Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.TECH(EE)/SEM-2/MPS-203/2013

2013

POWER SYSTEM PROTECTION

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Graph sheet will be supplied by the Institution.

Answer Q. No. **1** and any *four* from the rest. 5 × 14 = 70

1. Write short notes on the following :

   a) Capacitor Voltage Transformer & its equivalent circuit

   b) Signal mixing circuits

   c) Differential Busbar Protection

   d) Pilot Wire Feeder Protection.

2. a) Enumerate the sources of error in transformer protection and explain how these are overcome using biased differential relays. 5

b) A three-phase Delta/Star (grounded), 50 Hz transformer is rated 60 MVA, 33 kV/132 kV. The CT ratio on the 132 kV side is rated 300/5 amp.

i) Show the CT connections for a biased differential protection for the transformer

ii) Calculate the CT ratio on the 33 kV side. 9

3. a) Derive from the fundamental principles the generalized equation of a two-input amplitude comparator assuming that current and voltages are available as input to the signal mixing circuits. 6

b) A three-phase transmission line has three sections *A, B* and *C* connected in series. The three sections have following positive sequence impedances :

$Z_A = 5 + j15$ ohms

$Z_B = 8 + j24$ ohms

$Z_C = 10 + j30$ ohms.

In a complex R-X plane show the three step MHO distance relay settings for the line with the relay at the starting of the line *A*. Assume the following relay settings coverage :

Zone 1 : 85% of line *AB*

Zone 2 : Line *AB* + 35% of line *BC*

Zone 3 : Line *AB* + Line *BC* + 20% of line section *C*. 8

4. a) Deduce by using symmetrical component analysis the voltage and current signals required for the impedance measuring comparator to correctly measure the positive sequence impedance of a O/H line in case of line-to-line faults. 8

b) A 3-phase long transmission line has following sequence impedances :

$Z_{\text{positive}} = Z_{\text{negative}} = 0 + j20$ ohms

$Z_{\text{zero}} = 0 + j45$ ohms

In order to measure the positive sequence impedance correctly during a line-to-ground fault in phase a and ground, calculate the factor by which the phase current should be multiplied before putting into the comparator. 6

5. a) What are the signals required for a two input phase comparator to produce a mho characteristics ? 7

b) A 400 kV, 3-phase, 250 km long transmission line has a series positive sequence impedance of $Z_{+} = 20 + j45$ ohms per phase. A distance relay has to protect 80% of the line. Calculate the impedance setting on the relay secondary side taking the CT ratio to be 500/5 amp and PT ratio to be 400 kV/110 volt (line to line). 7

6. a) Explain with illustrations where it is necessary to use directional and non-directional over current relays. 7

b) A 6·0 kV single-phase distribution line has three sections *AB, BC, CD* connected in series. At the beginning of each line there are over current relays which have operating characteristics given by :

$T * I^{1.2} = 500$

Where T = operating time in seconds, I = fault current in amperes.

Calculate the operating time of the relay at A when a fault occurs at the far end of the line section CD. Each line section has a series impedance of $12 + j16$ ohms. 7

7. a) Explain with suitable diagram, the phenomena of 'power swing' in an integrated power system. How it may affect the operation of distance protection ? 7

b) With suitable diagram explain how input signals to an amplitude comparator are to be modified so as to use it as a phase comparator. 7

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