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B. Sc. in EEE, 4th Sem / DTE, 2nd Sem — Date: 8 March, 2024 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination — Summer Semester, A.Y.: 2022 - 2023
Course Number: EEE 4401/ EEE 4495 — Full Marks: 75
Course Title: Power System I — Time: 90 Minutes

There are **03 (three)** questions. Answer **all** the questions. The symbol(s) have their usual meanings. Marks of each question and corresponding CO and PO are written in the right margin. Assume reasonable value for any missing data, if required.

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1. Figure 1 shows the single line diagram (SLD) of a simple three-bus power system with generation at bus 1 and bus 3. The voltage at bus 1 is $V_1 = 1.025\angle 0°$ per unit. Voltage at bus 3 is fixed at 1.03 pu with a real power generation of 300 MW. A load of 400 MW and 200 Mvar is taken from bus 2. Line impedances are marked in per unit on a 100 MVA base. **10×2+5 (CO3) (PO3)**

a) Design the system for V_2 and V_3 with initial estimates of $V_2^{(0)} = 1.0 + j0$ and $V_3^{(0)} = 1.03 + j0$ and keeping $|V_3| = 1.03$. Perform **two iterations** for *Gauss-Seidel method.*

b) If after several iterations the bus voltages converge to

$V_2 = 1.001243\angle -2.1° = 1.000571 - j0.0366898$ pu

$V_3 = 1.03\angle 1.36851° = 1.029706 + j0.0246$ pu

Determine the line flows and line losses and the slack bus real and reactive power.

c) Construct a power flow diagram and show the direction of the line flows.

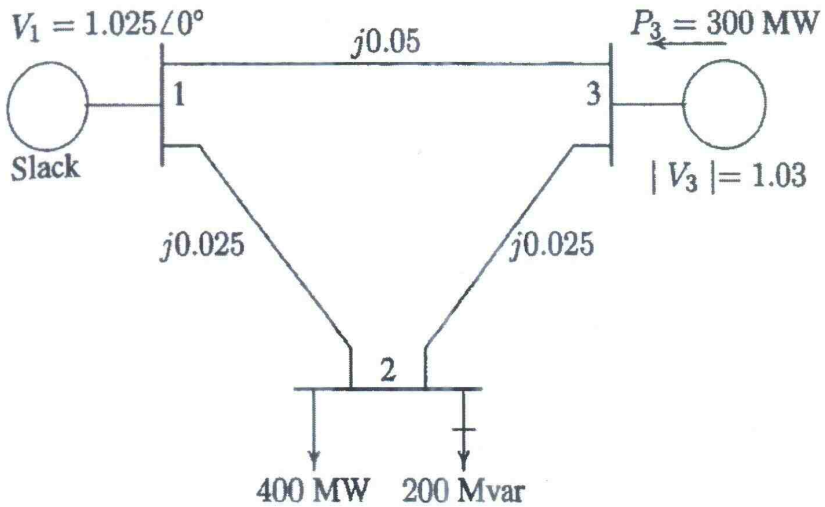

Figure 1

2. **a)** Explain briefly the advantages of the per unit system on the analysis of power system. **05 (CO1) (PO1)**

b) The three phase power and line to line ratings of the electric power system shown in Figure 2 are given below. **10 × 2 (CO2) (PO2)**

G1 : 60 MVA 20 kV X = 9%
T1 : 50 MVA 20/200 kV X = 10%
T2 : 50 MVA 200/20 kV X = 10%
M : 43.2 MVA 18 kV X = 8%
Line: 200 kV Z = 120 + j200 Ω

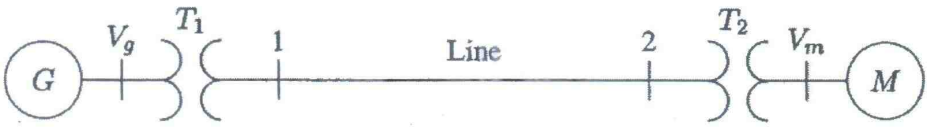

Figure 2

(i) Develop an impedance diagram showing all impedances in per unit on a 100 MVA base. Choose 20 kV as the voltage base for generator.

(ii) 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 and the internal emf of the generator in per unit and also in kV.

3. Using the *Newton-Raphson method*, find the intersection of the curves in Figure 3, **4+7×3 (CO2) (PO2)**

$$x_1^2 + x_2^2 = 4$$
$$e^{x1} + x_2 = 1$$

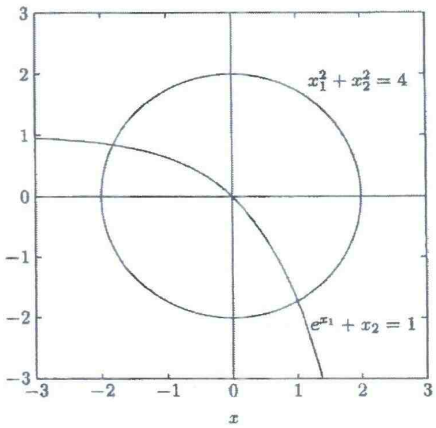

Figure 3

Start with the initial estimates of $x_1^{(0)} = 0.5$, $x_2^{(0)} = -1$.

a) Develop the *Jacobian matrix*, **J** by partial derivatives.

b) Find the solution of the above equations. Perform **three** iterations.