UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2023/2024

COURSE NAME	:	CIRCUIT THEORY
COURSE CODE	:	DAE 11103
PROGRAMME CODE	:	DAE
EXAMINATION DATE	:	JANUARY/FEBRUARY 2024
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **10** PAGES

Q1 (a) For the circuit shown in **Figure Q1(a),** compute the total resistance R_T with terminals a and b being:

(i) Open-circuited.

(3 marks)

(ii) Short-circuited.

(3 marks)

(b) Apply nodal analysis for the circuit with supernode condition in **Figure Q1(b).**

(i) Write the support equation.

(2 marks)

(ii) Determine the supernode equation.

(4 marks)

(iii) Compute V.

(6 marks)

(iv) Compute i.

(2 marks)

Q2 (a) Use the mesh analysis for the circuit in **Figure Q2(a).**

(i) Write the mesh equations for each loop.

(3 marks)

(ii) Determine the branch current controlling the dependent voltage source.

(2 marks)

(iii) Compute the current in the 4 Ω resistor.

(7 marks)

(iv) Compute the power dissipated in the 4 Ω resistor

(2 marks)

(b) (i) Explain the superposition theorem.

(4 marks)

(ii) Justify why the superposition theorem can be applied to passive direct current (DC) circuits.

(2 marks)

Q3 (a) Compute the maximum power delivered to the resistor R in **Figure Q3(a).**

(8 marks)

(b) For a 200 μF capacitor, the voltage is shown in **Figure Q3(b)**.

(i) Calculate the current.

(8 marks)

(ii) Sketch the current.

(4 marks)

Q4 (a) At $t = 3$ s, the current through a 10-mH inductor is $6^{e-t/2}$ A. Find:

(i) Voltage.

(4 marks)

(ii) Power.

(4 marks)

(b) For $t > 0$ of the free-source RC circuit in **Figure Q4(b),** if $V_c(0) = 15$ V, compute:

(i) V_c

(6 marks)

(ii) V_x

(3 marks)

(iii) i_x

(3 marks)

Q5 (a) The circuit in **Figure Q5(a)** is connected to 20 A source for a long time. At $t = 0$, the switch is opened. For $t > 0$, compute:

(i) $i_L(t)$ (5 marks)

(ii) $i_o(t)$ (2 marks)

(iii) $v_o(t)$ (2 marks)

(iv) Power dissipated in 10 Ω resistor. (2 marks)

(v) Energy stored in 2 H inductor. (2 marks)

(b) For the following sinusoid, find:

$$v(t) = 12 \cos (50t + 10°)$$

(i) Amplitude. (1 mark)

(ii) Phase. (1 mark)

(iii) Angular frequency. (1 mark)

(iv) Period. (2 marks)

(v) Frequency. (2 marks)

END OF QUESTIONS

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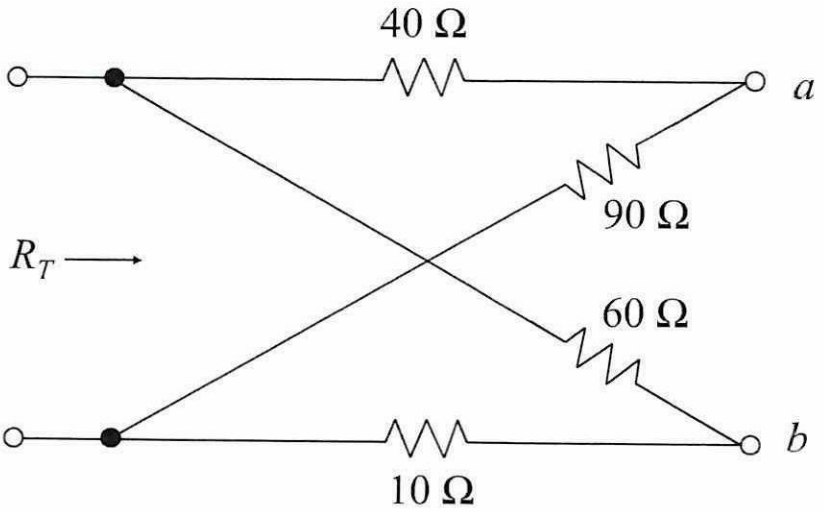

Figure Q1(a)

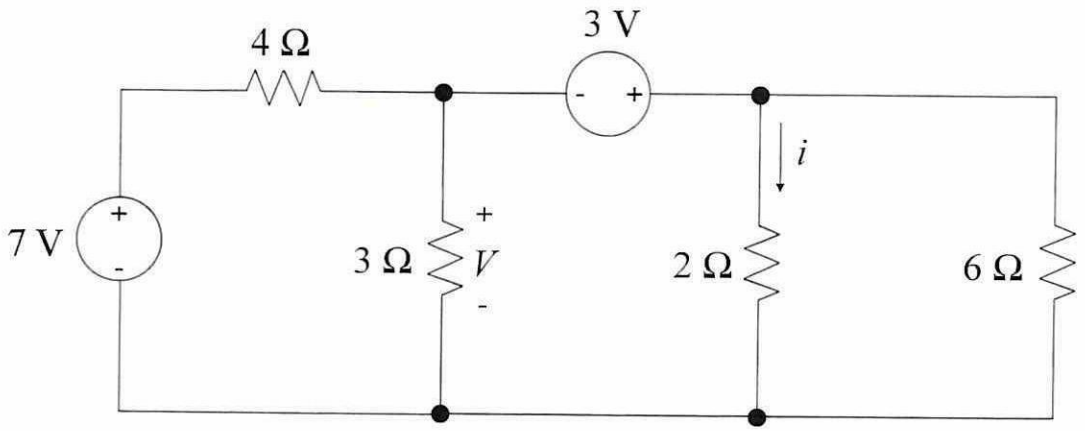

Figure Q1(b)

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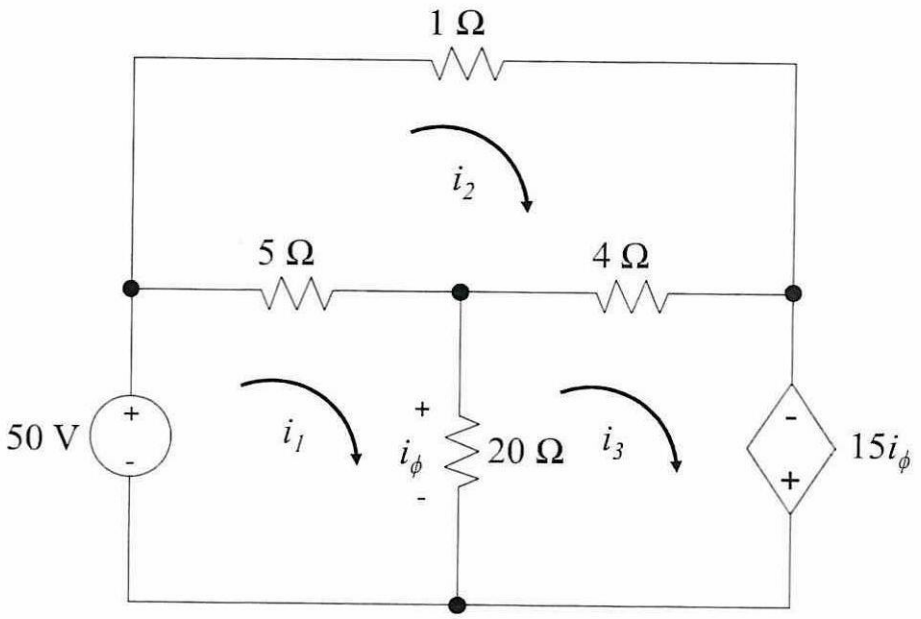

Figure Q2(a)

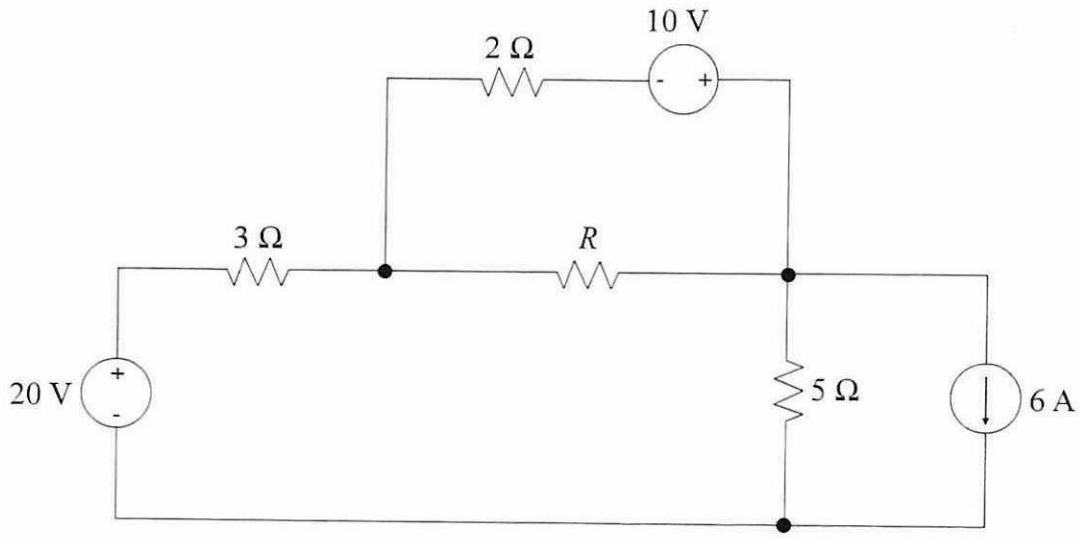

Figure Q3(a)

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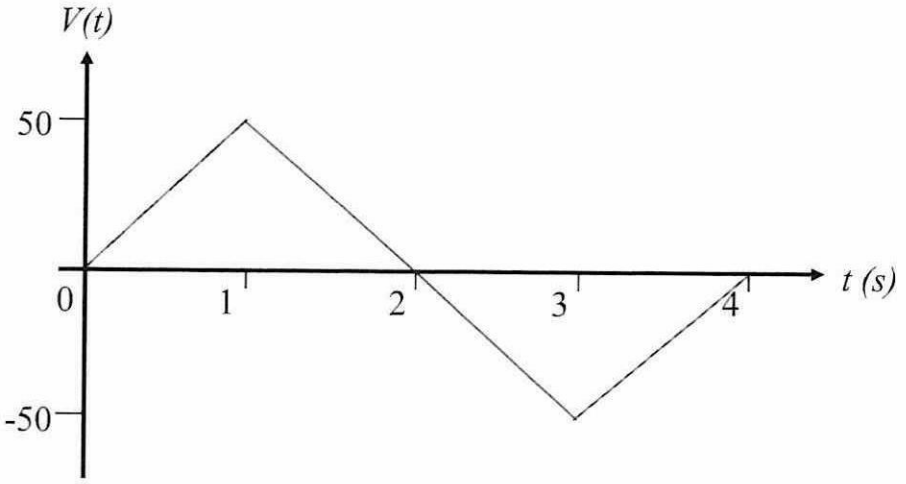

Figure Q3(b)

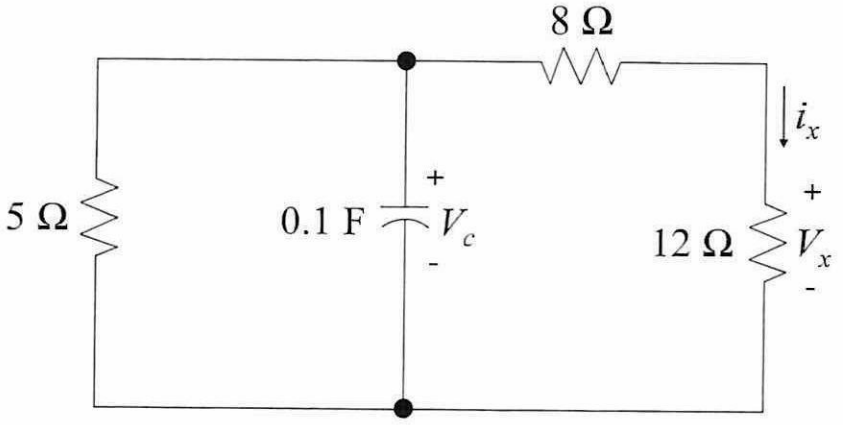

Figure Q4(b)

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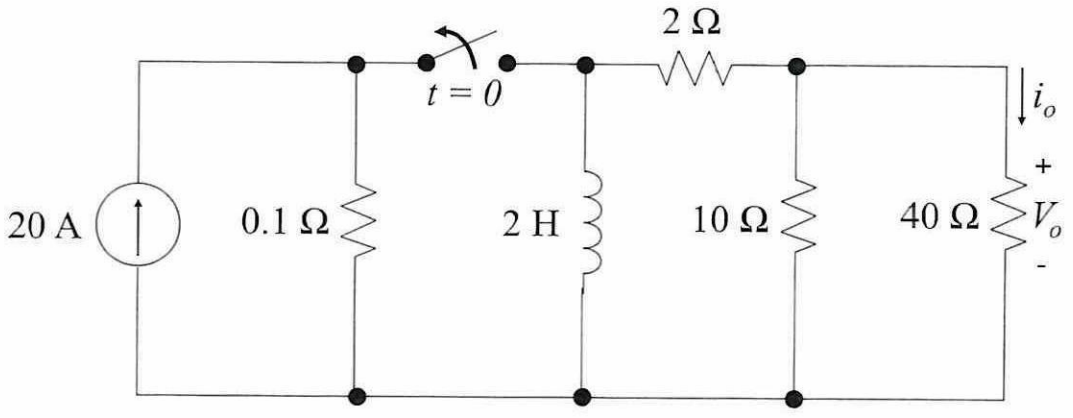

Figure Q5(a)

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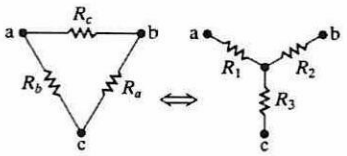
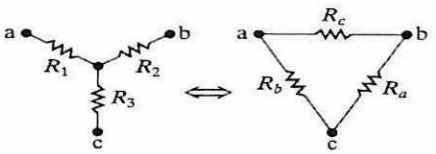
List of Formulae

$$i = \frac{dq}{dt} \qquad q = \int_{t_o}^{t} i dt \qquad v_{ab} = \frac{dw}{dq} \qquad p = Vi = \frac{dw}{dt}$$

$$R = \rho \frac{l}{A} \qquad G = \frac{1}{R} \qquad \sum_{n=1}^{N} i_n = 0 \qquad \sum_{n=1}^{N} V_n = 0$$





$$R_a = \frac{R_1 R_2}{R_1 + R_2 + R_3} \qquad R_1 = R_a + R_c + \frac{R_a R_c}{R_b}$$

$$R_b = \frac{R_2 R_3}{R_1 + R_2 + R_3} \qquad R_2 = R_a + R_b + \frac{R_a R_b}{R_c}$$

$$R_c = \frac{R_1 R_3}{R_1 + R_2 + R_3} \qquad R_3 = R_b + R_c + \frac{R_b R_c}{R_a}$$

$$P_L = i^2 R = \left(\frac{V_{Th}}{R_{Th} + R_L}\right)^2 R_L \qquad C = \frac{\varepsilon A}{d} \qquad i = C\frac{dv}{dt}$$

$$V(t) = \frac{1}{C}\int_{t_o}^{t} i\, dt + V(t_o) \qquad P = \frac{dw}{dt} = CV\frac{dv}{dt} \qquad w = \frac{1}{2}CV^2(t)$$

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$$v = L\frac{di}{dt} \qquad i = \frac{1}{L}\int_{t_0}^{t} v(t)dt + i(t_0) \qquad w = \frac{1}{2}Li^2$$

$$V(t) = V_o e^{-\frac{t}{RC}} \qquad \tau = RC \qquad i(t) = I_0 e^{-\frac{t}{\tau}} \qquad \tau = \frac{L}{R}$$

$$v(t) = V_m \sin(\omega t + \varphi) \qquad f = \frac{1}{T} \qquad \omega = 2\pi f$$

$$z = x + jy = r\angle\varphi$$
$$z_1 = x_1 + jy_1 = r_1\angle\varphi$$
$$z_2 = x_2 + jy_2 = r_2\angle\varphi$$
$$z_3 = x_3 + jy_3 = r_3\angle\varphi$$

Addition

$$z_1 + z_2 = (x_1 + x_2) + j(y_1 + y_2)$$

Subtraction

$$z_1 - z_2 = (x_1 - x_2) + j(y_1 - y_2)$$

Division

$$\frac{z_1}{z_2} = \frac{r_1}{r_2}\angle\varphi_1 - \varphi_2$$

Multiplication

$$z_1 \bullet z_2 = r_1 r_2 \angle\varphi_1 + \varphi_2$$

Reciprocal

$$\frac{1}{z} = \frac{1}{r}\angle - \varphi$$

Square Root

$$\sqrt{z} = \sqrt{r}\angle\left(\frac{\varphi}{2}\right)$$

Complex Conjugate

$$z* = x - jy = r\angle - \varphi = re^{-j\varphi}$$