MAJOR EXAMINATION

POER SYSTEM PROTECTION (ELL 400)

F.M.: 50 **Time: 2 Hours**

1. (a) From the torque equation, derive the operating characteristics of the MHO relay. Plot the MHO characteristics. Why the MHO relay is inherently directional? [5]

   (b) A 220 kV long transmission line is having an impedance of 2 + j8 Ω is protected by MHO relay. Find the setting of the relay if zone 1 covers 80% of the line length and assume a fault resistance of 2 Ω while deciding the setting. The characteristics angle of the relay is 70°. CT ratio 1000/1 A and PT ratio 220kV / 110 V. Draw the relay characteristics in the R-X plane. [5]

2. (a) Discuss the protection used for the Generator for (i) Unbalance Loading (ii) Loss of excitation and (iii) loss of prime mover [6]

   (b) An 11 kV, three phase, 30 MVA, star connected alternator is protected by an earth fault relay having 10% setting. The neutral of the alternator is earthed through a resistance. Find the value of the earth resistor needed to allow only 10 % of the winding to be left unprotected. CTR = 2000 / 1. What will be maximum value of earth fault current? [3 + 1.5]

3. **Discuss the need and importance of High Impedance Bus-bar differential protection scheme. Discuss the design of the scheme.** [5]

4. **Discuss the tripping characteristics of a cosine type phase comparator. Stepwise discuss the implementation of the cosine type phase comparator using various electronic circuit components.** [4.5]

5. **(a) Let the fault current signal is expressed by**

$$i(t) = 0.2\, e^{-10t} + 2 \sin(2\pi \times 50\, t + 30^\circ)$$

   Sample the signal at 1 kHz. Apply LES technique to find out the dc offset and fundamental [6]

   (b) Extract the fundamental of the signal applying DFT. Consider 4 samples of the signal. [6]

   (c) Discuss Mann and Morission algorithm. Mention its limitations. [3]

   (d) Realize a numerical OC relay [5]