

**COURSE NAME : ELECTRICAL ENGINEERING GROUP**  
**COURSE CODE : EE/EP**  
**SEMESTER : FIFTH**  
**SUBJECT TITLE : SWITCHGEAR and PROTECTION**  
**SUBJECT CODE :**

**Teaching and Examination Scheme:**

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS.	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	25 @	125

# - External

@ - Internal

\* On Line Examination

**NOTE:**

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 100 and to be entered in mark sheet under the head Sessional Work. (SW)**

**Rationale:**

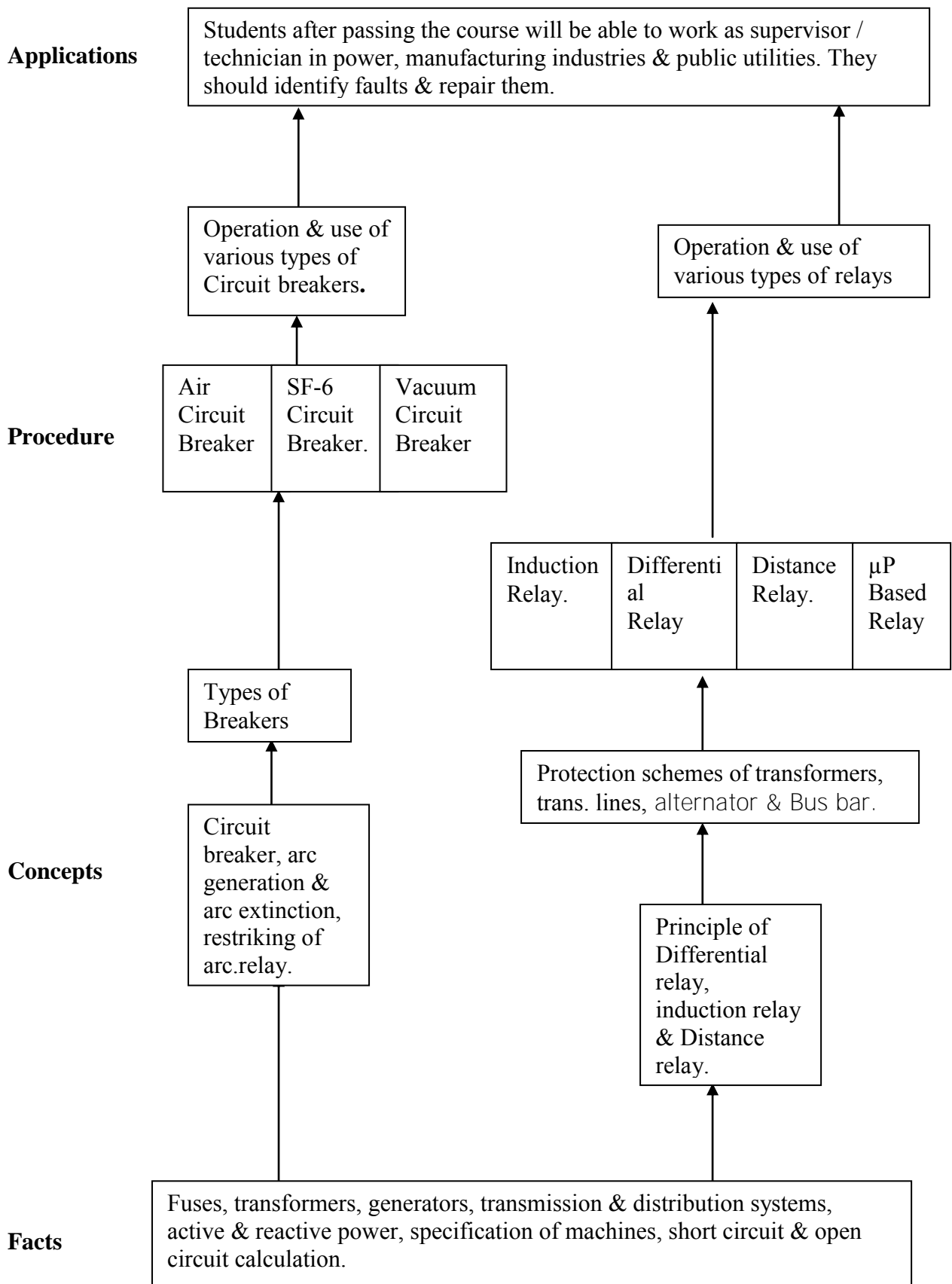
In spite of all care and precautions taken in the design, installation and operation of Power system and power equipments, abnormal conditions and faults do occur in the system. Some fault such as short circuits can prove highly damaging, not only to the components but also to the entire power system. However continuity of power supply is the need of the hour. So study of switchgear and protection is needed. It is expected that the knowledge of facts, concepts, principles and procedural aspects of switchgear and protection system must be known by students which ultimately help them to maintain the reliability of electric supply in discharging their duties as a supervisor or a technician in substation, manufacturing industries and public service utilities.

**General Objectives:**

The students will be able to

1. Understand the principles, concepts & procedural aspects of switchgear & protection
2. Identify various components of switchgear & protection system & their locations
3. Know the specification and to select a switchgear for a particular application
4. Identify various faults in power system & measures to minimize it
5. Know the basic concepts of protection scheme and to select appropriate protection scheme for a particular application.
6. Know the need of insulation co-ordination

**Learning Structure:**



**Theory:**

Topic and Contents	Hours	Marks
<p><b>Topic 1: Fundamental</b>  <b>Specific Objectives:</b></p> <ul style="list-style-type: none"> <li>➤ State the need and function of protection system</li> <li>➤ Differentiate the normal &amp; abnormal conditions of power system</li> <li>➤ List the types of fault &amp; their causes</li> <li>➤ Calculate short circuit current , short circuit kVA</li> </ul> <p><b>Contents:</b></p> <ul style="list-style-type: none"> <li>• Switchgear equipments- Symbols and functions</li> <li>• Functions of protective system.</li> <li>• Normal &amp; abnormal conditions.</li> <li>• Types of faults &amp; their causes.</li> <li>• Short circuit calculations( Symmetrical faults only)</li> <li>• Use of current limiting reactors &amp; their arrangements.</li> </ul>	04	10
<p><b>Topics 2: Circuit Interrupting Devices</b></p> <p><b>Specific Objectives:</b></p> <ul style="list-style-type: none"> <li>➤ List various methods of arc extinction</li> <li>➤ Select circuit breaker as per application</li> </ul> <p><b>Contents:</b></p> <ul style="list-style-type: none"> <li>• Construction, characteristics of HRC Fuse</li> <li>• Isolators- Vertical break, Horizontal break &amp; Pantograph type</li> <li>• Arc formation process, methods of arc extinction – High resistance method, Low resistance or current zero method <ul style="list-style-type: none"> <li>• Definition: Arc voltage, Recovery voltage, Restriking voltage, RRRV</li> </ul> </li> <li>➤ Circuit breakers- Concept, Classification, Working principle, Construction, Specification &amp; Applications of: <ul style="list-style-type: none"> <li>• L.T.- Air circuit breakers (ACB), Miniature circuit breakers ( M C B ) , Moulded case circuit breaker ( M C C B ) , Earth leakage circuit breaker (ELCB) , (More focus on LT C.B)</li> <li>• H.T – Air Blast Circuit Breaker, Sulpher Hexa Fluoride circuit breaker (SF<sub>6</sub>), Vacuum circuit breaker.</li> <li>• Comparison of fuse &amp; MCCB</li> <li>• Selection of MCCB for motor.</li> <li>• Selection and rating of circuit breakers</li> </ul> </li> </ul>	08	16
<p><b>Topic 3 – Protective Relaying</b>  <b>Specific Objectives:</b></p> <ul style="list-style-type: none"> <li>➤ List the essential qualities of protective relaying</li> </ul>	09	20

<ul style="list-style-type: none"> <li>➤ Classify various types relays</li> <li>➤ Selection of protective relays as per the system requirement</li> </ul> <p>Contents:-</p> <ul style="list-style-type: none"> <li>• Quality requirements of relay system: selectivity, speed, sensitivity, reliability, simplicity, Economy: meaning of the term and its significance in protective relaying</li> <li>• Basic Relay Terminology- Protective relay, relay time, pick up current, reset current, current setting, plug setting multiplier (PSM) ,Time setting multiplier (TMS)</li> <li>• Numericals on PSM &amp;TMS</li> <li>➤ Classification Electromagnetic relay –</li> <li>• Operation of Attracted armature type, Solenoid type and Balanced beam type relays.</li> <li>• Electro magnetic induction type – Operation of Shaded pole type and Watt hour meter type relays.</li> <li>• Block diagram , Operation, Advantages &amp; disadvantages of Static and <math>\mu</math>P based relays.</li> <li>• CT and PT as Protective transformers. -Safety precautions while using C.T. and P.T. , Circuit Diagram with Relay</li> <li>• Over current relay-Time current characteristics.</li> <li>• Operation of Static over current relay with block diagram</li> <li>• Operation of <math>\mu</math>P based over current relay with block diagram</li> <li>• Distance relaying- Principle, Operation of – Definite distance relay, Time distance relay and MHO relay</li> <li>• Directional relay- The need of directional relay, construction, operation of Induction type directional over current relay</li> <li>• Differential Relay- Operation of Current differential relay &amp; Voltage differential relay.</li> </ul>		
<p>Topic 4 –Protection of Alternator</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ State various faults and Abnormalities of alternator</li> <li>➤ Sketch various protection schemes of alternator</li> <li>➤ State the concept of reverse power protection</li> <li>➤ Calculate the % protection provided</li> </ul> <p>Contents:-</p> <ul style="list-style-type: none"> <li>• Abnormalities &amp; Faults</li> <li>• Circuit diagram with proper current direction of Differential protection, Over current, earth fault, inter -turn fault, negative phase sequence, over heating protection.</li> <li>• Reverse power protections. ( Simple numerical on differential protection )</li> </ul>	06	12
<p>Topic 5 –Protection of transformer</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ Identify various faults &amp; abnormalities of transformer</li> </ul>	08	14

<ul style="list-style-type: none"> <li>➤ State and draw various protection scheme of transformer</li> <li>➤ Importance of Buchholz Relay</li> <li>➤ Contents :- <ul style="list-style-type: none"> <li>• Abnormalities &amp; faults.</li> <li>• Differential, Biased differential protection</li> <li>• Limitations of differential protection of transformer,</li> <li>• Over current, Earth fault, Inter turn, Restricted earth fault, Over heating protection.</li> <li>• Buchholz relay ( Simple numerical on differential protection )</li> </ul> </li> </ul>		
<p>Topic 6- Protection of Motor Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ State various faults &amp; abnormalities of motor</li> <li>➤ Observe the behavior of single phasing preventer</li> <li>➤ Identify various protection provided for motors</li> </ul> <p>Contents;_</p> <ul style="list-style-type: none"> <li>• Abnormalities &amp; faults.</li> <li>• Short circuit protection, Overload protection, Single phase preventer- (circuit diagram, operation)</li> </ul>	03	06
<p>Topic 7- Protection of Busbar &amp; Transmission line Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ Identify the faults &amp; abnormalities of Transmission lines</li> <li>➤ State the principle of over current protection, distance protection</li> </ul> <p>Contents :-</p> <ul style="list-style-type: none"> <li>• Abnormalities &amp; faults.</li> <li>• Bus Bar Protection – Operation of Differential Protection and Fault bus protection schemes.</li> <li>• Transmission line, over current, distance protection. Pilot wire protection.</li> </ul>	04	10
<p>Topic 8- Neutral Earthing Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ State the need of Neutral earthing</li> <li>➤ Distinguish between equipment earthing and neutral earthing</li> <li>➤ List types of neutral earthing</li> </ul> <p>Contents:-</p> <ul style="list-style-type: none"> <li>• Introduction &amp; importance.</li> <li>• Types of earthing: diagram, procedure</li> <li>• Substation earthing: diagram, procedure</li> <li>• Difference between Equipment earthing and Neutral earthing</li> </ul>	02	04

<p>Topic 9-Over voltage protection Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ State the causes of over voltage</li> <li>➤ List types of lightning arrester</li> <li>➤ State the necessity of insulation co-ordination</li> <li>➤ Identify basic components of lightning arrester</li> </ul> <p>Contents :-</p> <ul style="list-style-type: none"> <li>• Causes of over voltages.</li> <li>• Lightning phenomena, over voltage due to lightning, typical waveform of lightning surge</li> <li>• Protection of transmission line &amp; substation from direct stroke.</li> <li>• Types of lightning arresters – Rod gap, Horn gap, Expulsion and Thyrite type , their construction &amp; principle of operation.</li> <li>• Surge absorber – Definition &amp; working with neat diagram.</li> <li>• Protection against traveling waves.</li> <li>• Necessity of Insulation co-ordination,</li> </ul>	04	08
<b>Total</b>	<b>48</b>	<b>100</b>

**Practical:**

**Skills to be developed:**

**Intellectual Skills:**

1. Identify different types of circuit breakers
2. Identify various faults on the system
3. Calculate the fault levels

**Motor Skills:**

1. Simulate circuit configuration to create various faults
2. Set the relays for various fault levels

**List of Practicals:**

1. To study different switchgear equipments used in Electrical power system and also to collect technical specification of various switchgear equipments through market survey.
2. To demonstrate the operation of MCB/MCCB
3. To perform Current (I) Vs Time (T) characteristics of fuse (Kit kat / HRC)
4. To set and test any one electromagnetic relay with C.T & P.T
5. To plot the characteristic of over current thermal /induction relay

6. To demonstrate the operation of single phasing preventer for protection of 3 phase induction motor
7. To visit a high voltage substation to study & observe the protection scheme of Transformer/ Busbar
8. To demonstrate operation of Buchholz relay
9. To understand the types & specification of lightning arresters through brochures /literature
10. Simulation of protection scheme of 1 - 5 kVA 3 phase transformer

**Learning Resources:**

**1. Books:**

<b>Sr. No.</b>	<b>Author</b>	<b>Title</b>	<b>Publisher</b>
1	S.Rao.	Switch gear & protection	Khanna Publications, New
2	Badriram & Vishwakarma P.N.	Power System Protection & Switchgear	TMH, New Delhi
3	V.K.Mehta	Principles of Power System	S.Chand &Co.
4	Bhavesbhalja, R.P. Maheshwari& N.G. Chothani	Protection &Switchgear	Oxford
5	R.P.Singh	Switchgear and Power System Protection	PHI
6	Mason C.R.	The art & science of protective relaying	-----