UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	POWER SYSTEM ANALYSIS
COURSE CODE	:	BEV20703
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JULY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS. **OPEN BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) State **THREE (3)** types of source of energy in power system operation.
(3 marks)

(b) **Figure Q1(b)** shows a single line diagram of a typical power system model. Line 1, Line 2, and Line 3 have reactances of 56.3Ω, 43.2Ω, and 51.6Ω, respectively. Calculate the per-unit (pu) impedance of all components available in the system using a common based of 100MVA and 20kV on the generator G_1 side.
(17 marks)

Q2 (a) Discuss the Gauss-Seidel method utilized in power flow analysis application.
(5 marks)

(b) **Figure Q2(b)** illustrates the single-line diagram of a simple three-bus test system model. There are two generators connected to Bus 1, and Bus 3, respectively. Bus 1 is selected as the slack bus in this analysis. The line impedances are marked in pu on a 100MVA base. For simplification, line susceptances and line charging are neglected. Apply Gauss-Seidel method to determine the value of $V_2^{(1)}$ and $V_3^{(1)}$. Perform **ONE (1)** iteration only.
(15 marks)

Q3 (a) Identify **THREE (3)** factors that influence the operating cost of a thermal plant.
(3 marks)

(b) The fuel-cost function in MYR/h for **THREE (3)** thermal plants are given by:

$$C_1 = 1470 + 30.24P_1 + 0.0168P_1^2$$
$$C_2 = 2100 + 30.66P_2 + 0.0105P_2^2$$
$$C_3 = 2520 + 28.31P_3 + 0.0126P_3^2$$

P_1, P_2, and P_3 are in MW. The total load is set to 750MW. The line losses and generator limits are neglected.

(i) Calculate the total cost in MYR/h when the generators share the load equally.
(3 marks)

(ii) Apply the iterative method to determine the optimal scheduling of generation using the initial value of $\lambda^1 = 31.5$MYR/MWh.
(10 marks)

(ii) Evaluate the cost saving gained every hour between the optimal scheduling of generators with the equal load sharing of generators.
(4 marks)

Q4 (a) Summarize the procedure to include the effects of load current in the fault analysis.

(5 marks)

(b) A single-line diagram of a four-bus power system is shown in **Figure Q4(b)**. Each generator is represented by an electromotive force (emf) behind the transient reactance. All impedances are expressed in per unit on a common MVA base. All resistances and shunt capacitances are neglected. The generators operate on no-load at their rated voltage with their emf in phase. A solid three phase fault occurs at Bus 4.

(i) Determine the impedance to the point of fault, the fault current and current that flows via generators in per unit during fault.

(7 marks)

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

(8 marks)

Q5 (a) (i) State the definition of power system stability.

(2 marks)

(ii) List **TWO (2)** major categories of power system stability.

(2 marks)

(b) A 60Hz synchronous generator with inertia constant $H = 5.6$MJ/MVA is connected to an infinite bus through a purely reactive circuit as shown in **Figure Q5(b)**. The generator is delivering real power $P_3 = 0.85$pu and $Q_3 = 0.081$pu to the infinite bus at a voltage of $V_3 = 1.0$pu. A temporary three-phase fault occurs at the sending end of Line 2 at point F. When the fault is cleared, both lines remain following the disturbance. Propose the stability limit of the system by determining the critical clearing angle (δ_c) and the critical fault clearing time (t_c) for the given disturbance.

(16 marks)

-END OF QUESTIONS-

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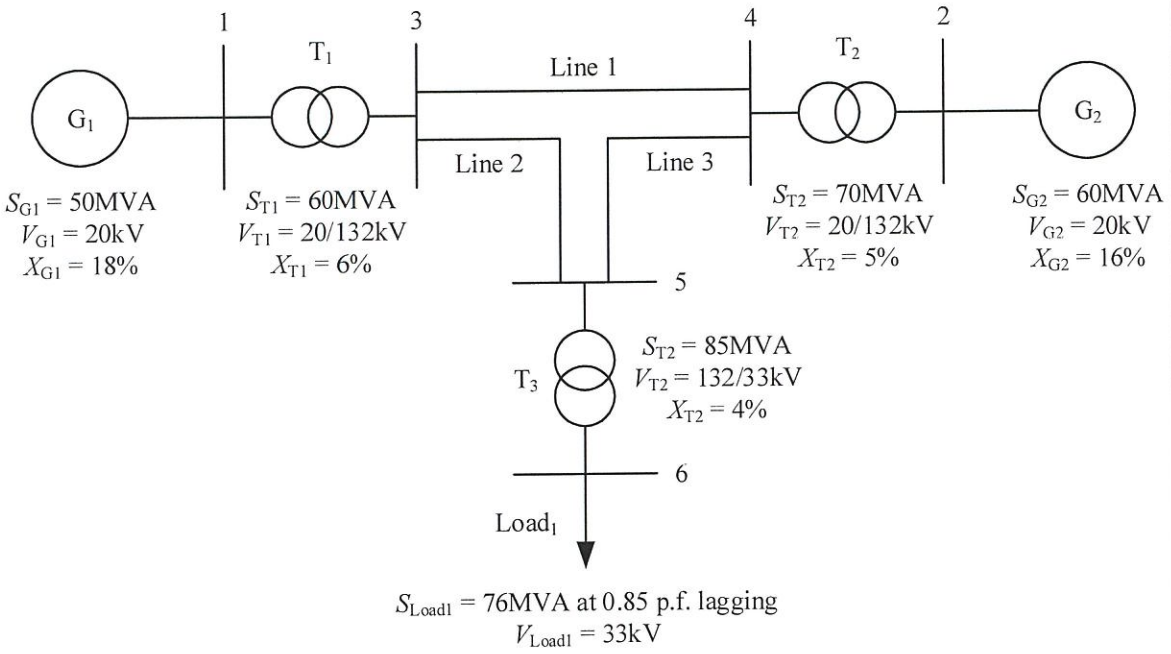

Figure Q1(b)

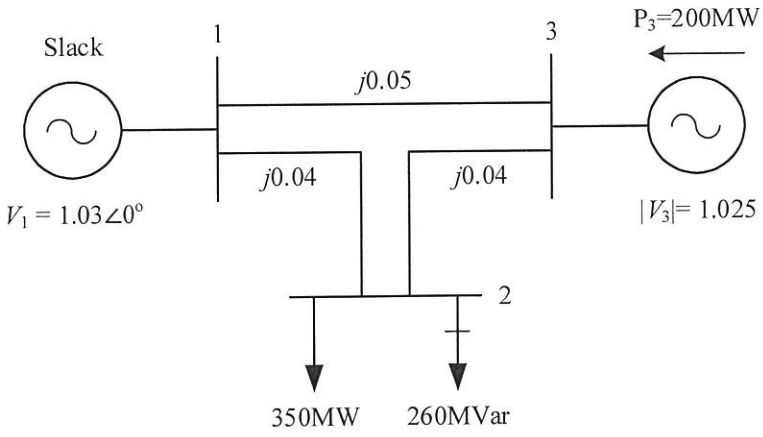

Figure Q2(b)

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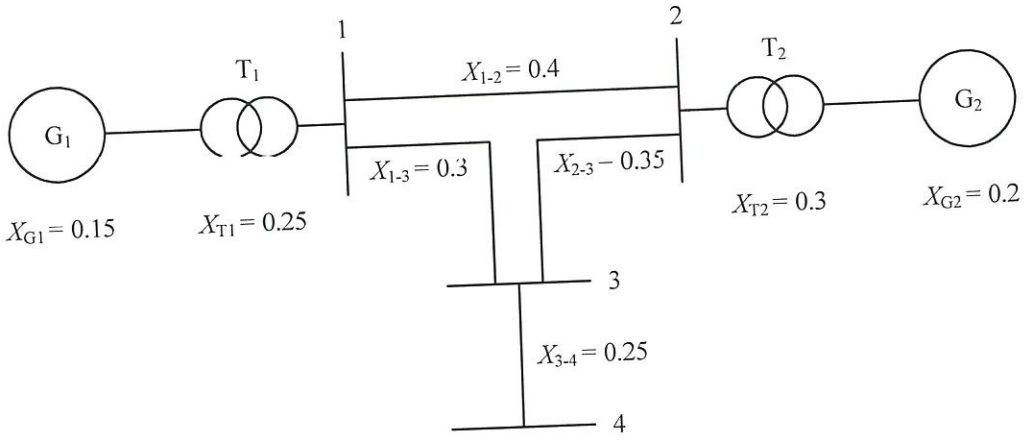

Figure Q4(b)

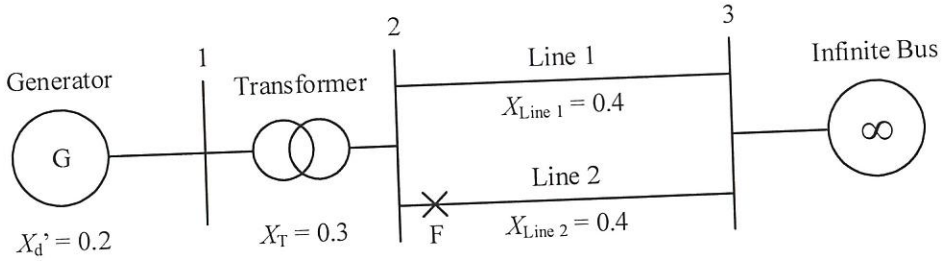

Figure Q5(b)