U.S.N

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Sixth Semester, B.E. - Electrical and Electronics Engineering

Semester End Examination; June/July - 2015

Power System Analysis and Stability

Time: 3 hrs *Max. Marks: 100*

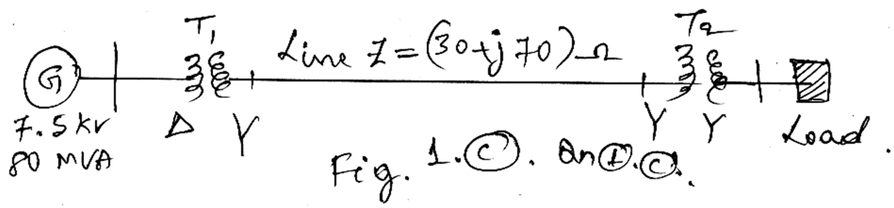
***Note**: Answer any **FIVE** full questions, selecting at least **TWO** full questions from each part.*

PART - A

1. a. Bring out the advantages of per unit system. 4

b. Show that the P.U. Impedance of the transformer is the same whether computed from primary or secondary side so long as the voltage based on the two sides are in the ratio of transformation. 6

c. A 3ϕ generator rated 80MVA, 7.5 kV with X″ of 20%, is connected to load as shown in the Fig. 1(C). The other end of the line is connected to a load of 50 MW at 0.9 p.f lagging at 13.8 kV, through transformers. Both the transformers are composed of three single phase transformers connected for 3ϕ operation. Each single phase transformer, in each bank, is rated 30 MVA, 8/127 kV with a reactance of 10%. Draw the impedance diagram. Select a base of 100 MVA, 220 kV in the transmission line. Determine the terminal voltage of the generator. 10



2 a. Draw the diagram of symmetrical short circuit armature current waveform of synchronous machine. With the help of diagrams, explain why and how $X''_d < X'_d < X_d$ in case of an alternator. 10

b. Two synchronous motors having X″ of 0.8 & 0.25 p.u. respectively on a base of 480 V, 2000 kVA are connected to a bus. This motor bus is connected by a line having a X of 0.023 Ω, to a bus of a power system. At the power system bus, the short circuit MVA of power system are 9.6 MVA for a nominal voltage of 480V. When the voltage at the motor bus is 440 V, neglecting load current, find the symmetrical RMS current is a 3ϕ fault at the motor bus. 10

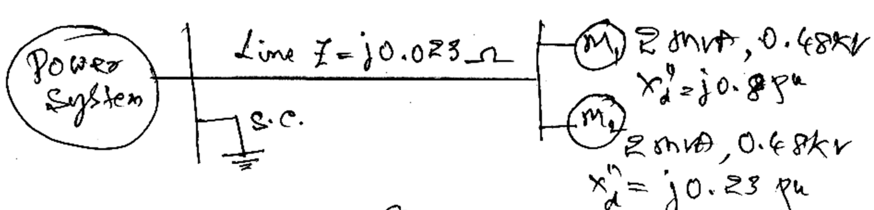


Fig. Qn.2.(b).

3 a. Show that the power in a 3 phase circuit can be computed from symmetrical components. 6

b. The current flowing to a balanced delta (Δ) connected load through line is 10 A. With the current in line 'a' as reference and assuming that line 'c' is open; find the symmetrical components of line currents. 6

c. The voltages at the terminals of a balanced load consisting of three 10 Ω resistors connected in Y are $V_{ab} = 100\angle 0^o$, $V_{bc} = 80.8\angle -121.44^o$, and $V_{ca} = 90\angle 130^o$ V. Determine the general expression for the relation between the symmetrical components of line and phase voltages i.e. between V_{ab1} & V_{an1} and between V_{ab2} and V_{bn2}. Assume that there is no neutral connection to the load. Find the line currents from the symmetrical components of the line voltages. 8

4 a. Explain the phase – shift of symmetrical components in a star – delta transformer bank with respect to voltage and current relations. 8

b. The voltages at the terminals of a balanced Y load consisting of 10 Ω resistors in each phase are $V_{ab} = 100\angle 0^o$, $V_{bc} = 90\angle 240^o$ and $V_{ca} = 95.5\angle 125.2^o$ V. find the power expended in the resistors from the symmetrical components of currents and voltages. Assume there is no connection to the neutral of the load. 12

PART – B

5 a. Derive an expression for the fault current in case of double line to ground fault (DLG fault). Draw the equivalent circuit showing the interconnection of sequence networks to simulate DCG fault. 10

b. An alternator rated 20 MVA, 13.8 kV and with $X_d'' = 0.25$ p.u, $X_2 = 0.35$ p.u, $X_0 = 0.1$ p.u. The neutral of the generator is solidly grounded. Determine the subtransient current in the generator and line to line voltages when a single line to ground (SLG) fault occurs at the terminals at the unloaded generator, operating at rated voltage. 10

6 a. A single line for ground (SLG) fault through fault impedance Z_f takes place at the terminals of an unloaded generator. Obtain the expression for fault current and the equivalent network to simulate the fault. 10

b. A synchronous motor is receiving power of 10 MW of 0.8 pf lagging at a voltage of 6 kV as shown in Fig. 6(b). A line to ground fault occurs at the middle of the transmission line through a fault reactance of 5 Ω. Determine the fault current. 10

The ratings of the apparatus are :

$G: 20MVA, 11kV, X_1 = j\,0.2, X_2 = X_0 = j\,0.1pu$

$T_1 = 18MVA, 11.5/34.5kV, X_1 = X_2 = X_0 = j0.1\,pu, X_n = j0.066pu$

$T_2 = 15MVA, 34.5/6.9kV, X_1 = X_2 = X_0 = j\,0.1pu$

$Syn.\,M: 15MVA, 6.9kV, X_1 = j0.2pu, X_2 = X_0 = j0.1pu, X_n = j0.066\,pu$

$Tr.Line: X_1\; X_2 = 5\Omega, X_0 = 20\Omega$

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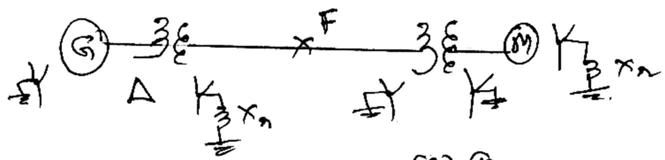

Fig. Qn.(6) (b).

7 a. Define stabilities as applied to power system and distinguish between,

i) Steady state stability (SSS) and SSS limit (SSSC) 6

ii) Transient state stability (TSS) and TSS limit (TSSL)

b. Derive the expression for Swing equation. 8

c. A 2 pole, 50 Hz, 11kV turbo – generator has a rating of 100 MW at 0.85 point lagging. Its rotor has a moment of inertia of 1,000 kg-m^2. Calculate inertia constant H and its angular momentum, H. 6

8 a. Mention the methods of improving stabilities in a power system. Explain. 10

b. Derive the expression for critical clearing angle (CCA) and critical clearing time (CCT), when fault occurs in any one of double circuit transmission line. The generator is connected to infinite bus through double circuit line. 10

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