Roll No……………………..

Dr B R Ambedkar National Institute of Technology, Jalandhar

B Tech (Electrical Engineering)

EEPC – 302, Power System Analysis

End Term Examination, May 2021

Duration: 120 Minutes Max. Marks: 40 Date: 07 May 2021

Marks Distribution & Mapping of Questions with Course Outcomes (COs)					
Question Number	1	2	3	4	5
Marks	10	10	10	10	10
CO No.	1	4	2	3	1
Learning Level	LO	IO	HO	IO	LO

Note:

1. Attempt any four questions.
2. Write the answers in hard copy (on A4 or any other sheet available) using blue/black pen with their sign on top and bottom of each page. Also put page numbers on upper right corner of each page of the answer booklet.
3. The time allowed for writing examination is 02 Hours. Extra 15 minutes are allowed for scanning and sending the answer booklet.
4. Follow the instructions regarding submission of answer booklet as issued by examination section.

1. Consider the power system shown in figure 1 and associated data given in the table I. Each three-phase transformer shown in figure is made by the bank of three single phase transformers. Draw the following sequence diagrams: (a) Positive sequence diagram (b) Negative sequence diagram (c) Zero sequence diagram. **(3)** **(3)** **(4)**

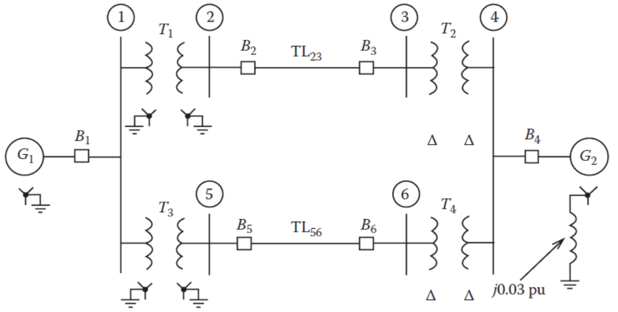

Figure 1: Single line diagram of power system for Q1

Table I: System data for Q1

Network component	**MVA rating**	**Voltage rating (kV)**	**X_1(pu)**	**X_2(pu)**	**X_0(pu)**
G_1	200	20	0.2	0.14	0.06
G_2	200	13.2	0.2	0.14	0.06
T_1	200	20/230	0.2	0.2	0.2
T_2	200	13.2/230	0.3	0.3	0.3
T_3	200	20/230	0.25	0.25	0.25
T_4	200	13.2/230	0.35	0.35	0.35
TL_{23}	200	230	0.15	0.15	0.3
TL_{56}	200	230	0.22	0.22	0.5

2. The one line diagram of the simple power system is shown in figure 2. The branch reactances and busbar loads are given in per unit on common base. Branch resistance is neglected. **(5)** **(5)**

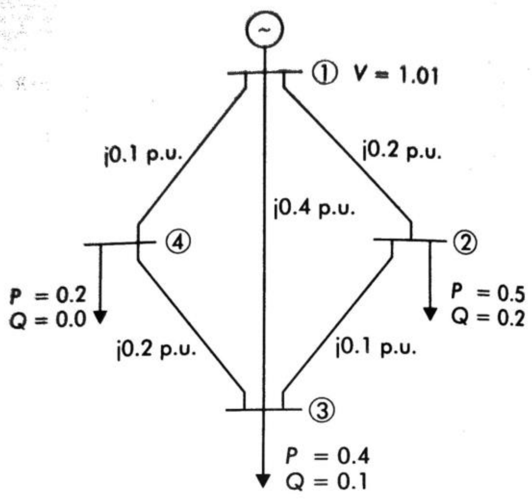

Figure 2: Single line diagram of power system for Q2

Determine the following:

(a) Bus admittance matrix for given power system.

(b) Voltages at all busbars after the first iteration of a Gauss-Seidel load flow method. Assume the initial voltages of all buses to be 1.01 pu.

3. (a) Obtain bus impedance matrix of given power system in figure 3 using building algorithm. **(5)**

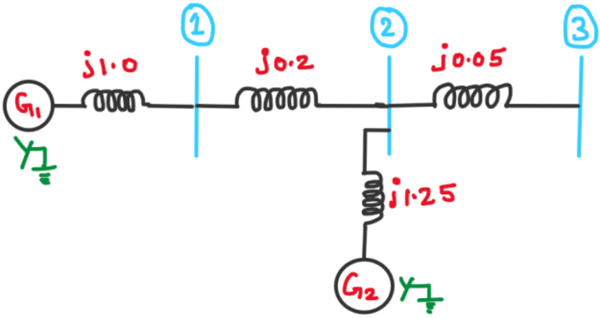

Figure 3: Single line diagram of power system for Q3(a)

(b) A balanced fault occurs at bus 3 in the power system shown in figure 4 through a fault impedance of $Z_f = j0.20$ per unit. Using the bus impedance matrix calculate the per unit fault current, bus voltages, and line currents during the fault. Also calculate short circuit capacity for selection of switchgears to protect the system. **(5)**

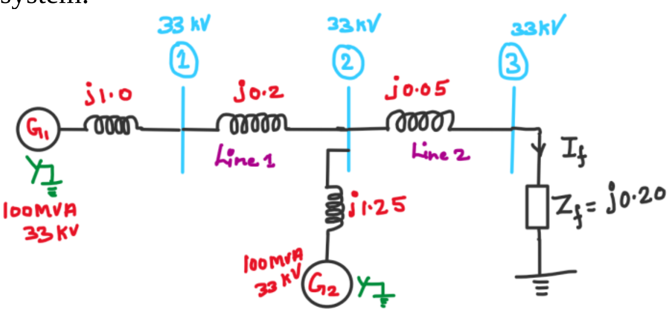

Figure 4: Single line diagram of power system for Q3(b)

4. (a) The positive-, negative- and zero sequence bus impedance matrices for a three-bus power system are given below: **(5)**

$$Z_{bus}^{1} = Z_{bus}^{2} = \begin{bmatrix} 0.16 & 0.10 & 0.15 \\ 0.10 & 0.20 & 0.12 \\ 0.15 & 0.12 & 0.25 \end{bmatrix}$$

$$Z_{bus}^{0} = \begin{bmatrix} 0.20 & 0.05 & 0.12 \\ 0.05 & 0.10 & 0.08 \\ 0.12 & 0.08 & 0.30 \end{bmatrix}$$

Determine the per unit fault current for

(i) Bolted single line to ground fault at bus 3.

(ii) Bolted line-to-line fault at bus 3

(iii) Bolted double-line to ground fault at bus 3

Explain briefly (Only two three sentences)

(b) What is difference between M and H constant used in power system stability? These constants should be high or low for stable power system? Why single machine connected to infinite bus system is preferred in power system stability studies instead of practical multi machine power system? **(3)**

(c) State critical clearing angle and time in the power system stability studies? Why their calculation is necessary for power system planning and operation? What is typical range or value of critical clearing angle & time? **(2)**

5. (a) A generator having inertia constant H =6.0 MJ/MVA is delivering power of 1.0 per unit to an infinite bus through a purely reactive parallel transmission line network. A symmetrical fault occurs near to generator bus. The maximum power that could be delivered is 2.5 per unit. When the fault is cleared the original network conditions again exist. Determine the critical clearing angle and critical clearing time. **(5)**

Explain briefly (Only two three sentences)

(b) Why Y_{BUS} matrix is preferred in load flow and Z_{BUS} matrix in the fault analysis? Why Y_{BUS} matrix is sparse matrix? Why Z_{BUS} matrix does not calculated by inversion of Y_{BUS} matrix for real power system? **(2)**

(c) Bus classification in load flow studies with known and unknown variables. How to choose slack bus for the large practical power system? What is effect on load flow results if slack bus changed? **(3)**