*Total number of printed pages: 2* **D/6th Semester/DEE611**

**2025**

SUBSTATION, SWITCHGEAR AND PROTECTION

Full Marks: 100

Time: Three hours

*End Term*

Answer any five questions.

1. (a) Write about how the Vacuum circuit breaker works with a neat figure. Mention some important applications of the Vacuum circuit breaker. [6]

   (b) Define the following:

   (i) Pick-up current, (ii) Making capacity, iii) Rate of rise of restriking voltage, and iv) Plug-setting multiplier. [2×4]

   (c)Write the advantages and disadvantages of SF6 circuit breaker. [6]

2. (a) What is a bus bar, and why is a bus bar required? What are the different types of bus-bar arrangements used in substations? [3+3]

   (b) Discuss the bus bar selection process. [6]

   (c) Draw the main and transfer bus bar scheme and discuss its advantages and disadvantages over other bus bar schemes. [8]

3. (a) Explain with a neat diagram, how a protective relay is connected with a current transformer and trip circuit for the protection of a line. [7]

   (b) Write the working principle of the impedance relay with a proper diagram. [7]

   (c) Determine the time of operation of a 5-ampere, 3-second overcurrent relay having a current setting of 125% and a time setting multiplier of 0·6 connected to the supply circuit through a 400/5 current transformer when the circuit carries a fault current of 4000 A. (Given: Corresponding to the plug-setting multiplier assume that the time of operation is 3.5 seconds) [6]

4. (a) Discuss the major equipment used in switchgear. [6]

   (b) Derive the torque equation of the electromagnetic induction type relay. [6]

   (c) A 50 Hz, 11 kV, 3-phase alternator with earthed neutral has a reactance of 5 ohms per phase and is connected to a bus-bar through a circuit breaker. The distributed capacitance upto circuit breaker between phase and neutral in 0·01 μF. Determine (i) peak re-striking

voltage across the contacts of the breaker (ii) frequency of oscillations (iii) the average rate of rise of re-striking voltage upto the first peak. [8]

5. (a) What is Buchholz relay? Explain its operation with proper diagram. [2+8=10]

   (b) Draw the schematic arrangement of differential protection of alternators. Explain its operation. [5+5=10]

6. (a) What is grounding or earthing? Why is grounding required. [2+3=5]

   (b) Write different types of faults which may occur on an alternator. [5]

   (c) A 10 MVA, 11 kV, 3-phase star-connected alternator is protected by the Merz-Price balance current system, which operates when the out of balance current exceeds 20% of full-load current. Determine what portion of the alternating winding is unprotected if the star point is earthed through a resistance of 9 Ω. The reactance of the alternator is 2 Ω. [10]