Q. Code: 337784

B.E./B.TECH. Degree Examination, December 2020

Fifth Semester

EE18501- Power System Analysis

(Regulation 2016)

Time: Three hours | Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. If Y_{Bus} is symmetric sparse matrix which one of the following is true?
   (a) Z_{Bus} is a symmetric sparse matrix
   (b) Jacobian matrix is a sparse matrix
   (c) Z_{Bus} is a Symmetric Full matrix
   (d) Both b & c
   (e) Both a & b.
2. When will you consider induction motor in a reactance diagram drawn for fault calculations?
   (a) during sub-transient conditions
   (b) during transient conditions
   (c) during steady state conditions
   (d) All of the above
3. In which fault zero sequence current cannot be used as fault indicator while designing protection circuits
   (a) LG fault (b) LL fault (c) LLG fault (d) LLLG fault
4. Which one is true in a transmission line connecting a two bus system?
   (a) SSSL > TSSL>Thermal limit
   (b) Thermal limit > SSSL > TSSL
   (c) TSSL > SSSL>Thermal limit
5. What are the assumptions made while drawing per unit reactance diagram of a power system?
6. Why direct solution of load flow problem is not possible?
7. Define Short circuit Capacity.
8. A power station with 4 generators each 60 MVA, 6 MJ/MVA is in proximity with another power station having 3 generators each 300 MVA, 3.5 MJ/MVA. Calculate the inertia constant of a single equivalent machine for use in stability studies. Assume a base value of 100 MVA.

PART B - (4 X16 = 64 marks)

09. (a) **(16)**

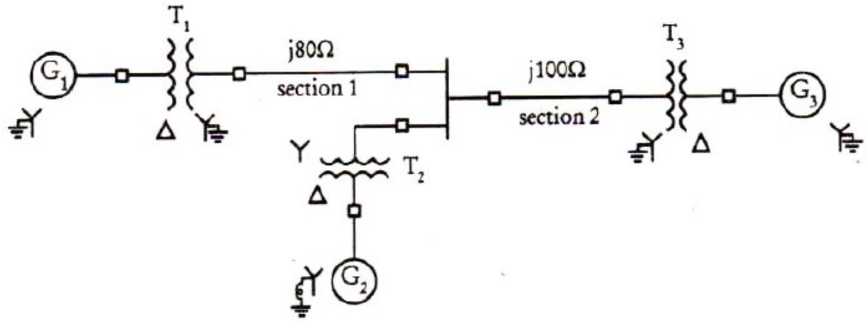

Figure 1

Figure 1 shows the single line diagram of power system. The generators and transformers are rated as:

Generator G1 = 20 MVA, 13.8 kV, X" = 20%

Generator G2 = 30 MVA, 18.0 kV, X" = 20%

Generator G3 = 30 MVA, 20.0 kV, X" = 20%

Transformer T1 = 25 MVA, 13.8/220 kV, X=10 %

Transformer T2= 3 single phase units each rated at 10 MVA, 127/18 kV, X = 10 %

Transformer T3 = 35 MVA. 220/22 kV, X = 10 %

Draw the reactance diagram using a base of 60 MVA and 18 kV on the generator G2 side.

(OR)

(b) (i) The three phase ratings of a three winding transformer are: **(8)**

Primary Y connected: 66kV, 15 MVA

Secondary Y connected: 13.2 kV, 10MVA

Tertiary Delta connected: 2.3 kV, 5 MVA

Neglecting resistance, the leakage impedances are

Z_{ps}=6% on 15 MVA, 66kV base

Z_{pt}= 7% on 15 MVA, 66kV base

Z_{st}= 5% on 10 MVA, 13.2kV base

Find the p.u impedances of the Y connected equivalent circuit for a base of 15 MVA, 66kV in the primary circuit.

(ii) For the transmission line with data shown in Table 1, form the bus admittance matrix. **(8)**

Table 1

Bus code p-q	Impedance (Z_{pq})	Line charging $y_{pq}/2$
1-2	0.02+j0.04	j0.02
2-3	0.04+j0.2	j0.02
3-5	0.15+j0.4	j0.025
3-4	0.02+j0.06	j0.01
4-5	0.02+j0.04	j0.01
1-5	0.08+j0.2	j0.02
2-5	0.08+j0.2	j0.02

10. (a) (i) Perform Load flow study using Newton Raphson method and determine the power flow solution for the two bus system shown in Figure 2. **(12)**

Bus 1 is a slack bus with V_1=1.0 pu at an angle of 0°.The line impedance is z_{12}= 0.12+j0.16 pu on a base of 100 MVA. Obtain the voltage magnitude and phase angle of bus 2. Start with an initial estimate of $|V_2|$=1.0 p.u and δ_2=0°. Perform two iterations.

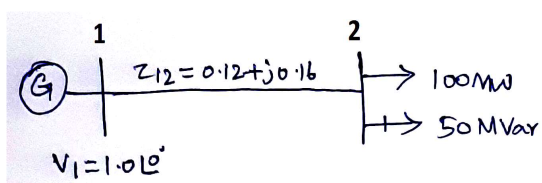

Figure 2

(ii) The line data, bus data and load flow results are given in Tables 2 and 3. Compute the Slack bus power. **(4)**

Table 2 Line data

Line	Admittance	Half line Charging Admittance
1-2	1.47-j5.88	j0.15
1-3	2.94-j11.77	j0.07
2-3	2.75-j9.17	j0.04

Table 3 Bus data & Load Flow Results

Bus	Bus Voltage	Generation		Load	
		MW	MVAR	MW	MVAR
1 (slack bus)	1.04 at 0°	-	-	0	0
2(PV bus)	1.02 at -3.09°	100	-	50	20
3(PQ bus)	0.93 at -7.01°	0	0	250	150

(OR)

(b) (i) Figure 3 shows the one-line diagram of a simple three bus power system with generation at buses 1 and 3. The voltage at bus 1 is V=1.025 per unit at an angle of 0 degree. Voltage magnitude at bus 3 is fixed at 1.03 p.u with real power generation of 150 MW. A load consisting of 200 MW and 100 MVar is taken from bus 2. Line impedances are marked in per unit on a 100 MVA base. Line resistances and Line charging susceptances are neglected. Assume Flat voltage profile at load bus. Perform two iterations in Gauss-seidal iterative procedure with acceleration factor =1.045. **(12)**

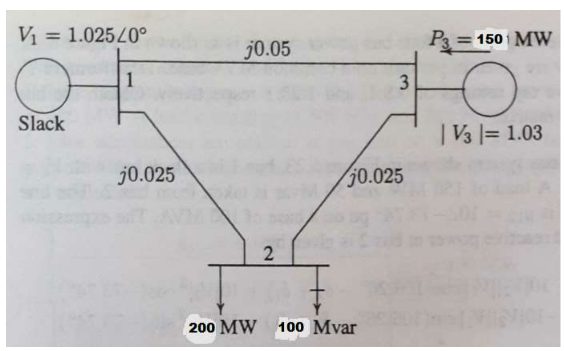

Figure 3

(ii) How will you model a tap changing transformer for power flow studies? **(4)**

11. (a) A power system shown in Figure 4 has following specifications: Rating of each machine 1200 KVA, 600 V with x1=x2=10%, x0 = 5 %. Each three phase transformer is rated 1200 KVA, 600/3300 V (Delta/Star) with leakage reactance of 5 %. The reactances of the transmission line are x1 = x2 = 20 % and x0 = 40 % on a base of 1200 KVA, 3300 V. The reactances of the neutral grounding reactors are 5 % on the KVA and voltage base of the machine. Calculate the fault current for a (a) single line to ground fault (on phase a) (b) Line to Line fault (a-b) (c) Line- Line to **(16)**

Ground fault occurs at the midpoint of transmission line.

Figure 4

(OR)

(b) (i) A 50 MVA, 11kV three phase synchronous generators was subjected to different types of faults. The fault currents are as follows. LG fault: 4200 A, LL fault: 2600A, LLLG fault: 2000A. The generator neutral is solidly grounded. Find the per unit values of the three sequence reactances of generator. **(8)**

(ii) Two generating stations with short circuit capacities of 1500 MVA, 1000 MVA respectively are interconnected by means of a reactor. Determine the value of the reactor to limit the short circuit capacity of station 1 to be 1600 MVA. **(8)**

12. (a) A power system with p.u reactance values is shown in Figure 5. Form Z_{bus} using Z_{bus} building algorithm. For a solid three phase fault occurring on bus 3, Calculate the Fault current (I^f) and Voltage at buses 1 & 2 during fault (V_1^f and V_2^f). Assume pre-fault voltages to be 1p.u and ignore pre-fault currents. **(16)**

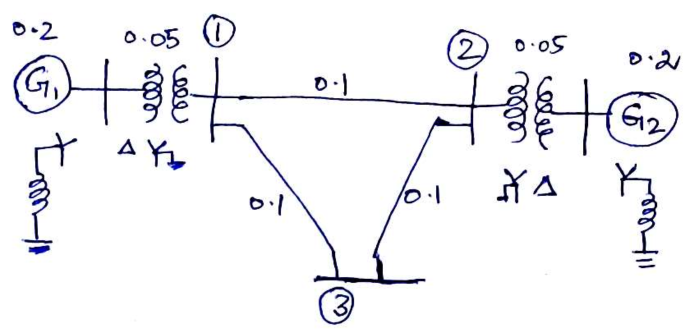

Figure 5

(OR)

(b) (i) Figure 6 represents a generator supplying power to infinite bus system. The generator is supplying 1.0 pu power with terminal voltage of 1.08 pu. Generator transient reactance is 0.12 pu . Transformer reactance is 0.09 pu. Line reactance is 0.18 pu. A 3 phase fault occurs at the terminals of the generator and the fault gets cleared after 1.25 cycle without any CB opening . **(14)**

Compute swing curve upto t = 0.05 sec . Use Ruge-kutta method . H=5pu. Infinite bus voltage may be assumed to be (1 + j0) pu and frequency as 50 HZ.

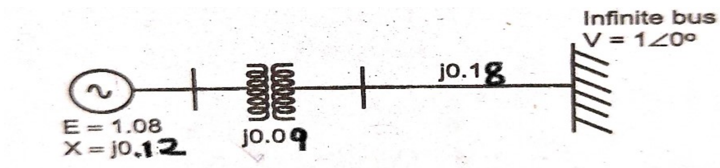

Figure 6

(ii) Draw power angle curve for a three phase fault with subsequent clearing in a power system in which a generator is connected to a infinite bus bar through a double circuited transmission line and show the accelerating and decelerating areas. **(2)**