USN

18EE71

Seventh Semester B.E. Degree Examination, Feb./Mar. 2022
Power System Analysis - II

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Explain the following terms in network topology with an example. **(06 Marks)**
i) Tree ii) Basic loops iii) Basic cut-sets.

b. Consider an oriented graph of the power system network shown below Fig Q1(b). Choose branches 1, 3 and 5 as twigs. Build a bus incidence matrix A and basic cut-set matrix B for the oriented graph. Select node 2 as reference.

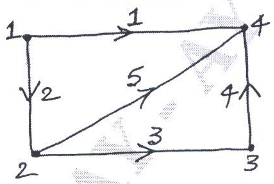

Fig Q1(b) **(08 Marks)**

c. A power system consists of four buses. The generators are connected at buses 1 and 3. The transmission lines are connected between buses 1-2, 1-4, 2-3 and 3-4 which have reactances of j0.25, j0.5, j0.4 and j0.1 respectively. Develop a bus admittance matrix by direct inspection method. Choose bus 1 as reference. **(06 Marks)**

OR

2 a. Build bus incidence matrix A and then bus admittance matrix Y_{bus} using singular transformation method for the power system network shown below in Fig Q2(a). Choose bus 1 as reference. The linedata of the power system are given in Table Q2(a) below.

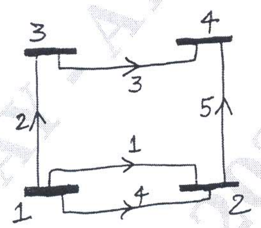

Fig Q2(a)

line No	Bus code (p-q)	Z(pu)	Mutual temperature Z_m(pu)
1	1 – 2	0.6	0.2 (line 2)
2	1 – 3	0.5	–
3	3 – 4	0.5	–
4	1 – 2	0.4	0.1 (line 1)
5	2 – 4	0.2	–

Table Q2(a)

(08 Marks)

b. Define primitive network and explain its two forms with neat representation circuit. Also derive their respective performance equations. **(06 Marks)**

c. Consider an oriented graph of the power system shown below in Fig Q2(c). Choose branches 1, 3 and 5 as twigs to form a tree. Build a basic loop incidence matrix C for the given oriented graph. Select node 2 as reference.

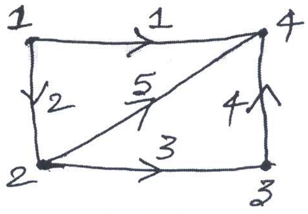

Fig Q2(c) **(06 Marks)**

Module-2

3 a. State the need of load flow study. Derive the static load flow equations or power flow equating to conduct load flow study in usual notations. **(06 Marks)**

b. For a 4 bus power system network shown below in Fig Q3(b), the generators are connected at all four buses, while loads are at buses 2 and 3. The real and reactive powers are listed below in table 3(b). Assuming a flat voltage start compute the unknown variables in all the buses other than the slack at the end of first GS iteration. Take acceleration factor as 1.4

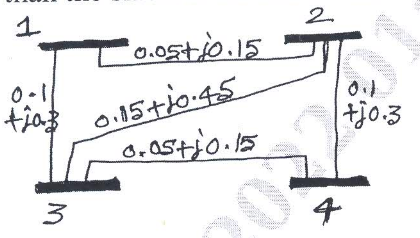

Fig Q3(b)

Bus No.	P_i(pu)	Q_i (pu)	V_i(pu)
1	–		$1.04\angle 0°$
2	0.5	–0.2	–
3	–1	0.5	–
4	0.3	–0.1	–

Table Q3(b)

(14 Marks)

OR

4 a. Explain the algorithm for Gauss – Seidel method to obtain load flow solution of a power system network with i) Absence of PV buses ii) Presence of PV buses. **(10 Marks)**

b. For the power system network shown below in Fig Q4(b), the line impedance are marked in pu. The bus data of the power system are shown below Table Q4(b). Compute the voltage in all buses other than slack at the end of first iteration using Gauss – Seidel method. Take $0 < Q_2 < 0.35$pu.

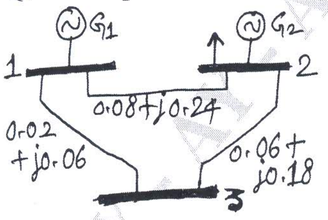

Fig Q4(b)

Bus No.	Voltage (pu)	Generation		Load	
		P_G	Q_G	P_D	Q_D
1	$0.05\angle 0°$	–	–	–	–
2	1.03	0.2	–	0.5	0.2
3	–	0	0	0.6	0.25

Table Q4(b)

(10 Marks)

Module-3

5 a. Derive the general expression for Jacobian elements in polar form with usual notations in NR method to obtain load flow solution. **(10 Marks)**

b. Explain the algorithm of Fast Decoupled Load Flow method with a neat flow chart for the load flow solution of a power system network. **(10 Marks)**

OR

6 a. In a two bus power system network shown below in Fig Q6(a), the bus – 1 is a slack bus with $V_1 = 1\angle 0°$pu and bus 2 is a load bus with P_2 = 100MW, Q_2 = 50MVAR. The line impedance is (0.12 + j0.16)pu on a base of 100MVA. Using NR method of load flow solution, compute the voltage at bus 2 at the end of first iteration.

Fig Q6(a) **(10 Marks)**

b. Compare Gauss – Seidal, Newton Raphson and Fast decoupled load flow method of load flow solution with respect to various parameters. **(10 Marks)**

Module-4

7 a. A constant load of 300mW is supplied by two 200MW generators 1 and 2 for which the respective incremental fuel costs are, $\frac{dC_1}{dP_{G1}} = 0.1P_{G1} + 20$ and $\frac{dC_2}{dP_{G2}} = 0.12\,P_{G2} + 15$, where P_G's in MW and costs C_1 and C_2 are in Rs/hr. Determine : i) the most economical division of load between the generators and ii) the saving in Rs./day there by obtained compared to equal load sharing between generators. **(10 Marks)**

b. Explain various constraints involved in unit commitment solution. **(10 Marks)**

OR

8 a. Two units are connected at two buses through a transmission line. If 100MW is transmitted from unit 1 at bus 1 to the load at bus 2, a line loss of 10MW is incurred. The incremental cost curve of the two units are,
$IC_1 = 16 + 0.02\,P_1$ Rs./MWhr and
$IC_2 = 20 + 0.04\,P_2$ Rs./MWhr
If the system incremental cost is Rs.26/MWhrs no load fuel costs are Rs. 250 and Rs. 350 per hour for units 1 and 2 respectively, then determine the following :
i) Power generations from both units and the power received by the load if the losses are included and also coordinated
ii) Power generating from both units for the power received by the load as calculated above, if the losses are included but not coordinated
iii) Net saving in fuel cost by coordinating the losses. **(12 Marks)**

b. Explain the Dynamic program algorithm with the recursive relation and also explain forward DP approach with a neat flow chart. **(08 Marks)**

Module-5

9 a. Explain the algorithm for short circuit studies to be carried out in large power systems. **(08 Marks)**

b. A 20MVA, 50Hz generator delivers 18MW over a double circuit line to an infinite bus. The generator has kinetic energy of 2.52MJ/MVA at rated speed. The generator has a transient reactance of 0.35pu. Each transmission line has a reactance of 0.2pu on a 20MVA base. The generator excitation voltage $|E'| = 1.1$pu and infinite bus voltage $V = 1\angle 0°$ pu. A three phase short circuit occurs at the midpoint of one of the lines. Plot the swing curve with the fault cleared by simultaneous opening of breakers at both ends of the line at 2.5 cycles after the occurrence of fault. Take a step size of time as 0.05sec. Also, calculate the critical clearing angle. Use point by point method. **(12 Marks)**

OR

10 a. For a three bus power system network show below in Fig Q10(a), the pu impedances are shown therein. Build bus impendence matrix Z_{bus} using step by step building algorithm. Add the elements in the order specified.

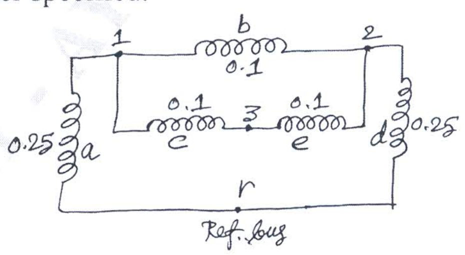

Fig Q10(a) **(10 Marks)**

b. Build an algorithm for numerical solution of swing equation by Runge - Kutta method. **(10 Marks)**

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