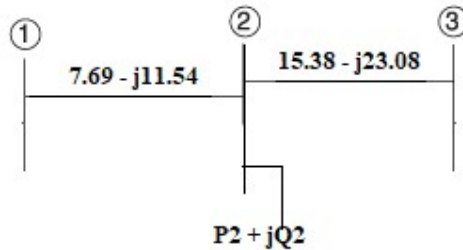


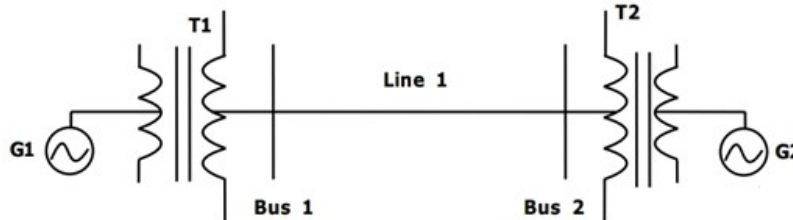
**INSTRUCTIONS:**

1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

- |  | [ ] | CO | BL |
|--|-----|----|----|
| Q.1(a) What is the objective of load flow study? Write down the load flow equations for an N-bus system.   | [2] | 2  | 1  |
| Q.1(b) Using Gauss-Seidel method find the bus voltage of bus 2 at the end of first iteration, the network is shown in figure below. The line admittances are shown in per-unit, $P_2 + jQ_2 = -5.96 + j1.46$ , $ V_3  = 1.02$ and $V_1 = 1.0 \angle 0^\circ$ . Take initial estimate of voltage magnitude as 1.0 and angle $0^\circ$ . | [3] | 2  | 3  |

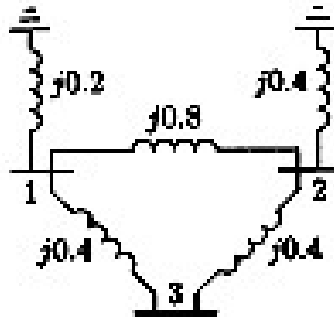


- |   |     |   |     |
|---|-----|---|-----|
| Q.2(a) Prove that the convention of taking conjugate of the current in the expression of complex power i.e. $\bar{S}_i = \bar{V}_i I_i^*$ gives actual power flow direction.  | [2] | 1 | 2   |
| Q.2(b) Define a per-unit system of calculation. Prove that the per-unit impedance referred to the primary side of the transformer is equal to the per-unit impedance referred to its secondary.   | [3] | 1 | 1,2 |
| Q.3(a) Why are the buses classified for solving the load flow problem? What are the different types of buses? How is the transmission line loss addressed while solving the load flow problem?  | [2] | 2 | 2   |
| Q.3(b) For the power system shown in the figure below, the specifications of the components are the following:<br>G <sub>1</sub> : 30 kV, 100 MVA, X = 9%, G <sub>2</sub> : 25 kV, 100 MVA, X = 9%, T <sub>1</sub> : 30/220 kV, 90 MVA, X = 12%, T <sub>2</sub> : 220/25 kV, 90 MVA, X = 12%, Line1: 220 kV, Z = 30 + j150 Ω. | [3] | 1 | 3   |

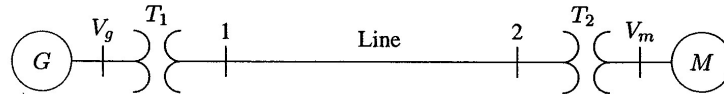


Choose 25kV as the base voltage at the generator 1 side, and 200MVA as the base MVA base. Draw the impedance diagram.

Q.4(a) Construct the bus admittance matrix for the network shown in figure below. Values [2] 2 2 indicated the line impedance.



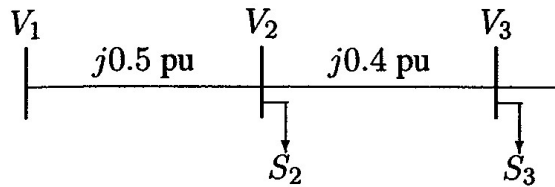
Q.4(b) The three-phase power and line ratings of the electric power system shown in the figure are given below [3] 1 3



G: 60 MVA, 20 kV,  $X = 9\%$ ;  $T_1$ : 50 MVA, 20/200 kV,  $X = 10\%$ ;  $T_2$ : 50 MVA, 200/20 kV,  $X = 10\%$ ; M: 43.2 MVA, 18 kV,  $X = 8\%$ ; Line: 200 kV,  $Z = 120 + j200\Omega$ . The motor is drawing 45 MVA, 0.80 power factor lagging at a line-to-line terminal voltage of 18 kV. Determine the terminal voltage of the generator in per-unit. Take 100 MVA base and 20 kV voltage base for generator.

Q.5(a) Describe (a) constant power load, (b) constant current load. [2] 1 2

Q.5(b) The one-line diagram of a three-phase power system is shown in figure below. [3] 1 3 Impedances are marked in per-unit on a 100 MVA, 400kV base. The load at bus 2 is  $S_2 = 15.93 \text{ MW} - j33.4 \text{ MVAR}$ , and at bus 3 is  $S_3 = 77 \text{ MW} + j14 \text{ MVAR}$ . It is required to hold the voltage at bus 3 at  $400\angle 0^\circ \text{ kV}$ . Working in per-unit determine the voltage at bus 1 and bus 2.



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