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## Seventh Semester B.E. Degree Examination, Feb./Mar.2022 Power System Protection

Time: 3 hrs.

Max. Marks: 100

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

### Module-1

- 1 a. With a neat diagram, explain zones of protection in a power system. (06 Marks)  
b. Discuss the essential qualities of a protective relay. (08 Marks)  
c. Explain various methods of back up protection. (06 Marks)

OR

- 2 a. Define the following terms :  
(i) Relay  
(ii) Operating force  
(iii) Pick up level  
(iv) Reset  
(v) Current setting (10 Marks)  
b. Write a short note on Automatic reclosure. (05 Marks)  
c. Write the advantage and disadvantages of the static relay. (05 Marks)

### Module-2

- 3 a. What is an impedance relay? Explain its operating principle, torque equation and operating characteristics of impedance relay. (08 Marks)  
b. Explain the operating principle of reverse power or directional relay with neat diagram. (06 Marks)  
c. Why IDMT relays are widely used for over current protection? (06 Marks)

OR

- 4 a. Discuss a protection scheme for parallel feeder. (06 Marks)  
b. Distinguish between earth fault relay and an over current relay. (06 Marks)  
c. Write and explain 3 stepped distance protection of transmission line. (08 Marks)

### Module-3

- 5 a. Define the term pilot with reference to power line protection. List the different types of wire pilot protection scheme and explain any one of the scheme. (08 Marks)  
b. Explain balanced (opposed) voltage differential protection. (06 Marks)  
c. The neutral point of a 11 KV an alternator is earthed through a resistance of  $12 \Omega$  the relay is said to operate when there is out of balance of a 0.8 A. The CT's have a ratio of 2000/5. What percentage of the winding is protected against earth fault? What must be the minimum value of earthing resistance required to give 90% of protection to earth phase. (06 Marks)

OR

- 6 a. With a neat sketch explain the working of frame leakage protection used for bus-zone protection. (08 Marks)  
b. With neat diagram, explain construction and operation of Burholz relay. (12 Marks)

**Module-4**

- 7 a. With a neat sketch, explain the recovery rate theory and energy balance theory of arc interruption in a circuit breaker. (10 Marks)
- b. Explain the terms: restriking voltage, recovery voltage and RRRV. Derive expression for restriking voltage and RRRV interms of system voltage, inductance and capacitance. (10 Marks)

**OR**

- 8 a. What are the different types of air blast circuit breaker? Discuss their operating principle and area of application. (08 Marks)
- b. With a neat sketch, explain the direct testing of circuit breaker. (06 Marks)
- c. What are the merits and demerits of SF<sub>6</sub> circuit breaker? (06 Marks)

**Module-5**

- 9 a. Define the following terms:
- (i) Fuse
  - (ii) Fuse element
  - (iii) Rated current
  - (iv) Minimum fusing current
  - (v) Fusing factor. (06 Marks)
- b. Describe the construction and operation of the HRC cartridge fuse with indicator. Write applications of the HRC fuse. (08 Marks)
- c. Write discrimination between fuse and over-current protective devices. (06 Marks)

**OR**

- 10 a. Write note on Klydonograph and magnetic link. (08 Marks)
- b. What is a Gas Insulated Substation? Discuss its advantages and disadvantages as compared to conventional air insulated substation. (08 Marks)
- c. Write short note on Arcing horn with diagram. (04 Marks)

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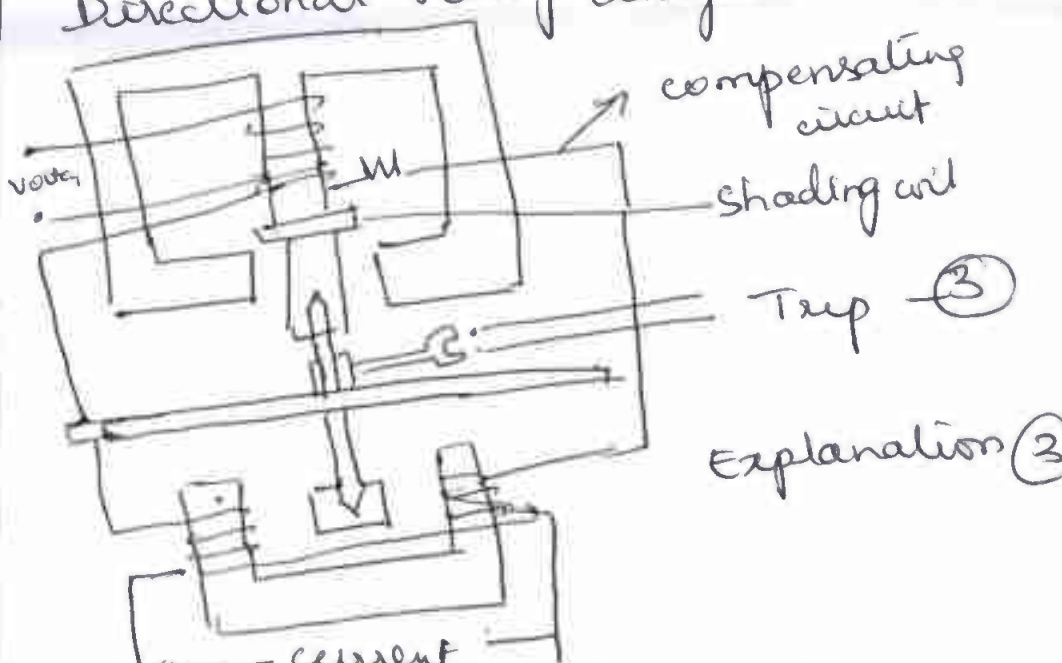
Scheme & Solutions

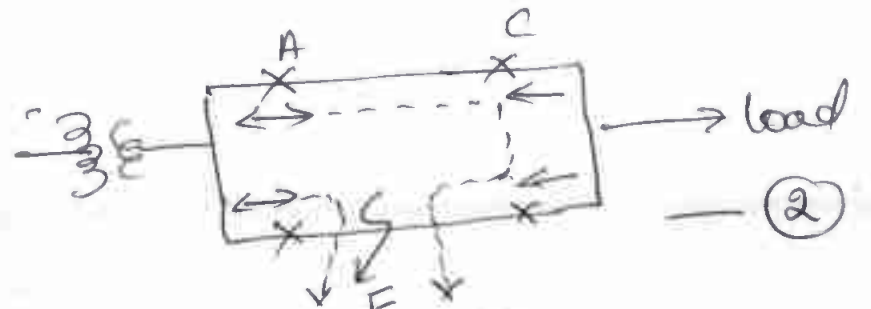
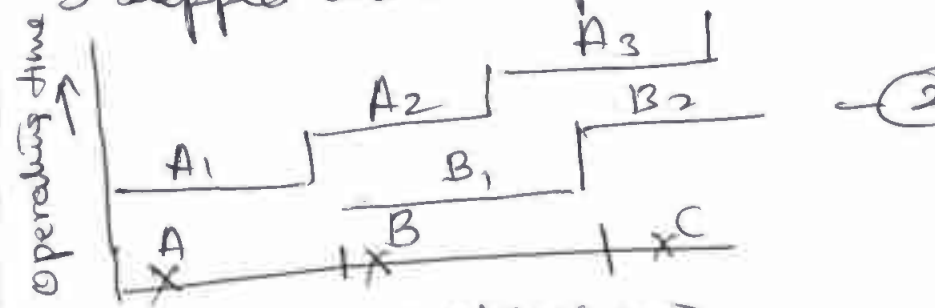
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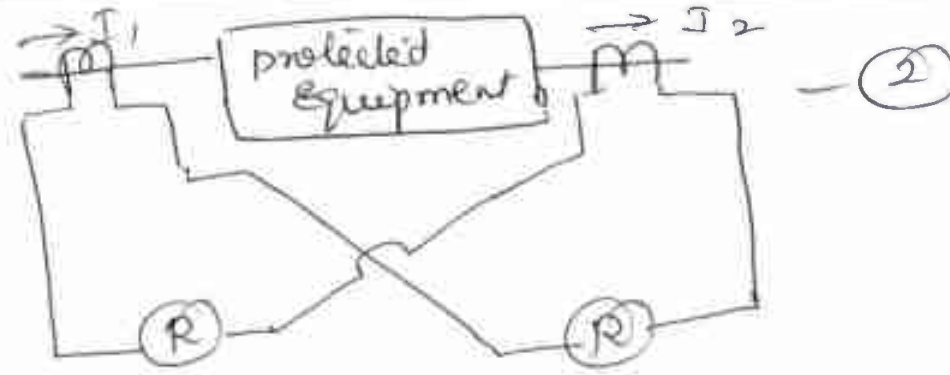
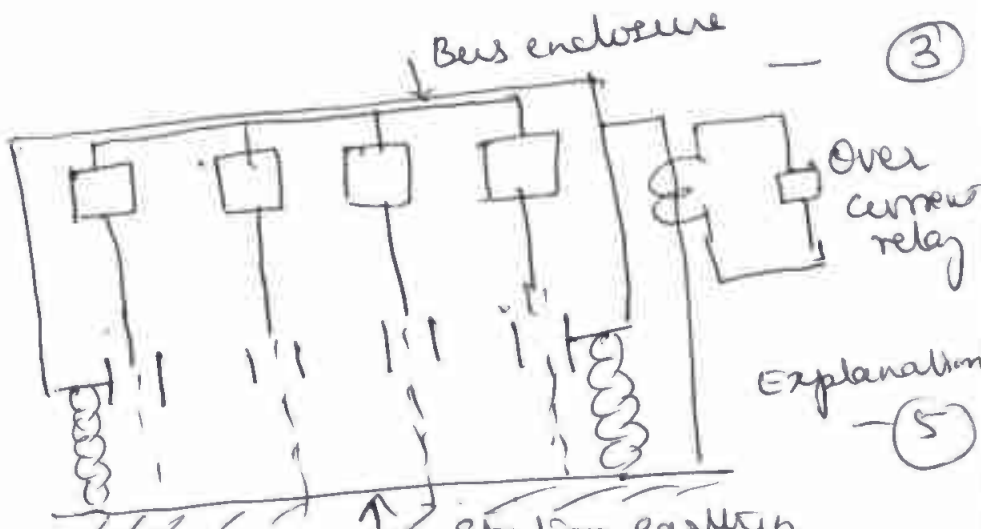
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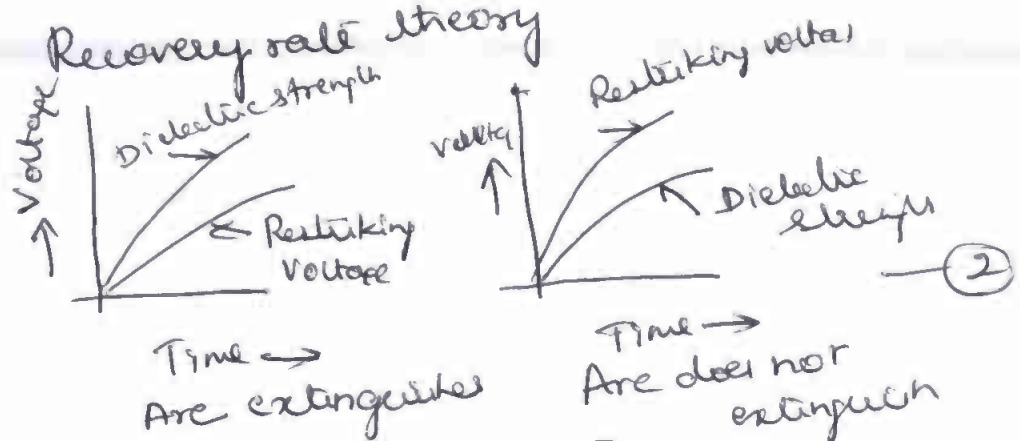
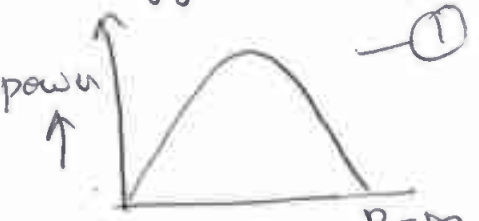
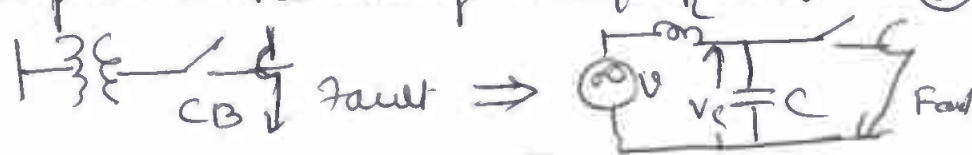
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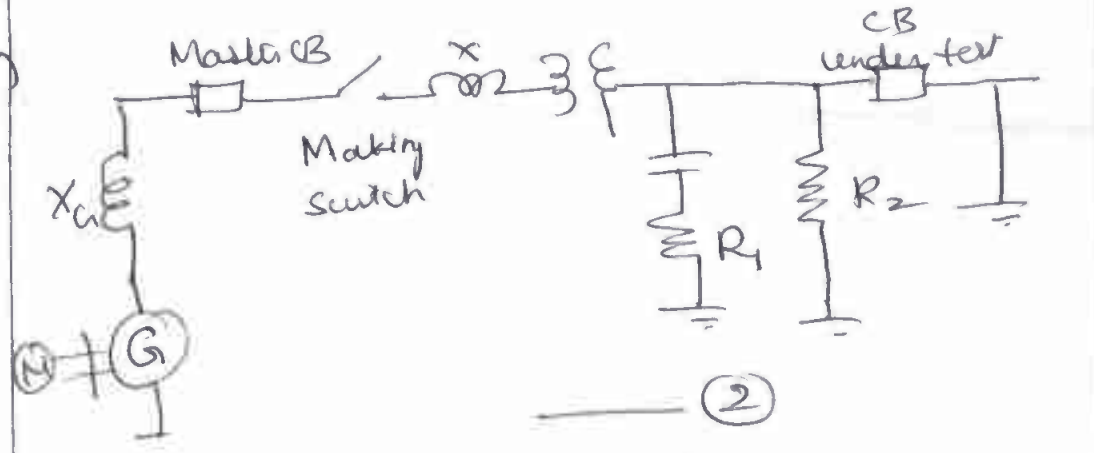
Question Number	Solution	Marks Allocated
1(a)	<p>Generator Protection</p> <p>Circuit breaker</p> <p>HV Switchgear protection</p> <p>Transformer protection</p> <p>Transmission line protection</p> <p>EHV Switchgear protection</p> <p>④</p> <p>Explanation — ②</p>	6M
b)	<p>Speed, fast operation. — ①</p> <p>Selectivity or discrimination — ②</p> <p>Sensitivity — ①</p> <p>Reliability — ①</p> <p>Stability — ①</p> <p>Adequateness — ①</p> <p>Simplicity &amp; economy — ①</p>	8M

Question Number	Solution	Marks Allocated
1(c)	Remote backup — (2) Relay backup — (2) Breaker backup — (2)	6M
2(a)	OR Relay — (2), Operating time — (2) pick up level — (2) Reset — (2) current setting — (2)	10M
(b)	Automatic reclosure definition — (2) working — (3)	5M
(c)	Advantages of static relay — (3) Disadvantages of static relay — (2)	5M
3(a)	Impedance relay definition — (2) operating principle — (2) torque equation — (2) Relay characteristic — (2)	8M
(b)	Directional relay diagram 	6M

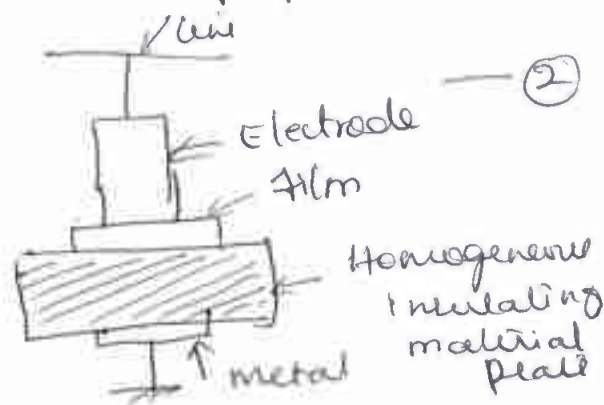

Question Number	Solution	Marks Allocated
3c	combination of current and time grading (IDMT) relays. Explanation.	6M
4(a)	 <p>Explanation — (4)</p>	6M
b)	earth fault relay 3 points — (3) Overcurrent relay 3 points — (3)	6M
c)	3 stepped distance protection  <p>Each step explanation (2) x 3 = (6)</p>	8M
5(a)	pilot explanation — (2) circulating current scheme Balanced voltage scheme Transley scheme (AET) Transley S protection Half wave comparison scheme Explanation any one scheme — (2)	8M

Question Number	Solution	Marks Allocated
5(b)	 <p>Explanation — (4)</p>	6M
(c)	<p>Given <math>V_L = 11 \text{ kV}</math>, <math>R = 12 \Omega</math> CT ratio <math>2000/5</math></p> <p>Relay current = <math>0.8 \text{ A} = i_{r0}</math> — (1)</p> <p>Minimum operating line current <math>I_0</math>  <math>= i_{r0} \times \frac{2000}{5} = 320 \text{ A}</math> — (1)</p> <p><math>V_{\text{phase}} = V = \frac{V_L}{\sqrt{3}} = 6.35 \text{ kV}</math> — (1)</p> <p>% wdg unprotected = <math>60.46\%</math> — (1)</p> <p><math>\therefore</math> % winding protected = <math>39.53\%</math> — (1)</p> <p>It is necessary to give 90% protection — (1)</p> <p><math>10\% = \frac{R \cdot I_0}{V} \times 100</math></p> <p><math>R = 1.984 \Omega</math> — (2)</p>	8M
6(a)	 <p>Explanation — (5)</p>	8M

Question Number	Solution	Marks Allocated
6 (b)	<p>Basic arrangement of Buchholz relay diagram — (2)</p> <p>Construction diagram — (4)</p> <p>Explanation — (3)</p> <p>Operation explanation — (3)</p>	12M
7 (a)	<p>Recovery rate theory</p>  <p>Are extinguishes</p> <p>Are does not extinguish</p> <p>Explanation (3)</p> <p>Energy balance theory</p>  <p>Explanation (4)</p>	10M
(b)	<p>Restriking voltage definition — (1)</p> <p>recovery voltage — (1)</p> <p>RRRV — (1)</p> <p>Expression Restriking voltage of RRRV (2)</p>  <p>Derivation — (2)</p> <p><math>RRRV = V_m \sin \omega t</math> — (3)</p>	10M

Question Number	Solution	Marks Allocated
8(a)	<p>Cross blast CB } — (2)                      Axial blast CB }                      operating principle } for each type                      area of application } (3) x 2</p>	8M
b)	 <p style="text-align: center;">(2)</p>	6M
	<p>Explanation — (4)</p>	6M
c)	<p>3 Merits of SF<sub>6</sub> CB — (3)                      3 Demerits of SF<sub>6</sub> CB — (3)</p>	
9(a)	<p>Fuse — (1)                      Fuse element — (1)                      Rated current — (1)                      Minimum fusing current — (1)                      Fusing factor — (2)</p>	6M
b)	<p>HRC fuse diagram — (2)                      construction — (2)                      operation — (3)                      Application — (1)</p>	8M



Question Number	Solution	Marks Allocated
9(c)	About Fuse — (3) Overcurrent protective device — (3)	6M
10(a)	Hydronograph  — (2)      Explanation — (2) Magnetic link construction — (2) operation — (2)	8M
b)	Gas Insulated Substation — (3) Advantages — (4) Disadvantages — (1)	8M
c)	 — (2)      Explanation (2)	4M