Reg. No. :

Question Paper Code : X 86078

M.E./M.Tech. DEGREE EXAMINATIONS, NOV./DEC. 2020
First Semester
Power Systems Engineering
PS 5101 – ADVANCED POWER SYSTEM ANALYSIS
(Regulations 2017)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Define sparse matrix.
2. Express LU decomposition.
3. List the significance of PV bus.
4. Define the term sensitivity factor in power system.
5. Give the application of OPF.
6. Define interior point algorithm.
7. Define mutual coupling.
8. Write down the boundary condition in double line to ground fault.
9. List the advantages of Euler's method of transient stability analysis.
10. State the factors influencing transient stability.

PART – B **(5×13=65 Marks)**

11. a) Solve the following equation using Gauss Elimination Method.

$$x + 2y + 3z = 1$$
$$-3x - 2y - z = 2$$
$$4x + 4y + 4z = 3$$

(OR)

b) Find the L and U triangular factors of the matrix.

$$A = \begin{bmatrix} 1 & 2 & -3 & 4 \\ 4 & 8 & 12 & -8 \\ 2 & 3 & 2 & 1 \\ -3 & -1 & 1 & -4 \end{bmatrix}$$

12. a) Draw the detailed flowchart of power flow analysis using Newton Rapson Method and explain its algorithm.

(OR)

b) Obtain the power flow solution by the FDLF method. Figure 12(b) shows the one-line diagram of a simple three bus power system with generators at bus 1 and 3. The magnitude of voltage at bus 1 is adjusted to 1.05 p.u. Voltage magnitude at bus 3 is fixed at 1.04 p.u. with a real power generation of 200 MW. A load consisting of 400 MW and 250 MVAR in power from bus 2. Line impedance is marked in p.u. on a 100 MVA base. And the line charging susceptance is neglected. Obtain the power flow solution by the FDLF method including line flow and line losses.

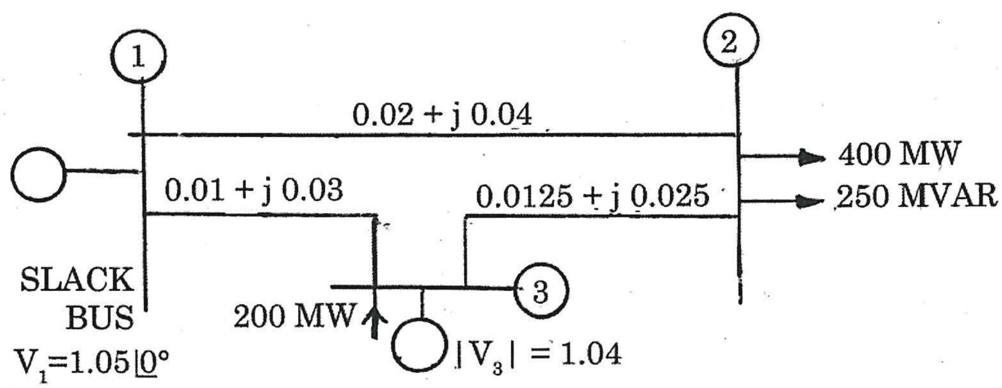

Figure 12(b)

13. a) Consider the three-bus, three-line power system shown in Figure 13(a). The fuel cost characteristics of two generators are as under :

$F_{c_1}(P_{g_1}) = 20P_{g_1}^2 + 175P_{g_1} + 50$ cost/hr

$F_{c_2}(P_{g_2}) = 30P_{g_2}^2 + 180P_{g_2} + 40$ cost/hr

Where P_{g_1} and P_{g_2} are in p.u on 100 MVA base. The line data and bus data are as follows.

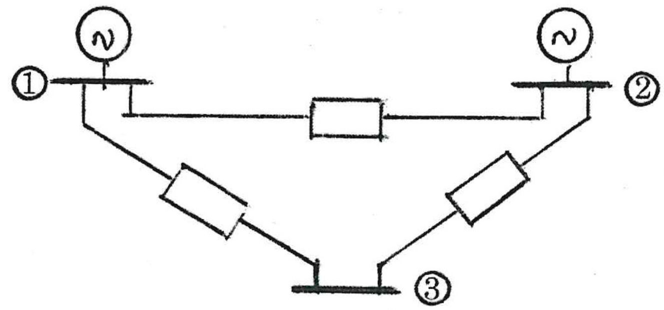

Figure 13(a)

Line data of the system

Line No.	From bus	To bus	Line impedance (p.u.)	B/2 (p.u.)
1	1	2	(0.05 + j 0.3)	j 0.01
2	1	3	(0.05 + j 0.3)	j 0.01
3	2	3	(0.05 + j 0.3)	j 0.01

The power and bus voltages of the system

Bus No.	Bus type	V (p.u.)	P_g (p.u.)	Q_g (p.u.)	P_d (p.u.)	Q_d (p.u.)
1	Slack	$0.02 \angle 0°$	?	?	0.2	0
2	PV	| 1.01 |	?	?	0.1	0.15
3	PQ	?	0	0	0.25	0.1

Find out the optimal power flow solution using gradient method.

(OR)

b) Formulate the security constrained optimum power flow problem and explain.

14. a) Find the bus impedance matrix for the system whose reactance diagram is shown in Figure 14(a). All the impedances are in p.u.

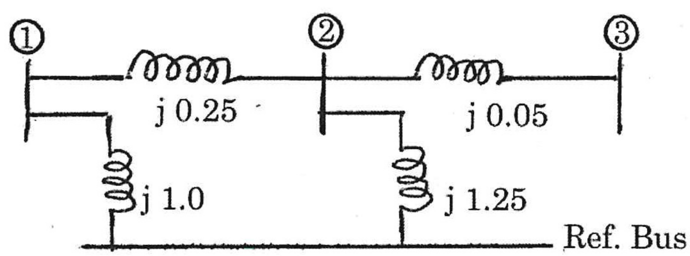

Figure 14(a)

(OR)

b) A three phase synchronous generator and a synchronous motor rated 25 MVA, 11 KV each have a sub transient reactance's of 15%. They are connected through a line with negligible resistances and having a reactance of 10% on the basis of the machine ratings. The motor is drawing 20 MW at a leading power factor of 0.8 at a terminal voltage of 10.78 KV, when a symmetrical three phase fault occurs at the motor terminals. Find the sub transient currents in a generator, motor and fault by using the internal voltages of the machines. Verify using Thevenin's theorem.

15\. a) Describe the computational algorithm for transient stability analysis using Modified Euler's method.

(OR)

b) Derive the expression of transient stability analysis for multi machine system model.

PART – C **(1×15=15 Marks)**

16\. a) Figure 16 (a) shows a 4 bus system. Treat bus 4 as reference. Find with the help of bus impedance matrix method, the post fault currents in all the branches and post fault voltages at all buses, if a three phase fault occurs at bus 3. The pre fault currents are neglected.

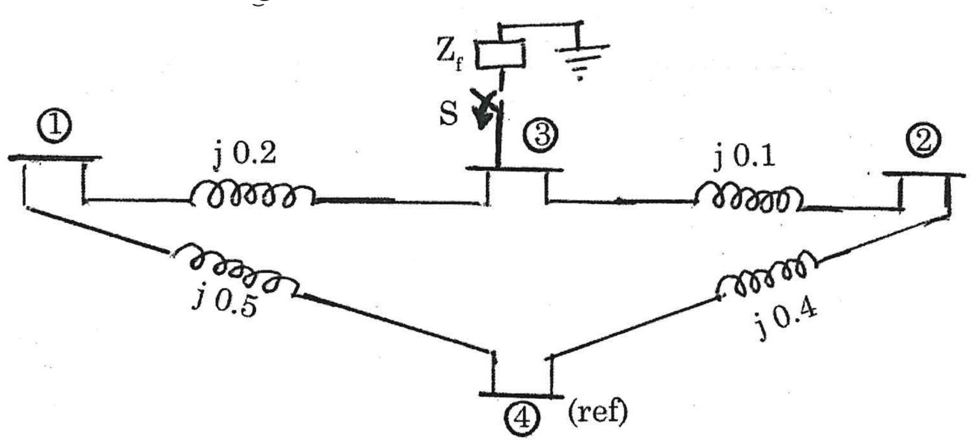

Figure 16 (a)

(OR)

b) A 30 MVA, 1 1 KV generator has $Z_1 = Z_2 = j0.2$ p.u., $Z_0 = j0.05$ p.u. A line to ground fault occurs on the generator terminals. (i) Find the fault current and line to line voltages during fault conditions. Assume that the generator neutral is solidly grounded and that the generator is operating at no load and at rated voltage at the occurrence of fault (ii) Find the line current for a 3 phase fault.