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18EE71

Seventh Semester B.E. Degree Examination, July/August 2022
Power System Analysis – 2

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following with example:
   (i) Oriented graph
   (ii) Basic loop
   (iii) Co-tree (06 Marks)

b. Determine Y_{BUS} by singular transformation for the system with data as follows:

Element No.	1	2	3	4	5
Bus code	0 – 1	1 – 2	2 – 3	3 – 0	2 – 0
Self admittance (P_u)	1.4	1.6	2.4	2.0	1.8

(07 Marks)

c. For the power system shown in Fig. Q1 (c), select ground as reference and a tree for which link elements are 1 – 2, 1 – 4, 2 – 3, 3 – 4. Obtain basic cutset and basic loop incidence matrices. Verify the relation $C_b = -B\ell^t$. (07 Marks)
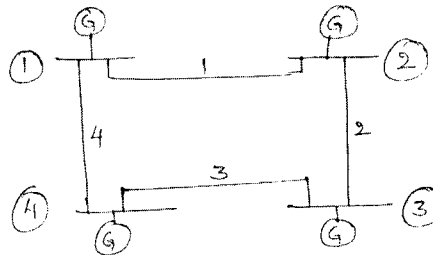

Fig. Q1 (c)

OR

2 a. The oriented connected graph of a system is shown in Fig. Q2 (a). Obtain basic cutset and basic loop incidence matrices. Hence verify the relation (i) $B\ell = A\ell K^t$ (ii) $B^t C = 0$. Take ground as reference. (08 Marks)
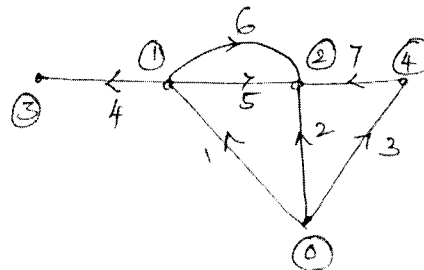

Fig. Q2 (a)

b. With usual notations, prove that $Y_{BUS} = A^T[y]A$ using singular transformation. (06 Marks)

c. For the given power system data, obtain Y_{BUS} (06 Marks)

Element	1	2	3	4	5	6	7
Impedence in pu	j0.4	j0.25	j0.1	– j0.2	j0.5	j0.3	j0.2

Module-2

3 **a.** In the power system network shown in Fig. Q3 (a), the slack bus voltage is $1.04 \angle 0°$. Bus 2 is PQ bus with $S_2 = 6 - j1.5$ pu and bus 3 is PV bus with voltage magnitude 1.02 pu and real power 0.8 pu. $Z_{12} = 0.04 + j0.6$ pu ; $Z_{23} = 0.02 + j0.03$ pu . Find the voltage at bus 2 at the end of first iteration using G-S method. **(08 Marks)**
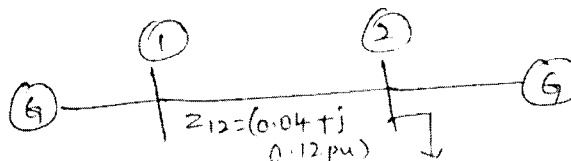

Fig. Q3 (a)

b. Derive the expressions for power flow equations used in load flow analysis. **(06 Marks)**

c. What are the different types of buses considered during load flow analysis? Explain briefly. **(06 Marks)**

OR

4 **a.** For the 3 bus system shown in Fig. Q4 (a), the elements of Y_{BUS} are as follows:
$Y_{11} = Y_{22} = Y_{33} = 5.868 - j23.514$ pu and $Y_{12} = Y_{13} = Y_{23} = Y_{31} = Y_{32} = -2.934 + j11.767$ pu. Reactive power limits at bus 3 are $0 \le Q_3 \le 1.5$ pu . Determine whether bus 3 continues as PV bus and thereafter determine new estimate of voltage at bus 3 using GS method. **(08 Marks)**
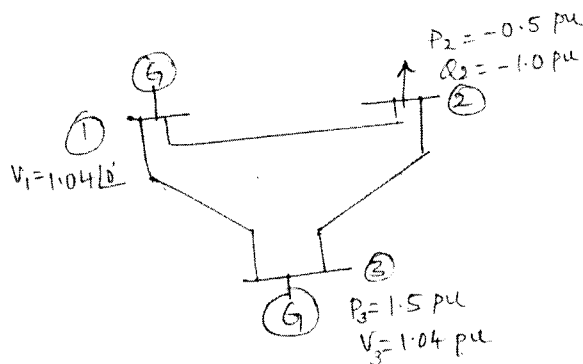

Fig. Q4 (a)

b. What are the data required to conduct load flow analysis? **(08 Marks)**

c. Discuss the operating constraints considered during load flow analysis. **(04 Marks)**

Module-3

5 **a.** Derive the expressions for diagonal elements of Jacobian matrices in NR method of load flow analysis. **(08 Marks)**

b. Starting from all the assumptions deduce the fast Decoupled load flow model. **(06 Marks)**

c. Compare Gauss-Seidel and NR load flow methods in respect of, (i) time / iteration and number of iterations (ii) Total solution time (iii) Convergence characteristics. **(06 Marks)**

OR

6 **a.** For a 3 bus system, the elements of Y_{BUS} are as follows :
$Y_{11} = Y_{22} = Y_{33} = 24.23 |{-75.95}$ pu ; $Y_{12} = Y_{13} = Y_{21} = Y_{23} = Y_{31} = Y_{32} = 12.13 |104.04$ pu. The bus voltage are $V_1 = 1.04 + j0$ pu (slack), $V_2 = 1 + j0$ pu (PQ bus), $V_3 = 1.04 + j0$ pu (PV bus). Determine the elements of sub matrix J_1 and J_4 of Jacobian matrix in NR load flow method. **(08 Marks)**

b. Explain with flow chart and equation how the load flow analysis is carried out using Newton Raphson method. **(08 Marks)**

c. Describe Fast Decoupled load flow method with a flow chart. **(04 Marks)**

Module-4

7 a. Derive an expression for transmission loss as a function of plant generation for a two plant system. **(06 Marks)**

   b. A two bus system is shown in Fig. Q7 (b). If 75 MW of power is imported to bus 1, a loss of 5 MW is incurred. Find the required generation for each plant and the power received by load when the plant incremented cost is 20 Rs./Mwh. The incremental fuel cost of two plants are given by $\dfrac{dF_1}{dP_1} = 0.03P_1 + 15$; $\dfrac{dF_2}{dP_2} = 0.05P_2 + 18$ **(08 Marks)**
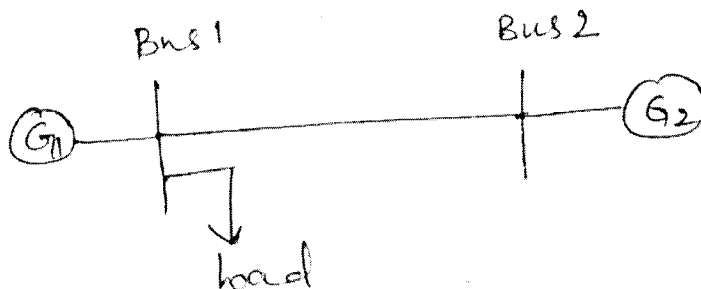

Fig. Q7 (b)

   c. Define unit commitment. Explain dynamic programming method of unit commitment solution. **(06 Marks)**

OR

8 a. Deduce the condition for optimal load dispatch considering transmission losses in a system. **(06 Marks)**

   b. The operating cost of F_1 and F_2 in Rs./h of two generating units each of 100 MW are $F_1 = 0.2PG_1^2 + 40PG_1 + 120$; $F_2 = 0.25PG_2^2 + 30PG_2 + 150$. Find (i) The optimal generation of 2 units for total demand of 180 MW and the corresponding total cost (ii) Saving in Rs./h in this case, as compared to equal sharing between the two generators. **(08 Marks)**

   c. Explain prior list method of unit commitment solution with a flow chart. **(06 Marks)**

Module-5

9 a. Form Z_{bus} using Building algorithm of the system shown in Fig. Q9 (a). Self impedances of the elements are marked on the diagram. **(06 Marks)**
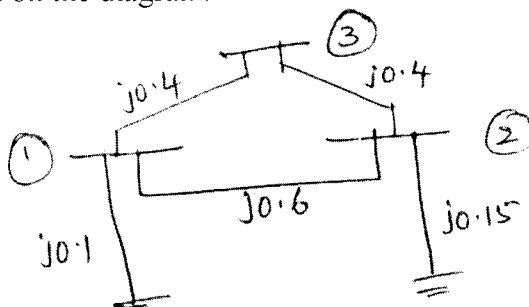

Fig. Q9 (a)

   b. Explain the steps involved in solving power system stability solution of swing equation using point-by-point method. **(08 Marks)**

   c. The swing equation of a synchronous generator is $\dfrac{d\delta}{dt} = \omega - 377$ r/s ; $\dfrac{d\omega}{dt} = 23[1 - 0.4\sin\delta]$. At t = 0 s ; $\omega = 377$ r/s and $\delta = 0.523$ r. Determine the values of ω and δ at 0.1 s using modified Euler method. Assume $\Delta t = 0.05$ s. **(06 Marks)**

OR

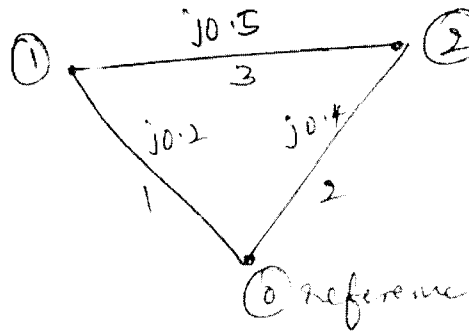10 a. Obtain Z_{bus} for the power system shown in Fig. Q10 (a). (06 Marks)

Fig. Q10 (a)

b. Explain Runge Kutta method for the solution of swing equation. (06 Marks)

c. Explain the algorithm for short circuit analysis using Bus Impedance matrix. (08 Marks)

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