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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE ASSESSMENT)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	POWER SYSTEM ANALYSIS
COURSE CODE	:	BEV20703
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	1) ANSWER **ALL** QUESTIONS. 2) OPEN BOOK EXAMINATION.

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

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Q1 (a) State **TWO (2)** major parts of a synchronous generator construction.

(2 marks)

(b) A 500 kV, 50 Hz, three-phase transmission line is 115 km long. The resistance and the inductance per phase are 0.025 Ω per km and 0.75 mH per km, respectively. The shunt capacitance is 0.0107 μF per km. The receiving end load is 315 MVA with 0.85 power factor lagging at 485 kV. The transmission line is modelled using the medium line model.

(i) Determine the receiving end voltage V_R and the receiving end current I_R of the line.

(4 marks)

(ii) Compute the total series impedance per phase Z and the total shunt admittance per phase Y of the line.

(4 marks)

(iii) Analyse the sending end voltage V_S and the sending end current I_S of the line.

(10 marks)

Q2 (a) Discuss the implementation of bus admittance matrix in power system studies.

(5 marks)

(b) **Figure Q2(b)** represents a single line diagram of typical power system with the line impedances are as indicated in pu on a 100 MVA base with a synchronous generator at *Bus 1*. The line charging susceptances are neglected. Point out the bus voltages of V_2 and V_3 in pu using Gauss-Seidel method with the initial estimates of $V_2^{(0)} = 1 + j0$ pu and $V_3^{(0)} = 1 + j0$ pu. Perform until **TWO (2)** iterations.

(15 marks)

Q3 (a) List **THREE (3)** operating scenarios that are typically considered in optimal dispatch of generation studies.

(3 marks)

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

$$C_1 = 1470 + 30.24P_1 + 0.0168P_1^2$$
$$C_2 = 2100 + 30.66P_2 + 0.0105P_2^2$$
$$C_3 = 2520 + 28.308P_3 + 0.0126P_3^2$$

P_1, P_2, and P_3 are in MW. The line losses are neglected. The generator outputs are subject to the following limits:

$$122 \text{ MW} \leq P_1 \leq 400 \text{ MW}$$
$$260 \text{ MW} \leq P_1 \leq 600 \text{ MW}$$
$$50 \text{ MW} \leq P_1 \leq 445 \text{ MW}$$

(i) Analyse the optimal dispatch scheduling of generation when the total load is 1335 MW by using the analytical method.

(11 marks)

(ii) Calculate the cost-saving gained every hour between the optimal scheduling of generators with the equal load sharing of generators.

(6 marks)

Q4 (a) Discuss **THREE (3)** periods of generator behaviours classified in power system fault analysis.

(6 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 similar MVA base. For simplicity, all resistances and shunt capacitances are neglected. The generators operate on no-load at their rated voltage with their emf in phase. A bolted three-phase fault occurs at *Bus 2*.

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

(6 marks)

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

(8 marks)

Q5 (a) List **FIVE (5)** examples of severe disturbance in power system operation.

(5 marks)

(b) A 50 Hz synchronous generator with inertia constant $H = 6.2$ 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 $P_3 = 0.985$ pu and $Q_3 = 0.610$ pu to the infinite bus at a voltage of $V_3 = 1.0$ pu. A temporary three-phase fault occurs at the receiving end of *Line 1* at point *F*. When the fault is cleared, both lines are remained 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.

(15 marks)

-END OF QUESTIONS-

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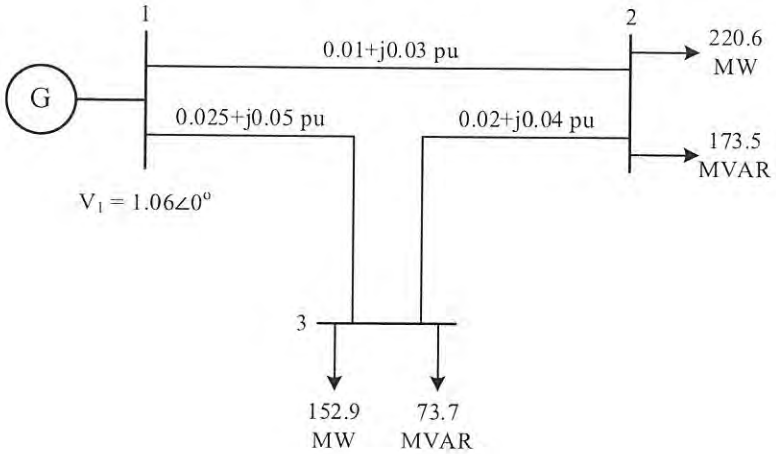

Figure Q2(b)

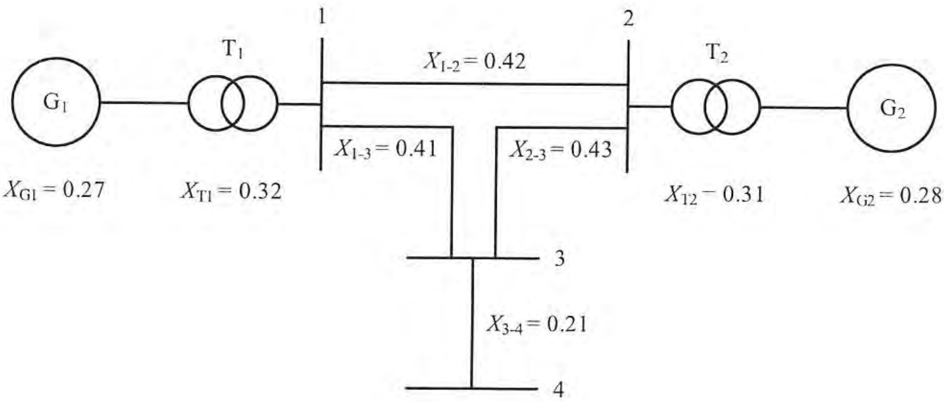

Figure Q4(b)

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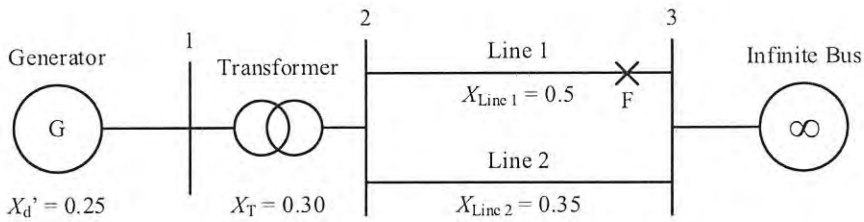

Figure Q5(b)