



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. $5 \times 14 = 70$

1. Write short notes on the following :

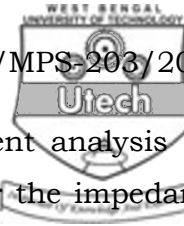
- a) Capacitor Voltage Transformer & its equivalent circuit
- b) Signal mixing circuits
- c) Differential Busbar Protection
- d) Pilot Wire Feeder Protection.

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 :
- $$Z_A = 5 + j15 \text{ ohms}$$
- $$Z_B = 8 + j24 \text{ ohms}$$
- $$Z_C = 10 + j30 \text{ ohms.}$$
- 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 :

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

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

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

=====