

4-YEAR DIPLOMA-IN-ENGINEERING PROGRAM

**ELECTRICAL TECHNOLOGY (67)
5th and 6th**

**SYLLABUS
(COURSE STRUCTURE-2010)**

FIFTH SEMESTER

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 organogram 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.

REFERENCE BOOKS

1. Power Plant Engineering
– G R Nagpal Thirteenth Edition 1994
2. Power Plant Engineering
– Fredrick T Morse
3. A Course in Power Plant Engineering
– S Domkunowar
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
Khetkar and S Rao
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.

$$I = \frac{V}{R_1 R_i}$$

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.

REFERENCE BOOKS

- 1 DC Machines – Samadder & Gongopadhyia
- 2 A course in Electrical Power – J. B. Gupta
- 3 Electrical Technology – 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.

- 19.1 Describe the principle of operation of digital single phase energy meter

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

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

- 20.1 Describe the principle of operation of digital three phase energy meter
- 20.2 Draw the block diagram of a digital three phase energy meter
- 20.3 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.
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4. Electric Instrumentation
– H. S. Kalsi

AIMS

- To develop the knowledge and skill on using semiconductor diode in power electronics.
- To familiarize with power switching device.
- To develop the knowledge & skill on inverter , Chopper & Cycloconverter
- To familiarize dc and ac control drive.
- To develop knowledge & skill on stepper motor control & Servo system .
- To develop knowledge & skill on Solar Power system
- To develop the knowledge & skill on high frequency heating and resistance welding.
- To familiarize Microwave heating.

SHORT DESCRIPTION

Power switching devices; Semiconductor diode in power electronics; Inverters, Chopper , Cycloconverter , Control of ac and dc drives, stepper motor , Photo device, Solar Power system , Induction Heating , Microwave heating, Resistance welding;

DETAIL DESCRIPTION

Theory :

- 1 Understand the Concept of Power Electronics.**
 - 1.1 Define the term power electronics.
 - 1.2 Mention the major components of a power electronic system.
 - 1.3 Describe the working of power electronic system.
 - 1.4 Mention the scope and application of power electronics.
 - 1.5 List the merits and demerits of power electronics.
 - 1.6 Mention the types of power semiconductor devices.
- 2 Understand the characteristics of semiconductor diodes in power Electronics**
 - 2.1 Mention the requirements of Power diode and transistor.
 - 2.2 Describe the basic structure of power diode.
 - 2.3 Identify the types of power semiconductor diode.
 - 2.4 Mention the reverse recovery characteristics of semiconductor diode.
 - 2.5 Mention the I-V characteristics of series connected diodes.
 - 2.6 Mention the I-V characteristics of parallel connected diodes.
- 3 Understand the features of Inverter.**
 - 3.1 Define inverter.
 - 3.2 Mention the basic principle of line-commuted and force commuted inverter.
 - 3.3 Describe the operation of single-phase line-commutated full-controlled inverter.
 - 3.4 Describe the operation of three-phase line-commutated full-controlled inverter.
 - 3.5 Describe the operation of single-phase series inverter.
- 4 Understand the features of choppers.**
 - 4.1 Define chopper.
 - 4.2 Mention the principle of operation of chopper.
 - 4.3 Mention the chopper control technique.
 - 4.4 Describe the operation of voltage step-down chopper.
 - 4.5 Describe the operation of voltage step-up chopper.
- 5 Understand the features of cycloconverter.**
 - 5.1 Define cycloconverter.
 - 5.2 Mention the types of cycloconverter.
 - 5.3 Describe the operation of single phase/ (mid-point and bridge Configuration) cycloconverter.
 - 5.4 Analyze operation of single phase (circulating and non circulating type) cycloconverters.
 - 5.5 Describe the operation of a three phase cycloconverter.
- 6 Understand the features of dc drives.**
 - 6.1 Define electric drive.
 - 6.2 Mention the elements of electric drive using power electronic converter.
 - 6.3 Explain the principle of operation of single phase (a) Half wave converter drive (b) full wave semiconverter drive, (b) full wave full converter drive (c) dual converter drive.
 - 6.4 Explain the principle of operation of three phase (a) Half wave converter drive (b) full wave semiconverter drive, (b) full wave full converter drive. (c) dual converter drive,
 - 6.5 Explain the operation of two quadrant and four quadrant chopper drive.

- 7 **Understand the feature of stepper motor Control & Servo system .**
- 7.1 Define stepper motor.
 - 7.2 Describe different types of stepper motor.
 - 7.3 Describe the excitation procedure of stepper motor.
 - 7.4 Describe the control of stepper motor.
 - 7.5 Describe the principle of operation and Construction of Dc servo , AC servo .Electrical modulator, hydraulic servomotor and hydraulic modulator
 - 7.6 Describe the basic concepts of DC & AC position control with servo system
- 8 **Understand Solar Power System.**
- 8.1 Define Photovoltaic (PV) effect.
 - 8.2 Describe the operation of a solar cell.
 - 8.3 List the materials suitable for solar cell.
 - 8.4 Discuss solar panel.
 - 8.5 Mention the types of PV power system.
 - 8.6 Describe the operation of various types of charge controllers.
- 9 **Understand Electronic Ballast.**
- 9.1 Mention the purpose of Ballast in discharge lamp circuit.
 - 9.2 List the important drawbacks of electromagnetic ballast.
 - 9.3 Describe the general block diagram of electronic ballast.
 - 9.4 Analyze the operation of various types of electronic ballast.
- 10 **Understand the features of induction and dielectric Heating.**
- 10.1 State the theory of induction and dielectric heating.
 - 10.2 Describe the principle of induction and dielectric heating.
 - 10.3 List the effects of frequency on induction and dielectric heating.
 - 10.4 Mention the effects of source voltage on induction and dielectric heating.
 - 10.5 Describe the factors for choosing frequency of induction and dielectric heating.
 - 10.6 List the advantages and applications of Induction and dielectric heating.
 - 10.7 Describe the source of high frequency of induction and dielectric heating
- 11 **Understand the features of microwave heating.**
- 11.1 Define microwave (MW).
 - 11.2 State the basic principle of microwave heating.
 - 11.3 Mention the frequencies used in MW heating.
 - 11.4 Describe the construction and operation of a Mw oven.
 - 11.5 Explain the energy dispersion system of a MW oven.
 - 11.6 Draw a block diagram of Industrial MW heating equipment.
 - 11.7 Discuss Different types of Applicators.
 - 11.8 List the Industrial applications of MW heating.
- 12 **Understand the features of office and home equipments.**
- 12.1 State the principle of multimedia projector.
 - 12.2 Mention the principle of operation of photo copier with block diagram.
 - 12.3 Explain the principle and operation of laser printer.
 - 12.4 Mention the principle and operation of washing machine.
 - 12.5 Explain the principle and operation of SMPS with block and circuit diagram.
 - 12.6 Explain the principle and operation of UPS and IPS.
- 13 **Understand the features of security system.**
- 13.1 State what is meant by electronic security system.
 - 13.2 Explain the operation of the (smoke) indication system.
 - 13.3 Describe the operation of touch and non touch type person (thief) detector using infrared detection system with block diagram.
 - 13.4 Explain the operation of video monitoring system using multiple monitor switching.
- 14 **Understand the features of resistance welding.**
- 14.1 State the theory of resistance welding.
 - 14.2 Mention the types of welding.
 - 14.3 Describe the basic arrangements of (a) spot welding (b) seam welding (c) but welding.
 - 14.4 Describe block representation of an ac resistance welding scheme.
- 15 **Understand the operation of Programmable Logic Controller (PLC).**
- 15.1 Define PLC.
 - 15.2 Describe the architecture of PLC.
 - 15.3 List the languages of programming PLC.
 - 15.4 Mention the Symbol used in Ladder diagram.
 - 15.5 Draw ladder diagram for Logic functions, Latching, Sequencing

- 15.6 Discuss Timer and counter.
15.7 List the mnemonics used by different PLC.

Practical :

1. Determine the V-I characteristics of series/parallel connected diodes.
2. Determine the V-I characteristics of MCT/FCT.
3. Study the operation of inverter circuit.
4. Study the operation of converter.
5. Construct the step down & step up operation of dc choppers.
6. Study the operation and application of SMPS.
7. Study the operation of UPS/IPS.
8. Study the operation and application of stepper motor control / AC/ DC motor control circuit
9. Study the operation and application of DC servo system
10. Study the operation and application of Solar power system.
11. Study the operation and application of Electronics ballast.
12. Study the operation and application of Microwave oven.
13. Study the operation of Multimedia projector , photo copier , laser printer & Washing machine.
14. Study the operation of **security system**.
15. Study the operation of resistance welding machine.
16. Study the operation of a PLC.

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7043

APPLIED MECHANICS

T	P	C
2	3	3

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 terms 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 ratio 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.

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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 Chezy'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
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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.

4-YEAR DIPLOMA-IN-ENGINEERING PROGRAM

ELECTRICAL TECHNOLOGY (67)

**SYLLABUS
(COURSE STRUCTURE-2010)**

SIXTH SEMESTER

6761

ALTERNATING CURRENT MACHINES – I

T	P	C
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AIMS

To provide the student with an opportunity to acquire knowledge, skills and attitude in the area of alternating current machines with special emphasis on :

- power transformer.
- auto transformer.
- 3-phase induction motor.

SHORT DESCRIPTION

Transformer : principle of operation & construction, emf equation, transformation ratio, losses, equivalent resistance, leakage reactance, tests, regulation, efficiency, three phase connection, auto transformer, parallel operation, Three-phase induction motor: working principle, construction, magnetic field, torque, power stage, tests, starting and speed control.

DETAIL DESCRIPTION

Theory:

TRANSFORMER

- 1 Understand working principle and construction of transformer.**
 - 1.1 Define transformer.
 - 1.2 Explain the working principle of transformer.
 - 1.3 Describe the construction of a transformer.
 - 1.4 Identify the materials used in transformer construction.
 - 1.5 List different types of transformers.
 - 1.6 Describe core type, shell type and spiral core type transformer.
 - 1.7 Compare the core type and shell type transformer.
- 2 Understand the emf equation.**
 - 2.1 Define emf equation.
 - 2.2 Express the derivation of emf equation.
 - 2.3 Solve problems on emf equation.
- 3 Understand the transformation ratio.**
 - 3.1 Explain voltage ratio and current ratio.
 - 3.2 Explain turns ratio.
 - 3.3 Solve problems on transformation ratio.
- 4 Understand different losses of transformer.**
 - 4.1 List the losses in transformer.
 - 4.2 Explain hysteresis loss, eddy current loss and core loss.
 - 4.3 Explain copper loss.
- 5 Understand the principle of operation of transformer on no-load condition.**
 - 5.1 Explain no-load operation of transformer.
 - 5.2 Define no-load voltage, current, mutual flux, no load power factor.
 - 5.3 Draw the vector diagram of transformer on no load.
 - 5.4 Solve problems related to no load test.
- 6 Understand the principle of operation of transformer on load condition.**
 - 6.1 Explain operation of transformer on load.

- 6.2 Draw the vector diagram of transformer on lagging, leading and unity power factor load condition.
- 6.3 Solve problems related to transformer on load.

7 Understand the open circuit test and short circuit test of transformer

- 7.1 Describe open circuit test.
- 7.2 Describe short circuit test.
- 7.3 Draw vector diagram.
- 7.4 Solve problems related to short circuit test.

8 Understand the equivalent resistance, magnetic leakage and leakage reactance of transformer.

- 8.1 Deduce the equivalent resistance of transformer as referred to primary.
- 8.2 Deduce the equivalent resistance of transformer as referred to secondary.
- 8.3 Explain magnetic leakage of transformer.
- 8.4 List the disadvantages of magnetic leakage.
- 8.5 Deduce equivalent resistance & leakage reactance of transformer in terms of primary and in terms of secondary.
- 8.6 Solve problems on equivalent resistance, leakage reactance and impedance of transformer.

9 Understand equivalent circuit of transformer.

- 9.1 Draw the equivalent circuit of transformer.
- 9.2 Explain the equivalent circuit of transformer.
- 9.3 Draw the equivalent vector diagram of transformer.

10 Understand the voltage regulation of transformer.

- 10.1 Define voltage regulation.
- 10.2 Express the deduction of the equation for voltage regulation at unity, lagging and leading power factor load.
- 10.3 Solve problems related to regulation.

11 Understand the percentage resistance, reactance & impedance.

- 11.1 Define percentage resistance, reactance and impedance.
- 11.2 Express the deduction of the equation for percentage resistance, reactance and impedance.

12 Understand the efficiency of transformer.

- 12.1 Express the deduction of the formula for calculation of efficiency of transformer.
- 12.2 Explain the factors affecting core loss and copper loss of the transformer.
- 12.3 Express the deduction of the equation for maximum efficiency.
- 12.4 Evaluate the variation of efficiency with power factor.
- 12.5 Explain all day efficiency.
- 12.6 Solve problems on efficiency and maximum efficiency.
- 12.7 Solve problems on all day efficiency.

13 Understand the cooling of transformer.

- 13.1 Explain the necessity of cooling of transformer.
- 13.2 Describe the methods of cooling the transformer.
- 13.3 Describe the transformer oil and its properties.

14 Understand the construction and principle operation of three phase transformer.

- 14.1 Describe the construction of three phase transformer.
- 14.2 Describe the different parts of a three phase transformer.
- 14.3 List various methods of connection of 3-phase transformer.
- 14.4 Describe the methods of star – star, delta – delta, star – delta and delta – star connection.
- 14.5 Describe the application of the above methods.
- 14.6 Describe open delta connection or V-V connection.
- 14.7 Describe scott or T-T connection.

- 14.8 Explain the application of V-V and T-T connection.
- 14.9 Draw the connection of 3-phase to 2-phase
- 14.10 Draw the connection of 2-phase to 3-phase.
- 15 Understand the principle of auto-transformer.**
 - 15.1 Describe auto-transformer.
 - 15.2 Explain the terms transformed power and conducted power.
 - 15.3 List the advantages and disadvantages of auto-transformer.
 - 15.4 Convert a 2-winding transformer to auto-transformer.
 - 15.5 Mention the uses of auto-transformer.
 - 15.6 Solve problems on auto-transformer.
- 16 Understand the principle of parallel operation of transformer.**
 - 16.1 Explain the purpose of parallel operation.
 - 16.2 List the conditions for parallel operation.
 - 16.3 Explain the purpose of polarity test.
 - 16.4 Describe the subtractive and additive polarity.
 - 16.5 Describe the test to determine the polarity of a transformer.
 - 16.6 Describe the parallel operation of transformers with equal voltage ratio.
 - 16.7 Solve problems related to parallel operation.
 - 16.8 List the conditions for parallel operation of 3-phase transformer.
 - 16.9 List the standard ratings of transformer.
 - 16.10 Explain the specification on the name plate of a transformer.

THREE PHASE INDUCTION MOTORS.

- 17 Understand the principle and construction of 3-phase induction motor.**
 - 17.1 Explain the general principle of induction motor.
 - 17.2 Distinguish between induction motor and conduction motor.
 - 17.3 List various types of induction motor.
 - 17.4 List different parts of a 3-phase induction motor.
 - 17.5 Describe the construction of stator of an induction motor.
 - 17.6 Describe the construction of squirrel cage rotor, double squirrel cage rotor and wound rotor of induction motor.
 - 17.7 Explain the purpose of skewing the rotor bars in a squirrel cage rotor.
 - 17.8 Define slip and slip speed.
 - 17.9 Express the derivation the equation $f_r = sf$ and $N_r = \frac{120f}{P}(1-s)$
 - 17.10 Explain rotor voltage, rotor current and rotor power.
 - 17.11 Mention the uses of induction motor.
 - 17.12 Solve problems related to slip. .
- 18 Understand the concept of development of rotating magnetic field.**
 - 18.1 Explain the development of rotating magnetic field for three phase induction motor in 3-phase supply.
 - 18.2 Express the deduction of the formula $\Phi_R = 1.5\Phi_m$.
 - 18.3 Explain the principle of rotation of a 3-phase motor.
- 19 Understand the principle of torque developed in rotor.**
 - 19.1 Explain starting torque, running torque and maximum torque.
 - 19.2 Express the deduction of the equation of starting torque, running torque and maximum torque.
 - 19.3 Describe the condition for maximum torque for running and starting condition.
 - 19.4 Mention the relation between torque and rotor power factor.
 - 19.5 Explain the relation between torque and speed.
 - 19.6 Draw the torque speed curve.
 - 19.7 Explain the effect of changing the voltage on torque and speed.

- 20 Understand the concept of power stages of induction motor.**
- 20.1 List the losses in 3-phase induction motor.
 - 20.2 Indicate different stages of power developed in an induction motor in a diagram.
 - 20.3 Solve problems on power distribution.
- 21 Understand the equivalent circuit and maximum power output of an induction motor.**
- 21.1 Draw the equivalent circuit of an induction motor.
 - 21.2 Explain the circuit diagram.
 - 21.3 Explain maximum power output of an induction motor.
 - 21.4 Express the deduction of the maximum power output $R_L = Z_o$.
- 22 Understand the principle of starting of a 3-phase induction motor.**
- 22.1 Explain the purpose of starter.
 - 22.2 List the starters used for starting 3-phase induction motor.
 - 22.3 Describe the direct online starter method, start-delta starter method (manual and automatic), auto transformer starter method of starting squirrel cage induction motor.
 - 22.4 Describe the rheostat method of starting slip ring induction motor. .
- 23 Understand the principle of speed control of induction motor.**
- 23.1 List the methods of speed control of 3-phase induction motor.
 - 23.2 Describe speed control by changing applied voltage, changing applied frequency and changing stator poles.
 - 23.3 Describe rheostat control method, concatenation method & injecting emf in rotor circuit.

Practical:

- 1 Determine the transformation ratio of a single phase transformer.**
- 1.1 Sketch the required circuit diagram.
 - 1.2 List the tools, equipments & materials for the experiment.
 - 1.3 Connect the equipment according to the circuit diagram.
 - 1.4 Apply the voltage to the high side and connect the load to the low side.
 - 1.5 Tabulate the readings from the instruments and calculate the transformation ratio from the formula: $a = \frac{V_p}{V_s} = \frac{I_s}{I_p}$
- 2 Determine the voltage regulation of single phase transformer by direct loading.**
- 2.1 Sketch the necessary circuit diagram.
 - 2.2 List the tools, equipment & materials required.
 - 2.3 Connect the meters according to the diagram.
 - 2.4 Connect the source to the primary keeping the secondary open and record no load voltage (V_o).
 - 2.5 Connect full load on the secondary & record the load voltage.
 - 2.6 Calculate the voltage regulation from the formula:

$$\% \text{ Voltage Reg.} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$
- 3 Perform the open circuit test of single phase transformer.**
- 3.1 Draw the circuit diagram.
 - 3.2 List the tools, equipment & materials required.
 - 3.3 Connect the equipment according to the diagram.
 - 3.4 Connect the low side of its rated supply voltage keeping high side open.
 - 3.5 Record the readings of the instruments.
 - 3.6 Calculate I_o , I_w , R_o and X_o .
 - 3.7 Draw no load vector diagram with data obtained.
- 4 Perform the short circuit test of a single phase transformer.**
- 4.1 Sketch the required circuit diagram.

- 4.2 List tools, equipment & materials required.
- 4.3 Connect the equipment according to the circuit diagram keeping high side to the source.
- 4.4 Short circuit the low side by a low resistance wire.
- 4.5 Energize the circuit by applying reduced voltage and increase the voltage until it takes full load of current.
- 4.6 Record the instrument readings.
- 4.7 Observe copper loss and calculate and find R_e' , X_e' & Z_e' .
- 5 Perform the polarity test of a single phase transformer.**
 - 5.1 Draw the required circuit diagram.
 - 5.2 Collect tools, equipment & materials required.
 - 5.3 Connect the equipment according to the diagram.
 - 5.4 Connect the circuit to the source.
 - 5.5 Record the voltmeter readings.
 - 5.6 Determine whether it is additive or subtractive polarity.
- 6 Perform parallel operation of two single phase transformers.**
 - 6.1 Draw the circuit diagram.
 - 6.2 Collect tools, equipment & materials required.
 - 6.3 Connect the equipment according to the circuit diagram with proper polarity.
 - 6.4 Energize the circuit and connect the load to the secondary.
 - 6.5 Record the power shared by each transformer.
- 7 Identify and rectify the troubles of a single phase transformer.**
 - 7.1 Select a single phase transformer.
 - 7.2 Collect the tools and equipment required.
 - 7.3 Take a test lamp or an AVO meter.
 - 7.4 Perform continuity test, earth test and insulation test employing test lamp and AVO meter.
 - 7.5 Identify the troubles and suggest remedial measures.
- 8 Perform transformer banking.**
 - 8.1 Collect the tools, equipment and materials required.
 - 8.2 Draw the circuit diagram of Y-Y, Y- Δ , Δ - Δ and Δ -Y banking respectively.
 - 8.3 Connect the equipment according to the diagram separately.
 - 8.4 Record the meter readings for each case separately.
 - 8.5 Calculate the voltage ratio in each case.
- 9 Perform the operation of auto-transformer and determining its transformation ratio.**
 - 9.1 Sketch the circuit diagram.
 - 9.2 Collect tools, equipment & materials required.
 - 9.3 Connect the equipment according to the circuit diagram.
 - 9.4 Energize the circuit and tabulate the meter readings.
 - 9.5 Calculate transformation ratio, conducted power & transformed power.
- 10 Perform the identification of the parts of a three phase induction motor.**
 - 10.1 Select a 3-phase induction motor.
 - 10.2 Collect different tools required for the experiment.
 - 10.3 List different parts of a 3-phase induction motor.
 - 10.4 Dismantle the parts of the motor.
 - 10.5 Identify different parts and make sketch of each part. .
 - 10.6 Assemble the dismantled parts.
- 11 Start a 3-phase induction motor by manual star-delta starter.**
 - 11.1 Take a 3-phase squirrel cage induction motor.
 - 11.2 Collect the equipment & tools required.
 - 11.3 Draw the working diagram to perform the experiment.
 - 11.4 Connect the starter with the motor as per diagram.

- 11.5 Start the motor with the starter: first in star and then in delta position.
- 11.6 Measure the speed of the motor with tachometer.
- 11.7 Calculate slip of the motor.
- 12 Start a 3-phase induction motor by automatic star-delta starter.**
 - 12.1 Take a 3-phase squirrel cage induction motor.
 - 12.2 Collect the equipment & tools required.
 - 12.3 Draw the working diagram to perform the experiment.
 - 12.4 Connect the starter with the motor as per diagram.
 - 12.5 Push the start button to start the motor automatically first in star and then in delta position.
 - 12.6 Measure the speed of the motor with tachometer.
 - 12.7 Calculate slip of the motor.

REFERENCE BOOKS

- 1. Electrical Machines by – Charles. S. Siskind
- 2. A text book of Electrical Technology – B. L Theraja
- 3. Electrical Machine – J B Gupta
- 4. Electrical Machines - M.V. Deshpande

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AIMS

To provide the student with an opportunity to acquire knowledge, skills and attitude in the area of Electrical Measurement and Measuring Instruments with special emphasis on :

- extension of instrument range
- operation of instrument transformer.
- measurement of the resistance of various ranges.
- Concept of operation of synchroscope, CRO and High voltage measurement.
- the concept of operation of meters for measurement of frequency, power factor, temperature, pressure, speed and flow.

SHORT DESCRIPTION

Extension of instrument ranges: instrument range; Ammeter shunt, Voltmeter multiplier; Instrument transformer: construction and use of CT & PT; Measurement of resistance: Low resistance, Medium resistance and High resistance; Multimeter; Digital instrument; Frequency Meter: Principle of measurement, construction and operation; Power factor meter: Construction and principles of operation; Digital power factor meter; Synchroscope; Cathode Ray Oscilloscope: construction, operation and application; Electronic voltmeter; Special meters: meters for temperature, pressure, speed and flow measurements.

DETAIL DESCRIPTION**Theory:****EXTENSION OF INSTRUMENT RANGE**

- 1 Understand extension of instrument range.**
 - 1.1 List different types of instrument for which extension is required.
 - 1.2 Explain the necessity for extension of instrument range.
 - 1.3 Describe the principles of extension of instrument range.
- 2 Understand the concept of ammeter shunt.**
 - 2.1 Describe the ammeter shunt for DC circuit.
 - 2.2 Express the deduction of the relation: $R_{sh} = \frac{R_m}{N - 1}$
 - 2.3 Explain ammeter shunt for AC circuit.
 - 2.4 Solve problems relating to ammeter shunt.
- 3 Understand the concept of voltmeter multiplier.**
 - 3.1 Describe voltmeter multiplier.
 - 3.2 Describe the swamping resistance.
 - 3.3 Explain voltmeter multiplier for AC instrument.
 - 3.4 Solve problems relating to voltmeter multiplier.

INSTRUMENT TRANSFORMER

- 4 Understand the concept of instrument transformer.**
 - 4.1 Describe current transformer (CT) and potential transformer (PT).

- 4.2 List the applications of current transformer and potential transformer.
- 4.3 Explain the advantages and disadvantages of CT and PT.
- 4.4 Describe the burden of instrument transformer.
- 4.5 Compare instrument transformer with power transformer.
- 5 Understand the concept of current transformer (CT).**
 - 5.1 Describe the construction of current transformer.
 - 5.2 Draw the connection diagram of CT with line.
 - 5.3 Draw and explain the vector diagram of current transformer.
 - 5.4 Determine actual current ratio, ratio error and phase angle error.
 - 5.5 Explain the characteristics of current transformer.
 - 5.6 Explain the classes of accuracy in instrument transformer.
 - 5.7 Explain the effect of open circuited secondary of current transformer.
 - 5.8 Describe the construction and use of clip on ammeters.
- 6 Understand the operation of potential transformer (PT).**
 - 6.1 Describe the construction of potential transformer.
 - 6.2 Draw the connection diagram of PT with line.
 - 6.3 Draw the vector diagram of PT.
 - 6.4 Draw the circuit showing CT, PT and Watt meter with 1-phase and 3-phase load.

MEASUREMENT OF RESISTANCE

- 7 Understand the measurement of resistance.**
 - 7.1 Classify resistance.
 - 7.2 Explain low, medium and high range of resistance.
- 8 Understand the principle of measurement of low resistance.**
 - 8.1 List the methods of measurement of low resistance.
 - 8.2 Describe the measurement of low resistance by ammeter- voltmeter method.
 - 8.3 Describe the measurement of low resistance by Kelvin's double bridge method.
 - 8.4 Solve problems on Kelvin's double bridge method.
- 9 Understand the measurement of medium resistance.**
 - 9.1 List the method of measurement of medium resistance.
 - 9.2 Describe Wheatstone bridge method of measurement of medium resistance.
 - 9.3 Mention the advantages of Wheatstone bridge method.
 - 9.4 Discuss the precaution in measuring medium resistance by Wheatstone bridge method.
 - 9.5 Solve problems related to Wheatstone bridge method.
- 10 Understand the measurement of high resistance.**
 - 10.1 Describe dielectric test of insulating materials.
 - 10.2 List the methods of high resistance measurement.
 - 10.3 Describe the guard wire method of measurement of high resistance.
 - 10.4 Describe the construction and working principle of megger.
 - 10.5 Describe the method of measurement of high resistance by a megger.
 - 10.6 Discuss the uses of megger.
 - 10.7 Describe measurement of earth resistance by earth tester.
- 11 Understand the multimeter.**
 - 11.1 Explain the circuit of analog multimeter.
 - 11.2 Describe the construction of analog multimeter.
 - 11.3 Describe the construction of digital multimeter.
 - 11.4 Describe the uses of multimeter.

FREQUENCY METER

- 12 Understand the principle of measurement of frequency.**

- 12.1 Name the methods of measuring frequency.
- 12.2 Explain the principle of mechanical resonance and electrical resonance.
- 12.3 Explain variation of impedance of an inductive circuit with the variation of supply frequency.

13 Understand the construction and working principle of frequency meter.

- 13.1 List different types of frequency meter.
- 13.2 Describe the construction and working principle of electrical resonance frequency meter.
- 13.3 Describe the construction and working principle of Weston frequency meter.

14 Understand the operation of digital frequency meter.

- 14.1 Describe the principle of operation of digital frequency meter.
- 14.2 Sketch the block diagram of a digital frequency meter.
- 14.3 Describe each block of a digital frequency meter.
- 14.4 Describe the function of time base selector in digital frequency meter.
- 14.5 Draw and Explain the operation of logic diagram of a digital frequency meter.

POWER FACTOR METER

15 Understand the construction and principle of operation of power factor meter.

- 15.1 List different types of power factor meter.
- 15.2 Describe construction and principle of operation of single phase dynamometer type power factor meter.
- 15.3 Describe the construction and principle of operation of three phase dynamometer type power factor meter.

16 Understand the principle of operation of digital power factor meter.

- 16.1 Describe the principle of operation of digital power factor meter.
- 16.2 Draw the block diagram of a digital power factor meter.
- 16.3 Describe each block of a digital power factor meter.

SYNCHROSCOPE

17 Understand the construction and principle of operation of synchroscope.

- 17.1 State synchronism and conditions for synchronizing of alternators.
- 17.2 List the method of synchronization of alternators.
- 17.3 Describe the construction and working principle of electro-dynamometer (Weston) type synchroscope.
- 17.4 Describe the construction and working principle of moving iron type synchroscope.

CATHODE RAY OSCILLOSCOPE

18 Understand the principle of cathode ray oscilloscope.

- 18.1 List various types electrodes of a cathode ray tube (CRT).
- 18.2 Sketch the diagram of a cathode ray tube with various electrodes.
- 18.3 Describe the construction and working principle of a cathode ray tube.
- 18.4 Draw the block diagram of a basic cathode ray oscilloscope (CRO).
- 18.5 Describe the function of different control knob in cathode ray oscilloscope.
- 18.6 Explain the operation of time base generator in CRO.
- 18.7 Explain the operation of horizontal and vertical amplifier in CRO.
- 18.8 Describe the function of trigger circuit.
- 18.9 Describe different wave forms in CRO for different signal inputs.

- 18.10 Describe the process of measurement of voltage, current, phase and frequency by CRO.
- 18.11 List the applications of CRO.
- 18.12 Describe lissajous pattern.

HIGH VOLTAGE MEASUREMENT

19 Understand the principle of high voltage measurement and testing.

- 19.1 Describe the high voltage measurement of electrical quantities.
- 19.2 List the equipment for high voltage measurement.
- 19.3 Describe the sphere gap method of high voltage measurement.
- 19.4 Describe the potential divider method of high voltage measurement.
- 19.5 Mention the advantages of sphere gap method of high voltage measurement.
- 19.6 Mention the disadvantages of sphere gap method of high voltage measurement.

20 Understand the operation of maximum demand indicator.

- 20.1 Explain the necessity of maximum demand indicator,
- 20.2 Describe the construction and working principle of Wright maximum demand indicator and Merz price maximum demand indicator.
- 20.3 Sketch the connection diagram of maximum demand indicator.

SPECIAL METERS

21 Understand the measurement of temperature.

- 21.1 List the names of temperature measuring meter.
- 21.2 Describe the principle of operation of electrical resistance thermometer.
- 21.3 Discuss the requirement of a conductor material to be used in resistance thermometer.
- 21.4 Describe shortly platinum resistance thermometer.

22 Understand the principle of measurement of pressure.

- 22.1 List different types of pressure measuring meter.
- 22.2 Describe measurement of pressure by using electrical transducers as secondary transducers.
- 22.3 Discuss the force summing device.
- 22.4 Discuss the secondary transducers.
- 22.5 Describe the measurement of pressure with diaphragm element and inductive transducer.

23 Understand the principle of measurement of speed.

- 23.1 List the names of tachometers.
- 23.2 Describe a DC tachometer.
- 23.3 Discuss the disadvantages of a AC tachometer.
- 23.4 Describe an AC tachometer.

24 Understand the principle of measurement of flow.

- 24.1 Name different flow measuring meter.
- 24.2 Describe the construction of turbine flow meter.
- 24.3 Describe the working principle of turbine flow meter.

Practical:

1 Determine the shunt resistance of an ammeter for extension of its range.

- 1.1 Sketch the circuit diagram for determining the shunt resistance of an ammeter.
- 1.2 Collect the tools, equipment and materials required.
- 1.3 Prepare the circuit according to the circuit diagram using proper equipment.
- 1.4 Check the equipment setting and connection before connecting power supply.
- 1.5 Record the readings from the meter.
- 1.6 Calculate the value of shunt resistance.

2 Determine the value of resistance of a voltmeter multiplier.

- 2.1 Sketch the circuit diagram for determining the resistance of voltmeter multiplier.

- 2.2 Connect the tools, equipment and materials required.
- 2.3 Prepare the circuit according to the circuit diagram.
- 2.4 Check the circuit before connecting power supply.
- 2.5 Record the reading from the meter.
- 2.6 Calculate the value of resistance of the multiplier.
- 3 Perform the handling of instrument transformer.**
 - 3.1 Select the current transformer and potential transformer.
 - 3.2 Select required tools, equipment and materials.
 - 3.3 Draw the circuit diagram.
 - 3.4 Connect the equipment according to the circuit diagram.
 - 3.5 Check all connection before supplying energy to the circuit.
 - 3.6 Records reading from the meter and calculate the transformation ratio.
- 4 Perform the measurement of low resistance by Ammeter–Voltmeter method.**
 - 4.1 Draw the circuit diagram for the measurement of low resistance by ammeter-voltmeter method.
 - 4.2 Connect the tools, equipment and materials required.
 - 4.3 Prepare the circuit according to the circuit diagram using proper equipment.
 - 4.4 Check the circuit before connecting power supply.
 - 4.5 Record the meter readings.
 - 4.6 Calculate the resistance from the meter readings.
- 5 Perform the measurement of earth resistance by earth tester.**
 - 5.1 Sketch the circuit diagram for the measurement of earth resistance by earth tester.
 - 5.2 Select a earth tester and required tools, equipment and materials.
 - 5.3 Connect the equipment according to the circuit diagram.
 - 5.4 Measure the earth resistance from the reading of the earth tester.
- 6 Perform the measurement of medium resistance by wheatstone bridge.**
 - 6.1 Draw the circuit diagram for measuring medium resistance by Wheatstone bridge.
 - 6.2 Select tools, equipment and materials required.
 - 6.3 Prepare the circuit according to the circuit diagram.
 - 6.4 Check all the connection before connecting power supply.
 - 6.5 Record the meter readings.
 - 6.6 Calculate the value of unknown resistance.
- 7 Perform the measurement of high resistance by a megger.**
 - 7.1 Select a high resistance.
 - 7.2 Select a megger.
 - 7.3 Connect the resistance with the megger.
 - 7.4 Measure the resistance from the reading of the megger.
- 8 Perform the measurement of frequency by a frequency meter.**
 - 8.1 Sketch the circuit diagram.
 - 8.2 Select a frequency meter.
 - 8.3 Select tools, equipment and materials.
 - 8.4 Connect the frequency meter to the supply or circuit whose frequency is to be measured.
 - 8.5 Measure the supply frequency from the meter.
- 9 Perform the measurement of power factor by a power factor meter.**
 - 9.1 Sketch the circuit diagram for measurement of power factor of a load by a power factor meter.
 - 9.2 Select the tools, equipment and materials required.
 - 9.3 Prepare the circuit according to the circuit diagram by using proper equipment.
 - 9.4 Check the circuit before connecting power supply.
 - 9.5 Record power factor from the power factor meter.
- 10 Perform the measurement by cathode ray oscilloscope and observe wave shape.**
 - 10.1 Choose a cathode ray oscilloscope (CRO).

- 10.2 Select a signal generator.
 - 10.3 Select tools and materials required.
 - 10.4 Connect the signal generator and CRO properly.
 - 10.5 Identify the control and function knobs of signal generator and CRO.
 - 10.6 Energize the signal generator and CRO.
 - 10.7 Observe the operation of different control knobs of CRO.
 - 10.8 Observe wave form on the screen.
- 11 Perform the measurement of voltage, current and frequency by cathode ray oscilloscope (CRO).**
- 11.1 Draw the circuit diagram for the measurement of voltage, current and frequency by CRO.
 - 11.2 Select the tools, equipment and materials required.
 - 11.3 Connect the equipment setting and connection according to the circuit diagram.
 - 11.4 Measure the voltage, current and frequency of the circuit by CRO.
 - 11.5 Prepare a report on it.
- 12 Measure high voltage peak value.**
- 12.1 Select sphere gap test equipment.
 - 12.2 Connect the sphere gap equipment terminals with high voltage source.
 - 12.3 Adjust the gap up to flash over occurred.
 - 12.4 Take sphere size, gap, length, ambient temperature & pressure.
 - 12.5 Find the value of voltage by using calibration table and taken data.

REFERENCE BOOKS

1. Electrical Measurements & Measuring Instruments
– Golding & Widdis.
2. A Course in Electrical & Electronic Measurements and Instrumentation - A.K Sawhney
3. A Text Book of Electrical Technology (volume-I) - B.L Theraja and A.K Theraja

6763 TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY – I

T	P	C
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AIMS

To provide the students with an opportunity to acquire knowledge, skills and attitude in the area of transmission and distribution electrical energy with special emphasis on:

- Different types of transmission and distribution systems of electrical energy.
- Comparison of different types of transmission and distribution system.
- Electrical and mechanical design of overhead lines.
- Survey of transmission and distribution line route.
- Performance calculation of overhead transmission line.

SHORT DESCRIPTION

Supply system: Different systems of transmission; Aspect of system loss; Mechanical design of overhead lines: support of overhead lines; conductors & conductor materials; Insulators; Effect of sag; Methods for survey of transmission/distribution line route; Voltage distribution of suspension insulator; Corona; Erection of poles and drawing of conductors of overhead line; Electrical design of overhead line: Resistance of the line conductor; Skin effect of transmission line; Effect of inductance on transmission line; Effect of capacitance of overhead transmission line; Performance of transmission lines: Voltage regulation and efficiency of short transmission line.

DETAIL DESCRIPTION

Theory:

SUPPLY SYSTEM

- 1 Understand different systems of transmission of electrical energy.**
 - 1.1 Explain the transmission and distribution system of electrical energy.
 - 1.2 Categorize various systems of transmission and distribution of electrical energy.
 - 1.3 Define Feeder and Distributor.
 - 1.4 Compare betⁿ feeder & Distributor.
 - 1.5 Compare between overhead and underground transmission and distribution system.
 - 1.6 Explain the advantages of high voltage transmission over low voltage transmission.
 - 1.7 Compare the cost of conductor of different overhead systems.
 - 1.8 Compare the cost of conductor of underground system with overhead system.
 - 1.9 Describe the process of choosing the working voltage for transmission and distribution system.
 - 1.10 Calculate the most economic working voltage for transmission of electrical energy.
 - 1.11 Express the equation for the most economic size of conductor by Kelvin's law.
 - 1.12 Solve problems on Kelvin's law.
 - 1.13 Describe the limitations to the application of Kelvin's law.
- 2 Understand different aspects of system loss.**
 - 2.1 Explain the term system loss
 - 2.2 List the factors involved in system loss.
 - 2.3 Explain how system loss can be minimized.
 - 2.4 Discuss the most economic power factor.

- 2.5 Express the equation for most economic power factor.
- 2.6 Solve problems on most economic power factor.

MECHANICAL DESIGN OF OVERHEAD LINES

3 Understand the supports of overhead lines.

- 3.1 List the main components of overhead lines.
- 3.2 Categorize the line supports.
- 3.3 Describe different types of line supports.
- 3.4 Mention the characteristics of line supports.
- 3.5 Describe the vibration dampers.

4 Understand the conductors and conductor materials.

- 4.1 List different types of line conductors used in overhead transmission and distribution lines.
- 4.2 Mention at least five properties of conductor materials.
- 4.3 Compare the properties of copper, aluminium and ACSR conductors.

5 Understand the line insulators and their characteristics.

- 5.1 List different types of insulators.
- 5.2 List insulator materials.
- 5.3 Describe the properties of insulator materials.
- 5.4 Describe the pin and suspension type insulators.
- 5.5 Compare the advantages and disadvantages of pin and suspension type insulator.
- 5.6 Mention the uses of different types of insulator.
- 5.7 List the causes of failure of insulators.
- 5.8 Explain different types of test of insulators.

6 Understand sag and its effect.

- 6.1 Explain the sag of transmission line.
- 6.2 List the factors affecting the sag.
- 6.3 Explain the spacing between conductors and span length.
- 6.4 Express the deduction of the formula to calculate the sag of conductors between two poles of equal height.
- 6.5 Express the deduction of the formula to calculate the sag of conductors between two poles of unequal heights considering effect of ice and wind pressure.
- 6.6 Solve problems on sag of transmission line.
- 6.7 Explain the effects of vibration on the transmission line and prevention of vibration.
- 6.8 Describe the measure for the prevention of vibration.

7 Understand the methods for survey of transmission / distribution line route.

- 7.1 List the survey instruments required for survey of transmission / distribution line.
- 7.2 Explain the uses, errors and accuracy of survey instruments.
- 7.3 Describe the process of measuring the angles by compass, level and theodolite.
- 7.4 Explain leveling, alignment, surveying and pegging of the route.
- 7.5 Explain the methods of measuring vertical and horizontal heights.
- 7.6 List the principle factors in routing overhead power lines.

8 Understand the voltage distribution of suspension insulator.

- 8.1 Explain string efficiency.
- 8.2 Describe the methods of improving string efficiency.
- 8.3 Solve problems on string efficiency.

- 8.4 Express the deduction of equation for voltage distribution across each unit of a string of suspension insulators.
- 8.5 Describe the methods of voltage grading in suspension insulators.
- 8.6 Describe the method of equalization of voltage of suspension insulators by guard ring.
- 8.7 Solve problems on voltage distribution and voltage grading.

9 Understand the phenomenon of corona.

- 9.1 Define corona of overhead transmission line.
- 9.2 Discuss the effect of corona.
- 9.3 Explain at least four factors that affect corona.
- 9.4 Describe the advantages and disadvantages of corona.
- 9.5 Express the derivation of the relation for disruptive critical voltage, visual critical voltage and power loss due to corona.
- 9.6 Discuss the methods for minimizing corona.

10 Understand the erection of poles / towers and drawing of conductors of overhead line.

- 10.1 Describe the procedure of erection of poles of overhead transmission / distribution line.
- 10.2 Describe the procedure of erection of towers of overhead transmission line.
- 10.3 Describe the procedure of fixing crossarm and insulator.
- 10.4 Describe the drawing of conductors of overhead line.
- 10.5 Describe the erection of stay / guy wire.

ELECTRICAL DESIGN OF OVERHEAD LINE

11 Understand the resistance of line conductor.

- 11.1 Describe the line constant of transmission line.
- 11.2 Express the deduction of the equation for calculating resistance of the line conductor.
- 11.3 Solve problems on the resistance of the line conductor.

12 Understand the skin effect of transmission line.

- 12.1 Explain the skin effect of transmission line.
- 12.2 Express the equation for calculating skin effect resistance.
- 12.3 Explain the proximity effect.

13 Understand the effect of inductance on transmission line.

- 13.1 Explain the flux linkage of a conductor due to internal and external flux.
- 13.2 Express the deduction of the equation for inductance of a single phase and three phase overhead transmission line in terms of Geometrical Mean Distance (GMD) and Geometrical Mean Radius (GMR).
- 13.3 Solve problems on inductance of single phase and three phase lines.
- 13.4 Describe the inductance of three-phase line with double circuit.
- 13.5 Explain the transposition of line conductors.

14 Understand the effect of capacitance of overhead transmission line.

- 14.1 Explain the electric potential of a transmission line.
- 14.2 Express the derivation of the equation to calculate the capacitance of single phase and three phase overhead transmission line.
- 14.3 Solve problems on capacitance of single phase and three phase overhead transmission line.
- 14.4 Explain the capacitance of double circuit three phase overhead line.
- 14.5 Explain Ferranti effect.

PERFORMANCE OF TRANSMISSION LINES

15 Understand the voltage regulation and efficiency of short transmission line.

- 15.1 Classify overhead transmission line.
- 15.2 Express the equation to calculate voltage regulation of overhead short transmission line.
- 15.3 Express the equation to calculate efficiency of overhead short transmission line.

- 15.4 Identify the effect of load power factor on voltage regulation and efficiency of overhead short transmission line.
- 15.5 Draw vector diagram of short transmission line performance calculation.
- 15.6 Solve problems on voltage regulation and efficiency of overhead short transmission line.

Practical:

- 1 Survey and estimate the electrical loads of an area.**
 - 1.1 Select the area / section of which the electrical loads are to be surveyed.
 - 1.2 Observe and record the load of each point of the area.
 - 1.3 Calculate the amperage of the area and the sub-area.
 - 1.4 Calculate the load of main circuit and sub-circuits.
- 2 Plot the integrated load curve, actual load curve and ideal load curve.**
 - 2.1 Draw the integrated load curve.
 - 2.2 Draw the actual load curve.
 - 2.3 Draw the ideal load curve.
- 3 Perform the selection of economical voltage for generation, transmission and distribution of electrical power.**
 - 3.1 Select generating voltage.
 - 3.2 Select voltage for transmission and distribution of electrical power.
 - 3.3 Select required type of insulators and poles.
- 4 Prepare the layout diagram of an electrical project.**
 - 4.1 Draw the layout of the selected electrical project.
 - 4.2 Draw the complete wiring diagram of the electrical project showing transmission line, distribution line and service mains.
 - 4.3 Indicate the power source.
- 5 Perform the identification of different components of LT and HT over head lines.**
 - 5.1 Identify the components of LT over head lines.
 - 5.2 Identify the components of HT over head line.
 - 5.3 Follow safety paractices.
 - 5.4 Prepare a report.
- 6 Perform the measurement of the horizontal distance between poles.**
 - 6.1 Collect the instruments/ equipment commonly used in surveying.
 - 6.2 Measure the horizontal distance between poles over different ground conditions using tape and chain.
 - 6.3 Record the measurement of distance.
 - 6.4 Plot the line route showing the measurements.
- 7 Perform the measurement of the angles and heights of poles / towers.**
 - 7.1 Select the instruments for measuring angles and heights of poles.
 - 7.2 Measure horizontal angles.
 - 7.3 Measure vertical angles.
 - 7.4 Measure vertical heights of poles / towers.
- 8 Survey and level the power lines.**
 - 8.1 Visit an actual high voltage power line route covering a distance of approximately five span.
 - 8.2 Record ground levels, angle of route, interfering obstacles and length.
 - 8.3 Draw a ground profile of the line route, showing the support positions and ground clearance on river crossing and canal crossing.
- 9 Perform the measurement of sag of a transmission / distribution line.**
 - 9.1 Fix up the sag boards.
 - 9.2 Set the theodolite in proper position.
 - 9.3 Measure the sag of a transmission / distribution line using theodolite.
 - 9.4 Prepare a report.

REFERENCE BOOKS

1. A Course in Electrical Power

6866 DIGITAL ELECTRONICS AND MICROPROCESSORS

T	P	C
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AIMS

To provide the students with an opportunity to acquire knowledge, skill and attitude in the field of Digital Electronics and Microprocessor with special emphasis on:

- Number system, Binary arithmetic and codes
- Logic gates, ICs and Boolean Algebra
- Combinational and Sequential logic circuits
- Semi conductor memories, A/D and D/A converters
- Architecture of 8-bit Microprocessors
- Simple programming using the instruction set of 8085
- Peripheral chips compatible to 8-bit microprocessors.

SHORT DESCRIPTION

Basic Digital Circuits; Numbers systems and codes; Combinational logic circuits; Flip-flops and shift registers; Counters; A/D and D/A converters; Semiconductor memories; 8085 microprocessors.

DETAILS DECEPTION

Theory:

DIGITAL ELECTRONIC

1 Understand Number systems and codes.

- 1.1 Describe binary, octal and Hexadecimal Number systems.
- 1.2 Convert one number system to another.
- 2.3 Compute binary, Octal and hexadecimal arithmetic.
- 2.4 Describe BCD Code, Excess- 3 Code, Gray Code, Alphanumeric Codes.
- 2.5 Convert one type of code to another.
- 2.6 Describe the method of error detection and correction by using Parity bit.
- 2.7 Describe the function of Hamming code.
- 2.8 Describe the applications of codes.

2 Understand the basic digital circuits.

- 2.1 Describe the digital signals.
- 2.2 State the main reasons for the widespread use of digital systems.
- 2.3 Describe AND, OR, NOT, NAND, NOR and XOR operations.
- 2.4 Describe the realization of basic logic operations using NAND and NOR gates.
- 2.5 Describe the boolean algebraic theorems.
- 2.6 Simplify the logic expressions by using boolean algebra.
- 2.7 Simplify the logic expressions by using Karnaugh map (upto 4 Variables).
- 2.8 Describe the characteristics of digital ICs.
- 2.9 Describe different types of digital logic families.

3 Understand Combinational Logic circuits.

- 3.1 Describe the operation of a digital multiplexer and demultiplexer.
- 3.2 Describe the operation of half adder and full adder.
- 3.3 Describe the operation of half subtractor and full subtractor.
- 3.4 Explain the function of arithmetic logic unit (ALU) with block diagram.

- 3.5 Describe the operation of digital comparators.
- 3.7 Describe the function of parity generator/checkers.
- 3.8 Describe the function of priority encoders and BCD-to-7 segment decoder with block diagram.

4 Understand the concept of Flip-Flops and shift registers.

- 4.1 Describe the operation of a sequential circuit with block diagram.
- 4.2 Describe the working principle of clocked S-R flip-flop, J-K flip-flop, Master-slave flip-flop, D-type flip-flop and T-type flip-flop.
- 4.3 State the applications of flip-flops.
- 4.4 Discuss the function of registers.
- 4.5 Describe the operation of shift registers.
- 4.6 Mention the applications of shift registers.
- 4.7 List some common ICs used as flip-flops and shift registers.

5 Understand the features of Counters.

- 5.1 Describe the operation of ripple or asynchronous counters.
- 5.2 Describe the principle of UP/DOWN counters.
- 5.3 Describe the modulus of the Counter.
- 5.4 Describe the operation of synchronous counters.
- 5.5 Explain the function of combination counter.
- 5.6 Discuss the principle of ring counter and Johnson counters.
- 5.7 List some common ICs used as a counter with block diagram.

6 Understand the principles of A/D and D/A Converters.

- 6.1 Discuss the general principles of D/A and A/D conversion.
- 6.2 Describe the operation of weighted-resistor D/A converter.
- 6.3 Describe the operation of R-2R ladder D/A converter.
- 6.4 Explain the characteristics of D/A converter.
- 6.5 Describe the operation of sample and hold Circuits.
- 6.6 Describe the operation of parallel comparator A/D converter.
- 6.7 Describe the operation of successive-approximation A/D converter.
- 6.7 Describe the operation of dual-slope A/D converter.
- 6.8 Describe the use of A/D converter as voltage-to-frequency and voltage-to-time converters.
- 6.9 List some popular ICs used as A/D and D/A converters.

7 Understand the features of Semiconductor Memories.

- 7.1 Describe the operation of a memory device with block diagram.
- 7.2 Describe the concept of READ and WRITE operation of memories.
- 7.3 Mention the classification of memories.
- 7.4 Mention the characteristics of memories.
- 7.5 Discuss the principle of sequential memory.
- 7.6 Discuss the principles of ROM, PROM, EPROM, EEPROM and Flash memory.
- 7.7 Mention the principle of static and dynamic RAM.
- 7.8 Identify some commercial memory ICs.

MICROPROCESSORS

8 Understand the features of Simple Microprocessors (8-bit)

- 8.1 Describe the block diagram of a digital Computer.
- 8.2 Define Microprocessor..
- 8.3 Describe the architecture of 8085 microprocessor.
- 8.4 Describe the pin diagram and function of each pin of Intel 8085 microprocessors.
- 8.5 Describe the registers of Intel 8085 microprocessors.
- 8.6 Differentiate between microcontrollers and microprocessors.

9 Understand the Programming of 8085 Microprocessors.

- 9.1 Describe the instruction set of 8085 microprocessors.
- 9.2 Explain the addressing modes of the Intel 8085 microprocessors.
- 9.3 Mention the simple programs using the 8085 instructions.

10 Understand the 8085 microprocessor system.

- 10.1 Draw a 8085 based computer.
- 10.2 Explain the process of demultiplexing AD_7 - AD_0 bus using latch.
- 10.3 Describe the technique of generate control signals.
- 10.4 Mention the function of interrupt controls and serial I/O controls.
- 10.5 Differentiate between memory mapped I/O and standard I/O.
- 9.6 Discuss the function of programmable peripheral Interface (PPI), programmable DMA controller and programmable interrupt controller (PIC).
- 9.7 Discuss the function of Programmable Interval Timer and Programmable Communication Interface.
- 9.8 List 8-bit, 16-bit, 32 bit and 64-bit Microprocessors.

Practical:

- 1. Verify truth tables of logic gates.
- 2. Construct basic gates with NAND and NOR gates and verify the truth tables.
- 3. Make circuits of adder & subtractor and verify the truth tables.
- 4. Make circuits of different flip-flops and verify the truth tables.
- 5. Make circuits of different shift registers and observe their operations.
- 6. Make circuits of different counters and observe their operations.
- 7. Study the operation of A/D converters.
- 8. Study the operation of D/A converters.
- 9. Study the hardware of a microprocessor based single board computer (8 bit/16 bit).
- 10. Make the simple programs using the 8085 instruction set and test them on 8085 trainer.

REFERENCE

- 1. Digital fundamentals -Floyd
- 2. Modern Digital Electronics -R.P. Jain
- 3. Microprocessor Architecture, Programming and Applications with 8085 -Ramesh S Gaonkar

AIMS

- To be able to understand the basic concepts of environment and environmental pollution.
- To be able to understand the concepts of ecology, ecosystems, global environmental issues, air pollution, water pollution, soil pollution, radioactive pollution, sound pollution, etc.
- To be able to understand the methods of controlling air pollution, water pollution and sound pollution.
- To be able to understand the management of waste, soil and pesticide pollution and
- To be able to understand the major environmental issues and problems in Bangladesh.

SHORT DESCRIPTION

Basic concepts of environment; Ecology & eco-systems; global environmental issues Air and atmospheric layers; Air pollution sources & effects; climate change, green house effect and depletion of ozone layer; Control of air pollution; Water pollution sources & effects; Monitoring of water pollution; Waste water treatment; Sound pollution and its control; Soil pollution and its management; Radioactive pollution and its control; Solid waste management; Major environmental issues and disaster management- Arsenic pollution; Pesticides pollution and its management, Environmental legislations and guidelines frame work and policy in Bangladesh.

DETAIL DESCRIPTION

- 1. Understand the basic concepts of environment.**
 - 1.1 Define: environment, Marine environment, Freshwater environment, Nutrients, Mangrove forest, Photo-chemical oxidant, Pollutant, Receptor, Sink, Pathways of pollutant, Speciation.
 - 1.2 Mention the main components of environment.
 - 1.3 Mention the functions of environment.
 - 1.4 Describe natural environment, man-made environment and social environment.
- 2. Understand ecology and eco-systems.**
 - 2.1 Define ecology and eco-system.
 - 2.2 Mention the range of tolerance in eco-system.
 - 2.3 Explain the biotic and abiotic components of eco-system.
 - 2.4 Explain briefly how does eco-system work.
 - 2.5 Explain the stability of eco-system.
 - 2.6 Explain the following ecological terms:
Food chain, Food web, Biodiversity, Biomass, Ecological pyramid, Pyramid of biomass, Pyramid of energy, Bio-concentration, Bio-magnification, Restoration ecology.
 - 2.7 Narrate the following bio-geochemical cycles of eco-system.
 - a) Carbon cycle
 - b) Nitrogen cycle
 - c) Phosphorus cycle
 - d) Sulphur cycle.
 - e) Hydrologic cycle
 - 2.8 Describe the following global environmental issues: Global environment, Earth and other environmental summits, climate change and ozone layer depletion.

- 3 Understand the air and the atmospheric regions.**
- 3.1 Mention different layers of atmosphere.
 - 3.2 Mention the average composition of the atmosphere at sea level.
 - 3.3 Describe the chemical species and particulates present in the atmosphere.
 - 3.4 Describe the importance ozone layer.
- 4 Understand the air pollution and its sources & effects.**
- 4.1 Define air pollution.
 - 4.2 Mention the composition of clean dry atmospheric air.
 - 4.3 List the air pollutants.
 - 4.4 Identify the sources of air pollutions.
 - 4.5 List the green house gases.
 - 4.6 Mention the effects of air pollution on human health, animals, plants and non-living things.
 - 4.7 Explain the formation of photo-chemical smog and its effect.
 - 4.8 List the disasters of major air pollution in the world mentioning location, causes and effects.
 - 4.9 Explain the causes of acid rain and its effect on eco-system.
- 5 Understand the control of air pollution at the sources.**
- 5.1 Mention the methods of air pollution control.
 - 5.2 Describe the following devices: gravitational settling chamber, cyclone separator, wet scrubber, centrifugal scrubber, fabric filter, catalytic converter.
- 6 Understand the sources of water pollution and its effects.**
- 6.1 Define water pollution.
 - 6.2 Mention the specification of ideal water as per recommendation of the World Health Organization (WHO).
 - 6.3 List the different types of water pollutants.
 - 6.4 Describe the sources of water pollution.
 - 6.5 Describe the effects of water pollution on human health, animal, plants and environment.
- 7 Understand the monitoring of water pollution.**
- 7.1 Define the following terms:
 - (i) Dissolved oxygen (DO).
 - (ii) Biochemical oxygen demand (BOD).
 - (iii) Chemical oxygen demand (COD).
 - (iv) Total organic carbon (TOC).
 - (v) Threshold limit value (TLV).
 - 7.2 Mention the method of determination of pH value of water.
 - 7.3 Mention the method of determination of dissolved oxygen (DO) in a sample of water.
 - 7.4 Mention the method of determination of biochemical oxygen demand (BOD) in a sample of water.
 - 7.5 Mention the method of determination of chemical oxygen demand (COD) in a sample of water.
- 8 Understand the waste water treatment.**
- 8.1 Define the primary treatment, secondary treatment and tertiary treatment of waste water.
 - 8.2 Define the following terms; ETP, Oxidation pond, waste stabilization pond, trickling filter, Activated slug.
 - 8.3 Mention the methods of primary and secondary treatment of industrial waste water.
- 9 Understand the sound pollution and its control.**
- 9.1 Define sound, sound wave and sound pollution.
 - 9.2 Mention the scale of measuring sound intensity.

- 9.3 Mention the sources of sound pollution.
- 9.4 Describe the effect of sound pollution on human health.
- 9.5 Describe the methods of control of sound pollution.
- 10 Understand the soil pollution and its management.**
- 10.1 Define soil pollution.
- 10.2 List the classification of soil pollution.
- 10.3 Mention the sources of soil pollution.
- 10.4 Describe the effect of soil pollution on human health.
- 11 Understand the radioactive pollution and its control.**
- 11.1 Define radioactive pollution.
- 11.2 Mention the sources of radioactive pollution.
- 11.3 List the causes of radioactive pollution.
- 11.4 Explain the effect of radioactive pollution on human health.
- 11.5 Describe the method of control of radioactive pollution.
- 12 Understand the solid waste management.**
- 12.1 Define solid waste.
- 12.2 List the sources of solid waste.
- 12.3 Mention the classification of solid waste.
- 12.4 Mention the methods of collection of solid waste.
- 12.5 Mention the waste management strategies in Bangladesh.
- 12.6 Describe the recycling of solid wastes.
- 12.7 Describe the potential method of disposal of solid waste.
- 13 Understand the major environmental issues in Bangladesh.**
- 13.1 List the major environmental issues in Bangladesh.
- 13.2 Describe the following disaster management of Bangladesh flood, cyclone, tidal surge, Cyclone(SIDR, AILA, Nargis, Tsunami), landslide, earthquakes and salinity.
- 14 Understand the arsenic pollution in Bangladesh.**
- 14.1 Mention the arsenic pollution of water in Bangladesh.
- 14.2 Explain the effects of arsenic pollution on human health.
- 14.3 Describe the causes of arsenic in ground water.
- 15 Understand the pesticide pollution in Bangladesh and its management.**
- 15.1 Define pesticide.
- 15.2 Make a list of pesticides.
- 15.3 Mention the causes of pesticide pollution in Bangladesh.
- 15.4 Describe the effect of pesticide pollution in the environment.
- 16 Understand the national environmental legislations and guidelines environmental frame work and policy in Bangladesh.**
- 16.1 Define, EA, EIA, IEA, NEMAP, DOE, BELA, GPS, GIS
- 16.2 Mention environmental act and legislations prescribed for air and water quality.
- 16.3 Describe environmental act prescribed for industries in Bangladesh.
- 16.4 Describe the guide lines of environment prescribed for industries in Bangladesh.
- 16.5 Describe the environmental frame work in Bangladesh.

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৩. বায়ু ও পানি দূষণ এবং প্রতিকার
— মুহাম্মদ কাউছার হাবিব ভূইয়া
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12. Water Pollution
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Atia Rahman, M. Ashraf Ali and Farooque Choudhury

AIMS

- To be able to develop the working condition in the field of industrial or other organization.
- To be able to understand develop the labor management relation in the industrial sector.
- To be able to develop the management techniques in the process of decision making.
- To be able to manage the problems created by trade union.
- To be able to understand the network , PERT, CPM & MBO
- To be able to perform the marketing.
- To be able to maintain inventory.

SHORT DESCRIPTION

Basic concepts of management; Principles of management; Scientific management; Organization; Span of supervision; Motivation; Personnel management and human relation; Staffing and manpower planning ; Training of staff; Industrial dispute; Concept of leadership; Concepts and techniques of decision making; Concept of trade union; Inventory control; Economic lot size ; Break even analysis; Labour and industrial law; PERT , CMP ; Network ; Marketing; Production management;

1 Understand the basic concepts & principles of management.

- 1.1 Define management and industrial management.
- 1.2 State the objectives of modern management.
- 1.3 Describe the scope and functions of management.
- 1.4 State the principles of management.
- 1.6 State the activity level of industrial management from top personnel to workmen.
- 1.7 Describe the relation among administration, organization & management.
- 1.8 Define Production Management and functions of Production Management.
- 1.9 Explain the social responsibilities of management.

2 Understand the concept of scientific management.

- 2.1 Define scientific management.
- 2.2 Discuss the basic principles of scientific management.
- 2.3 Explain the different aspects of scientific management.
- 2.4 Discuss the advantages and disadvantages of scientific management.
- 2.5 Describe the difference between scientific management and traditional management.
- 2.6 Describe the following four periods of management thought:
 - (i) pre-scientific management.
 - (ii) scientific management.
 - (iii) human relations
 - (iv) refinement extension and synthesis of management theories and practices.

3 Understand the concepts of organization and organization structure.

- 3.1 Define management organization.
- 3.2 State the elements of management organization.
- 3.3 Discuss the types of organization structure
- 3.4 Describe different forms of organization structure.
- 3.5 Distinguish between line organization and line & staff organization.
- 3.6 Distinguish between line organization and functional organization.

3.7 Describe the feature advantages and disadvantages of different organization structure.

3.8 Define organizational chart.

3.9 Describe the different types of organizational chart.

4 Understand the basic concept of span of supervision.

4.1 Define span of supervision and optimum span of supervision.

4.2 Discuss the considering factors of optimum span of supervision.

4.3 Discuss advantages and disadvantages of optimum span of supervision.

4.4 Define delegation of authority.

4.5 Explain the principles of delegation of authority.

4.6 Explain the terms: authority, responsibility and duties.

5 Understand the concept of motivation.

5.1 Define motivation.

5.2 Discuss the importance of motivation.

5.3 Describe financial and non-financial factors of motivation.

5.4 State the motivation process or cycle.

5.5 Discuss the motivation theory of Maslows and Harzbergs.

5.6 Differentiate between theory-X and theory-Y.

5.7 Discuss the relation between motivation and morale.

6 Understand the concept of leadership.

6.1 Define leadership.

6.2 Discuss the importance and necessity of leadership.

6.3 Discuss the functions of leadership.

6.4 Identify the types of leadership.

6.5 Describe the qualities of a leader.

6.6 Distinguish between autocratic leader and democratic leader.

7 Understand the basic concepts and techniques of decision making.

7.1 Define decision making.

7.2 Discuss the importance and necessity of decision making.

7.3 Discuss different types of decision making .

7.4 Describe the steps in decision making.

8 Understand the concept of personnel management and human relation.

8.1 Define personnel management.

8.2 Discuss the importance of personnel management.

8.3 Discuss the functions of personnel management.

8.4 Define staffing.

8.6 Define recruitment and selection of employees.

8.7 Describe various sources of recruitment of employees.

8.8 Describe the various methods of selection of employees.

8.9 Discuss the advantages and disadvantages of internal sources of recruitment.

8.10 Discuss the disadvantages of external sources of recruitment.

8.11 Define training and orientation of employee.

8.12 Discuss the importance and necessity of training.

8.13 Discuss the various methods of training of workmen, technicians and executive personnel.

9. Understand the concept of inventory control

9.1 Define inventory.& inventory control.

9.2 Describe the function of inventory control.

- 9.3 Discuss the necessity and importance of inventory control.
- 9.4 Mention the advantages and disadvantages of inventory control.
- 9.5 Explain the following terms :
- Bin card or Bin tag.
 - Purchase requisition.
 - Store requisition.
 - Material transfer note.
 - First in first out (FIFO).
 - Last in first out(LIFO).
 - PERT
 - CPM
 - NETWORK
 - MBO

10 Understand the concept of economic lot size & break even analysis

- 10.1 Define economic lot size.
- 10.2 Discuss the effects of over supply and under supply.
- 10.3 Describe the method of determination of economic lot size.
- 10.4 Explain the terms :
- Safety stock
 - Determination of safety stock
 - Lead time
- 10.5 Define break even point and break even chart.
- 10.6 Explain the terms :
- Break even analysis.
 - Fixed cost.
 - Variable cost.
- 10.7 Discuss the importance of break even analysis.
- 10.8 Describe the method of preparing break even chart.
- 10.9 Describe different methods of break even analysis.
- 10.10 Draw break even chart in different method.
- 10.11 Mention the advantages and disadvantages of break even analysis.

11 Understand the concept of Marketing and inventory control

- 11.1 Define marketing.
- 11.2 Discuss the function of marketing.
- 11.3 State the objectives of marketing.
- 11.4 Explain the terms :
- Brand
 - Producer
 - Consumer
 - Customer
 - Copyright
 - Trade mark
- 11.5 Discuss product life-cycle and marketing strategies in different stages of a product life-cycle
- 11.6 Define purchasing
- 11.7 Describe the five “R” of purchasing principles

12 Understand the concept of trade union and industrial law

- 12.1 Define trade union.
- 12.2 Mention the objectives of trade union.
- 12.3 Discuss the function of trade union.
- 12.4 Describe different types of trade union.
- 12.5 Mention the names of major trade union in Bangladesh.
- 12.6 Define labour and industrial law.

12.7 Discuss the importance of labour and industrial law.

12.8 Explain the terms :

- Factory Act. (1965)
- Minimum Wage Act (1957).
- Industrial Disputes Act.
- Work Men Compensation Act.
- Trade Union Act.

AIMS

To provide the students with an opportunity to acquire knowledge, skills and attitude in the area of communication engineering with special emphasis on:

- various types of modulation demodulation
- radio receiver and transmitter
- telephone system
- digital communication system
- communication switching system
- optical fiber communication
- satellite communication
- modem and mobile communication

SHORT DESCRIPTION

Communication network; Modulation; demodulation Receiver and transmitter; Telephone system; Digital communication; Communication switching system; Optical fiber; Satellite communication; Digital Communication, modem and mobile communication.

DETAIL DESCRIPTION**Theory:****1 Understand the features of communication network.**

- 1.1 Mention the allocation of frequency bands for various communication system.
- 1.2 Explain the nature of audio, video, digital data system.
- 1.3 Explain channel band width and channel capacity.
- 1.4 Describe different types of internal and external noise, noise figure and SNR (signal to noise ratio).
- 1.5 State the variety of communication network.
- 1.6 State the nature of satellite communication.
- 1.7 Basic communication system with block diagram.

2 Understand the features of modulation.

- 2.1 Explain the amplitude modulation.
- 2.2 Drive the equation for the amplitude modulated wave.
- 2.3 Define modulation index, depth of modulation, SSB, SSB-SC, DSB, DSB-SC and VSB modulation.
- 2.4 Drive the equation for frequency modulated wave (without analysis of besel function).
- 2.5 State the meaning of the terms modulation index, maximum frequency deviation and deviation ratio of FM wave.
- 2.6 Difference between amplitude and frequency (modulation).
- 2.7 Explain the PPM, PDM and PWM signals with application.
- 2.8 State the principles of multiplexing and demultiplexing.
- 2.9 Explain the principles of FDM and TDM with block diagram.

3 Understand the modulator and demodulator.

- 3.1 Explain the principles of operation of collector modulator, base modulator, balanced modulator, suppressed carrier balanced modulator and varactor diode modulator (without equation deduction).
- 3.2 State the basic principles of SSB-SC generation and QAM.
- 3.3 Mention the methods of AM detection.
- 3.4 Explain the operation of linear (diode) detector.

- 3.5 Mention the methods of FM detection.
- 3.6 Explain the working principle of various FM detectors.
- 3.7 List the advantages of ratio detector over foster seely discriminator circuit.

4 Understand the features of radio receiver and transmitter.

- 4.1 Explain the block diagram of AM transmitter.
- 4.2 Explain the operation of SSB transmitter with block diagram.
- 4.3 Explain the block diagram of superheterodyne AM receiver with wave form.
- 4.4 Explain the block diagram of Armstrong system FM transmitter.
- 4.5 Explain the sensitivity, selectivity, fidelity and signal to noise ratio.

5 Understand the features of telephone system.

- 5.1 State telephone system.
- 5.2 Describe the working principle of modern telephone hand set transmitter and receiver (without deduction of equation).
- 5.3 Describe the operation of automatic subscriber telephone set.
- 5.4 Describe advantages & disadvantages of side tone.
- 5.5 Describe the tones used in automatic telephone.
- 5.6 Describe the digital telephone set.
- 5.7 Define different types of telephone exchange.

6 Understand the concept of digital communication.

- 6.1 State the advantages of digital communication.
- 6.2 Describe the sampling theorem.
- 6.3 Describe the quantisation and coding principle of PCM.
- 6.4 Mention different types of media used for data transmission.
- 6.5 Describe the function of line driver and line receiver.
- 6.6 Describe synchronous and asynchronous mode of data transfer.
- 6.7 Describe the function of USART.

7 Communication switching system.

- 7.1 Define communication switching.
- 7.2 Mention different types of communication switching (analog and digital).
- 7.3 Function of switching system.
- 7.4 Characteristics of switching system.
- 7.5 Describe centralized and distributed stored program (SPC) switching system.
- 7.6 Define the following: message, circuit and packet switching, STS and TST switching.
- 7.7 Mention the different types of cables and connectors.

8 Understand Optical Fiber.

- 8.1 Define Optical Fiber.
- 8.2 Basic block diagram of Optical communication system.
- 8.3 Construction of optical fiber.
- 8.4 Advantages and disadvantages of optical fiber.
- 8.5 Mention different types of light sources and detectors of optical fiber.
- 8.6 Describe different types of optical fiber splices.

9 Understand the satellite communication.

- 9.1 Discuss the principles of satellite communication.
- 9.2 Describe the advantages of satellite communication.
- 9.3 Describe satellite earth station with block diagram.
- 9.4 Describe the working principle of terminals (VSAT).
- 9.5 Describe the applications of various satellites.
- 9.6 List different location of satellite earth station in Bangladesh.

10 Understand the digital communications.

- 10.1 Describe the working principle of facsimile.
- 10.2 Function of MODEM in data communication.
- 10.3 State the application of network.
- 10.4 Describe the local area network.
- 10.5 Describe the wide area network.
- 10.6 Describe ethernet.
- 10.7 Define ISDN, SDH, STN, SONET, FDDI, Internet and WWW, WAP, VOIP.

11. Understand the mobile communication.

- 11.1 State the mobile communication system.
- 11.2 List the application of mobile communication.
- 11.3 Describe the simple mobile network system.
- 11.4 Describe the function of base station of mobile communication system.
- 11.5 Define GSM, CDMA, FDMA, WIMAX, Bluetooth, Wi-fi.

Practical:

1 Study the operation of Amplitude modulator.

- 1.1 Select the required equipment, tools and materials.
- 1.2 Connect the circuit and equipment.
- 1.3 Input different modulations and carrier signals.
- 1.4 Record the required data.
- 1.5 Calculate the modulation index for each set of data.

2 Study the operation of Frequency modulator.

- 2.1 Select the required equipment, tools and materials.
- 2.2 Setup the circuit board and the equipment.
- 2.3 Input the proper signals.
- 2.4 Make the proper adjustment.
- 2.5 Observe the FM wave.

3 Study the operation of Amplitude demodulator.

- 3.1 Select the required equipment, tools and materials.
- 3.2 Connect the circuit and equipment.
- 3.3 Input different modulated signals.
- 3.4 Observe the output wave.

4 Study the operation of Frequency demodulator.

- 4.1 Select the required equipment, tools and materials.
- 4.2 Setup the circuit board and the equipment.
- 4.3 Input the proper signals.
- 4.4 Make the proper adjustment.
- 4.5 Observe the output wave.

5 Study the super heterodyne AM radio receiver.

- 5.1 Select a radio receiver and required tools & materials.
- 5.2 Identify the circuit diagram of receiver.
- 5.3 Make the list of the components.
- 5.4 Trace the circuit of the receiver.

6 Study the modern telephone hand set transmitter and receiver.

- 6.1 Select a modern telephone set.
- 6.2 Identify the transmitting and receiving section.

6.3 Make a list of components.

7 Study the Optical Fiber communication system.

- 7.1 Select the required equipment, tools and materials.
- 7.2 Identify the transmitting and receiving section.
- 7.3 Connect the circuit and equipment.
- 7.4 Observe the output.

8 Study the Optical Fiber joints and couplers.

- 8.1 Select required tools & materials.
- 8.2 Make Optical Fiber joints.
- 8.3 Test the joint.

9 Study the satellite home receiving system

- 9.1 Select required tools & materials.
- 9.2 Connect the satellite receiver with antenna and TV receiver.
- 9.3 Adjust the channel frequency.
- 9.4 Observe different channels.

10 Study the operation of a modem.

- 10.1 Select a modem.
- 10.2 Observe the operation of a mode.

11 Study the operation of fax.

- 11.1 Select a fax and required tools & materials.
- 11.2 Switch on the machine.
- 11.3 Give a message.
- 11.4 Observe the process of operation.

12 The student will visit the nearest automatic telephone exchange, digital telephone exchange, Grameen phone network system, Bangladesh Railway, Ground satellite station and VSAT.

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