B. Sc. in EEE, 4th Sem.
DTE, 2nd Sem.

Date: 12 May, 2023
Time: 10:00 am–1:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course Number: EEE 4401/ EEE 4495
Course Title: Power System II

Summer Semester : 2021 - 2022
Time : 3 Hours
Full Marks: 150

There are **06 (six)** questions. Answer all **06 (six)** questions. The symbol(s) have their usual meanings. Marks of each question and corresponding CO's and PO's are written in the brackets. Assume reasonable value for any missing data.

1. a) A generator having a solidly grounded neutral and rated 50 MVA, 30 kV has positive-, negative-, and zero-sequence reactances of 25, 15, and 5 percent, respectively. Find out what reactance must be placed in the generator neutral to limit the fault current for a bolted line-to-ground fault to that for a bolted three-phase fault. **(10) (CO1) (PO1)**

b) Three 15 MVA, 30 kV synchronous generators A, B, and C are connected via three reactors to a common bus bar, as shown in Fig. 1(b). The neutrals of generators A and B are solidly grounded, and the neutral of generator C is grounded through a reactor of 2.0 Ω. The generator data and the reactance of the reactors are tabulated below. **(15) (CO2) (PO2)**

Item	X^1	X^2	X^0
G_A	0.25 pu	0.155 pu	0.056 pu
G_B	0.20 pu	0.155 pu	0.056 pu
G_C	0.20 pu	0.155 pu	0.060 pu
Reactor	6.0 Ω	6.0 Ω	6.0 Ω

A *line-to-ground fault* occurs on phase a of the common bus bar. Neglect prefault currents and assume generators are operating at their rated voltage. Determine the fault current in *phase a*.

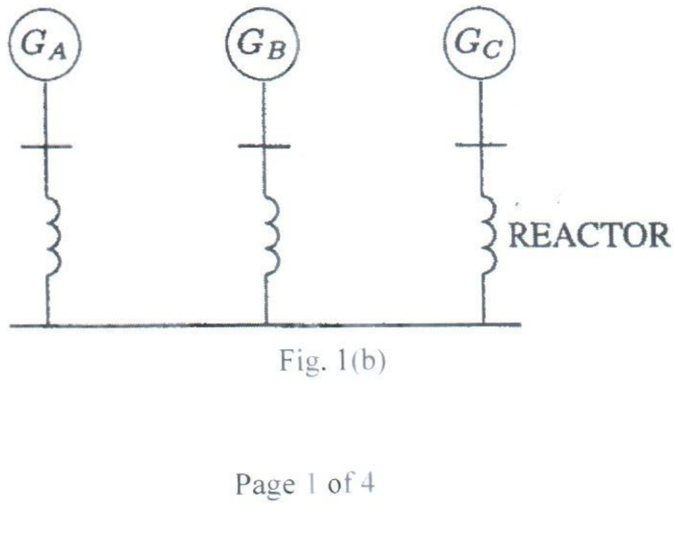

Fig. 1(b)

2. One line diagram of a simple three bus power system with generation at bus 1 is shown in Fig. 2. The voltage at bus 1 is $V_1 = 1.05\angle 0^{\circ}$ per unit. Voltage magnitude of bus 3 is fixed at 1.04 pu with a real power generation of 200 MW. A load consisting of 400 MW and 250 MVAR is taken from bus 2. Line impedances are marked in per unit on a 100 MVA base. Sketch the power flow diagram by the ***Gauss-Seidel method*** including line flows and line losses. Perform *two* iterations. **(25) (CO2) (PO2)**

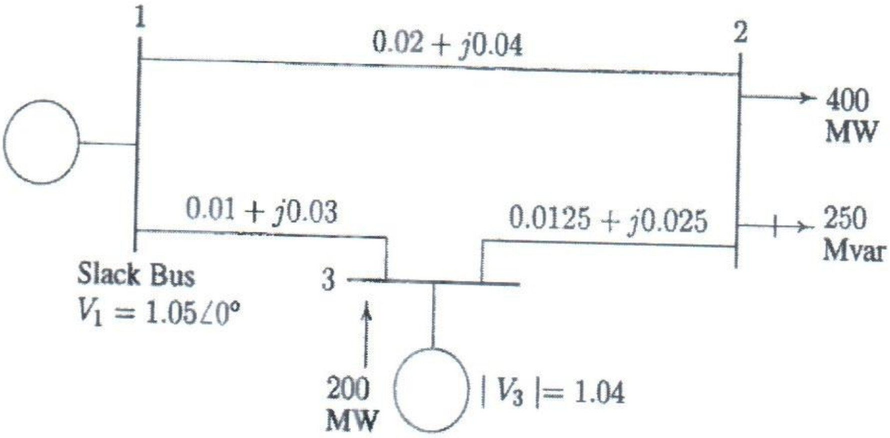

Fig. 2

3. The one line diagram of a simple three bus power system is shown in Fig. 3. Each generator is represented by an emf behind the subtransient reactance. All impedances are expressed in per unit on a common MVA base. All resistances and shunt capacitances are neglected. The generators are operating on no load at their rated voltage with their emfs in phase. A *three-phase fault* occurs at *bus 3* through a fault impedance of $Z_f = j0.19$ per unit. **(13+12) (CO3) (PO3)**

(i) Design the system using ***Thevenin's theorem*** by calculating the impedance to the point of fault and the fault current in per unit.

(ii) Also determine the bus voltages and line currents during fault.

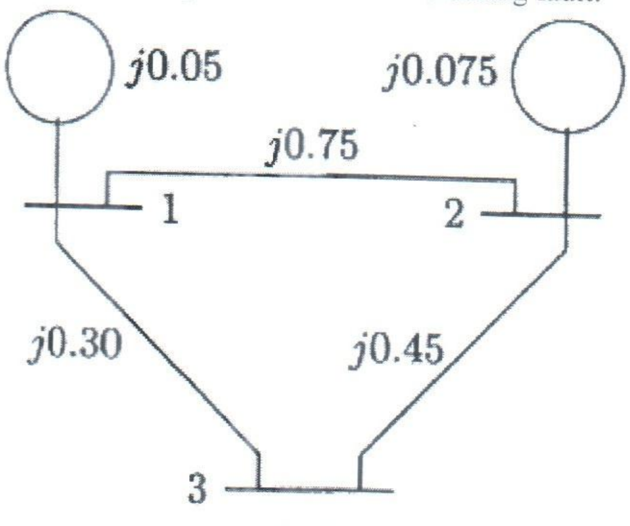

Fig. 3

4. The per unit bus impedance matrix for the power system shown in Fig. 4 is given by following Z_{bus}. A *three-phase fault* occurs at *bus 4* through a fault impedance of Z_f = j0.0025 per unit. Design the system using the ***bus impedance matrix method*** by computing the following(s): **(25) (CO3) (PO3)**

i) fault current, ii) bus voltages, and iii) short circuit currents in the lines during fault.

$$Z_{bus} = j\begin{bmatrix} 0.150 & 0.075 & 0.140 & 0.135 \\ 0.075 & 0.1875 & 0.090 & 0.0975 \\ 0.140 & 0.090 & 0.2533 & 0.210 \\ 0.135 & 0.0975 & 0.210 & 0.2475 \end{bmatrix}$$

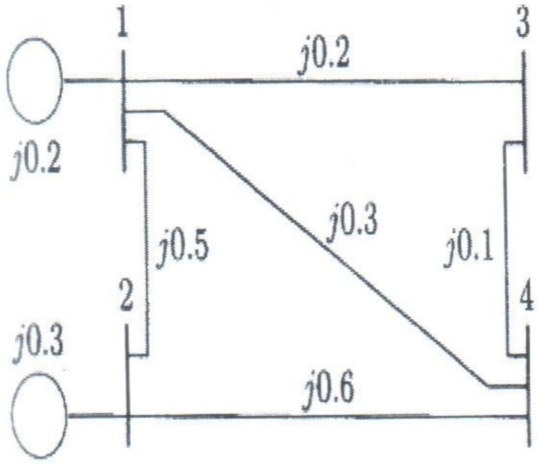

Fig. 4

5. The one line diagram of a three phase power system is as shown in Fig. 5. The transformer reactance is 20 percent on a base of 100 MVA, 23/115 kV and the line impedance is Z = j66.125 Ω. The load at bus 2 is S_2 = 184.8 MW + j6.6 Mvar, and at bus 3 is S_3 = 0 MW + j20 Mvar. It is required to hold the voltage at bus 3 at 115∠0° kV. Determine the per unit as well as actual values of the following(s): **(25) (CO2) (PO2)**

i) voltage at bus 2 and

ii) voltage at bus 1.

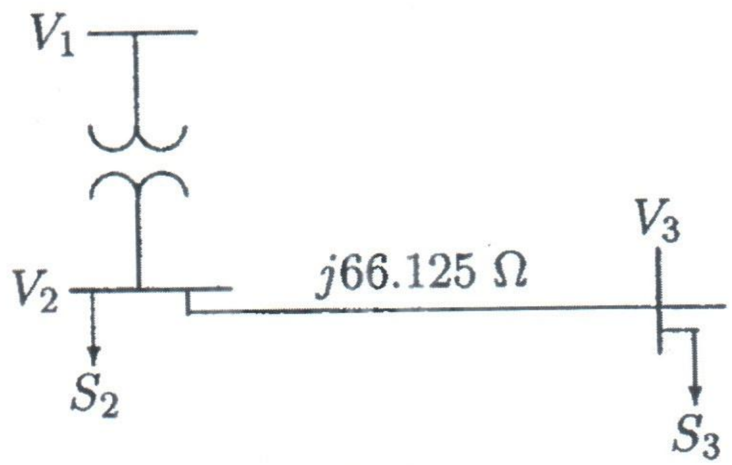

Fig. 5

6. a) In the three phase system shown in Fig. 6(a), phase a is on no load and phases b and c are short circuited to ground. The following currents are given: $I_b = 91.65\angle 160.9°$ and $I_n = 60.00\angle 90°$. Sketch the symmetrical components of current for phase a, $Ia^{(0)}$, $Ia^{(1)}$, and $Ia^{(2)}$ using ***Fortescue's theorem***. **(12) (CO1) (PO1)**

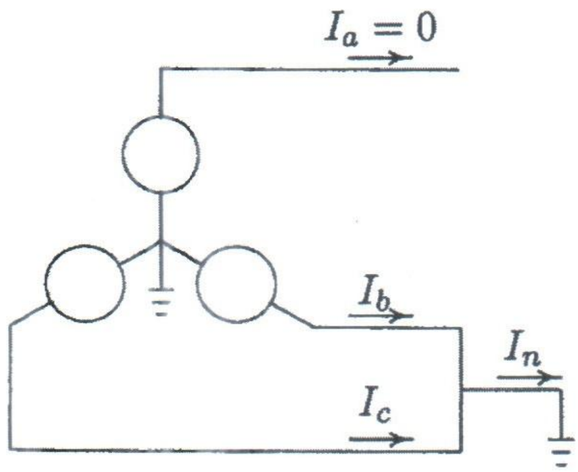

Fig. 6(a)

b) Using the method of ***building algorithm***, find the bus impedance matrix, Z_{bus} for the network shown in Fig. 6(b). **(13) (CO2) (PO2)**

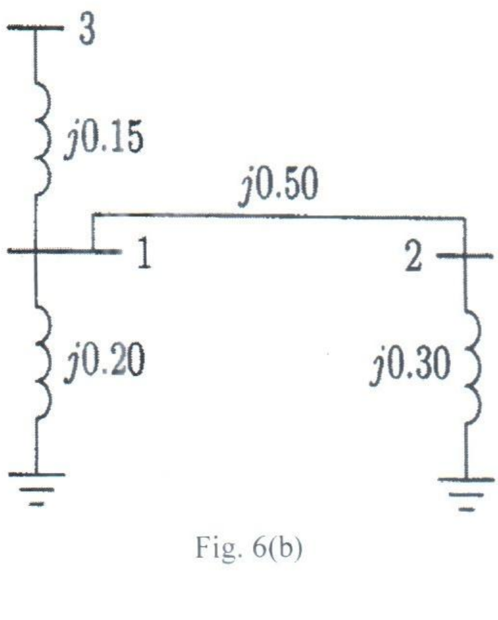

Fig. 6(b)