BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR

M.E.(Elec.), 1st Semester Examination, 2013

Advanced Power System Analysis (EE–908)

Time: 3 hours Full Marks: 70

(*i*) *Answer any three questions from Group -A and any two from Group -B*

(*ii*) *Marks are indicated in the margin*

(*iii*) *The symbols are of usual meanings*

GROUP – A

1.(*a*) Derive the formula $Y_{BUS} = A^t\,[y]\,A$.

(*b*) The pu reactances of the elements of Figure 1 are shown with the network diagram. The circled numbers indicate bus numbers and the underlined numbers indicate transmission line numbers. Assuming bus ① as reference and neglecting mutual coupling, compute Y_{BUS} using $Y_{BUS} = A^t\,[y]\,A$. (7+7)

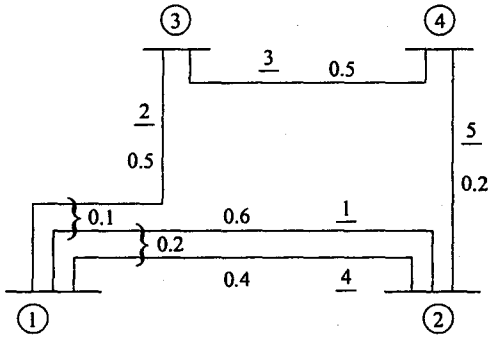

Figure 1: Problems 1(b) & 2(b)

2. (*a*) Derive the equations for formation of Z_{BUS} when the partial network is added to a mutually coupled branch in a $1-\phi$ network.

(*b*) The bus impedance matrix of the network of Figure 1 is already obtained as

Z_{BUS} =

	②	③	④
②	0.2712	0.1263	0.2298
③	0.1263	0.3436	0.1885
④	0.2298	0.1885	0.3609

Modify Z_{BUS} to include an element from bus ② to bus ④ with a self reactance of 0.3 pu and coupled to element 5 with mutual reactance of 0.1 pu.

Given: Inversion of $\begin{bmatrix} 0.2 & 0.1 \\ 0.1 & 0.3 \end{bmatrix}$ is $\begin{bmatrix} 6 & -2 \\ -2 & 4 \end{bmatrix}$ (7+7)

3. (*a*) State the assumptions made in representing $3-\phi$ power system network for short circuit studies.

(b) (i) Draw the circuit diagram representing a three phase to ground fault of a $3-\phi$ system, and (ii) write the fault impedance and admittance matrices in phase components and in sequence components, and also (iii) write the general expressions for current and voltage at the faulted bus using both fault impedance and admittance matrices. (4+(2+4+4))

4. For a three phase to ground fault at bus ④ of the network of Figure 2, calculate the (i) total fault current, (ii) bus voltages during fault and (iii) the short circuit currents in the lines connected to the faulted bus using symmetrical components. Assume fault impedance $Z_F = 0.1$ pu. (2+6+6)

$$Given: \quad z^{(1)}_{43,43} = 0.60 \quad and \quad z^{(1)}_{24,24} = 0.40$$

$$and \quad Z^{(1)}_{BUS} = \quad Z^{(2)}_{BUS} =$$

	②	③	④
②	0.0876	0.0149	0.0586
③	0.0149	0.0876	0.0439
④	0.0586	0.0439	0.2928

where $Z^{(1)}_{BUS}$ and $Z^{(2)}_{BUS}$ are the positive and negative sequence reactance matrices respectively.

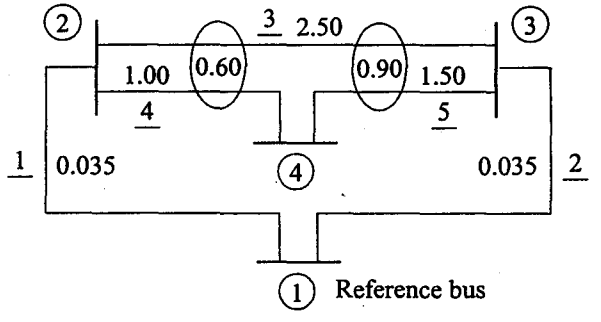

Figure 2: Problem 4

GROUP – B

5. Line Data of a four bus system is as follows:

Line Number	From Bus	To Bus	Series Impedance (p.u.)	Half Line Charging Admittance (p.u.)
1	1	2	0.01008 +j 0.05040	J 0.05125
2	1	3	0.00744 + j0.03720	J 0.03875
3	2	4	0.00744 + j0.03720	J 0.03875
4	3	4	0.01272 + j 0.06360	J 0.06375

(a) Calculate the elements of bus admittance matrix using the above line data.

(b) Modify the bus admittance matrix calculated in (i) if a parallel line (with line parameters same as existing line) is installed connecting bus nos. 1 and 2 and a capacitance with an admittance j.1 p.u. is connected at bus no. 3.

(c) Explain the terms (i)acceleration factor and (ii) tolerance in connection with load flow study.

[9+3+2]

6. Develop the model of a phase shifting transformer with a voltage ratio E_p/E_s = a + j b and admittance ***y*** so as to consider it in the bus admittance matrix. [14]

7. Develop the equations required to make a load flow study of a four bus system using Newton Raphson Method and describe the Newton Raphson Load Flow algorithm.

[14]

X