



## P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

**Sixth Semester, Electrical and Electronics Engineering**

**Semester End Examination; June - 2017**

**Switchgear and Protection**

Time: 3 hrs

Max. Marks: 100

**Note:** Answer *FIVE* full questions, selecting *ONE* full question from each unit.

### UNIT - I

- 1 a. With a neat sketch, describe the construction and operation of the HRC fuse. 7
- b. Explain why arc formation is desirable part of the process of interrupting current before interruption but undesirable after interruption at current zero. 4
- c. The short circuit current of 3 phase 132 kV system is 8000 A. The current chopping occurs at 2.5% of the peak value of the current. Calculate the prospective value of the voltage which will appear across the contacts of the circuit breaker. The value of stray capacitance to the earth is 100 pF. 6
- d. Define the following terms for fuses: 3
  - (i) Cut off
  - (ii) Pre-arcing frame
  - (iii) Arcing time
- 2 a. Explain the considerations in selecting a fuse for, 6
  - (i) Transformer protection
  - (ii) Motor protection
- b. What is resistance switching? Derive expression for critical resistance in terms of inductance and capacitance, which gives no transient oscillation. 7
- c. For a 3 phase, 132 kV, 50 Hz system, the reactance and capacitance upto the location of the circuit breaker are  $3 \Omega$  and  $0.015 \mu\text{F}$ , respectively. Calculate the following : 7
  - (i) Frequency of transient oscillations
  - (ii) Frequency value of restricting voltage across the contacts of the circuit breaker
  - (iii) Maximum value of RRRV.

### UNIT - II

- 3 a. With a neat sketch, explain the arc interruption process in air-break circuit breaker incorporating. 7
- b. With a neat sketch, explain the construction and operation of minimum oil circuit breaker. 10
- c. List the important properties of  $\text{SF}_6$  gas. 3
- 4 a. With a neat diagram and waveforms, explain the synthetic testing of circuit breaker. 10
- b. With a neat diagram, explain the construction and operation of puffer type  $\text{SF}_6$  circuit breaker. 10

Contd...2

**UNIT - III**

- 5 a. Discuss the role of back-up protection, what are the methods of giving back-up protection. 6
- b. Define and explain the following :
- (i) Sensitivity of a relay (ii) Relay time, fault clearing time 9
- (iii) Stability of Protective system.
- c. Determine time of operation of an IDMT relay of rating 5A and having current setting of 125% and TMS = 0.5. The relay is connected through a CT of 400/5 A. The fault current is 4000 A. The operating time for PSM of 8 is 3.2 s at TMS = 1. 5
- 6 a. Explain the impedance relay characteristics on the R-X diagram. Discuss the range setting of three impedance relays placed at a particular location. Discuss why the I zone unit is not set for the protection of the 100% of the line. 10
- b. Explain the operating characteristics of a percentage differential relay. Also explain the problems associated with Differential protection. 10

**UNIT - IV**

- 7 a. Explain the Merz-price protection system for generators. 10
- b. An 11 kV, 100 MVA generators is grounded through a resistance of 6  $\Omega$ . The CTs have a ratio of 1000/5. The relay is set to operate when there is an out of balance current of 1 A. What percentage of generator winding will be protected by the percentage differential scheme of protection? 6
- c. List the abnormal operating condition for which generator needs to be protected. 4
- 8 a. Explain the protection of generator against loss of excitation. 10
- b. A 11 kV, 100 MVA, generator is provided with differential scheme of protection the percentage of the generator winding to be protected against phase to ground fault is 80% . The relay is set to operate when there is 15% out of balance current. Determine the value of resistance to be placed in the neutral to ground connection. 6
- c. Briefly explain the protection scheme of generator against over speeding. 4

**UNIT - V**

- 9 a. With a neat circuit diagram, explain the Merz-price differential protection scheme for protection of 3 phases  $\Delta$  -  $\times$  connected transformer. Also explain the principle of Harmonic restraint. 14
- b. A star-delta, 11 kV/6.6 kV transformer is protected by means of differential protection system. The 6.6 kV delta connected side has CT ratio of 600/5. Calculate CT ratio of HV side. 6
- 10 a. What are the abnormal conditions in induction motor and explain the protection against phase reversal and overload? 12
- b. Explain the protection system for Induction motors against phase faults and ground faults. 8