Code : 031733/031833

B.Tech 7th Semester Special Exam., 2020

SWITCHGEAR AND PROTECTION

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Answer the following questions in short (any *seven*) : 2×7=14

(a) Differentiate between sensitivity and reliability of a protective relay.

(b) State the basic difference between isolator and circuit breaker.

(c) List out the applications of carrier-current relaying.

(d) Write the role of conservator in a transformer.

(e) A circuit breaker is rated at 1500 amps, 2000 MVA, 33 kV, 3 sec, oil circuit breaker. Determine the rated nominal current, braking current and making current.

(f) Define HRC fuse.

(g) List out the properties of SF_6 gas.

(h) In a system of 132 kV, line-to-ground capacitance and inductance are 0·01 μF and 5 H, respectively. Determine the voltage appearing across the poles of CB if a magnetizing current of 5 amps (instantaneous value) is interrupted.

(i) Draw the CT connections for 3-phase *(i)* star-delta and *(ii)* delta-star transformers.

(j) Briefly discuss the role of harmonic restrain relay in power transformer.

(k) Derive the expression for the critical resistance of the circuit breaker.

2. *(a)* Define the following with concerned waveforms in the context of circuit breaker : 6

(i) Restriking voltage

(ii) RRRV

(iii) Recovery voltage

(b) A relay of rating 5 amps, 2·2 sec with relay setting of 125% and TMS = 0·6, is connected through a CT ratio of 400/5 amps. The fault current is 4000 amps. Determine the operating time of the relay for corresponding PSM given in the following IDMT relay data : 8

PSM	2	4	6	8	10
Operating time (in sec)	6	5	4	3·5	3

3. (a) With a neat and labelled sketch, explain protection of power transformer using Buchholz relay. Conclude whether the Buchholz relay can be used for external fault of transformer or not. 6

(b) With the help of X-R diagram, explain the operation of the following relays with their applications : 8

(i) Reactance relay

(ii) Impedance relay

(iii) MHO relay

4. (a) How do single-phasing, phase reversal and overloading affect the operation of an induction motor? Discuss the protection measures for the same. 6

(b) Discuss one protection scheme to protect induction motor against (i) phase fault and (ii) ground fault. 8

5. (a) Discuss in detail the rotor earth fault and loss of field protection of an alternator. 6

(b) A 33 kV, 50 Hz, 3-phase star-connected alternator is protected using circulating current protection. The pilot wires are connected to secondary winding of 100/5 amps ratio current transformer. The protective relay is adjusted to operate with an out-of-balance current of 1 amp in pilot wires. Determine—

(i) the earthing resistance which will protect 90% of the winding;

(ii) the percentage of the winding which would be protected if the earthling resistance is 15 ohm.

6. A 3-phase, 33/6·6 kV, star-delta connected power transformer is protected by using differential protection scheme. The CT ratio on the low-voltage side if transformer is 400/5 amps—

(a) determine the CT ratio on the high-voltage side of transformer;

(b) draw the connection diagram of differential protection of transformer and explain how it works under fault condition. 14

7. Explain the construction and working of SF_6 circuit breakers. 14

8. Discuss different methods of interrupting the arc current in circuit breaker. Explain two main theories of current zero interruption. How is current zero obtained in an HVDC circuit breaker? 14

9. (a) Explain the operation of static and electromechanical relays with neat diagram(s). Discuss the advantages and limitations of static relays over electro-mechanical relays. 7

(b) With a neat sketch, explain the working principle of minimum oil circuit breaker. 7

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