CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION
OCTOBER 2025 SEMESTER SESSION

SUBJECT CODE	:	**LEB21503**
SUBJECT TITLE	:	**ELECTRO-TECHNIQUE 1**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**BACHELOR OF ELECTRICAL AND ELECTRONICS ENGINEERING TECHNOLOGY (MARINE) WITH HONOURS**
TIME / DURATION	:	**9.00 AM – 12.00 PM (3 HOURS)**
DATE	:	**29 JANUARY 2026**

INSTRUCTIONS TO CANDIDATES

1. Please **CAREFULLY** read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of **FIVE (5)** questions.
4. Answer **FOUR (4)** questions **ONLY**.
5. Please write your answers in the answer booklet provided.
6. Answer **ALL** questions in English language only.

THERE ARE 7 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

INSTRUCTION: Answer FOUR (4) questions only.
Please use the answer booklet provided.

Question 1

(a) Define period, cycle and frequency in sinusoidal waveform.

(6 marks)

(b) With reference to the series-parallel RLC circuit in Figure 1:

i. Calculate the total impedance, Z_T.

(7 marks)

ii. Calculate the currents I, I_1 and I_2.

(8 marks)

iii. Draw the phasor diagram for V_s, I, I_1 and I_2.

(4 marks)

Give your answers in two decimal points.

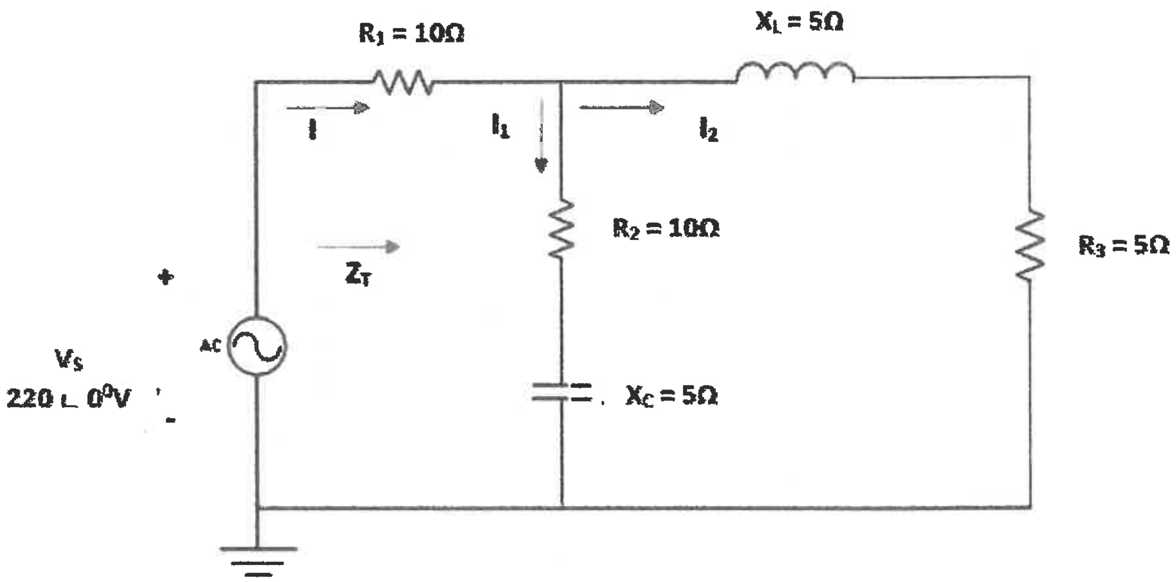

Figure 1

Question 2

(a) Determine THREE (3) advantages of three-phase system over single-phase system.

(6 marks)

(b) Each transmission line of the three-wire, three-phase system in Figure 2 has an impedance of 20 + j30 Ω. The system delivers a total power of 200 kW at 12,000 V to a balanced three-phase load with a lagging power factor of 0.75. Calculate:

i. the magnitude of the line voltage E_{AB} of the generator.

(9 marks)

ii. the power factor of the total load applied to the generator.

(6 marks)

iii. the efficiency of the system.

(4 marks)

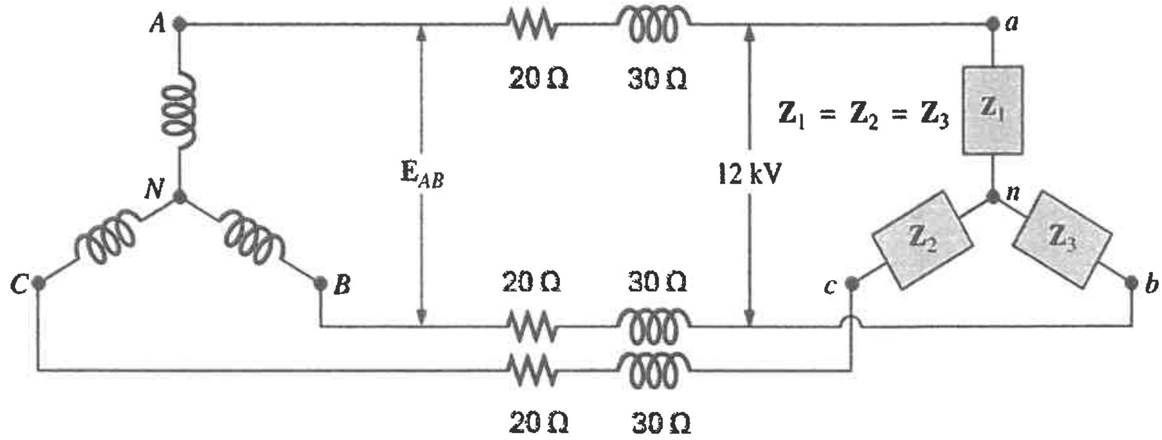

Figure 2

Question 3

(a) Describe THREE (3) effects of harmonics in electrical systems.

(6 marks)

(b) A single-phase, nonlinear load was found to have the data shown in Table 1. Calculate:

i. the rms current drawn by the load.

(3 marks)

ii. the THD_F and THD_R of the current.

(8 marks)

Table 1

Harmonic order	1	3	5	7	9	11	13	15	17
Frequency (Hz)	60	180	300	420	540	660	780	900	1020
rms Voltage (V)	118	0	0	0	0	0	0	0	0
Voltage phase angle (^{0})	0	0	0	0	0	0	0	0	0
rms Current (A)	118	60	20	19	12	12	9	9	6
Current phase angle (^{0})	-28	91	-84	92	-77	97	-75	101	-71
Power (kW)	10.0	0	0	0	0	0	0	0	0

(c) Three single-phase loads are placed on the 3-phase, Y-connected system. The loads have currents containing the harmonic values given in Table 2. Calculate:

i. the rms current in the phases.

(3 marks)

ii. the rms current on triplen harmonics in the neutral conductor.

(2 marks)

iii. the percentage of differences between rms current in the phases and triplen harmonics effect in the neutral conductor.

(3 marks)

Table 2

h	1	3	5	7	9	11	13	15
$I_{h,(rms)}$ A	48	45	42	38	33	28	23	18

Question 4

(a) Define an electrical machine and state the differences between a motor and a generator.

(6 marks)

(b) A DC shunt generator in Figure 3 has shunt field winding resistance of 50 Ω. It supplies a load of 8 kW at a voltage of 240 V. If its armature resistance is 0.5 Ω, calculate the induced e.m.f. of the generator.

(8 marks)

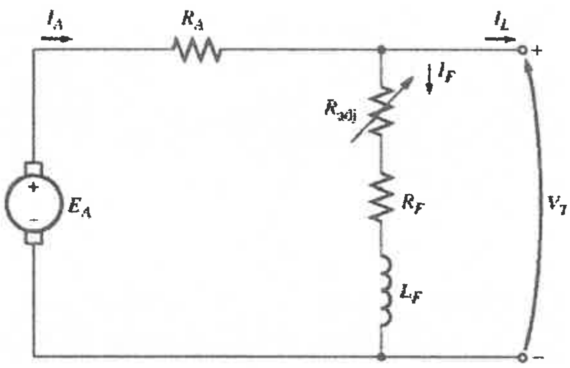

Figure 3

(c) A separate excited DC generator in Figure 4 turning at 1200 r/min produces an induced voltage of 138 V. The armature resistance is 4 Ω and the machine delivers a current of 20 A. Calculate:

i. the terminal voltage, V_T.

(3 marks)

ii. the heat dissipated in the armature (W).

(2 marks)

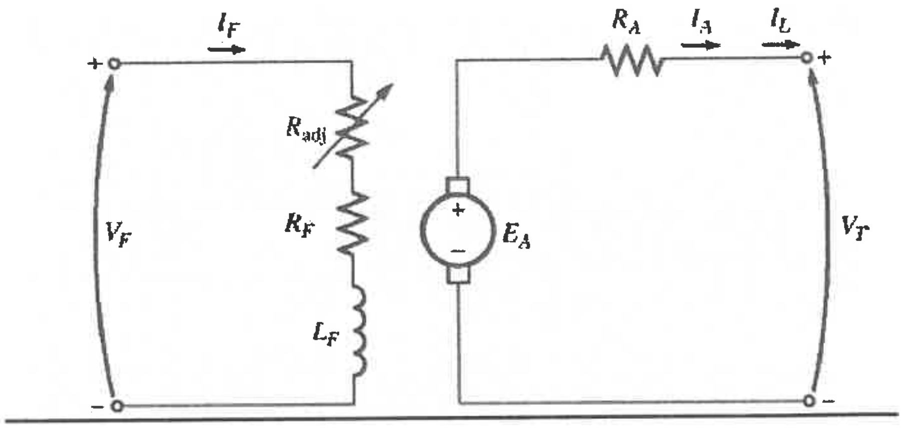

Figure 4

(d) Figure 5 shows a DC series motor running with a speed of 1100 r/min while taking a current of 15 A from the supply. The armature and series field winding resistances are 0.3 Ω and 0.5 Ω respectively. The supply voltage is 240 V. Calculate the speed of the motor if the load is changed such that the current drawn by the motor is increased to 30 A. Assume the flux produced is proportional to the current.

(6 marks)

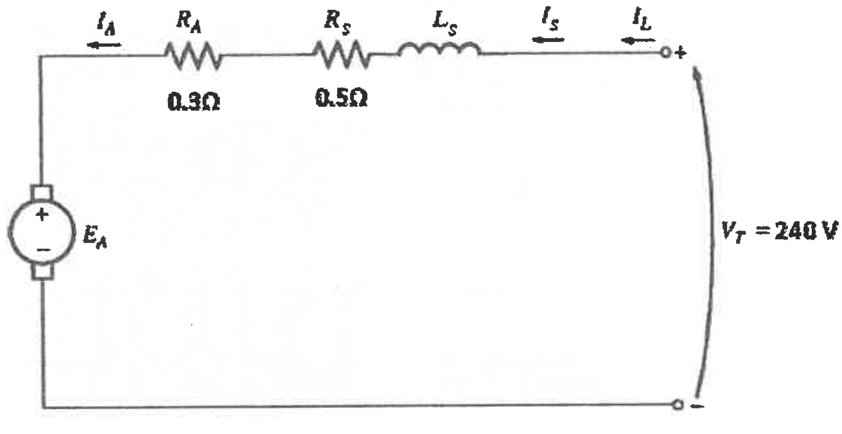

Figure 5

Question 5

(a) Describe the reliability and economy of interconnected power systems.

(6 marks)

(b) Figure 6 shows a generator supplying a load. A second load is to be connected in parallel with the first one. The generator has a no-load frequency of 51.1 Hz and a slope S_p of 1 MW/Hz. Load 1 consumes a real power of 1100 kW at 0.8 PF lagging, while load 2 consumes a real power of 800 kW at 0.85 PF lagging.

i. Calculate the operating frequency of the system before the switch is closed.

(3 marks)

ii. Calculate the operating frequency of the system after load 2 is connected.

(3 marks)

iii. Explain the action that could be taken by the operator to restore the system frequency to 50 Hz after load 2 is connected.

(3 marks)

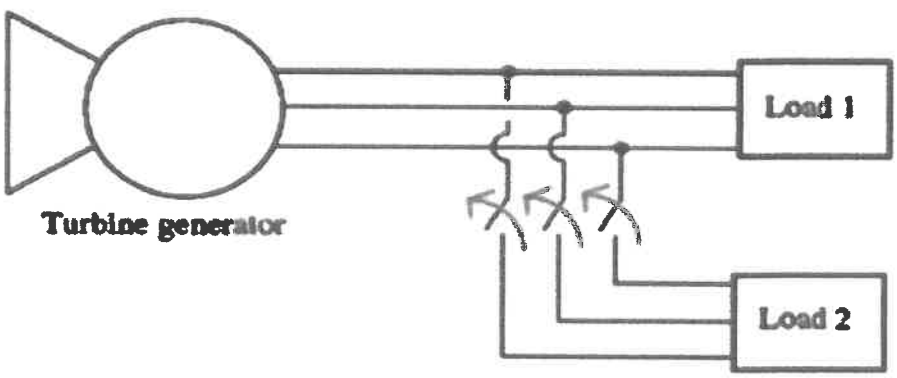

Figure 6

(c) Two generators supplying a load. Generator 1 has a no-load frequency of 61.5 HZ and a slope SP_1 of 1 MW/Hz. Generator 2 has a no-load frequency of 61.0 Hz and a slope SP_2 of 1 MW/Hz. The two generators are supplying a real load totaling 2.5 MW at 0.8 PF lagging. The resulting system power-frequency or house diagrams are shown in Figure 7 below.

i. Calculate the frequency the system is operating and the power supplied by each of the two generators.

(4 marks)

ii. Suppose an additional 1 MW load was attached to this power system. Calculate the new system frequency be and the power would G1 and G2 supply.

(6 marks)

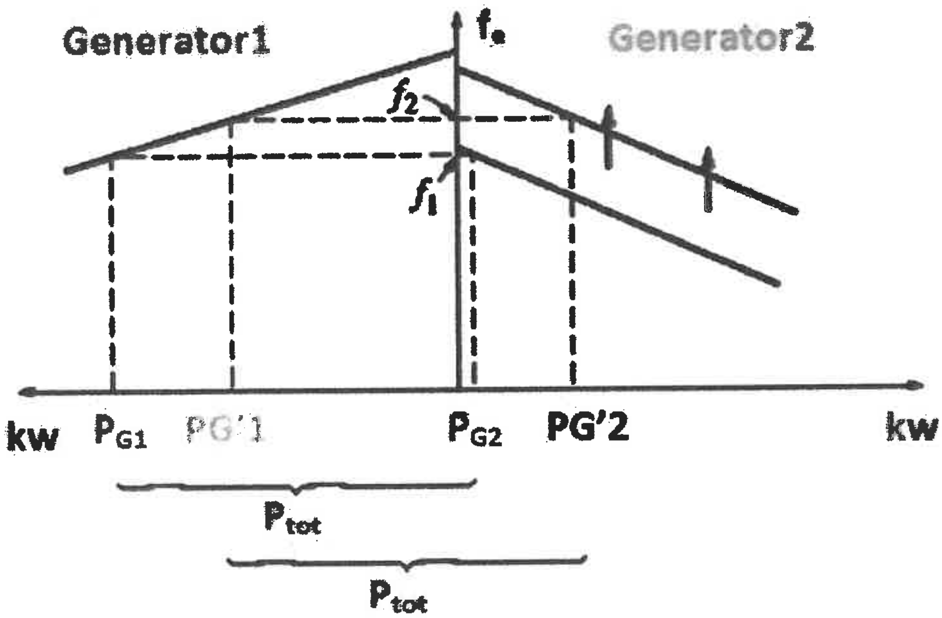

Figure 7

END OF EXAMINATION PAPER

LEB21503 ELECTRO-TECHNIQUE 1
FORMULA SHEET

$$E_A = \frac{øZN}{60} \times \frac{P}{A}$$

$$T_a = \frac{øZI_A}{2\pi} \times \frac{P}{A} \; (Newton - meter)$$

$$V = E + I_a R_a$$

$$V = E - I_a R_a$$

$$n = \frac{P_{out}}{P_{in}} \times 100\%$$

$$\frac{n_2}{n_1} = \frac{E_{A2}}{E_{A1}} \times \frac{\varphi_1}{\varphi_2} \; If \, \varphi_2 = \varphi_1, then \frac{n_2}{n_1} = \frac{E_{A2}}{E_{A1}}$$

$$\frac{n_2}{n_1} = \frac{E_{A2}}{E_{A1}} \times \frac{\varphi_1}{\varphi_2} = \frac{E_{A2}}{E_{A1}} \times \frac{I_{A1}}{I_{A2}}$$

$$I_{rms} = \frac{1}{\sqrt{2}} I_m = 0.707 I_m$$

$$V_{rms} = \frac{1}{\sqrt{2}} V_m = 0.707 V_m$$

$$i(t) = I_m \, sin \, \omega t = I_m \sin \alpha$$

$$v(t) = V_m \, sin \, \omega t = V_m \sin \alpha$$

$$\cos \alpha = \sin(\alpha + 90^0)$$

$$\sin \alpha = \cos(\alpha - 90^0)$$

$$-\sin \alpha = \sin(\alpha \pm 180^0)$$

$$-\cos \alpha = \sin(\alpha + 270^0) = \sin(\alpha - 90^0)$$

$$V_L = \sqrt{3} V_ø \angle 30^0$$

$$I_L = I_ø$$

$$I_L = \sqrt{3} I_ø \angle -30^0$$

$$V_L = V_ø$$

$$P_T = \sqrt{3} V_L I_L cos\Theta^{Vø}_{Iø} = 3 I_L{}^2 R_ø$$

$$Q_T = \sqrt{3} V_L I_L cos\Theta^{Vø}_{Iø} = 3 I_L{}^2 X_ø$$

$$S_T = 3 S_ø$$

$$S_T = \sqrt{3} V_L I_L$$

$$F_p = \frac{P_T}{S_T} = cos\Theta^{Vø}_{Iø}$$

$$THD_F = \frac{\sqrt{\sum_{h=2}^{\infty} V_{h,rms}{}^2}}{V_{1,rms}} \, X \, 100\%$$

$$THD_R = \frac{\sqrt{\sum_{h=2}^{\infty} V_{h,rms}{}^2}}{V_{rms}} \, X \, 100\%$$

$$SD = \frac{n_{nl} - n_{fl}}{n_{fl}} \times 100\%$$

$$f_e = \frac{n_m P}{120}$$

$$P = S_p (f_{nl} - f_{sys})$$