(2) Examination copies. (2)

THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY, PATIALA

END-SEMESTER TEST

Subject: Computer Applications to Power System Analysis (PS-001)
Session: July-Dec., 2006
Course Instructor: Parag Nijhawan
M.Marks: 72 **Time: 3hours**

Instructions: ***Question-1 is compulsory. Attempt any four questions out of the remaining five questions.*** The weightage of each question is indicated. Attempt all parts of one question at one place; otherwise, part(s) done at subsequent place(s) will be taken as over-attempt(s). Assume any missing data, if required. Notations have their usual meaning.

NOTICE: Evaluated answer sheets will be shown to the students on 07/12/2006 at 12.30PM in C-104.

1) a) Prove the following:
(i) $Y_{BUS} = A^tYA$ (ii) $Y_{BR} = B^tYB$,
Where A is bus incidence matrix, B is cut-set incidence matrix, Y_{BUS} is bus admittance matrix, Y is primitive admittance matrix and Y_{BR} is branch admittance matrix.
b) For the network shown in Figure-1, obtain the Y_{BUS} and Y_{BR} matrices by singular transformations. Take bus 1 as reference. The values of the impedances for the network are given below:

Element Number	Self		Mutual	
	Bus Code p-q	Impedance $z_{pq,pq}$	Bus Code r-s	Impedance $z_{pq,rs}$
1	1-2(1)	0.6		
2	1-3	0.5	1-2(1)	0.1
3	3-4	0.5		
4	1-2(2)	0.4	1-2(1)	0.2
5	2-4	0.2		

(6,6)

2) A 100MVA, 13.2kV (L-L) cylindrical rotor generator is operated at rated voltage. The generator is Y-connected, impedance grounded, and is driving a Y-Y connected transformer exciting a 138kV (L-L) transmission line, as shown in Figure-2. The sequence impedances for the elements are given below:

$$Z_{gen}^{012} = j\begin{bmatrix} 0.34 & 0 & 0 \\ 0 & 0.1 & 0 \\ 0 & 0 & 0.1 \end{bmatrix} \text{(p.u.)}, \qquad Z_{wye,G}^{012} = j\begin{bmatrix} 0.36 & 0 & 0 \\ 0 & 0.06 & 0 \\ 0 & 0 & 0.06 \end{bmatrix} \text{(p.u.)},$$

$$Z_{line}^{012} = j\begin{bmatrix} 1.0 & 0 & 0 \\ 0 & 0.34 & 0 \\ 0 & 0 & 0.34 \end{bmatrix} \text{(p.u.)}$$

The transformer has 0.06p.u. reactance and 0.1p.u. grounded reactance on the generator side. Find the fault current and bus voltages for balanced three-phase fault to ground occurring at the transformer terminals. (15)

3) Real and reactive line flows are measured at both ends of three transmission lines on the three-bus, three-line power transmission system shown in Figure-3. The set of power flow measurements, using a 100MVA floating voltage base are:
S_1=0.41-j0.11, S_2=-0.40+j0.10, S_3=-0.105+j0.11, S_4=0.14-j0.14, S_5=0.72-j0.37, S_6=-0.70+j0.35; Z_{12}=0.08+j0.24, Z_{23}=0.06+j0.18, Z_{31}=0.02+j0.06
The line charging and shunt terms are negligible. Consider each line flow measurement to be performed with c_1=0.02 accurate meters with 100MW, 100MVAR full scale range, and c_2=0.005 transducer errors. Calculate the weighting factor for each measurement, and hence find the state vector $\mathbf{E}_{BUS}$ after performing two iterations. (15)

4) Discuss Z_{BUS} building algorithm, in detail. How can the Z_{BUS} matrix be updated, if any line is removed from the previously existing network, or the impedance value of existing line gets modified. (Include the effect of mutual coupling also). (15)

5) a) What do you understand by Load Flow problem? What are the various types of buses that exist in the power system network? Discuss the characteristic of each bus and also, clearly distinguish between the PV bus and the Voltage-Controlled bus.
b) Write the flow chart to solve the LF problem using NR method. (6,9)

6) Write short notes on **any three** the following:
a) Compare: (i) NR and FDLF based LF solution (ii) GA and classical methods based OPF
b) State Estimation and its scope of improvement
c) Symmetrical components and its application to LLG fault problem
d) SD based OPF solution (15)

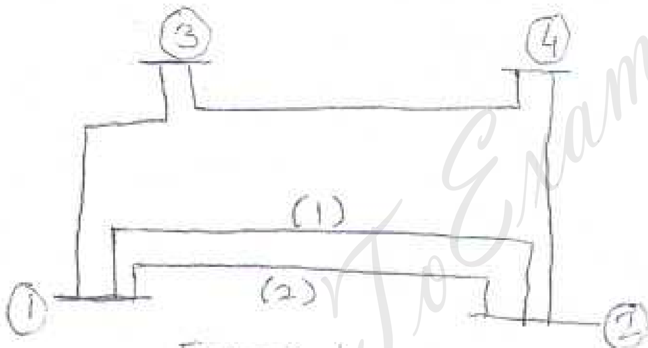

Figure-1

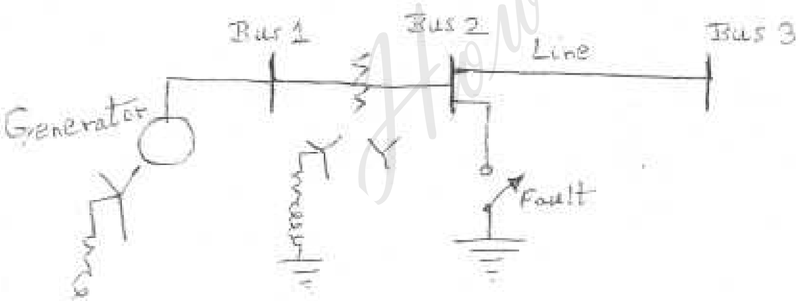

Figure-2

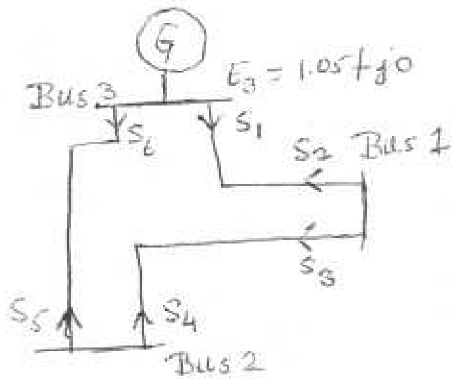

Figure-3