M.E.(Elec.), 1st Semester Examination, 2011

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*) What are the (i) loops and basic loops, and (ii) cut-sets and basic cut-sets?

(*b*) With reference to Figure 1, show basic loops and basic cut-sets.

(*c*) Draw and define primitive networks in impedance and admittance forms for 1-ϕ network. (4+6+4)

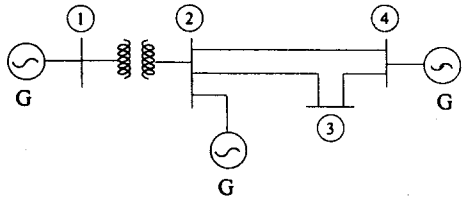

Figure 1: Problem 1(b)

2.(*a*) Establish the relationship $Z_{BUS} = (A^t\,[y]\,A)^{-1}$.

(b) The pu reactances of the elements of Figure 2 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 couplings, compute Y_{BUS} using $Y_{BUS} = A^t\,[y]\,A$. (7+7)

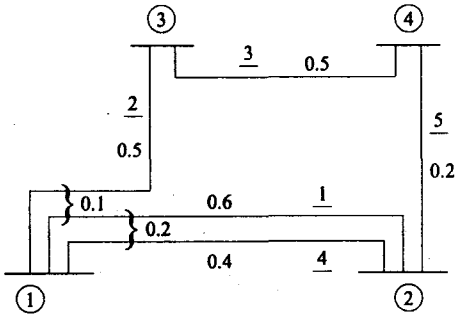

Figure 2: Problems 2(b) & 3

3. The following symmetric elements of bus impedance matrix is obtained after connecting an element 6 between bus ④ and bus ② in Figure 2 which has self reactance of 0.3 pu and is coupled to element 5 with mutual reactance of 0.1 pu.

$Z_{22} = 0.2697$; $Z_{23} = 0.1285 = Z_{32}$; $Z_{24} = 0.2344 = Z_{42}$; $Z_{33} = 0.3403$;
$Z_{34} = 0.1816 = Z_{43}$; $Z_{44} = 0.3462$

Also given that the inversion of $\begin{bmatrix} 0.2 & 0.1 \\ 0.1 & 0.3 \end{bmatrix}$ is $\begin{bmatrix} 6 & -2 \\ -2 & 4 \end{bmatrix}$.

Modify the above bus impedance elements after removing the element 6 from the network. (14)

4.(*a*) (i) Why is short circuit studies needed? (ii) What are the assumptions made in representing a power system network for short circuit studies?

(b) In admittance form of representation of fault circuit, derive general expressions for (i) current at the faulted bus; *ii*) voltage at the faulted bus; *iii*) voltages at the buses other than the faulted bus and *iv*) fault currents flowing through the elements in phase components. ((2+2)+(4+1+1+4))

GROUP – B

5. In an existing n bus power system, a phase shifting transformer with a complex ratio $a_s + jb_s$ is being newly connected between two existing buses ⓟ and ⓠ. Explain in detail how different elements of existing bus admittance matrix will get changed. Derive any mathematical expression used for this purpose. (14)

6. Justify the following:

(i) Choice of slack bus is a must in load flow study

(ii) $P-\delta$ and $Q-|V|$ couplings are strong but $P-|V|$ and $Q-\delta$ couplings are weak

(iii) On-line load flow studies are time critical

(iv) D.C. load flow method is not an iterative method and it does not provide any information on Q-flows through lines or voltage magnitudes at buses

(3+4+3+4)

7. State the assumption made in Fast Decoupling Load Flow (FDLF) method, derive the voltage the voltage equations and describe the FDLF algorithm. (14)