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10EE61

# Sixth Semester B.E. Degree Examination, June/July 2018
## Power System Analysis & Stability

Time: 3 hrs. Max. Marks:100

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



## PART – A

1 a. What is a per unit system? What are its advantages and disadvantages? **(06 Marks)**

b. Show that the pu impedance of a transformer is same either referred to primary or secondary side of it. **(06 Marks)**

c. The single line diagram of a power system is shown below. Draw its pu impedance diagram:

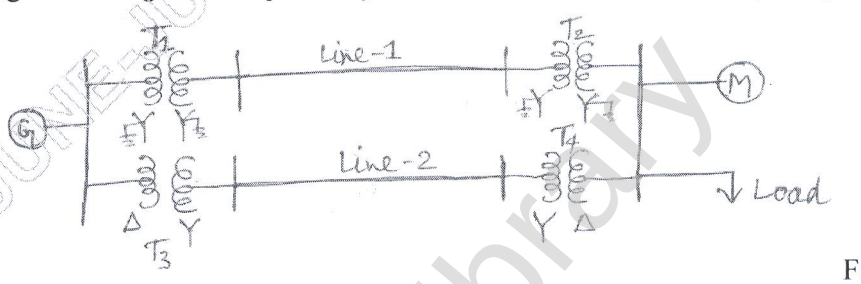


Fig. Q1 (c)

G : 90 MVA, 11 KV, X″ = 18%
$T_1$ : 70 MVA, 11/110 KV, X = 15%
$T_2$ : 60 MVA, 110/11 KV, X = 10%
$T_3$ : Three 1ϕ units each rated 10 MVA, 11/127 KV, X = 9%
$T_4$ : Three 1ϕ units each rated 16.6667 MVA, 127/11 KV, X = 12%
Line-1 : z = j80 Ω
Line-2 : z = j120Ω
M = 85 MVA, 11 KV, X″ = 13%
The load absorbs 74 MVA, 0.8 pf lagging at 6.5 KV. Select a common base of 100 MVA, 11 KV on the gen side. **(08 Marks)**

2 a. Define a fault that occur in a power system. What are the main causes for it? Also define the symmetrical faults. **(05 Marks)**

b. Briefly explain how a synchronous machine on no-load offers a timely varying reactance, when subjected to a sudden 3ϕ short circuit across its terminals. **(07 Marks)**

c. A transformer rated at 50 MVA and having a SC reactance of 5% is connected to the bus-bar which is supplied through two 66 KV feeder cables (lines) each having an impedance of (1.5+j2.5) Ω. One of the feeders is connected to a generating station rated at 80 MVA and having a SC reactance of 10% and the other feeder is connected to another generating station rated at 100 MVA and having SC reactance of 15%. Determine the MVA at the fault point in the event of a SC between the secondary terminals of the transformer. Choose base MVA as 400 and base KV as 66 on the generator side. The single line diagram of power system is shown in Fig. Q2 (c). **(08 Marks)**

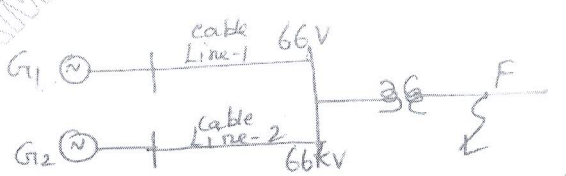


Fig. Q2 (c)

3 a. Explain the three sets of symmetrical components with their phasor diagram. **(04 Marks)**

b. Define the complex operator '$\alpha$' and state its properties. **(04 Marks)**

c. A delta connected balanced resistive load is connected across an unbalanced three phase supply as shown below. Find the symmetrical components of line currents and delta currents. **(12 Marks)**

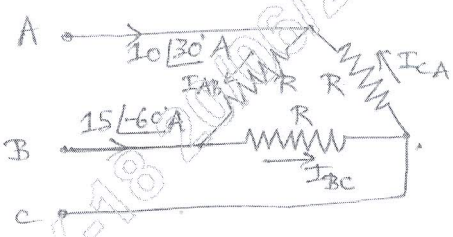


Fig. Q3 (c)

4 a. Draw the three sequence networks of an unloaded synchronous machine and transmission lines. **(05 Marks)**

b. A single line diagram of the power system is shown below. The positive, negative and zero sequence reactances of the components are given below along with their ratings. Draw the positive, negative and zero sequence networks of this power system on the base of generator ratings.

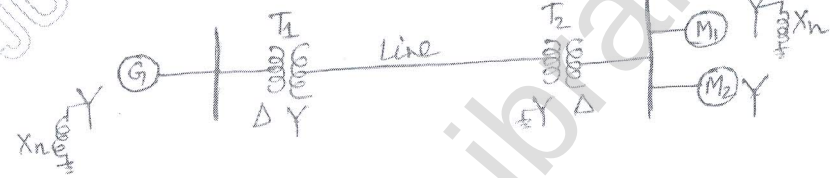


Fig. Q4 (b)

G : 30 MVA, 13.8 KV, $X'' = 0.15$ pu, $X_2 = 0.15$ pu and $X_n = 2\ \Omega$, $X_0 = 0.05$ pu

$M_1$ : 20 MVA, 12.5 KV, $X'' = 0.2$ pu, $X_2 = 0.15$ pu and $X_n = 2\ \Omega$, $X_0 = 0.05$ pu

$M_2$ : 10 MVA, 12.5 KV, $X'' = 0.2$ pu, $X_2 = 0.15$ pu and $X_0 = 0.05$ pu

$T_1$ : 35 MVA, 13.2/115 KV, $X = 0.1$ pu

$T_2$ : Three 1$\phi$ units each rated 10 MVA, 12.5/67 KV, $X = 0.1$ pu

Line : $X_1 = X_2 = 80\ \Omega$ and $X_0 = 250\ \Omega$ **(15 Marks)**

## PART – B

5 A 25 MVA, 11 KV, 3$\phi$ generator has a sub transient reactance of 20%. The generator supplies two motors over a transmission line with transformers at both ends. The motors have rated inputs of 15 and 7.5 MVA, both at 10 KV with the subtransient reactance of 25%. The three phase transformers are both rated 30 MVA, 10.8/121 KV with a leakage reactance of 10% each. The series reactance of the line is 100 $\Omega$. Assume that the negative sequence reactance of each machine is equal to its subtransient reactance. Also, assume the zero sequence reactances for the generator and motors as 0.06 pu on its own ratings. The current limiting reactors of 2.5 $\Omega$ each are connected in the neutral of the generator and motor. The zero sequence reactance of the line is 300 $\Omega$. Select a base of 25 MVA and 11 KV in the generator circuit, then draw the positive, negative and zero sequence networks of the system. If a solid LG fault occurs at the point F as shown below, calculate the fault current at the fault point. Neglect the prefault current. **(20 Marks)**

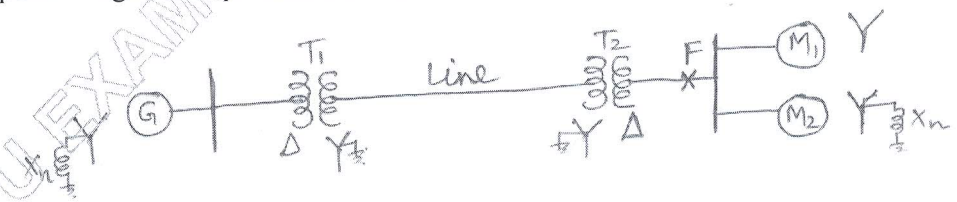


Fig. Q5

6 a. Define an unsymmetrical fault that occur in the power system. What are its various types? **(04 Marks)**

b. Write short notes on open conductor faults in a power system. **(06 Marks)**

c. Derive an equation for fault current, if a double line to ground fault occurs with a fault impedance '$Z_f$' on an unloaded synchronous generator, whose neutral is grounded through an impedance $Z_n$. The generator has balanced emfs and sequence impedances $Z_1$, $Z_2$ and $Z_0$. **(10 Marks)**

7 a. Derive a swing equation of a synchronous generator connected to an infinite bus, with usual notations. **(06 Marks)**

b. Define steady state and transient stability limits. What are the ways to improve them? **(07 Marks)**

c. A 50 Hz, four pole turbo generator rated 100 MVA, 11 KV has an inertia constant of 8.0 MJ/MVA.

(i) Find the stored energy in the rotor at synchronous.

(ii) If the mechanical input is suddenly raised speed to 80 MW for an electrical load of 50 MW, find the rotor acceleration neglecting mechanical and electrical losses.

(iii) If the above mentioned acceleration is maintained for 10 cycles, find the change in torque angle and rotor speed at the end of this period. **(07 Marks)**

8 a. What is equal area criterion? Explain the equal area criterion of stability when there is a sudden loss of one of the parallel lines shown below. **(10 Marks)**


Fig. Q8 (a)

b. Explain in detail, the measurement of negative and zero sequence impedances of synchronous machines. **(10 Marks)**

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