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Sixth Semester B.E. Degree Examination, Dec.09/Jan.10

Switchgear and Protection

Time: 3 hrs.

Max. Marks:100

Note:1. Answer any FIVE full questions.

2. Any missing data may be suitably assumed.

- 1 a. Define the following terms as applied to circuit breakers:
 - i) Restriking voltage ii) RRRV iii) Recovery voltage. (06 Marks)
- b. Derive an expression for Restriking voltage and RRRV in terms of system voltage, inductance voltage and capacitance. (08 Marks)
- c. In a 220 kV system, the reactance and capacitance upto the location of circuit breakers is 8Ω and $0.025 \mu\text{F}$ respectively. A resistance of 600Ω is connected across the contacts of circuit breaker. Determine the following:
 - i) Natural frequency of oscillations.
 - ii) Damped frequency of oscillations.
 - iii) Critical value of resistance, which will give no transient oscillations.
 - iv) The value of resistance which will give damped frequency of oscillations, one-fourth of natural frequency of oscillations. (06 Marks)
- 2 a. Explain the following with reference to circuit breaker: i) Breaking capacity of circuit breaker ii) Making capacity iii) Short-time capacity. (06 Marks)
- b. With a neat sketch, explain synthetic testing (parallel current injection method) of circuit breakers. (08 Marks)
- c. Explain the operating principle of circuit breaker. (06 Marks)
- 3 a. With a neat sketch, describe the working principle of Sf_6 circuit breakers. What are the advantages over other types of circuit breakers? (10 Marks)
- b. With a neat sketch explain axial-airblast type circuit breakers. (10 Marks)
- 4 a. Explain clearly the characteristics of fuse. (04 Marks)
- b. Define the following with reference to protection system i) Sensitivity ii) Reliability
iii) Selectivity. (06 Marks)
- c. With a neat sketch, describe the working principle of a liquid fuse. (10 Marks)
- 5 a. What is a Relay? What are the essential qualities of relay? Explain. (06 Marks)
- b. Explain clearly with neat sketch, the working of directional-induction type over current relay. (08 Marks)
- c. If the current rating of relay is 5A, RSM = 1.5, TMS = 0.4, C.T. ratio = 400/5, fault current = 6000 A, determine the operating time of the relay. At TMS = 1, operating time at various PSM are (06 Marks)

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| PSM | 2 | 4 | 5 | 8 | 10 | 20 |
| Operating time in seconds | 10 | 5 | 4 | 3 | 2.8 | 2.4 |
- 6 a. Explain the principle of working and operating characteristics of a percentage biased differential relay. (10 Marks)
- b. Explain the differential scheme of bus bar protection. What are the drawbacks of this scheme and how this can be overcome? (10 Marks)
- 7 a. Explain the principles of 3 zones of protection for transmission lines. (10 Marks)
- b. List the different protective schemes provided for protection of generators. (06 Marks)
- c. List the various abnormal conditions against which large induction motor has to be protected. (04 Marks)
- 8 a. Explain the working of Buchholz's relay. (08 Marks)
- b. Describe the harmonic restraint relay used to protect transformers. (08 Marks)
- c. A 3 phase transformer of 220/11000 line volts is connected in star/delta. The protective transformers on 220 V side have a current ratio of 600/5. What should be the C.T. ratio in 11000 V side? (04 Marks)