Question Paper

Exam Date & Time: 29-Apr-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
IV SEMESTER B.Sc. (Applied Sciences) - in Engg
END SEMESTER THEORY EXAMINATION APRIL/MAY 2019
POWER SYSTEM ANALYSIS [IEE 243 - S2]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.

Missing data, if any, may be suitably assumed

1) A 50Hz generator is working with P_{mech} = 1 pu, transferring 1 per unit power to a load through a short line. The power angle equation is $P_e = P_{max}\text{Sin}\delta$ A three phase fault occurs at the terminals of the generator. (10)

A) Using equal area criterion, determine the critical clearing angle. Assume P_{max}= 2 p.u, H= 6MJ/MVA. Derive the formulae used.

B) Starting from first principles, derive the swing equation of a synchronous machine. (5)

C) Distinguish between transient stability and steady state stability. (5)

2) Three resistance of 25 Ω, 50 Ω, 100 Ω are connected in star to a balanced three phase 500 V supply. Find the symmetrical components of line current of Phase A. (10)

A)

B) Prove that for a single line to ground fault all the sequence networks are connected in series. (10)

3) The slack bus voltage of the network shown in Figure 3A is $V_1 = 1.0 \angle 0^0$. (10)

A) With initial voltages of bus #2 and bus #3 as $V_2^{(0)} = 1 \angle 0^0$ and $V_3^{(0)} = 1 \angle 0^0$, obtain the new values of V_2 and V_3 at the end of one iteration, using Gauss Siedel method

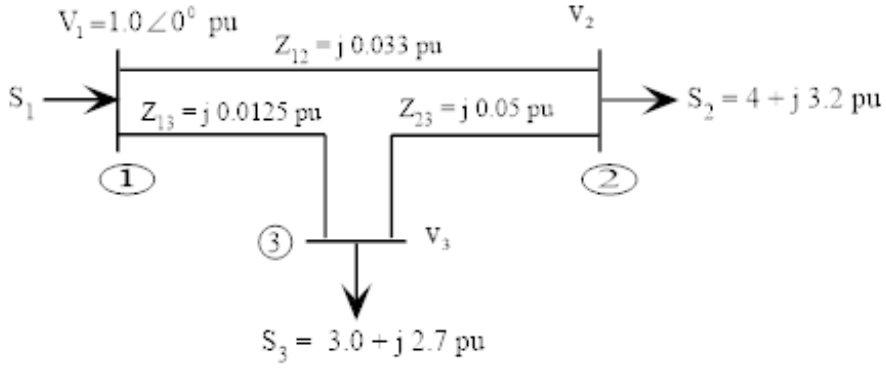

Figure 3A

B) Using matrix algebra, eliminate node-3 in the network shown in Figure. 3B and draw the reduced network. Values on figure represent voltages and reactances in p.u on a common base. Verify by star delta conversion. (10)

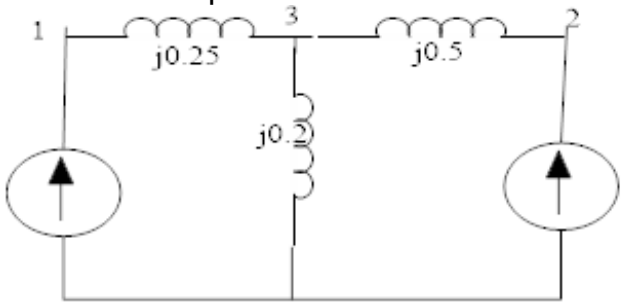

Figure. 3B

4) A) For the system shown in Figure 4A, Determine the rating of circuit breaker C. consider 30 KV and 100 MVA as the base values in the generator circuits. (10)

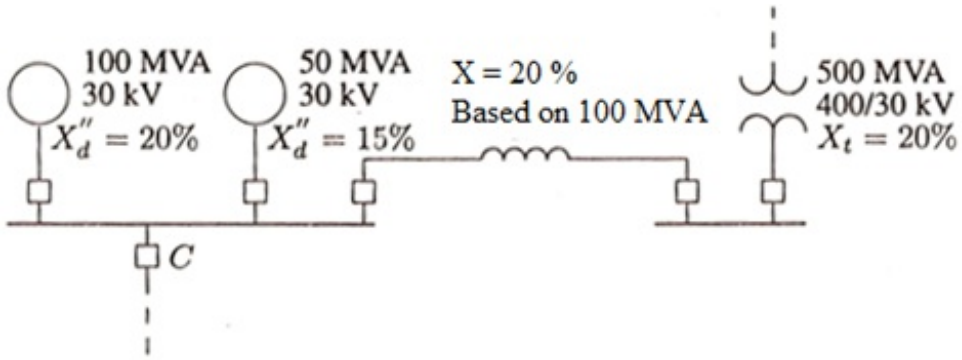

Figure 4A

B) Derive the expression for three phase power in terms of symmetrical component voltages and currents. (10)

5) A) The single line diagram of a power system is as shown in Figure 5A. Bus 2 is loaded with 50 MVA, at 11 KV with load power factor of 0.8 lag. A three phase fault occurs at Bus 2. Find a) fault current and b) generator bus voltage. Consider 50 MVA and 11KV as the base values in the load circuit. (10)

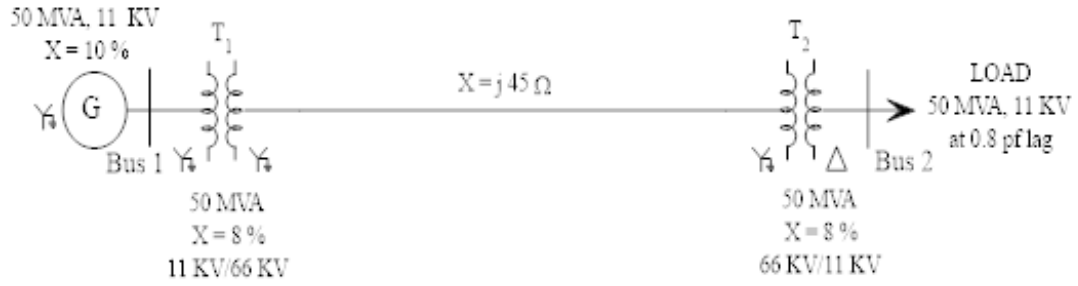

Figure 5A

B) Derive the equation for the natural frequency of oscillations when an alternator is subjected to a small change in load. (10)

6) A) A 50 Hz, Synchronous generator has H=5 MJ/MVA, and Xd'=0.3 p.u. It is delivering 1 p.u. power to an infinite bus through a transformer and a double circuit line. The transformer reactance is 20 %. Each line has a reactance of 30 %. The voltage behind transient reactance of generator is 1.17 p.u. A three phase fault occurs at the middle of one of the lines. The fault is cleared by the opening of the faulted line. Determine the critical clearing angle and critical clearing time. (14)

B) Solve the following two equations in X1 and X2 using Newton-Raphson method. Show calculations for one iteration. (6)

$f_1(x_1,x_2) = x_1^2 + 3x_1x_2 - 4 = 0 \quad f_2(x_1,x_2) = x_1x_2 - 2x_2^2 + 5 = 0 \; x_1^0=1 \; \& \; x_2^0 = 2$

7) A) The power system network shown in Figure 7A is on no load condition, find the fault current for Single line to ground fault. (10)
The fault occurring at the midpoint of line L_2.
All the reactances shown are in pu based on 100MVA, 11kV in the generator circuit. The transformers T_1 and T_2 are identical and so also the lines L_1 and L_2.

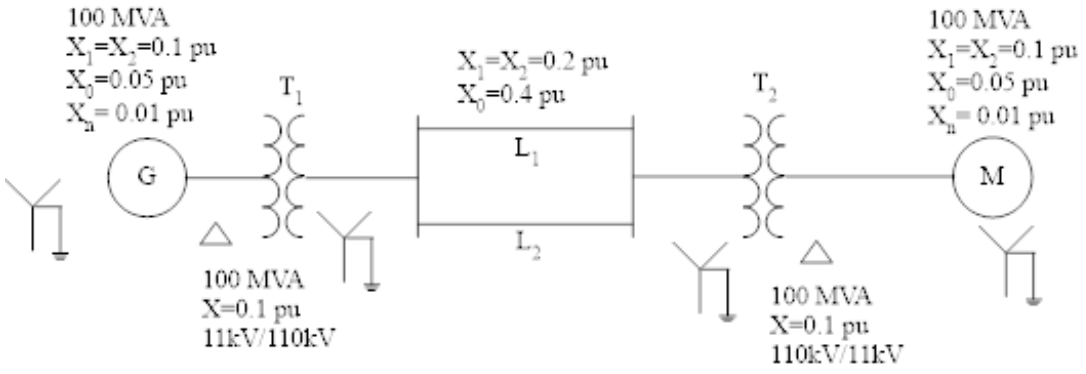

Figure 7A

B) Using Newton-Raphson method, obtain the modified values of voltage magnitude and phase angle of bus 2 for the power system network shown in Figure 7B after one iteration. Assume initial voltage of bus 2 as $1\angle 0$. (10)

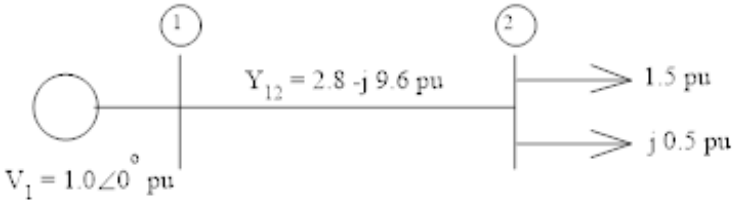

Figure 7B

8) The primary, secondary and tertiary windings of a three winding transformer are rated as 11 kV, 6 MVA star/ 3.3 kV, 3 MVA, star/ 400 V, 3 MVA, delta respectively. Three short circuit tests on this transformer gave the following results: (12)

A)

Secondary shorted; primary excited: 500 V, 100 A,
tertiary-shorted; primary excited : 600 V, 100 A,
and tertiary shorted ; secondary excited : 100 V, 200 A

a) Find the per unit leakage reactances of the star equivalent circuit. Neglect resistances.

The primary is energised at rated voltage and the secondary is an open circuit. For a three phase balanced short circuit at the tertiary terminals, calculate the short circuit current and the secondary terminal voltage.

B) Draw the zero sequence network for different transformer connections. (8)

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