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10EE61

Sixth Semester B.E. Degree Examination, Dec.2015/Jan.2016

Power System Analysis and Stability

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. What are the advantages of per unit system? **(04 Marks)**

b. Draw the per phase basis modeling of synchronous machine, transformer, transmission Line and Load. **(04 Marks)**

c. A 300MVA, 20KV three – phase generator has a subtransient reactance of 20%. The generator supplies a number of synchronous motors over a 64km transmission line having transformers of Fig. Q1 (c). The motors, all rated 13.2KV, are represented by just two equivalent motors. The neutral of one motor M_1 is grounded through reactance. The neutral of second motor M_2 is not connected to ground. Rated inputs to the motors are 200MVa and 100MVA for M_1 and M_2 respectively. For both motors X″ = 20% the three – phase transformer T_1 is rated 350MVA, 230/20KV with leakage reactance of 10%. Transformer T_2 is composed of three single phase transformers each rated 127/13.2KV, 100MVA with leakage reactance of 10%. Series reactance of transmission line is 0.5 Ω/km. Draw the reactance diagram with all reactance's marked in per unit. Select the generator rating as base in the generator circuit. **(12 Marks)**

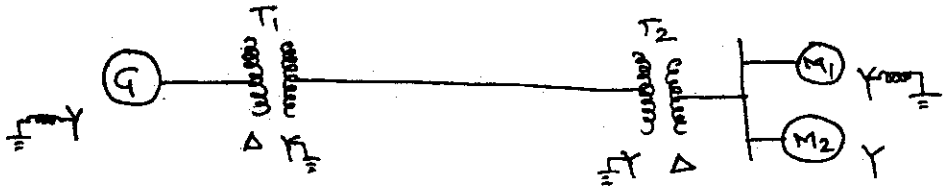

Fig. Q1 (c)

2 a. With the help of waveform at the time of three phase symmetrical fault on 3 – ϕ synchronous generator, define synchronous reactances. (steady state, transient and sub – transient condition). **(06 Marks)**

b. A synchronous generator and synchronous motor each rated 25MVA, 11KV having 15% subtransient reactance are connected through transformers and line as shown in Fig Q2 (a) . The transformers are rated 25MVA, 11/66KV and 66/11KV with leakage reactance of 10% each. The line has a reactance of 10% on base of 25MVA, 66KV. The motor is drawing 15MW at 0.8 power factor leading and terminal voltage of 106 KV when a symmetrical three phase fault occurs at the motor terminals. Find subtransient current in the generator motor and fault.

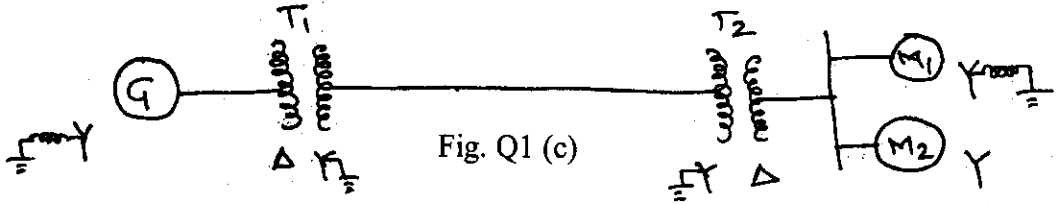

Fig. Q1 (c)

Choose base of 25MVA, 11KV in the generator circuit. **(14 Marks)**

3 a. Derive phase currents of unbalanced system in terms of sequence currents. **(05 Marks)**

b. Develop an expression for three phase power in terms of symmetrical components. **(05 Marks)**

c. A delta connected balanced resistive load is connected across an unbalance three phase supply as shown in Fig Q3 (c). With currents in lines A and B specified, find the symmetrical components of line currents. **(10 Marks)**

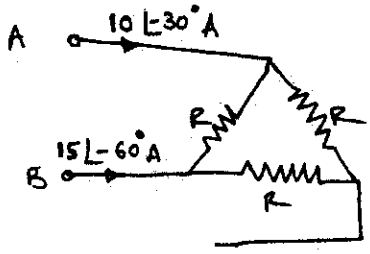

Fig. Q3 (c)

4 a. Draw zero sequence equivalent circuits of three phase transformer banks, together with diagram of connections and the symbols for one line diagram for following configuration. **(06 Marks)**

i)	
ii)	
iii)	Δ-Y
iv)	Δ-Δ
v)	

b. A 25MVA, 11KV, three phase generator has a subtransient reactance of 20%. The generator supplies two motors over a transmission line with transformers at both ends as shown in the one – line diagram of Fig Q4 (b). the motors have rated inputs of 15 and 7.5MVA, both 10KV with 25% subtransient reactance. The three phase transformers are both rated 30MVA, 10.8/121KV, connection Δ - Y with leakage reactance of 10% each. The series reactance of the line is 100ohms. Assume zero sequence reactances for the generator and motors of 0.06 pu – current limiting reactors of 2.5 ohms each are connected in the neutral of the generator and motor No.2. The zero sequence reactance of the transmission line is 300 ohms. Choose base of 25MVA and 11KV in generator circuit. Assume that negative sequence reactance of each machine is equal to its subtransient reactance. Draw the Positive, Negative and zero sequence networks of the system with reactances marked in per unit.

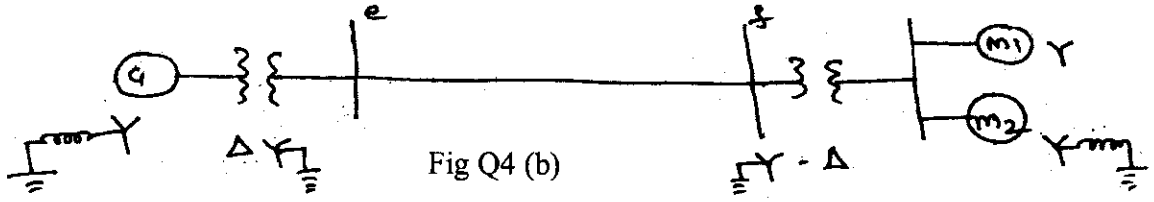

Fig Q4 (b)

(14 Marks)

PART – B

5 a. Derive the equation for the fault current when single – line – to – ground fault occurs on an unloaded generator. **(08 Marks)**

b. A salient – pole generator without dampers is rated 20MVA, 13.8KV and has direct axis subtransient reactance of 0.25 pu. The negatively, 0.35 and 0.10 per unit. The neutral of the generator is solidly grounded. Determine the subtransient current in the generator for subtransient conditions when a double link – to – ground fault occurs at the terminals of the generator. Assume that the generator is unloaded and operating at rated voltage when fault occurs Neglect resistance. **(12 Marks)**

6 a. Write a note on open conductor faults in power system. **(08 Marks)**

b. A two bus system is shown below the generators G_1 and G_2 are identical Neglecting pre – fault current and losses, calculate the fault current for L-G fault at bus – 1. All pu reactances are based on common base values.

Reactances of components (on common box)

Equipment	+ve sequence reactance (pu)	-ve sequence reactance (pu)	Zero sequence reactance (pu)
a_1	0.17	0.14	0.05
a_2	0.17	0.14	0.05
T_1	0.11	0.11	0.11
T_2	0.11	0.11	0.11
Line	0.22	0.22	0.60

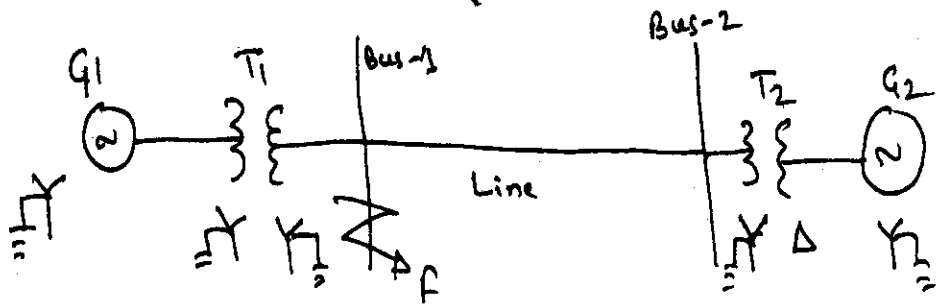

Fig Q6 (b)

(12 Marks)

7 a. Derive the swing equation

$$m\frac{d^2\delta}{dt^2} = P_a = P_s - P_e$$ **(06 Marks)**

b. Derive expression for critical clearing angle. **(08 Marks)**

c. A 50Hz, four pole turbo – generator rated 100MVA, 11KV has an inertia Constance of 2 MJ/MVA.

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

ii) If mechanical input is suddenly raised to 80mw for an electrical load of 50mw, find rotor acceleration, neglecting mechanical and electrical losses. **(06 Marks)**

8 Write short notes on :

a. Operation of 3 – Q Induction motor with one line open.

b. Steady state and transient stability.

c. Line – Line fault on unloaded generator.

d. Concept of equal area criterion. **(20 Marks)**

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