

**COURSE TITLE** : ELECTRICAL POWER UTILIZATION & SYSTEM PROTECTION  
**COURSE CODE** : 6031  
**COURSE CATEGORY** : A  
**PERIODS/WEEK** : 5  
**PERIODS/SEMESTER** : 75  
**CREDITS** : 5

**TIME SCHEDULE**

MODULE	TOPICS	PERIODS
1	Fuse and Circuit Breakers	18
2	Protective Relays and Protection	19
3	Lighting, Heating, Welding and Electrolysis	19
4	Electric Traction	19
<b>Total</b>		<b>75</b>

Course Outcome:

Sl.	Sub	On completion of this course the student will be able:
1	1	To comprehend the various type of fuses and their performance.
	2	To understand the various types of circuit breakers.
2	1	To comprehend various types of protective relays.
	2	To understand the protection schemes in power system.
3	1	To comprehend the electrical heating, welding process and the equipment.
	2	To understand the electrolysis process.
	3	To understand the lighting applications of electricity.
4	1	To comprehend the electric drives.
	2	To understand the Electric traction.

Specific Outcome:

### **MODULE I Fuse and Circuit Breakers**

- 1.1.1 To define fuse.
- 1.1.2 To define important terms for the analysis of fuses.
- 1.1.3 To describe the factors effecting current carrying capacity of fuse elements.
- 1.1.4 To describe inverse current characteristics of fuse.
- 1.1.5 To state advantages and disadvantages.
- 1.1.6 To explain the classifications of fuses.
- 1.1.7 To explain the constructions of HRC.
- 1.1.8 To describe the working of HRC fuses.
- 1.1.9 To describe the selection of HRC fuses.
- 1.1.10 To state the advantages and disadvantages of fuse.
  
- 1.2.1 To define circuit breaker (CB).
- 1.2.2 To explain the arc phenomena and arc extinction.
- 1.2.3 To describe the terms associated with circuit breaking.
- 1.2.4 To describe the Classification of CB.
- 1.2.5 To describe the working principle of oil CB.
- 1.2.6 To explain the Air blast CB.
- 1.2.7 To explain the principle and operation of SF6 CB
- 1.2.8 To explain the principle and operation of vacuum CB
- 1.2.9 To define CB ratings.
- 1.2.10 To explain the difference between fuse and CB

### **MODULE –II Protective Relays and Protection**

- 2.1.1 To define protective relays.
- 2.1.2 To State the basic requirements of protective relaying.
- 2.1.3 To describe the typical time current characteristics.
- 2.1.4 To explain the principles involved in obtaining Inverse time characteristics of relays.
- 2.1.5 To explain the principles involved in Inverse definite minimum time lag.
- 2.1.6 To explain the principle involved in different time settings.
- 2.1.7 To classify the relay based on construction.
- 2.1.8 To explain the relay based on principles of operation.
- 2.1.9 To explain the relay based on time of operation.
- 2.1.10 To explain the principles of operation & applications of the attracted armature type relays and solenoid plunger type relays.
- 2.1.11 To describe the construction and principle of operation of an induction type over current relay.
- 2.1.12 To explain the working of directional over current relay
- 2.1.13 To explain the construction and operation of distance relay.

- 2.2.1 To explain the primary and back up protection.
- 2.2.2 To explain the differential protection of alternators.
- 2.2.3 To explain the earth leakage protection of alternators.
- 2.2.4 To explain the Merz - Prize protection of 3 phase transformers.
- 2.2.5 To describe the working of Buchholz relay.
- 2.2.6 To describe the Protection of bus bars.
- 2.2.7 To explain the various protections of transmission lines.
- 2.2.8 To explain the apparatus used in power stations and sub stations.
- 2.2.9 To explain the protection by ground wires.
- 2.2.10 To describe different protection methods used against lightning.
- 2.2.11 To explain operation of the Lightning arrester.
- 2.2.12 To describe thyrite types lightning arresters.
- 2.2.13 To State the soil resistivity.
- 2.2.14 To explain how the soil resistivity is measured.
- 2.2.15 To explain different methods of neutral earthing

### **MODULE III Lighting, Heating, Welding and Electrolysis**

- 3.1.1 To state modes of heat transfer
- 3.1.2 To list the advantages of electric heating
- 3.1.3 To list the requirements of good heating material
- 3.1.4 To explain with sketches
  - i. Direct resistance heating
  - ii. Indirect resistance heating
- 3.1.5 To state the Industrial application of the direct & indirect resistance heating.
- 3.1.6 To explain direct arc furnace & indirect arc furnace with diagram.
- 3.1.7 To explain the principle of operations of low and high frequency induction furnaces.
- 3.1.8 To explain the principle of operations of core type and core less type induction furnaces.
- 3.1.9 To explain the principle of dielectric heating.
- 3.1.10 To list the industrial applications of the dielectric heating.
- 3.1.11 To state different types of Electric welding.
- 3.1.12 To explain the principles and applications of a) Spot b) Seam c) butt welding.
- 3.1.13 To explain the characteristics of a welding generator.
- 3.1.14 To explain with sketch the principle of operation of welding transformer used with a reactance coil.
  
- 3.2.1 To describe the process of electrolysis.
- 3.2.2 To state the Faraday's laws of electrolysis.
- 3.2.3 To explain the field of applications of electrolysis.
- 3.2.4 To understand the lighting applications of electricity.
- 3.2.5 To explain the main lighting loads.

- 3.2.6 To describe the main objects of street lighting.
- 3.2.7 To explain the various flood lighting schemes.
- 3.2.8 To compute simple problems.

#### **MODULE IV Electric Traction**

- 4.1.1 To state the advantage of Electric drives.
- 4.1.2 To list the factors governing the selection of motors.
- 4.1.3 To classify the electric drives.
- 4.1.4 To state the advantages and disadvantages of group drive.
- 4.1.5 To state the advantages and disadvantages of individual drive.
  
- 4.2.1 To explain different systems of traction.
- 4.2.2 To state the advantages of electric traction.
- 4.2.3 To state the importance of the speed time curves.
- 4.2.4 To state each stage of the speed time curve.
- 4.2.5 To sketch the simplified speed time curve and derive the relation.
- 4.2.6 To explain the Practical importance of the above curves.
- 4.2.7 To solve the simple problems using speed time curves.
- 4.2.8 To explain the meaning of traction effort.
- 4.2.9 To explain the term specific energy consumption.
- 4.2.10 To derive the formula for energy output of drive axles in accelerations;
  - i. To overcome friction.
  - ii. To overcome gradient.
- 4.2.11 To list the factors affecting specific energy consumption.
- 4.2.12 To state the important requirements of traction motor.
- 4.2.13 To explain the suitability of motors for electric traction DC series motor or series motor.
- 4.2.14 To state the advantages of electric braking.
- 4.2.15 To explain the methods of electric braking;
  - i. Plugging.
  - ii. Regenerative.
  - iii. Rheostatic.
- 4.2.16 To state the method of regenerative braking of DC shunt motor, DC series motor and 3-phase induction motor.
- 4.2.17 To explain the method of Rheostatic braking on DC shunt motor and series motor

### **CONTENTS**

#### **MODULE – I**

Definition of fuse- important terms- current rating of fuse elements- fusing current- fusing factor- prospective current –cut off current- pre arcing time-arcng time- total operating time- breaking

capacity- current carrying capacity factors. Inverse current characteristics- advantages and disadvantages of fuse – types of fuses- low voltage fuses- high voltage fuses - HRC fuse- construction-working- selection for various applications-advantages and disadvantages. Circuit breakers definition- arc phenomenon-arc extinction- methods of arc extinction - high resistance method- low resistance method - Important terms – arc voltage - restriking voltage - recovery voltage—RRRV-current chopping. Classification of CB – OCB – ABCB (axial blast and cross blast) - SF6 – VCB – working and applications. CB rating – breaking capacity - making capacity - short time rating - difference between fuse and C B.

## **MODULE- II**

Bus-bar protection- differential protection- fault bus protection - protection of lines- time graded over current protection- differential protection-distance protection. Protection against over voltage - voltage surge- causes of over voltages (internal or external causes). Lightning – protection against lightning- lightning arresters - rod gap arresters - horn gap arresters - surge absorber- neutral grounding- equipment grounding- advantages of neutral grounding- methods of neutral grounding- solid grounding - resistance grounding- reactance grounding- voltage transformer earthing.

## **MODULE- III**

Modes of heat transfer- conduction- convection – radiation – examples- advantages of electric heating- requirement of good heating element- different types of electrical heating (direct resistance or indirect resistance). Applications of induction furnace- (low and high frequency- application of core and coreless – dielectric heating- application of dielectric welding –application and working - spot- seam - butt – electrical characteristics of welding generator- electrolysis- low and application - Lighting loads - street light - flood lights - problems.

## **MODULE- IV**

Electric drive definitions- components of electric drive- block diagram- advantages- selection of drive- - factors governing the selection of motor- nature of drive- group drive- industrial drive- applications- advantages and disadvantages. Traction definition- different types of traction- electric supply for traction- speed time curve- importance of speed time curve- comparison- main line service- urban- sub urban service- different terms- average speed- scheduled speed- crest speed- simplification of speed time curve - simple problems - traction effort- specific energy consumption - derivation- energy output at drive axles- friction and gradient.

## **REFERENCE:**

1. J B Gupta. A course in Power systems: S K Kataria & sons.
2. Suryanarayanan N V. Utilization of electric power: new age international publishers ltd.
3. V K Metha. Power system protection: Khanna Publishers