



**BANGLADESH TECHNICAL EDUCATION BOARD**  
Agargaon, Dhaka-1207

4-YEAR DIPLOMA-IN-ENGINEERING PROGRAM  
SYLLABUS (PROBIDHAN-2016)

**ELECTRICAL TECHNOLOGY**  
TECHNOLOGY CODE: **667**

7th SEMESTER

DIPLOMA IN ENGINEERING  
PROBIDHAN-2016

**ELECTRICAL TECHNOLOGY (667)**

**7<sup>th</sup> SEMESTER**

Sl. No	Subject Code	Name of the subject	T	P	C	Marks				Total
						Theory		Practical		
						Cont. assess	Final exam	Cont. assess	Final exam	
1	66771	Alternating Current Machines-2	3	3	4	60	90	25	25	200
2	66772	Electrical Engineering project	0	6	2	0	0	50	50	100
3	66773	Switch Gear & Protection	3	3	4	60	90	25	25	200
4	66774	Transmission and Distribution of Electrical Power-2	3	3	4	60	90	25	25	200
5	66775	Testing and Maintenance of Electrical Equipment	1	3	2	20	30	25	25	100
6	66863	Instrumentation and Process Control	2	3	3	40	60	25	25	150
7	65853	Innovation & Entrepreneurship	2	0	2	40	60	0	0	100
<b>Total</b>			<b>14</b>	<b>21</b>	<b>21</b>	<b>280</b>	<b>420</b>	<b>175</b>	<b>175</b>	<b>1050</b>

# 66771 Alternating Current Machines – 2

T P C

3 3 4

## AIMS

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

- Alternator
- Synchronous motor
- Single phase motor
- Motor control

## SHORT DESCRIPTION

Alternators: Principle, construction, emf equation, effect of load on alternator; voltage regulation, parallel operation and starting procedure of alternator; Synchronous motor: Operation, torques and excitation, Phase swinging, Starting method and uses, Power factor correction; Single phase motor: Operation of single phase motor; Operation of AC commutator motor; Motor control: Speed control of single phase motor; Starting of three phase induction motor; Controlling speed of three phase induction motor.

## DETAIL DESCRIPTION

### Theory:

#### 1. Understand the principle of alternator.

- 1.1 Define Alternator
- 1.2 Explain the principle of alternator.
- 1.3 Differentiate between Alternator and DC generator.
- 1.4 Describe the methods of excitation of alternator.
- 1.5 Explain the rating of alternator.

#### 2. Perceive the constructional features of alternators.

- 2.1 List the main parts of alternator.
- 2.2 Explain the advantages of stationary armature.
- 2.3 Describe the stator frame & stator core.
- 2.4 Classify rotor of alternator.
- 2.5 Describe salient pole type rotor and cylindrical type rotor.
- 2.6 Describe damper winding.
- 2.7 Describe three phase armature windings of single layer and double layer type.
- 2.8 Explain pitch factor and distribution factor.
- 2.9 Explain fractional pitch, full pitch, half coiled winding and whole coiled winding.
- 2.10 List the advantages of fractional pitch winding.
- 2.11 Solve problems related to pitch factor & distribution factor.

#### 3. Understand the principle of emf equation.

- 3.1 Describe emf equation.
- 3.2 Define Harmonics: fundamental, 3rd harmonic and 5th harmonic.
- 3.3 Explain the effect of pitch factor and distribution factor on harmonics.
- 3.4 Solve problems related to emf equation.

**4. Evaluate the effect of load and no load condition of an alternator.**

- 4.1 Describe alternator on no load.
- 4.2 Describe the effect of resistance and leakage reactance on an alternator.
- 4.3 Explain the effect of armature reaction on emf of alternator.
- 4.4 Explain synchronous reactance and synchronous impedance.
- 4.5 Draw the vector diagram of a loaded alternator.
- 4.6 Describe resistance test, no-load test / open circuit test and short circuit test of alternator.
- 4.7 Solve problems related to synchronous reactance and synchronous impedance.

**5. Understand the principle of voltage regulation and efficiency of alternator.**

- 5.1 Define voltage regulation.
- 5.2 Explain voltage regulation at unity power factor, lagging power factor and leading power factor.
- 5.3 Solve problems related to voltage regulation of alternator.
- 5.4 List the losses occurred in alternator.
- 5.5 Explain the losses and efficiency of alternator.
- 5.6 Solve problems on losses and efficiency of alternator.

**6. Understand the principle of parallel operation and starting procedure of alternators.**

- 6.1 Define the term synchronizing.
- 6.2 Describe the purposes of synchronizing alternators.
- 6.3 List the conditions for synchronizing.
- 6.4 Describe the dark & bright lamp methods of synchronizing three phase alternator.
- 6.5 Explain the method of paralleling the alternators by synchroscope.
- 6.6 Explain synchronizing current and synchronizing power.
- 6.7 Explain the effect of unequal voltage on synchronizing two alternators.
- 6.8 Describe the distributions of load between two alternators in parallel.
- 6.9 Describe the steps of starting an alternator.

**7. Understand the principle of operation of synchronous motor.**

- 7.1 Define synchronous motor.
- 7.2 Explain the principle of operation of synchronous motor.
- 7.3 Describe the effect of increase in load of synchronous motor with vector diagram.

**8. Understand the torques and excitation of a synchronous motor.**

- 8.1 Describe different types of torque.
- 8.2 Explain the effect of excitation on armature current and power factor with vector diagram.
- 8.3 Construct V-curves.
- 8.4 Explain V-curves.
- 8.5 Describe the different point and position of V- curve in respect of power factor

**9. Predict the hunting or phase swinging of synchronous motor.**

- 9.1 Explain hunting or phase swinging.
- 9.2 List the disadvantages of hunting.
- 9.3 Explain the disadvantages
- 9.4 Remedies of hunting.

**10. Perceive the starting method and uses of synchronous motor.**

- 10.1 List the methods of starting synchronous motor.
- 10.2 Describe the procedures of starting a synchronous motor.
- 10.3 Compare synchronous motor with induction motor.
- 10.4 Mention the field of application of synchronous motor.

**11. Understand the principle of power factor corrections.**

- 11.1 Define synchronous condenser.
- 11.2 Distinguish between synchronous motor and synchronous condenser.
- 11.3 Explain the methods of power factor corrections with the help of synchronous motor and synchronous condenser.
- 11.4 Solve problems on power factor correction related to synchronous condenser.

**12. Understand the principle of operation of AC commutator motor.**

- 12.1 Describe the principle of operation of Schrage (poly phase commutator motor) motor.
- 12.2 Application of Schrage motor.
- 12.3 Mention the advantages and disadvantages of Schrage motor

**13. Understand the principle of operation of single phase motor.**

- 13.1 Explain why single phase motor is not self starting.
- 13.2 Describe double revolving field theory and cross magnetizing field theory.
- 13.3 List the methods of making single phase motor self starting.
- 13.4 Describe standard split phase motor
- 13.5. Describe capacitor motor and double capacitor motor.
- 13.6 Describe shaded pole motor & repulsion motor.
- 13.7 Describe hysteresis motor, universal motor, reluctance motor & AC series Motor
- 13.8 Explain the losses and efficiency of single phase motor.
- 13.9. Understand the working principle of stepper motor.
- 13.10 Explain Types, advantages and application of stepper motor

**14. Interpret Starting and Speed Control of Single Phase Induction Motor.**

- 14.1 Understand the principle of speed control of single phase motor.
- 14.2 List the methods of speed control of single phase motor.
- 14.3 Describe the methods of speed control of single phase motor.
- 14.4 Describe the method of reversing the direction of rotation of single phase induction motor using timers and relays.

**15. Paraphrase the Starting and Speed Control of Three Phase Induction Motor.**

- 15.1 Describe the operation of three phase induction motor by auto-transformer action using relay and timer.
- 15.2 Describe the methods of reversing the direction of rotation of three phase induction motor using relay and timer.
- 15.3 Describe the methods of controlling speed of three phase induction (squirrel cage) motor by reduced voltage method using relays and timers.
- 15.4 Describe the methods of controlling speed of three phase induction (wound rotor) motor by inserted resistance.

## PRACTICAL

### 1. Perform the winding of stator of an alternator.

- 1.1 Find pole pitch, pitch factor, distribution factor for developing 4 pole, 3-phase, 36 slots double layer winding of alternator.
- 1.2 Draw the developed winding diagram.
- 1.3 Draw the connection diagram for star connection.
- 1.4 Make a stator winding of an alternator.

### 2 Perform the resistance test of an alternator.

- 2.1 Select the required tools, equipment, machine and materials.
- 2.2 Draw circuit diagram for the test.
- 2.3 Connect the instruments according to the circuit diagram.
- 2.4 Check the prepared circuit.
- 2.5 Energize the circuit with power supply.
- 2.6 Tabulate instrument readings.
- 2.7 Calculate ohmic value of coil resistance and effective value of resistance.

### 3. Perform the open circuit test of an alternator.

- 3.1 List and collect the required tools, equipment, machine and materials.
- 3.2 Draw the circuit diagram for the test.
- 3.3 Connect the instruments according to the circuit diagram.
- 3.4 Check the prepared circuit.
- 3.5 Connect the circuit with the power supply.
- 3.6 Tabulate instrument readings.
- 3.7 Draw  $E_g$  and  $I_f$  curve.

### 4. Perform the short circuit test of an alternator.

- 4.1 List and collect the required tools, equipment, machine and materials.
- 4.2 Draw the circuit diagram.
- 4.3 Connect the instruments according to the circuit diagram.
- 4.4 Check the developed circuit.
- 4.5 Connect the circuit with the power supply.
- 4.6 Tabulate the instrument readings.
- 4.7 Calculate synchronous reactance and impedance.
- 4.8 Draw  $I_a$  and  $I_f$  curves.

### 5. Determine voltage regulation of an alternator through synchronous impedance method.

- 5.1 List and collect the required tools, equipment, machine and materials.
- 5.2 Draw the circuit diagram.
- 5.3 Connect the instruments according to the circuit diagram.
- 5.4 Check the prepared circuit.
- 5.5 Connect the circuit with the power supply.
- 5.6 Verify  $I_f$  and observe the voltage at the terminals.
- 5.7 Tabulate instrument readings and calculate voltage regulation.

**6. Determine voltage regulation of an alternator using different types of load (Resistive, Inductive and Capacitive load).**

- 6.1 List and collect the required tools, equipment, machine and materials.
- 6.2 Draw the circuit diagram.
- 6.3 Connect the instruments according to the circuit diagram.
- 6.4 Check the circuit.
- 6.5 Connect the prepared circuit with the power supply.
- 6.6 Tabulate the instrument reading.
- 6.7 Calculate the regulation.

**7. Perform the parallel operation of alternators by bright lamp method.**

- 7.1 List and collect the required tools, equipment, machine and materials.
- 7.2 Draw the circuit diagram.
- 7.3 Connect the equipment according to the circuit diagram.
- 7.4 Start the prime mover.
- 7.5 Check the generating voltages and phase sequences.
- 7.6 Adjust the speed of the incoming machine.
- 7.7 Close the switch at the full bright condition of the lamp.

**8. Perform the operation of synchronous motor and draw V-curves by changing field excitation.**

- 8.1 List and collect the required tools, equipment, machine and materials.
- 8.2 Draw the circuit diagram.
- 8.3 Connect the instruments according to the diagram.
- 8.4 Check the circuit.
- 8.5 Change the field excitation.
- 8.6 Tabulate armature and field current.
- 8.7 Draw the V-curve.

**9. Start the three phase induction motor (squirrel cage) by auto-transformer starter using relay and timer.**

- 9.1 Collect tools, equipment and materials required.
- 9.2 Draw connection diagram of the power, control and signal circuit.
- 9.3 Connect motor, relays, timer etc, according to the circuit diagram.
- 9.4 Apply voltage to the circuit.
- 9.5 Observe the operation of the motor.
- 9.6 Follow safety rules.

**10. Start three phase induction motor (wound-rotor) by stepped resistance method using relay and timer.**

- 10.1 Collect tools, equipment and materials required.
- 10.2 Draw the connection diagram of the power, control and signal circuit.
- 10.3 Connect motor, relays and timer according to the circuit diagram.
- 10.4 Apply voltage to the circuit.
- 10.5 Observe the operation of the motor.
- 10.6 Follow safety rules.

**11. Perform reversing the direction of rotation of three phase induction motor using relay and timer.**

- 11.1 Collect tools, equipment and materials required.
- 11.2 Draw circuit diagram of the power, control and signal circuits.

- 11.3 Connect motor, relay, timer etc. to the circuit.
- 11.4 Apply voltage to the circuit.
- 11.5 Observe the operation of the motor.
- 11.6 Change the direction of rotor.
- 11.7 Follow safety practices.

**12. Operate a single phase capacitor motor with a regulator.**

- 12.1 List the tools and equipment required for the experiment.
- 12.2 Sketch a working diagram.
- 12.3 Identify two sets of coil of the motor.
- 12.4 Connect two sets of coil and capacitor in series with the proper set of coil so that the air blows downward.
- 12.5 Connect the regulator with the fan and supply power.
- 12.6 Change the direction of rotation of the motor by changing the connection.

**13. Start a shaded pole induction motor (on crow model).**

- 13.1 Draw the working diagram of the experiment.
- 13.2 List the required tools and equipment.
- 13.3 Connect the motor according to the diagram.
- 13.4 Energize the motor with the supply voltage.
- 13.5 Measure the speed by tachometer.
- 13.6 Calculate the slip of the motor.

**REFERENCE BOOKS**

1. Direct Current and Alternating Current Machines – Charles S. Siskind
2. Alternating Current Machines – B F Puchstein, T C Lloyd, A G Conrad.
3. A Text Book of Electrical Technology - B.LTheraja
4. Electrical Machincs – Desh pand



# 66772 Electrical Engineering Project

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## AIMS

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

- Design and construction of electrical appliances, equipment and machineries.
- Developing innovative ideas of the students and put them in action.
- Improve operation of electrical equipment through original thinking.

## SHORT DESCRIPTION

Electrical projects based on the availability of materials and facilities in the Institutes and market. Possible projects may be the improvement of design and construction of electromagnetic fan regulator, electronic fan regulator, choke coil, electronic ballast, power supply unit, solar power system, inverter, small transformer, small motor starter, water level controller, rewinding of single phase motor and three phase induction motor. New ideas leading to actual construction will be given due importance.

## DETAIL DESCRIPTION

### 1. Design and construct fan regulator (Electromagnetic type).

- 1.1 Study the different manufacturer's literature, catalogue or manuals.
- 1.2 Sketch the working drawing and circuit diagram.
- 1.3 Select the materials and size of the core and core.
- 1.4 Collect the tools, equipment and materials required for construction of a fan regulator.
- 1.5 Construct core, base slider, form and covers of the fan regulator.
- 1.6 Wind the wire on the former to manufacture coil.
- 1.7 Insert core in the wound former and test the winding.
- 1.8 Warp winding with cotton tape and insert ampere tubes and connect terminals in tapping.
- 1.9 Apply varnish to fill the core and winding and Bake the winding and core
- 1.10 Analyze the construction cost and Compare the design & construction of fan regulator with that of manufactured.

### 2. Design and construct fan regulator (Electronic type).

- 2.1 Study different manufacturers literature/manuals or catalogues.
- 2.2 Select the speed regulating circuits for construction of fan regulator.
- 2.3 List materials & accessories required.
- 2.4 Construct circuit with proper connection.
- 2.5 Test the constructed circuit.
- 2.6 Set the base and cover.
- 2.7 Analyze the construction cost.
- 2.8 Prepare a report.

### 3. Design and construct choke coil.

- 3.1 Study different manufacturer's literature / catalogue or manuals.
- 3.2 Sketch the detail working drawing and circuit diagram.
- 3.3 Select the core materials, wires, size & shape of core, tools and equipment.
- 3.4 Construct core, base and cover for the project work.

- 3.5 Make a former and wind the wire for winding.
- 3.8 Insert the core in the wound former and Test the winding.
- 3.9 Warp the winding with the ampere cloth and Insert terminals into the ampere tube.
- 3.10 Connect the terminals and apply varnish and Fix up the wound former on the metal case.
- 3.11 Connect the choke with the tube light and observe its performance.
- 3.12 Measure the power factor.
- 3.13 Analyze the cost of making the choke.
- 3.14 Prepare a detail report on the project.

#### **4. Design and construct electronic ballast.**

- 4.1 Study the different manufacturer's literature / catalogue or manuals.
- 4.2 Select ballast power for 40W / 20W tube light.
- 4.3 Draw the circuit diagram of the ballast.
- 4.4 Fix up the components necessary for the ballast.
- 4.5 Connect the ballast with the tube light and observe its performance.
- 4.6 Compare the energy cost of electronic ballast with electromagnetic one.
- 4.7 Prepare a detail report on the project.

#### **5. Design and construct a power supply unit.**

- 5.1 Study different manufacturer's literature / catalogue or manual.
- 5.2 Draw the circuit diagram and working diagram.
- 5.3 List the materials required for manufacturing power supply unit.
- 5.4 Calculate the INPUT / OUTPUT voltage rating of a power supply unit.
- 5.5 Prepare a PCB regarding the circuit
- 5.6 Insert the components on the PCB as per circuit diagram and solder them.
- 5.7 Fix up the PCB and other components.
- 5.8 Test the PSU.
- 5.9 Analyze the design and construction.
- 5.10 Prepare a complete report on the project.

#### **6. Design and construct a emergency light.**

- 6.1 Study different manufacturer's literature / catalogue or manuals.
- 6.2 Calculate the input and output rating and develop the detail specification.
- 6.3 Draw the circuit diagram and working diagram.
- 6.4 Select the materials required for manufacturing the emergency light.
- 6.5 Fix up the components.
- 6.6 Connect power and observe the performance.
- 6.7 Analyze the cost of construction.
- 6.8 Prepare a report on the project.

#### **7. Design and construct a battery charger.**

- 7.1 Study different manufacturer's literature / catalogue or manuals.
- 7.2 Draw the circuit diagram and working diagram.
- 7.3 Select the materials required for manufacturing the battery charger.
- 7.4 Calculate the input / output related data for battery charger.
- 7.5 Fix up all components.
- 7.6 Connect power and observe the performance.

7.7 Analyze the cost of construction.

7.8 Prepare a report on the project.

**8. Construct a solar power system.**

8.1 Study different manufacturer's literature / catalogue or manuals.

8.2 Select the output power of the plant.

8.3 Draw the layout diagram of the solar plant.

8.4 Select the materials required for manufacturing the solar plant.

8.5 Develop the circuit.

8.6 Fix up all the components accordingly.

8.7 Analyze the cost of the plant.

8.8 Compare per unit production cost with conventional energy plants.

8.9 Prepare a report on the project.

**9. Construct an inverter.**

9.1 Study the related catalogue or manuals.

9.2 Select the rating of the inverter.

9.3 Draw the circuit diagram.

9.4 Prepare the required PCB.

9.5 Insert the components on the PCB and solder them.

9.6 Construct a metal case and place the PCB into the case.

9.7 Identify the input / output terminals.

9.8 Test the inverter (Harmonic components of current and power factor.)

9.9 Analyze the cost of the inverter.

9.10 Prepare a report on the project.

**10. Design and construct a small transformer.**

10.1 Study the manufacturer's catalogue / manuals and other relevant literatures.

10.2 Select the rating of a small transformer and materials and size of the core.

10.4 Calculate the wire size and number of turns for both sides of winding.

10.5 List the materials required for construction of the transformer.

10.6 Draw the working drawing for the core and Construct the core and former for windings.

10.7 Wind wire on the former, Insert core in the former and Test the windings.

10.8 Warp winding with cotton tape, Apply varnish to the winding and bake.

10.9 Fix the transformer into the metal case and Fix up the terminals on the case.

10.10 Test the transformer on no-load and on-load.

10.11 Analyze the cost for manufacturing the transformer.

**11. Perform design and construction of a small motor starter (electronic).**

11.1 Study the related catalogue / manuals and literatures.

11.2 Select the size, rating & type of motor starter and materials required for manufacture the starter

11.3 Draw circuit diagram and working drawing.

11.4 Prepare required PCB and Insert the components on the PCB and solder them.

11.5 Construct a metal case and place the PCB into the case and Fix up bush nut for connecting terminals and power line.

11.6 Connect the starter with motor and Connect power supply and observe the performance.

11.7 Analyze the cost of construction of motor starter.

11.8 Analyze the design and construction of the motor starter.

## **12. Design and construct water level controller.**

12.1 Study the catalogue / manuals and other related books / publications.

12.2 Design the water level controller circuit.

12.3 Draw the circuit diagram.

12.4 List the materials required for the construction.

12.5 Sketch the layout plan for the construction of water level controller.

12.6 Construct the water level controller.

12.7 Connect the controller with motor and float in water tank.

12.8 Test the performance of controller.

12.9 Analyze the cost of construction.

12.10 Analyze the design and construction.

## **13. Design and construct Instant power supply (IPS)**

13.1 Study different manufacture's literature/catalogue or manuals.

13.2 Calculate the input/output voltage rating of an instant power supply.

13.3 Draw the CKT. Diagram.

13.4 List the materials required for manufacturing IPS.

13.5 Prepare the PCB according to the circuit diagram.

13.6 Insert the Components on the PCB as Per circuit diagram and solder them.

13.7 Fix up the PCB and other components.

## **14. Re-wind a single phase motor.**

14.1 Disassemble a single phase motor.

14.2 Select the winding materials, tools & equipment for winding of motor

14.3 Draw the winding diagram of motor.

14.4 Remove the existing damaged winding and Count the number of turns and weight the removed coil

14.5 . Lean and wash the slots by petrol and Make a former and winding of coil on former.

14.6 . Insert the leather weight paper into the slot of stator of the motor and Place the coil in the slots of the core.

14.7 Joint the coil as per winding diagram and Put ampere tube in terminals.

14.8 Test the winding for continuity, insulation resistance, short circuit, open circuit and earth or body.

14.9 Warp the coil with cotton tape and Apply varnish and bake the coils.

14.10 Assemble the motor and Connect power and test the performance of the motor.

14.11 Analyze the cost of rewinding of motor.

## **15. Rewind 3-phase induction motor.**

15.1 Disassemble the stator of the motor.

15.2 Take out the coil from the stator and Count the number of turns of one of the damaged coil.

15.3 Measure the size of wire of the damaged coil.

15.4 Select tools, equipment and materials for winding.

15.5 Construct former and Wound the coils on former for making coils.

15.6 Clean and wash the slots and

15.7 Insert the insulating paper and coils into the slots of stator of the motor.

15.8 Make group connection and Test the winding of each group for open circuit, short circuit & body on earth

15.9 Warp the ends of coils with cotton tape and Connect the terminals of the group to the terminal posts of the terminal box.

15.10 Apply varnish on winding and bake and Connect the motor with power line and Test the motor.

15.11 Analyze the cost of rewinding.

#### REFERENCE BOOKS

1. Electrical Charger & IPS – Sharma.
2. Basic Motor Dynamo Fan – S. Mondal.
3. AC and DC Motor winding Practical- K.B Bhatia.
4. Motor winding with single phase and three phase Motor Data – S.K. Gupta.
5. Basic Practical Knowledge – M.M. Khoibar Ali.
6. Hobby Electronics - দেবশীষ বন্দোপাধ্যায়।
৭. ইলেকট্রনিক্সের কথা মজার প্রজেক্ট- সৌমেন কুমার সাহা।

**AIMS**

To provide the student with an opportunity to acquire knowledge, skill and attitude in the area of switchgear and protection with special emphasis on :

- Busbar and sub-station equipment.
- Circuit breakers and relays.
- Protection system for busbar, alternators, transformer, feeder and transmission line.
- Protection against over voltage.
- Sub station.

**SHORT DESCRIPTION**

Switch gear; Electrical faults; Busbar arrangements; Short circuit current calculation; power system stability; Current limiting reactors; Fuses; Circuit breakers; Relays; Protection of alternator & transformer; Protection of feeder & transmission line; Busbar protection; Over-voltage on transmission line; Protection against lightning; Sub-station.

**DETAIL DESCRIPTION****Theory:****1. Understand the concepts of switch gear.**

- 1.1 Define switch gear.
- 1.2 Discuss the importance of switch gear protection of electrical system.
- 1.3 List different types of switch gear.
- 1.4 Mention the switch gear equipment.

**2. Paraphrase the concepts of electrical faults.**

- 2.1 Define electrical faults.
- 2.2 Name the different types of faults in electrical power system.
- 2.3 Discuss the causes of faults in electrical power system.
- 2.4 Describe different types of faults in electrical power system.

**3. Perceive the concepts of busbar arrangements.**

- 3.1 Define busbar.
- 3.2 Describe different types of busbar.
- 3.3 Mention different types of busbar arrangements.
- 3.4 Explain different types of busbar arrangements.
- 3.5 Mention different types of faults in busbar.

**4. Interpret the short circuit current calculation.**

- 4.1 Define short circuit faults.
- 4.2 Describe the causes of short circuit fault.
- 4.3 Name different types of short circuit fault.
- 4.4 Mention the steps for symmetrical fault calculations.
- 4.5 Distinguish between symmetrical and unsymmetrical fault.
- 4.6 Explain the method of calculation of short circuit current.
- 4.7 Distinguish between per unit method and percentage method.

- 4.8 Discuss the advantages of per unit methods of short circuit current calculation
- 4.9 Solve problems on short circuit current calculation.

**5. Perceive the power system stability.**

- 5.1 Define stability.
- 5.2 Describe transient, dynamic and steady state stability.
- 5.3 Explain swing equation
- 5.4 Discuss the factors affecting transient stability.
- 5.5 Explain the method of improving transient stability.
- 5.6 Analyze the effect of sudden change in mechanical input.

**6. Understand the principle of operation of current limiting reactors.**

- 6.1 Define current limiting reactor.
- 6.2 Describe the principle of operation of current limiting reactor.
- 6.3 Discuss different types of current limiting reactors with diagram.
- 6.4 List the advantages and disadvantages of different types of current limiting reactor (CLR).
- 6.5 Solve problems related to the current limiting reactor (CLR).

**7. Recognize the operation and construction of fuses.**

- 7.1 Describe the principle of operation of fuses.
- 7.2 List different types of fuses.
- 7.3 Describe the current ratings of fusing element, fusing factor and breaking capacity.
- 7.4 Classify fuses according to the construction and current carrying capacity.
- 7.5 Describe the constructional features of the following fuses:
  - a. High Rupturing Capacity (HRC) fuse.
  - b. Carbon Tetrachloride (CTC) fuse.
  - c. Dropout fuse.
  - d. Horn gap fuse.

**8. Perceive the concept of construction and operation of circuit breaker.**

- 8.1 Define circuit breaker.
- 8.2 Describe the principle of operation of a circuit breaker and its function.
- 8.3 Describe arc and the process of its production & extinguishment.
- 8.4 Describe the construction and the principle of operation of the following circuit breakers:
  - a. Plain-break type circuit breaker.
  - b. Oil Circuit Breaker (OCB)
  - c. Low oil content circuit breaker.
  - d. Air Circuit Breaker (ACB).
  - e. Gas [Sulphur-Hexafluoride, SF<sub>6</sub>] circuit breaker.
  - f. Vacuum Circuit Breaker (VCB).
  - g. Magnetic actuator type Circuit Breaker
- 8.5 Compare between Gas circuit breaker (GCB) and Vacuum Circuit Breaker (VCB).
- 8.6 Describe the mountings and ratings of a circuit breaker.
- 8.7 Explain miniature types of circuit breaker such as MCB, MCCB.
- 8.8 Describe the principle of operation of an automatic recloser(auto reclosr) and Isolator.
- 8.9 Compare among the circuit breaker, auto-recloser, fuse and isolator.

8.10 Solve problems on ratings of circuit breaker

**9. Clarify the features of relay.**

9.1 Define relay.

9.2 Classify the relays on the basis of construction, principle of operation, mode of use, qualities and the timing characteristics.

9.3 Describe the principle of operation and construction of the following protective and control relays:

- a. Solenoid and plunger type relay.
- b. Induction type over current relay.
- c. Reverse power relay.
- d. Directional over load relay.
- e. Thermal relay.
- f. Buchholz relay.
- g. Differential relay.
- h. Induction type impedance or distance relay.
- i. Numeric Relay
- j Earth fault (EF)and Restricted Earth fault Relay(REF)

9.4 Describe control and relay panel.

9.5 List the factors to be considered for the maintenance of a relay.

**10. Understand the principle of protection of alternator and transformer.**

10.1 List the major features of good protective gears for alternators and transformers.

10.2 List the major faults that may occur in alternator and transformer.

10.3 Describe Merz-Price protection of alternator.

10.4 Describe Merz-Price protection of transformer.

10.5 Solve problems on transformer protection (Merz-Price system).

10.6 Describe the reverse power protection of alternators by reverse power relay.

10.7 Describe the internal fault protection of transformer by Buchholz relay.

**11. Perceive the principle of protection of feeder and transmission line.**

110.1 Describe the time graded protection of radial feeder.

11.2 Describe the reverse power and over load protection of parallel feeders by over current and reverse power relay.

11.3 Explain time graded protection of ring main system.

11.4 Describe Merz-Price voltage balance system for protection of feeder for internal (in between the relay set) fault.

11.5 Explain Translay system of protection for internal (in between the relay set) fault of feeder.

11.6 Describe the over load protection of transmission lines by definite distance relay.

11.7 Discuss the over load protection of transmission line by time distance relay.

**12. Understand the principle of static relays and protections.**

12.1 Define static relay.

12.2 List the advantages of static relays.

12.3 Describe amplitude comparator.

12.4 Explain level detector.

12.5 Describe static-time-lag over current relay.

12.6 Analysis busbar protection by static relay.



12.7 Describe busbar protection by saturable reactor protection system

**13. Paraphrase the causes and effects of over voltage on a transmission line.**

13.1 Describe surge.

13.2 Explain the resonance in transmission line.

13.3 Explain the switching effect.

13.4 Describe the causes of insulation failure and its effect.

13.5 Discuss the arcing earth.

13.6 Describe the construction and function of peterson coil.

13.7 Explain lightning and its effect.

13.8 Classify the lightning strokes.

13.9 Explain electrostatic induction.

**14. Perceive the system of protection against lightning.**

14.1 Describe the protective function and principle of operation of a lightning arrester.

14.2 Distinguish between lightning arrester, surge diverter and surge absorber.

14.3 Describe the construction and principle of operation of the following lightning arresters:

- a. Rod gap
- b. Horn gap
- c. Expulsion type
- d. Oxide film
- e. Thyrite

14.4 Explain the protective function of a condenser or diverter.

14.5 Explain the function of Ferranti Surge Absorber.

14.6 Explain the function of ground wire.

**15. Realize the utility and function of a sub-station.**

15.1 Describe the function and importance of a sub station as a part of the power supply system.

15.2 Distinguish between indoor and outdoor sub-station.

15.3 List the factors to be considered in selecting the site of a sub- station.

15.4 Sketch the layout plan of an indoor sub-station.

15.5 List different components of an indoor sub station.

15.6 Mention the functions of the components of an indoor sub-station.

15.7 Sketch the layout plan of an indoor sub-station.

15.8 List different components of an outdoor sub-station and describe their function.

**16. Understand the concept of Gas Insulated Sub Station( GIS)**

16.1 Define Gas Insulated Sub Station (GIS)

16.2 Familiarize with different parts of a Gas Insulated Sub Station (GIS)

16.3 List the advantage of Gas Insulated Sub Station (GIS)

16.4 Compare between Air Insulated Sub Station & Gas Insulated Sub Station

16.5 Describe Gas monitoring system of a Gas Insulated Sub Station

16.6 Describe Gas handling process and precaution about quality of GAS.

**Practical:**

**1. Categorize different types of fuses and measure the current carrying capacity of**

**HRC fuse.**

1.1 Identify and sort out different type of fuses from a given number of fuses.

1.2 Sketch different parts of HRC fuse.

1.3 Select a HRC fuse for a particular electrical circuit.

1.4 Connect the selected HRC fuse to the circuit.

1.5 Increase the load and measure the fusing current.

**2. Perform the identification of different parts of an Air blast Circuit Breaker (ACB) with tripping their mechanism.**

2.1 Identify different parts of an Air blast Circuit Breaker (ACB) with its moving and fixed contacts.

2.2 Sketch the main parts of the ACB.

2.3 Turn on and Turn off the ACB manually and observe its make and break mechanism.

2.4 Sketch the connection diagram of the ACB in a circuit and connect physically according to the diagram.

2.5 Read the name plate of the ACB and record its current rating.

2.6 Check the breaking operation during abnormal condition of the ACB by making a short circuit.

**3. Perform the identification of different parts of an Vacuum Circuit Breaker (VCB) and observe the tripping mechanism.**

3.1 Identify different parts of a VCB with special stress on its moving and fixed contacts.

3.2 Sketch the main parts of a VCB.

3.3 Turn-on and Turn-off the VCB manually and observe its make and break mechanism.

3.4 Check the oil level of the VCB.

3.5 Draw the connection diagram of the VCB in a circuit..

3.6 Connect the CB according to the diagram.

3.7 Read the name plate of the VCB and note down its current rating.

3.8 Check the breaking operation during abnormal condition of the VCB by making a short circuit

**4. Perform the identification of different parts of a Sulphur- Hexafluorid ( $SF_6$ ) Gas Circuit breaker and observe their tripping mechanism.**

4.1 Identify different parts of a  $SF_6$  circuit breaker with its moving and fixed contacts.

4.2 Sketch the main parts of the  $SF_6$  circuit breaker.

4.3 Turn-on and Turn-off the GCB (Gas circuit Breaker) manually and observe its make and break mechanism.

4.4 Connect the GCB according to the diagram.

4.5 Read the name plate of the GCB and record its current rating.

4.6 Check the breaking operation during abnormal condition of the GCB by making a short circuit.

**5. Perform the operation and identification of different parts of an induction type over current relay (IOR).**

5.1 Identify, sketch and level different parts of an induction type over current relay.

5.2 Draw the circuit diagram of the Induction type Over current Relay (IOR).

5.3 Sketch the diagram of the mimic trip circuit consists of a 1.5 V dry cell and small torch light bulb simulating the tripping arrangement.

5.4 Connect the relay (IOR) according to the circuit diagram and set the load current and allow it to work beyond the set value of load current.

5.5 Observe the operation of the relay and the simulation tripping.

**6. Sketching the layout of the electrical sub-station situated in campus and understanding its operation.**

6.1 Identify different protective devices, equipment and accessories of the sub station.

6.2 Note the rating of transformer, circuit breaker, isolator, CT & PT, HT & LT switch gear.

6.3 Sketch the front view of the panel board.

6.4 Draw the block diagram of the sub-station showing all the components.

6.5 Draw the single line diagram of the sub-station.

6.6 Sketch the layout diagram of the sub-station.

**7. Visit an outdoor distribution sub-station situated near to the institute campus and prepare a report.**

7.1 Identify the in-coming and out-going line of the sub-station.

7.2 Identify different equipments, their ratings and positions in the sub-station.

7.3 Read the name plate and record all the information including the feeder capacity.

7.4 Draw the front view of the control panel.

7.5 Sketch the layout of the sub-station showing the position of all the components by block diagram.

7.6 Draw the single line diagram of the outdoor sub-station.

7.7 Submit a complete technical report of the study visit.

**8. Study a widely used lightning arrester.**

8.1 Identify different components of thyrite lightning arrester or any type of given lightning arrester.

8.2 Sketch the cross sectional view of the given lightning arrester and label its different components.

**9. Visit a nearest grid sub-station of the national grid system and submit a report.**

9.1 Identify the incoming and outgoing lines.

9.2 Identify different equipment, their ratings and positions in the sub-station.

9.3 Read the name plate of the sub-station equipment and record all the information.

9.4 Draw the front view of the control panel.

9.5 Draw the layout of the sub-station showing the positions of all the components by block.

9.6 Draw the single line diagram of the grid sub-station.

9.7 Submit a complete technical report of the study visit.

**10. Study the catalogue and write the report.**

10.1 Collect commercial catalogue and price list of switch gear and protective devices from different local and foreign manufactures.

10.2 Study the collected literature.

10.3 Draw a standard specification for the required switch gear.

10.4 Submit a technical report based on the information of the collected papers.

**REFERENCE BOOKS**

1 Switch Gear & Protection - S. Rao.

2 Electrical Power - J. B. Gupta.

3 Principles of Power System - V. K. Mehta.

4 Modern Power System - Nagrath Kothari.

5. Fundamental of switchgear and Protection - J. B. Gupta

## AIMS

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

- Performance calculation of medium and long transmission line.
- DC and AC distribution system.
- Diagnosing faults of transmission and distribution line and measures for repair.
- Underground cable.

## SHORT DESCRIPTION

Medium and long transmission line; High Voltage DC transmission; DC distribution system; AC distribution system; Underground cables; Laying & jointing of underground cables; Insulation resistance and dielectric stress of UG cables; Capacitance in underground cables; Cable faults localization; Operation and maintenance of distribution line; Insulation resistance measurement; Grid system.

## DETAIL DESCRIPTION

### Theory:

#### **1. Analyze the effect of line constants of medium transmission line.**

- 1.1 Describe the effect of line constants of medium transmission line.
- 1.2 Express the equation for sending end voltage and current by end-condenser method, nominal T method and nominal  $\pi$  method for medium transmission line.
- 1.3 Draw the phasor diagrams of end-condenser method, nominal T method and nominal  $\pi$  method for medium transmission line.
- 1.4 Solve problems on end-condenser method, nominal T method and nominal  $\pi$  method for medium transmission line.

#### **2. Evaluate the effect of line constants of long transmission line.**

- 2.1 Describe the effects of line constants of long transmission line.
- 2.2 Analyze long transmission line (Rigorous method of solution).
- 2.3 Solve problems related to long transmission line.
- 2.4 Prepare the list of Application of rigorous method in long transmission line.

#### **3. Analyze the high voltage DC transmission.**

- 3.1 Describe the high voltage DC transmission system.
- 3.2 State the limitations of AC transmission.
- 3.3 Discuss the economic comparison between AC and DC transmission system.
- 3.4 List the advantages of HVDC.
- 3.5 List the disadvantages of HVDC.
- 3.6 Classify HVDC links.
- 3.7 List the fields of application of HVDC.

#### **4. Enumerate the DC distribution system.**

- 4.1 Describe the classification of distribution system.
- 4.2 Describe DC distribution.
- 4.3 List different types of distributors.

- 4.4 List different types of loading.
- 4.5 Describe DC distributor fed at one end.
- 4.6 Describe DC distributor fed at both ends.
- 4.7 Describe uniformly loaded distributor.
- 4.8 Describe ring distributor.
- 4.9 Solve problems on different types of distribution system.

#### **5. Understand the AC distribution system.**

- 5.1 List different types of AC distribution system.
- 5.2 Express the equation for sending end voltage of AC distributors.
- 5.3 Solve problems on sending end voltage of AC distributor.
- 5.4 Explain the methods employed for the solution of network problem of interconnected system.
- 5.5 Solve problems on 3- $\phi$ , 4 wire, Y- connected unbalanced loads.

#### **6. Understand the construction, insulating materials and types of underground cables.**

- 6.1 Define underground cables.
- 6.2 List the advantages and types of underground cables.
- 6.3 List the insulating materials used in underground cables
- 6.4 Describe the construction of low, high and super high voltage single phase and three phase underground cables.
- 6.5 Explain the insulating materials for cables.
- 6.6 List the properties of insulating materials for cables.
- 6.7 Describe the measurement of insulation resistance of cable.
- 6.8 Identify different sizes of cable.
- 6.9 List the causes of failure of underground cable.
- 6.10 Describe aerial cables and submarine cables.

#### **7. Perceive the laying and jointing of underground cable**

- 7.1 Explain different methods of underground cable laying.
- 7.2 Explain the method of terminating underground cables.
- 7.3 Describe the heat shrink type and cold shrink type of cables jointing.
- 7.4 Describe care and protection to be taken while doing jointing and terminating the cables.

#### **8. Analyze the insulation resistance and dielectric stress in a single core cable and three core cable**

- 8.1 Describe the insulating resistance of single core cable.
- 8.2 Express the equation for insulation resistance of single core cable.
- 8.3 Solve problems on insulation resistance in single core cable.
- 8.4 Deduce the equation for dielectric stress in a single core cable.
- 8.5 Solve problems on dielectric stress in a single core cable.
- 8.6 Describe the insulation resistance of a three core cable.
- 8.7 Express the equation for insulation resistance of three core cable.
- 8.8 Express the equation for dielectric stress in a three core cable.
- 8.9 Solve problems on insulation resistance of three core cable and dielectric stress in a three core cable.

**9. Understand the concept of capacitance in underground cable.**

- 9.1 Describe the capacitance of single core cable.
- 9.2 Express the equation for capacitance of single core cable.
- 9.3 Solve problems on capacitance of single core cables.
- 9.4 Describe the capacitance of a three core underground cable.
- 9.5 Express the equation for the capacitance of three core cable.
- 9.6 Solve problems on capacitance of three core cable.
- 9.7 Describe the grading of cables.
- 9.8 Deduce the equation of grading of cables.
- 9.9 Solve problems on grading of cables of a single core cable.

**10. Perceive the cable faults and their localization.**

- 10.1 List different types of cable faults.
- 10.2 Explain the causes of cable faults.
- 10.3 Describe different methods of locating cable faults.
- 10.4 Express the equation for locating the faults by Blavier test.
- 10.5 Express the equation for locating faults by Murray Loop test and Varley Loop test.
- 10.6 Solve problems on locating faults of cable.

**11. Understand the operation of distribution line.**

- 11.1 Sketch the circuit diagram of the distribution system.
- 11.2 Explain the operation of panel board of transmission system.
- 11.3 Describe load dispatch centre (LDC).
- 11.4 Explain the operation of a distribution system.

**12. Analyze the features of maintenance work of distribution line.**

- 12.1 Identify the damage and faults in the distribution line during routine (weekly/monthly) inspection or at the time of emergency.
- 12.2 Describe the procedure of repairing the damage and faults in the line.
- 12.3 Find the causes for damage and faults occurred.
- 12.4 Prepare the list of tools and materials for the repair work.
- 12.5 Discuss the function of personal protective equipment used for repair and maintenance of distribution line.

**13. Enumerate the methods of measuring insulation resistance of the system when power is on.**

- 13.1 Describe in brief the method of measuring the insulation resistance of the system when the power is ON.
- 13.2 Express the deduction of the equation for measuring the insulation resistance of the system when the power is ON.
- 13.3 Solve problems on measuring insulation resistance when power is ON.
- 13.4 Discuss the safety procedures for measuring insulation resistance of the line when power is ON.

**14. Understand the grid system.**

- 14.1 Describe grid system.
- 14.2 Explain in brief the necessity of grid system.
- 14.3 List different types of grid system.
- 14.4 Identify the advantages of grid system.
- 14.5 Outline the grid system of Bangladesh.
- 14.6 Outline the grid system of some advance countries.

**Practical:**

**1. Sketch the layout diagram of panel board.**

- 1.1 Sketch the layout of panel board.
- 1.2 Identify different sections of the panel board.
- 1.3 Prepare a list of equipment and instruments of panel board with specification.

**2. Measure the insulation resistance of low tension (LT) cables by Megger.**

- 2.1 Select and collect tools, equipment and cables
- 2.2 Draw the circuit diagram of for connecting Megger
- 2.3 Connect as per the CKT diagram.
- 2.4 Perform the experiment to measure the insulation resistance of low tension cables.
- 2.5 Record the data and calculate the value
- 2.6 Follow safety practices.

**3. Measure the insulation resistance of High tension (HT) cables by Megger.**

- 3.1 Select and collect tools, equipment and cables
- 3.2 Draw the circuit diagram of for connecting Megger
- 3.3 Connect as per the CKT diagram.
- 3.4 Perform the experiment to measure the insulation resistance of high tension cables.
- 3.5 Record the data and calculate the value
- 3.6 Follow safety practices.

**4. Draw the cross sectional view of different types of underground cable.**

- 4.1 Select and collect different types of cables
- 4.2 Study the cross section of underground cable.
- 4.3 Draw the cross sectional views of different types of underground cables.

**5. Locate ground fault by Murray loop test for underground cable.**

- 5.1 Select and collect tools, equipment and cables
- 5.2 Draw the circuit diagram of Murray loop test for ground fault.
- 5.3 Connect as per the CKT diagram.
- 5.4 Perform experiment to locate the ground fault.
- 5.5 Record the data and calculate the value.
- 5.6 Follow safety practices.

**6. Locate short circuit fault of underground cables by Murray loop test.**

- 6.1 Select and collect tools, equipment and cables
- 6.2 Draw the circuit diagram of Murray loop test for short circuit fault.
- 6.3 Connect as per the CKT diagram.
- 6.4 Perform experiment to locate the short circuit fault.
- 6.5 Record the data and calculate the value.
- 6.6 Follow safety practices.

**7. Perform the experiment to measure the insulation resistance of the system when power is ON.**

- 7.1 Select and collect tools, equipment and cables
- 7.2 Draw the circuit diagram for the experiment.
- 7.3 Connect as per the CKT diagram.
- 7.4 Perform experiment to measure the insulation resistance.
- 7.5 Calculate insulation resistance from the data.
- 7.6 Follow safety practices.

**8. Perform the experiment to locate the underground cable ground fault by Varley loop test.**

- 8.1 Select and collect tools, equipment and cables
- 8.2 Sketch the diagram of Varley loop test for ground fault.

- 8.3 Connect as per the CKT diagram.
- 8.4 Locate the ground fault by experiment.
- 8.5 Record the data and calculate the value.
- 8.6 Follow safety practices.

**9. Perform the experiment to locate the under ground cable short circuit fault by Varley loop test.**

- 9.1 Select and collect tools, equipment and cables
- 9.2 Sketch the diagram of Varley loop test for short circuit fault.
- 9.3 Connect as per the CKT diagram.
- 9.4 Locate the short circuit fault by experiment.
- 9.5 Record the data and calculate the value.
- 9.6 Follow safety practices.

**10. Perform the experiment to locate the under ground cable fault by Blavier test.**

- 10.1 Select and collect tools, equipment and cables
- 10.2 Draw the diagram of Blavier test for underground cable fault.
- 10.3 Connect as per the CKT diagram.
- 10.4 Record the data and calculate the value.
- 10.5 Locate the underground fault by experiment.
- 10.6 Follow safety practices.

**REFERENCE BOOKS**

1. A Course in Electrical Power - J. B. Gupta.
2. Principles of Power System - V. K. Mehta.
3. Electrical Power System (3rd Revised Edition) - Ashfaq Husain
4. EHV-AC & HV DC Transmission Engineering and Practice – S. Rao.
5. A Text Book of Electrical technology – B.L Theraja and A. K Theraja.
6. Solution of Electrical Problems – B.L. Theraja.



**Aims**

To provide the students opportunities to acquire knowledge, skills and attitude in the area of Testing and Maintenance of electrical equipment with the special emphasizes on:

- Trouble shooting and maintenance of electrical equipment,
- Faults findings and remedy the faults of Battery, DC Generators, DC motors,
- Faults findings and remedy the troubles Transformers, Induction motors, Alternators,
- Faults findings and remedy the troubles Synchronous motor and Circuit breaker

**Short description**

Trouble shooting and maintenance of electrical equipment, Identification of trouble and remedy the troubles of Battery, DC Generators, DC motors, Identification of trouble and remedy the troubles of Transformers, Induction motors, Alternators, Identification of trouble and remedy the troubles Synchronous motor and Circuit breaker

**Detail Description****Theory****1. Identify the hand tools and equipment for trouble shooting and maintenance of electrical equipment.**

- 1.1 Mention the name of hand tools and their uses
- 1.2 Name the equipment used for trouble findings and trouble shooting for electrical appliances and electrical machines
- 1.3 Name the equipment used for trouble findings and trouble shooting for electrical machines

**2. Find the trouble and repair the troubles of Batteries, DC Generator and DC Motors**

- 2.1 Identify the troubles of Batteries
- 2.2 Explain the troubles of the storage Batteries
- 2.3 Describe the process of repair and maintenance of storage batteries
- 2.4 Identify the Faults of DC Generator and Dc Motor
- 2.5 Explain the faults of the Dc Generator and Dc Motor
- 2.6 Describe the process of repair and maintenance of DC Generator and Dc Motor

**3. Indicate the faults and remedy the faults of single phase and three phase transformer.**

- 3.1 List the name the Faults of single phase Transformer
- 3.2 Explain the faults of single phase Transformer
- 3.3 Describe the process of repair and maintenance of single phase Transformer
- 3.4 Mention the Faults of three phase Transformer
- 3.5 Explain the faults of three phase Transformer
- 3.6 Describe the process of repair and maintenance three phase Transformer

**4. Outline the probable faults of single phase and three phase Induction motor.**

- 4.1 List the name the Faults of single phase Induction Motor
- 4.2 Illustrate the faults of single phase Induction Motor
- 4.3 Describe the process of repair and maintenance of single phase Induction Motor
- 4.4 Mention the Faults of three phase Induction Motor
- 4.5 Explain the faults of three phase Induction Motor
- 4.6 Demonstrate the process of repair and maintenance three phase Induction Motor

## **5. Recognize the trouble and remedy the troubles of Alternators and Synchronous motors**

- 5.1 List the name the Faults of Alternators
- 5.2 Illustrate the faults of Alternators
- 5.3 Describe the process of repair and maintenance of Alternators
- 5.4 Mention the Faults of Synchronous motors
- 5.5 Explain the faults of Synchronous motors
- 5.6 Demonstrate the process of repair and maintenance Synchronous motors

## **6. Express the trouble and remedy the troubles of Circuit breaker**

- 6.1 List the name the Faults of Circuit breaker
- 6.2 Illustrate the faults of Circuit breaker
- 6.3 Describe the process of repair and maintenance of Circuit breaker

### **Practical**

#### **1. Identify the tools and equipment for testing and Maintenance of electrical works**

- 1.1 List the hand tools used in electrical testing
- 1.2 Mention the name of electrical maintenance equipment
- 1.3 Draw and write down the operation of electrical maintenance equipment
- 1.4 Perform the operation of each electrical maintenance equipment

#### **2. Perform the different test of Battery**

- 2.1 Mention the name of the probable test of storage Battery
- 2.2 Draw the circuit diagram
- 2.3 Collect tools and equipment
- 2.4 Measure the emf of each cell of storage Battery
- 2.5 Measure the specific gravity of the electrolyte of storage battery
- 2.6 Record the reading of test data.

#### **3. Measure emf generation of DC Generator**

- 3.1 Collect the tools and equipment for measuring emf
- 3.2 Draw circuit diagram and connect for measuring emf
- 3.3 Measure the emf of a dc generator
- 3.4 Mention the reasons of failure of emf generation

#### **4. Detect the causes of failure of running DC motors**

- 4.1 Mention the different tests for finding the faults of DC Motor
- 4.2 Identify the mechanical faults of DC motor
- 4.3 Find the electrical faults of DC Motor
- 4.4 Draw circuit diagram and connect for continuity test
- 4.5 Perform the continuity test of the DC motor
- 4.6 Perform the short circuit test of DC Motor

#### **5. Perform different routine test of a Three Phase Distribution Transformer**

- 5.1 List the causes of overheating of a Transformer
- 5.2 List the name of different test of a Transformer
- 5.3 Draw circuit diagram and connect for continuity test of transformer
- 5.3 Perform Winding Resistance & continuity test of a Transformer
- 5.4 Perform Vector Group test of a Transformer
- 5.5 Perform the Insulation resistance test o a Transformer
- 5.6 Record the test data and result

## **6. Point out the faults of an Induction motors**

- 6.1 Detect the faults of an Induction Motor
- 6.2 Mention the mechanical faults of an Induction Motor
- 6.3 Mention the Electrical faults of an Induction Motor
- 6.4 Collect the tools and equipment for testing an Induction Motor
- 6.5 Perform continuity test by using Megger, Avometer and Test lamp of an Induction motor
- 6.6 Perform insulation resistance between two coils and between phase and earth test of an Induction motor

## **7. Determine causes of failure of emf generation of an Alternators**

- 7.1 Collect the tools and equipment for measuring emf
- 7.2 Draw circuit diagram and connect for measuring emf
- 7.3 Measure the emf of an Alternator
- 7.4 Mention the reasons of failure of emf generation of an Alternators
- 7.5 Mention the mechanical faults of an Alternator
- 7.6 Mention the Electrical faults of an Alternator

## **8. Detect the troubles and remedy the troubles Synchronous motor**

- 8.1 Detect the faults of an Synchronous Motor
- 8.2 Mention the mechanical faults of an Synchronous Motor
- 8.3 Mention the Electrical faults of an Synchronous Motor
- 8.4 Collect the tools and equipment for testing an Induction Motor
- 8.5 Perform continuity test by using Megger, Avometer and Test lamp of an Synchronous motor
- 8.6 Perform insulation resistance between two coils and between phase and earth test of an Synchronous motor

## **9. Determine the common faults of High Voltage Circuit Breaker**

- 9.1 Mention the name of different test of a HV Circuit Breaker
- 9.2 Collect the tools and equipment for testing the HV Circuit Breaker
- 9.3 Draw circuit diagram and connect for insulation resistance test for HVCB
- 9.4 Perform the Insulation resistance test by using megger
- 9.5 Record the data and result of the Insulation resistance test

## **10. Perform the testing of HV circuit breaker**

- 10.1 Mention the name of different faults of a HV Circuit Breaker
- 10.2 Collect the tools and equipment for testing the HV Circuit Breaker
- 10.3 Draw circuit diagram and connect for insulation resistance test for HVCB
- 10.4 Perform the Contact resistance test with micro-ohm tester.
- 10.5 Record the data and result of the Insulation resistance test

## **Reference Books**

1. Basic Practical knowledge- M. M. Khoibar Ali
2. AC and DC Motor winding practical - K. B. Bhatia
3. Electrical Equipment: Testing and Maintenance thesis - A.S.Gill
4. Testing Commissioning Operation & Maintenance of Electrical Equipment - S. Rao
5. Installation Maintenance and Repair of Electrical Machines and Equipment - Madhavi Gupta

**OBJECTIVES**

Upon completion of these content student will be able to achieve and acquire knowledge, skills and attitude in the area of instrumentation and process control with special emphasis on:

- Transducer
- Signal conditioning
- Recorders.
- Measuring techniques of special quantities
- Data acquisition
- Control theory
- Servo control

**SHORT DESCRIPTION**

Transducers; Passive transducer; Self generating type transducer; Measuring technique by transducer; Signal conditioning; Recorders; Measuring techniques of special quantities; Data acquisition; Control theory; Servo control;

**DETAIL DESCRIPTION****Theory:****1. Understand the basic features of transducers.**

- 1.1 Define transducer and sensor.
- 1.2 Mention different types of transducer and sensor.
- 1.3 Describe difference between transducers and sensors
- 1.4 Describe the parameters of electrical transducer.
- 1.5 Describe the factors to be considered in selecting a transducer.
- 1.6 Describe mechanical devices as primary detector.
- 1.7 Mention the different electrical phenomena employed in transducers.

**2 Understand the features of passive transducers.**

- 2.1 Describe the operation of different types of resistive transducers.
- 2.2 Explain the basic principle of strain gauges
- 2.3 Describe the working principle of resistance thermometer.
- 2.4 Describe the construction of different types of thermistor.
- 2.5 Describe the working principle of inductive transducer.
- 2.6 Describe the construction and working principle of linear variable differential transformer (LVDT)
- 2.7 Describe the displacement measurement by using LVDT.
- 2.8 Describe the construction and working principle of Rotary variable differential transformer (RVDT)
- 2.9 Describe the working principle of pressure inductive transducer.
- 2.10 Describe the working principle of pressure capacitive transducer.

**3 Understand the features of self-generating type transducers.**

- 3.1 Describe the working principle of Piezoelectric transducers

- 3.2 Explain the basic principle of photo emissive, photoconductive and photo voltaic cell.
- 3.3 Define seebeck effect.
- 3.4 Describe the construction of thermocouples and thermopile.
- 3.5 Explain the working principle of thermocouple and thermopile.
- 3.6 Describe the concept of digital encoding transducer
- 3.7. Describe the principle and operation of optical displacement transducer.
- 3.8 Describe the principle and operation of photo optic transducer.

**4 Understand the measuring technique by using transducers.**

- 4.1 Describe the weight measuring technique by load cell (pressure cell).
- 4.2 Explain the basic principle of resistance temperature detector (RTD).
- 4.3 Explain the basic principle of reluctance pulse pick-up.
- 4.4 Describe the working principle of magnetic flow meter.
- 4.5 Describe the sound intensity measurement technique by capacitor microphone.
- 4.6 Describe the liquid level measurement technique by dielectric gauge.
- 4.7 Describe the torque measurement technique by magnetostriction gauge.
- 4.8 Explain synchro system.
- 4.9 Describe the angular displacement measurement technique by synchro system.

**5 Understand the concept of signal conditioning.**

- 5.1 Describe signal conditioning system with block diagram.
- 5.2 Explain the basic principles of DC and AC signal conditioning system.
- 5.3 Explain the basic principle of data conversion system.
- 5.4 Describe the operation of an instrumentation amplifier.
- 5.5 Describe the basic principle of instrumentation system.
- 5.6 Describe use of operational amplifier with capacitive displacement transducer.
- 5.7 Describe radio telemetry with block diagram.

**6 Understand the features of recorders.**

- 6.1 State the necessity of recorder in instrumentation system.
- 6.2 State different types of recorders.
- 6.3 Describe the principle of operation of strip chart recorder.
- 6.4 Describe the principle of operation of X-Y recorder (galvanometer and null type).
- 6.5 Describe the principle of operation of magnetic recorder.
- 6.6 Describe the principle of operation of digital recorder.
- 6.7 Describe the operation of frequency modulation recording.
- 6.8 Explain the method of recording temperature and sound by strip chart recorder.

**7 Understand the measuring techniques of special quantities.**

- 7.1 Describe the method of Temperature, compensation and cancellation Techniques.
- 7.2 Describe the method of measurement of pressure using electrical transducer
- 7.3 Describe the method of measurement of torque by using different method such as by inductive transducer, digital method.
- 7.4 Describe the method of measurement of temperature by using thermometer, thermocouple.
- 7.5 Describe the method of measurement of flow by electromagnetic flow meter.
- 7.6 Describe the method of measurement of humidity by humidity hygrometers

**8 Understand the concept of data acquisition.**

- 8.1 Define data acquisition.
- 8.2 Describe the component of analog and digital data acquisition system.
- 8.3 Describe the principle single channel and multi channel data acquisition system.
- 8.4 Describe the basic principle of operation of data logger.
- 8.5 Describe the method of data transmission.
- 8.6 Describe the digital recording and use of recorder in digital system.

## **9 Understand the concept of control theory.**

- 9.1 Mention the types of control systems.
- 9.2 Define open loop & closed loop control system.
- 9.3 State the meaning of transfer lag.
- 9.4 Describe two-step & three step control systems.
- 9.5 Describe proportional, derivative and integral control.
- 9.6 Explain compound control system such as PI, PD, DI & PID control.
- 9.7 Mention the advantages & disadvantages of proportional, derivative and integral control system.

## **10 Understand the concept of servo control.**

- 10.1 Describe the construction of DC servo, AC servo, stepper motor, electrical modulator, hydraulic servomotor and hydraulic modulator.
- 10.2 Describe the principle of operation of DC servo & AC servo stepper motor, electrical modulator, hydraulic servomotor and hydraulic modulator.
- 10.3 Describe the basic concepts of DC position control with servo system.
- 10.4 Describe the idea of AC position control with synchro sensing element.
- 10.5 Describe the speed control system for sheet metal processing unit.
- 10.6 Describe Online and Offline computer control system with block diagram.

## **Practical :**

### **1. Measure the displacement by linear variable resistance transducer.**

- 1.1 Select a potentiometer and required tools & materials.
- 1.2 Couple the object with sliding contact to the potentiometer.
- 1.3 Build up the circuit for measurement of displacement.
- 1.4 Switch on the power supply.
- 1.5 Measure input and output voltage of the potentiometer.
- 1.6 Measure the displacement or force using appropriate formula.

### **2. Measure the temperature by resistance thermometer.**

- 2.1 Select a resistance thermometer (such as platinum resistance thermometer) and a heat source with mounting facility and required tools & materials.
- 2.2 Measure the thermometer resistance at room temperature.
- 2.3 Record the temperature of heat source.
- 2.4 Make the temperature of the source steady.
- 2.5 Measure the resistance of the thermometer.
- 2.6 Calculate the temperature using appropriate formula.

**3. Determine the temperature coefficient of thermistor.**

- 3.1 Select a thermistor and required tools & equipment.
- 3.2 Connect the thermistor with measuring equipment.
- 3.3 Provide a temperature regulated heat source for the thermistor.
- 3.4 Rise temperature in step and measure the corresponding resistance of the thermistor.
- 3.5 Plot the data for temperature verses resistance characteristics.
- 3.6 Observe the graph.

**4. Measure the thickness of a material by capacitive transducer.**

- 4.1 Select an appropriate capacitive transducer with required tools and materials.
- 4.2 Set up the materials to measure the thickness between the plates of the capacitor.
- 4.3 Connect the meter and source as required.
- 4.4 Switch on the power supply.
- 4.5 Measure the capacitance between two plates.
- 4.6 Calculate the thickness using appropriate data and formula.

**5. Measure the displacement by linear variable differential transformer (LVDT).**

- 5.1 Select an iron core, wire and required tools & equipment.
- 5.2 Construct a LVDT with an iron core and coil with one primary and secondary keeping iron movable.
- 5.3 Connect the primary with AC source.
- 5.4 Connect the two secondary with the oscilloscope.
- 5.5 Move the iron core from left to right.
- 5.6 Observe the wave shapes.
- 5.7 Observe the null position.
- 5.8 Measure the voltage increasing or decreasing with core movement or displacement.

**6. Measure the temperature by thermocouple.**

- 6.1 Select a thermocouple (such as iron-constant) and required tools & materials.
- 6.2 Connect one end of the thermocouple to a voltmeter with proper arrangement.
- 6.3 Apply heat on the other end of the thermocouple in the fire.
- 6.4 Observe the reading of the meter.
- 6.5 Calibrate the meter for temperature.
- 6.6 Measure the temperature.

**7. Measure the strain by strain gauge.**

- 7.1 Select a strain gauge bridge and required tools & materials.
- 7.2 Attach the strain gauge at the point where strain or torque is to be measured.
- 7.3 Apply strain.
- 7.4 Read the change in the resistance due to strain.
- 7.5 Calculate the value of strain or torque using appropriate formula.

**8. Measure the light intensity by photocell.**

- 8.1 Select a photoelectric device, light source and required tools & materials.
- 8.2 Construct the circuit with photoelectric device.

- 8.3 Separate the light source from the photoelectric device with a window having small aperture which is controlled by force summing member of the pressure transducer.
- 8.4 Open the aperture for the photoelectric device.
- 8.5 Measure the change in output.
- 8.6 Measure the light intensity.

**9. Measure the vibration by piezoelectric transducer.**

- 9.1 Select a Piezoelectric crystal and necessary tools & materials.
- 9.2 Construct the circuit for piezoelectric pickup.
- 9.3 Set up the object whose displacement or pressure is to be measured to the appropriate crystal plane.
- 9.4 Energize the circuit and measure the voltage and hence measure the displacement or pressure.

**10. Study the operation of magnetic tape recorder.**

- 10.1 Select a magnetic tape recorder.
- 10.2 Observe the tape transport mechanism.
- 10.3 Identify the electronic components of magnetic tape recorder.
- 10.4 Observe the recording and playback operation.

**11. Study the operation of PID control system.**

- 11.1 Select required tools & materials.
- 11.2 Construct the circuit as per diagram.
- 11.3 Adjust all the controls properly.
- 11.4 Observe the operation of PID control system.

**12. Study the operation of closed loop speed control with DC servo system.**

- 12.1 Select required equipment, tools & materials.
- 12.2 Construct the circuit as per diagram.
- 12.3 Change the input signal.
- 12.4 Observe mechanism of control.

**Reference Books:**

- 1. Mechanical and Industrial Measurement  
-R. K. Jain
- 2. Control Engineering  
-Nole M. Morris
- 3. Feedback Control System Analysis & Synthesis  
-J.J.D Azzo
- 4. Industrial Electronics  
-G. K. Mithal
- 5. Electrical and Electronic Measurement and Instrumentation  
-A.K. Sawhney
- 6. Elements of Electronic Instrumentation and Measurement  
-Joseph J. Carr
- 7. Electronic Instrumentation -HS Kalsi
- 8. Control system Engineering -Nagrath and Gopal



**AIMS**

- To be able to understand the concept of entrepreneurship & entrepreneur.
- To be able to understand the concept of environment for entrepreneurship.
- To be able to understand the sources of venture ideas in Bangladesh.
- To be able to understand the project selection.
- To be able to understand business planning.
- To be able to understand the insurance and premium.
- To be able to understand the MDG & SDG.

**SHORT DESCRIPTION**

Concepts of entrepreneurship & entrepreneur; Entrepreneurship & economic development; Environment for entrepreneurship; Entrepreneurship in the theories of economic growth; Sources of ventures ideas in Bangladesh; Evaluation of venture ideas; Financial planning; Project selection; Self employment; Entrepreneurial motivation; Business plan; Sources of assistance & industrial sanctioning procedure; Concept of SDG; SDG 4,8 .

**DETAIL DESCRIPTION**Theory :**1. Understand the basic concept of entrepreneurship & entrepreneur.**

- 1.1 Define entrepreneurship & entrepreneur.
- 1.2 Discuss the characteristics and qualities of an entrepreneur.
- 1.3 Mention the classification of entrepreneur.
- 1.4 Discuss the necessity of entrepreneurship as a career.
- 1.5 Discuss the prospect of entrepreneurship development in Bangladesh.

**2. Understand the concept of entrepreneurship and economic development.**

- 2.1 Define economic development.
- 2.2 Discuss the economic development process.
- 2.3 Discuss the capital accumulation or rate of savings.
- 2.4 Discuss the role of entrepreneur in the technological development and their introduction into production Process.
- 2.5 Discuss the entrepreneur in the discovery of new product.
- 2.6 Discuss the discovery of new markets.

**3. Environment for entrepreneurship development:**

- 3.1 Define the micro environment.
- 3.2 Discuss individual income, savings and consumption.
- 3.3 Define macro environment.
- 3.4 Discuss political, socio-cultural, economical, legal and technological environment.
- 3.5 Difference between micro and macro environment .

**4. Understand the concept of entrepreneurship in the theories of economic growth.**

- 4.1 Define entrepreneurship in the theories of economic growth.
- 4.2 Discuss the Malthusian theory of population and economic growth.
- 4.3 Discuss the stage theory of growth.
- 4.4 Discuss the Schumpeterian theory of economic development.
- 4.5 Discuss the entrepreneurship motive in economic development.

## **5. Understand the sources and evaluation of venture ideas in Bangladesh.**

- 5.1 Define sources of venture ideas in Bangladesh.
- 5.2 Discuss different types of sources of venture ideas in Bangladesh.
- 5.3 Define evaluation of venture ideas.
- 5.4 Discuss the factors that influence the selection of venture idea.

## **6. Understand the concept of project selection and financial planning.**

- 6.1 Define project.
- 6.2 Discuss the idea of project.
- 6.3 Describe the guide lines for project ideas.
- 6.4 Discuss the sources of project ideas.
- 6.5 Discuss the evaluation of project ideas.
- 6.6 Describe the technical aspect of project.
- 6.7 Define financial planning.
- 6.8 Discuss the long term financial plan.
- 6.9 Discuss the short term financial plan.

## **7. Understand the concept of self employment.**

- 7.1 Define self employment.
- 7.2 Describe different types of employment.
- 7.3 Describe the importance of business as a profession.
- 7.4 Discuss the reasons for success and failure in business.

## **8. Understand the business plan and the concept of the environment for entrepreneurship.**

- 8.1 Define business plan.
- 8.2 Describe the importance of business plan.
- 8.3 Discuss the contents of business plan.
- 8.4 Define environment of business.
- 8.5 Describe the factors which effect environment on entrepreneurship

## **9. Understand the concept of sources of assistance & industrial sanctioning procedure.**

- 9.1 Define sources of assistance.
- 9.2 Describe different types of sources of assistance.
- 9.3 Discuss the aid of sources.
- 9.4 Discuss the industrial policy.
- 9.5 Define foreign aid.

## **10. Understand the insurance and premium.**

- 10.1 Define insurance and premium
- 10.2 Describe the essential conditions of insurance contract.
- 10.3 Discuss various types of insurance.
- 10.4 Distinguish between life insurance and general insurance.

## **11. Understand the concept of Sustainable Development Goals (SDG)**

- 11.1 Define Sustainable development
- 11.2 State UN targets of MDG
- 11.3 State UN targets of SDG
- 11.4 Describe the importance of SDG
- 11.5 Explain the objectives of SDG
- 11.6 State the Challenges to achieve SDGs
- 11.7 Explain the actions to face the challenges of SDGs
- 11.8 State the of 7<sup>th</sup> 5 years plan
- 11.9 Mention the link of 7<sup>th</sup> 5 years plan with SDGs
- 11.10 Write down the 5 ps of sustainable development goals

## **12. Understand SDG 4,8 and 17**

- 12.1 Describe SDG 4 and its targets
- 12.2 State the elements of Quality education for TVET
- 12.3 Describe the gender equality and equal access of TVET for economic growth
- 12.4 Describe SDG 8 and its targets
- 12.5 Explain Green development, Green Economy, Green TVET & Green Jobs
- 12.6 Explain the role an entrepreneur for achieving SDG

## **Reference book :**

1. A hand book of new entrepreneur-by p.c jain.
- 2.A manual on business opportunity Identification and selection-by j.B patel and S S modi.
- 3.Uddokta unnoyan Nirdeshika -Md.Sabur khan.
- 4.Entrepreneurship- bashu and mollik.
- 5.Business Entrepreneurship-kage faruke.
6. Website, Youtube and Google