pumps.
- 12.3 Compare the centrifugal and reciprocating pumps.
- 12.4 Describe the construction of various centrifugal pumps.
- 12.5 Describe the operation of different types of centrifugal pumps.
- 12.6 State the meaning of cavitation of centrifugal pumps.
- 12.7 Express the deduction of formula to calculate discharge of centrifugal pumps.
- 12.8 Power required to drive a centrifugal pumps.
- 12.9 Mention the efficiencies of centrifugal pump.

ROTARY PUMPS

13 Understand the features of rotary pumps.

- 13.1 State what is meant by rotary pump.
- 13.2 Mention the classification of rotary pumps.
- 13.3 Describe the construction of various rotary pumps.
- 13.4 Describe the operation of different types of rotary pumps.
- 13.5 List the advantages and disadvantage of rotary pumps over centrifugal and reciprocating pumps.
- 13.6 Mention the application of rotary pumps.

HYDRAULIC DEVICES

14 Understand the features of hydraulic devices.

- 14.1 State hydraulic devices.
- 14.2 Identify the hydraulic devices.
- 14.3 Mention the function of hydraulic devices viz. hydraulic press, hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic lift, etc.
- 14.4 Describe the construction of various hydraulic devices.
- 14.5 Describe the operation of different types of hydraulic devices.

Practical :

- 1. Calibrate a bourdon tube pressure gage with a dead weight gage.
- 2. Verify Bernoulli's equation by Bernoulli's apparatus equipped with hydraulic test bench.
- 3. Determine C_c , C_v , and C_d by orifice apparatus equipped with hydraulic test bench.
- 4. Determine the discharge through a pipe by the venturimeter or orifice meter equipped with hydraulic test bench.
- 5. Determine the loss of head due to sudden enlargement of pipe by the manometer.
- 6. Determine the loss of head due to friction by fluid friction apparatus.
- 7. Determine the fluid energy loss through various fittings (elbows, bends and valves)..
- 8. Determine the moment force of a jet of water striking targets of different shape with the impact of jet apparatus.
- 9. Test the performance of a reciprocating pump with the reciprocating pump test rig.
- 10. Test the performance of a centrifugal pump with the centrifugal pump test rig.

11. Test the performance of an impulse turbine with the impulse (Pelton wheel) turbine test rig.
12. Test the performance of a Francis turbine with the Francis turbine test rig.

REFERENCE BOOKS

- | | | | |
|---|---|---|----------------|
| 1 | Hydraulics and Hydraulic Machinery | – | Kings |
| 2 | Hydraulics and Hydraulic Machinery | – | Luiss |
| 3 | A Text Book of Hydraulics, Fluid Mechanics and Hydraulic Machines | – | R. S. Khurmi |
| 4 | Fluid Mechanics Hydraulics and Hydraulic Machines | – | K. R. Arora |
| 5 | Hydraulics, Fluid Mechanics, and Fluid Machines | – | S. Ramamrutham |
| 6 | Fluid Mechanics including Hydraulics Machines | – | K. Subramanya |

5851 BOOK KEEPING & ACCOUNTING

T	P	C
2	0	2

AIMS

- To be able to understand the principles and practices of book keeping and accounting.
- To be able to understand the procedures of general accounting, financial accounting and their applications.

SHORT DESCRIPTION

Concept of book keeping and accounting; Transactions; Entry systems; Accounts; Journal; Ledger; Cash book; Trial balance; Final accounts; Cost account & financial accounting; Depreciation; Public works accounts.

DETAIL DESCRIPTION**1 Understand the concept of book keeping and accounting.**

- 1.1 Define book keeping and accountancy.
- 1.2 State the objectives of book keeping.
- 1.3 State the advantages of book keeping.
- 1.4 Differentiate between book keeping and accounting.
- 1.5 State the necessity and scope of book keeping and accounting.

2 Understand the transactions.

- 2.1 Define transactions and business transaction.
- 2.2 Explain the importance of transactions.
- 2.3 Describe the characteristic features of transactions.
- 2.4 Discuss the classification of transaction.
- 2.5 Identify the transaction from given statements stating reasons.

3 Understand the entry system.

- 3.1 State the aspects of transactions.
- 3.2 Define single entry system.
- 3.3 State the objectives of single entry system.
- 3.4 Discuss the disadvantages of single entry system.
- 3.5 Define double entry system.
- 3.6 Discuss the principles of double entry system.
- 3.7 Justify whether double entry system is an improvement over the single entry system.
- 3.8 Distinguish between single entry and double entry system of book keeping.

4 Understand the classification of accounts.

- 4.1 Define accounts.
- 4.2 State the objectives of accounts.
- 4.3 Illustrate different type of accounts with example.
- 4.4 Define "Golden rules of Book keeping".
- 4.5 State the rules for "Debit" and "Credit" in each class of accounts.
- 4.6 Determine Debtor (Dr) and Creditor (Cr.) from given transactions applying golden rules.
- 4.7 Define accounting cycle.
- 4.8 State the different steps of accounting cycle.

5 Understand the Journal.

- 5.1 Define Journal.
- 5.2 State the object of Journal.
- 5.3 State the functions of Journal.
- 5.4 Mention the various names of Journal.
- 5.5 Interpret the form of Journal.
- 5.6 Journalize from given transactions.

6 Understand the ledger.

- 6.1 Define ledger.
- 6.2 Interpret the form of ledger.
- 6.3 State the functions of ledger.
- 6.4 Distinguish between Journal and Ledger.
- 6.5 Prepare ledger from given transactions.
- 6.6 Explain why ledger is called the king of all books of accounts.

7 Understand the cash book.

- 7.1 Define cash book (single, double and triple column).
- 7.2 Explain cash book as both Journal and Ledger.
- 7.3 Prepare double column cash book from given transactions showing balances.
- 7.4 Prepare triple column cash book from given transaction and find out the balances.
- 7.5 Define petty cash book.
- 7.6 Prepare analytical and imprest system of cash book.
- 7.7 Define discount.
- 7.8 Explain the different types of discount.

8 Understand the trial balance.

- 8.1 Define trial balance.
- 8.2 State the object of a trial balance.
- 8.3 Discuss the methods of preparation of a trial balance.
- 8.4 Explain the limitations of a trial balance.
- 8.5 Prepare trial balance from given balance.

9 Understand the final accounts.

- 9.1 State the components of final account.
- 9.2 Distinguish between trial balance and balance sheet.
- 9.3 Identify the revenue expenditure and capital expenditure.
- 9.4 Select the items to be posted in the trading account, profit & loss account and the balance sheet.
- 9.5 State the adjustment to be made from the given information below or above the trial balance.
- 9.6 Prepare trading account, profit & loss account and balance sheet from the given trial balance & other information.

10 Understand the cost and financial accounting.

- 10.1 Define financial accounting.
- 10.2 State the objectives of financial accounting.
- 10.3 Define cost accounting.
- 10.4 Discuss the relationship between financial Accounting and cost accounting.
- 10.5 State the elements of direct cost and indirect cost.
- 10.6 Prepare cost sheet showing prime cost, factory cost, cost of production, total cost and selling price.
- 10.7 Discuss the capital budgeting
- 10.8 Discuss the discounted cash flow method
- 10.9 Explain the following terms:
 - a. Fixed cost b. Variable cost c. Factory cost d. Overhead cost e. Process cost
 - f. Direct cost g. Operating cost h. Standard cost

11 Understand the depreciation

- 11.1 Define depreciation.
- 11.2 State the objects of depreciation.
- 11.3 Discuss the necessity for charging depreciation.
- 11.4 Describe the different methods of determining depreciation.

11.5 Explain the relative merits and demerits of different method of depreciation.

12 Understand the public works accounts.

12.1 State the important aspects of public works accounts.

12.2 Describe the main features of public works accounts.

12.3 Explain "Revenue and Grant".

12.4 Define Value Added Tax (VAT)

12.5 State the merits and demerits of VAT.

12.6 Define Bill and Voucher.