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Sixth Semester B.E. Degree Examination, January/February 2006
Electrical & Electronics Engineering
Switch Gear and Protection

Time: 3 hrs.)

(Max.Marks : 100)

Note: Answer any FIVE full questions.

1. (a) What are the basic functions of a circuit breaker? Discuss the theories of arc interruption with respect to a circuit breaker. (6 Marks)
- (b) Discuss the operating principle of SF_6 circuit breaker. What are its advantages over other types of circuit breakers? For what voltage range is it recommended? (8 Marks)
- (c) In a 132 kV system, the reactance per phase upto the location of the circuit breaker is 5Ω and capacitance to earth is $0.03\mu F$. Calculate maximum value of restriking voltage, maximum value of RRRV and the frequency of transient oscillation. (6 Marks)
2. (a) Explain the phenomenon of current chopping in a circuit breaker. What measures are taken to reduce it? (6 Marks)
- (b) What is resistance switching? Derive the expression for critical resistance in terms of system inductance and capacitance, which gives no transient oscillation. (8 Marks)
- (c) In a 132 kV system, the reactance and capacitance upto the location of circuit breaker is 5Ω and capacitance to earth is $0.02\mu F$, respectively. A resistance of 500Ω is connected across the contacts of the circuit breaker. Determine the natural frequency of oscillation, damped frequency of oscillation and critical resistance. (6 Marks)
3. (a) Mention the different types of tests that are performed on a circuit breaker. Explain the parallel current injection method of synthetic testing of a circuit breaker. (8 Marks)
- (b) A 11 kV generator connected through 5 cycle circuit breaker to transformer rated 8000 KVA with the reactances of and $X''_d = 9\%$, $X'_d = 5\%$ and $X_d = 100\%$. It is operating at no load and rated voltage, when 3 phase short circuit occurs between breaker and transformer. Find
 - i) Sustained short circuit current in breaker
 - ii) Initial RMS current in circuit breaker
 - iii) Maximum possible DC component of short circuit current in circuit breaker
 - iv) Momentary current rating of the breaker
 - v) Current to be interrupted
 - vi) Interrupting KVA.

4. (a) Define Fuse and explain the issues concerning material selection for fuse elements. (5 Marks)
- (b) What are the considerations in selecting a fuse for protection of :
 i) Transformer ii) Motor iii) Capacitors
 iv) Heaters v) Lighting loads. (5 Marks)

(c) Describe the construction and operation of HRC cartridge fuse. (10 Marks)

5. (a) With the aid of a schematic diagram, explain the construction and operation of a directional overcurrent relay. (6 Marks)

(b) Discuss the overcurrent protection schemes for
 i) Parallel feeders and ii) Ring mains. (8 Marks)

- (c) The current rating of a relay is 5A. PSM=1.5, TMS=0.4, CT ratio=400/5, fault current = 6000A. Determine the operating time of the relay for a TMS=0.4. At TMS=1, operating time at various PSM are :

PSM	2	4	5	8	10	20
Operating time(s)	10	5	4	3	2.8	2.4

(6 Marks)

6. (a) Explain the distance protection by
 i) Impedance relays and ii) Reactance relays. (10 Marks)

(b) Discuss the protection of induction motors against phase fault, ground fault and abnormal conditions like single phasing, phase reversal and overloading. (10 Marks)

7. (a) Discuss the generator protection schemes against

- i) Stator faults
 ii) Rotor faults and
 iii) Abnormal running conditions. (12 Marks)

(b) The neutral of a three-phase, 20MVA, 11kV alternator is earthed through a resistance of 5Ω . The relay is set to operate when there is an out of balance current of 1.5A. The CTs have a ratio of 1000/5. What percentage of winding is protected against an earth fault and what should be the minimum value of earthing resistance to protect 90% of the winding? (8 Marks)

8. Write explanatory notes on any FOUR of the following :

- (a) Construction and operation of vacuum circuit breakers
 (b) Operating mechanisms of circuit breakers
 (c) Construction and working of Buchholz's relay
 (d) Differential protection of transformers
 (e) Directional and phase comparison carrier protection schemes. (4×5=20 Marks)