Dr Sushil Chauhan 3/5/2022 12 48

National Institute of Technology, Hamirpur (HP)

B. Tech. End-sem Examination

Branch :EE **Semester:6th**

Course code: EE-322 **Title of the Course: Power System Analysis**

Time: 3 Hours **Maximum Marks: 50**

Note: Attempt any FIVE questions

Q.1(a) Derive an expression for the ABCD parameters of a long length transmission line from first principle. Prove that transmission line is symmetric and bilateral network. (5)

(b) Derive ∏-equivalent circuit for tap-changing transformer with an admittance, y_t referred to unity side and off-nominal turn ratio, a. Also explain how it helps in regulating voltage and reactive power. (5)

Q.2(a) Using topological concepts, give formulation to obtain Z_{BUS}. (5)

(b) In Z_{BUS} bus building algorithm, when a link is added to an existing partial network how elements of partial Z_{BUS} get modified. Also take into account special cases. (5)

Q.3(a) The one-line diagram of a 4-bus system is shown in Fig. 1. The system data is given in Table 1. Formulate Y_{BUS} without line 1-2. If line 1-2 is added, show how Y_{BUS} get modified. (7)

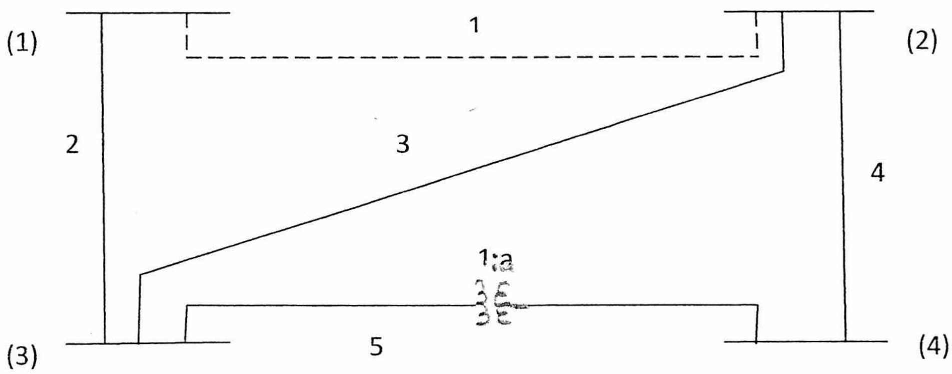

Fig. 1

Table 1

Line no.	**Between buses p-q**	**Line impedance (pu) R + jX**	**Half-line charging admittance ($Y_c/2$)**	**Off-nominal turn ratio, a**
1.	1-2	0.05 + j0.15	2.0 – j6.0	-
2.	1-3	0.1 + j0.3	1.0 – j3.0	-
3.	2-3	0.15 + j 0.45	0.6667 – j2.0	-
4.	2-4	0.10 + j0.30	1.0 – j3.0	-
5.	3-4	0.0 + j0.133	-	0.909

(b) Refer to 3(a):A load, $P_{D2} + jQ_{D2} = 0.123 + j0.518$ is connected at bus no. (2). Convert the load into equivalent admittance and incorporate it into the Y_{BUS} obtained in previous part and get modified Y_{BUS}. (3)

Q.4(a) What information is conveyed by load flow studies? How do we classify buses in load flow? List known and unknown variables for each kind of bus. (4)

(b) Consider the system shown in Fig.2. Each of the three lines has a series impedance of 0.02 + j0.08 pu and total shunt admittance of j0.02 pu. The specified quantities at the buses are tabulated below.

Bus	Real load demand, P_D (pu)	Reactive load demand, Q_D (pu)	Real power generation, P_G	Reactive power generation, Q_G	Voltage specification
1. Slack)	2.0	1.0	Unspecified	Unspecified	$\lvert V_1 \rvert = 1.04$; $\delta_1 = 0.0$
2. (P-Q)	0.0	0.0	0.5	1.0	Unspecified
3. (P-V)	1.5	0.6	0.0	Unspecified But $1.5 \geq Q_{G3} \geq 0$	$\lvert V_3 \rvert = 1.04$

(49)

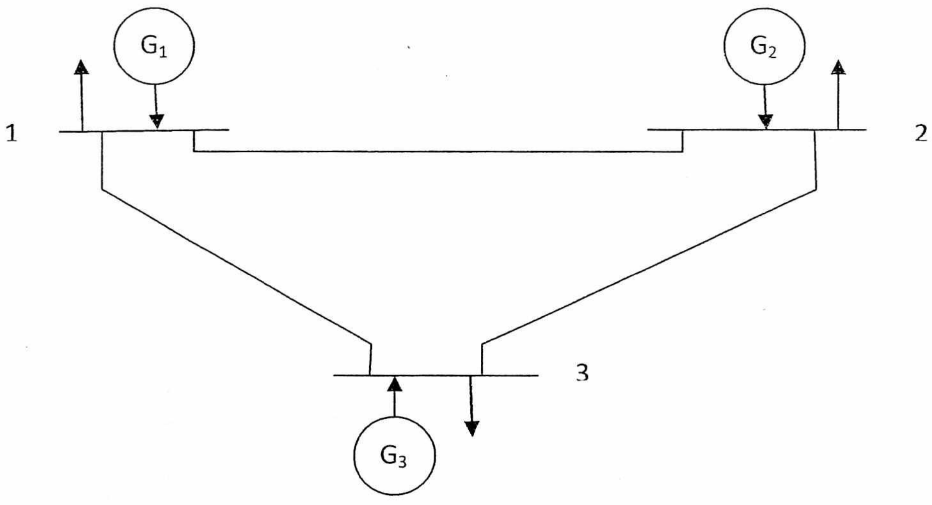

Fig.2

Perform ONE iteration of Gauss-Seidal method illustrating each step of computations. (6)

Q.5(a) Derive an expression in phase domain for fault current, voltage at faulted bus, voltage at any other bus and current flowing through various elements of power network when a generalized type of fault occurs at *pth* bus. (6)

(b) Derive an expression for fault admittance matrix [Y_F] in symmetrical component domain with nonzero value of fault impedance/admittance. (4)

Q.6(a) Derive swing equation for a machine connected to infinite bus. Give point by point method for the solution of swing equation. (5)

(b) A 50 Hz synchronous generator having inertia constant H = 5.2 s and xd' = 0.3 pu, is connected to an infite bus through a double circuit line as shown in Fig.3. The reactance of the connecting HT transformer is j0.2 pu and reactance of each line is j0.4 pu. $|E_g|$ = 1.2 pu and $|V|$ = 1.0 pu and P_e = 0.8 pu. Determine the critical clearing angle and post-fault steady state operating angle when a transient three-phase-to- ground fault occurs at the HT terminals of the transformer and gets cleared automatically with both lines intact. (5)

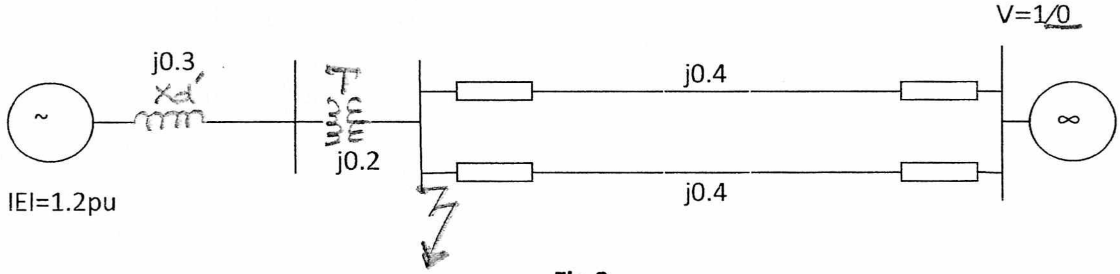

Fig.3

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