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# MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

*A Constituent Institution of Manipal University*

## VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

## MAKEUP EXAMINATIONS, DEC 2016 - JAN 2017

## SUBJECT: SWITCHGEAR AND PROTECTION [ELE 401]

REVISED CREDIT SYSTEM

**Time: 3 Hours** **Date: 26 December 2016** **MAX. MARKS: 50**

**Instructions to Candidates:**

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitably assumed.
- Graph sheets shall be supplied, if required.

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**1A.** Write a brief note on arc formation and arc quenching in case of circuit breakers. Explain Slepian's and Cassie's theories with respect to arc interruption. ***(04)***

**1B.** In a 132KV 50Hz, 3 phase system, reactance and capacitance to ground per phase up to the location of circuit breaker are 5Ω and 0.02μF respectively. Determine the following

(i) Average value of RRRV

(ii) Natural frequency of oscillations of restriking voltage

(iii) Value of resistance to eliminate the restriking voltage transient

(iv) Damped frequency of oscillations if a resistance of 500 Ω is connected across the contacts of the circuit breaker. ***(03)***

**1C.** Discuss the major problem associated with development of HCDC circuit breakers. Suggest and describe a suitable method to overcome this problem. ***(03)***

**2A.** With the help of a neat sketch, describe the construction and principle of operation of Vacuum Circuit breaker. What are the advantages and disadvantages of vacuum circuit breakers? ***(04)***

**2B.** With the help of a single line diagram of major equipments in a substation, explain the necessity and functions of isolator and earthing switch. List the sequence of operation of these equipments along with circuit breaker while (i) opening and (ii) closing a circuit. ***(03)***

**2C.** What do you mean by routine tests and type tests? Why are they conducted? List the important routine tests and type tests conducted on HVAC circuit breakers. ***(03)***

**3A.** Derive an expression for the operating force of an attraction type electromagnetic relay when energized by an AC quantity and hence discuss the problem associated with AC operation. How can it be overcome? ***(03)***

**3B.** With a neat sketch, describe the construction and operation of a HRC cartridge fuse. Why tin joints are used along with silver for fuse element? ***(04)***

**3C.** A 33 kV, 3 phase, 50 Hz, overhead 60 km line has a capacitance to ground of each line equal to 0.015 μF per km. Determine the inductance and KVA rating of Peterson coil. Repeat calculations for 10 km length of line. Comment on the two values of inductance calculated. ***(03)***

**4A.** Discuss the consequences of loss of excitation to an alternator. Describe different schemes of protection to protect the alternator against excitation failure. ***(04)***

**4B.** A relay with TMS=1 and rated for 5 A has its operating time given by $t = \frac{14.5}{PSM^{0.8}-1}$. Two such relays are used for the protection of a radial feeder with two sections. Relay A at the beginning of feeder is set with a current setting of 130% and time multiplier setting of 0.8 while relay B at the beginning of second section is set with a current setting of 160%. The CT associated with each relay has a ratio of 250/5 A. For discrimination purpose, a delay of 0.7 seconds is required between the operating times of the two relays. For a fault current of 4000 A at the distant end of the feeder, obtain the time setting multiplier of relay B. ***(03)***

**4C.** With a neat diagram, explain the construction and working principle of an induction cup type protective relay. ***(03)***

**5A.** Discuss the problems encountered in differential overcurrent relay in its basic version. How is it overcome in biased differential relay. ***(04)***

**5B.** A 3 phase, 33/6.6kv star/delta connected transformer is protected by differential system. The CTs on LT side have ratio of 300/5 Amp. Find the CT's ratio on HV side. Also draw the differential protection scheme for the same. ***(03)***

**5C.** What is the effect of single phasing operation of a 3 phase Induction motor on its performance? With the help of a neat connection diagram, explain the working of single phase preventer used to protect induction motor against single phasing. ***(03)***

**6A.** With the help of relevant diagram and wave forms explain the phase comparison method of carrier pilot protection of transmission lines. ***(04)***

**6B.** Write the general expressions for amplitude comparator and phase comparator. Mention the settings of various constants to realise an impedance relay using both types of comparators. ***(03)***

**6C.** Obtain the 3 Zone settings for (i) impedance relay (ii) reactance relay and (iii) mho relay with a characteristic angle of $15^{o}$ from the following data:

C.T: 1000/1 amp P.T: 220KV/110 volts

Primary impedances of first, second and third line are (2+j6) Ω, (2.5+j5) Ω and (3.5+j7) Ω respectively

Zone #01 is designed to cover 80% of the first line. Zone #02 covers first line and extends upto 50% of the second line. Zone #03 covers both first and second line and extends upto 15% of the third line. ***(03)***