Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	CIRCUIT THEORY
COURSE CODE	:	DAE11103
PROGRAMME CODE	:	DAE
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ 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 **NINE (9)** PAGES.

Q1 (a) The power absorbed by the element in the circuit of **Figure Q1(a)** is given as:

$$p(t) = \begin{cases} 6t & 0s \le t \le 0.5s \\ -6t + 6 & 0.5s < t \le 1s \\ 0 & t > 1s \end{cases}$$

Find the total energy absorbed by the element in 1s.

(5 marks)

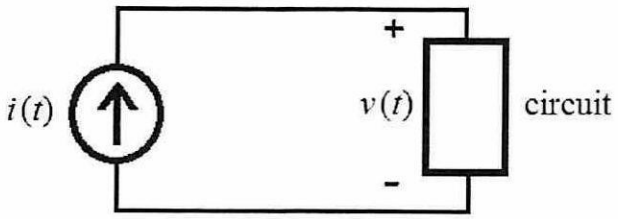


Figure Q1(a)

(b) Two electric circuits, represented by boxes A and B, are connected as shown in **Figure Q1(b)**. The reference direction for the current i in the interconnection and the reference polarity for the voltage v across the interconnection are shown in the figure. For each of the following sets of numerical values, calculate the power in the interconnection and state whether the power is flowing for A to B or vice versa.

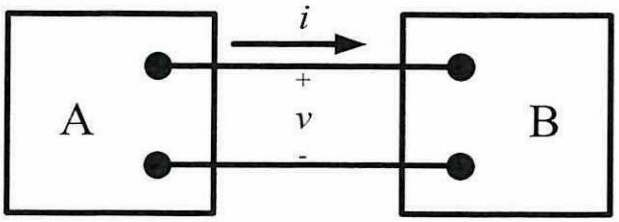


Figure Q1 (b)

(i) $i = 15$ A, $v = 20$ V

(2 marks)

(ii) $i = -5$ A, $v = 100$ V

(2 marks)

(iii) $i = 4$ A, $v = -50$ V

(2 marks)

(iv) $i = -16$ A, $v = -25$ V

(2 marks)

(c) Find equivalent resistance, R_{ab} for the circuit in **Figure Q1 (c)**.

(7 marks)

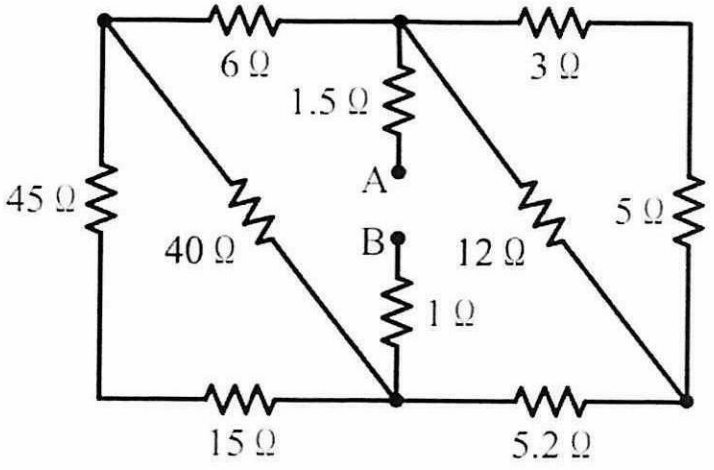


Figure Q1 (c)

Q2 (a) With the aid of suitable diagram, briefly explain the concept of current divider rules.

(2 marks)

(b) Using Kirchhoff Voltage Law (KVL), evaluate V_1, V_2, V_3 and V_4 in **Figure Q2 (b)**.

(8 marks)

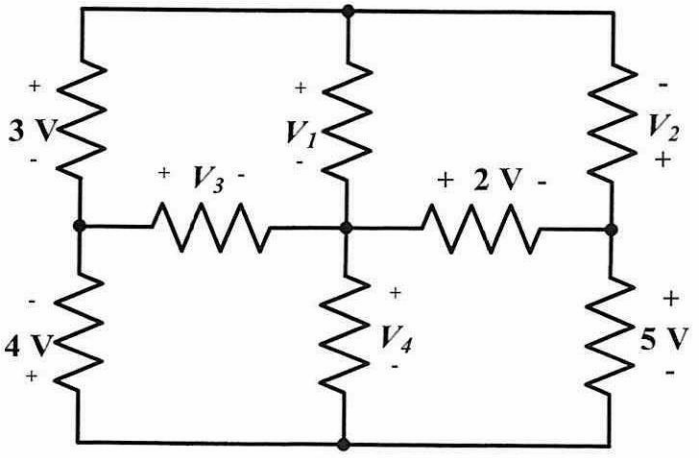


Figure Q2 (b)

(c) Calculate V_1, V_2 and I_1 in **Figure Q2 (c)** using nodal analysis.

(10 marks)

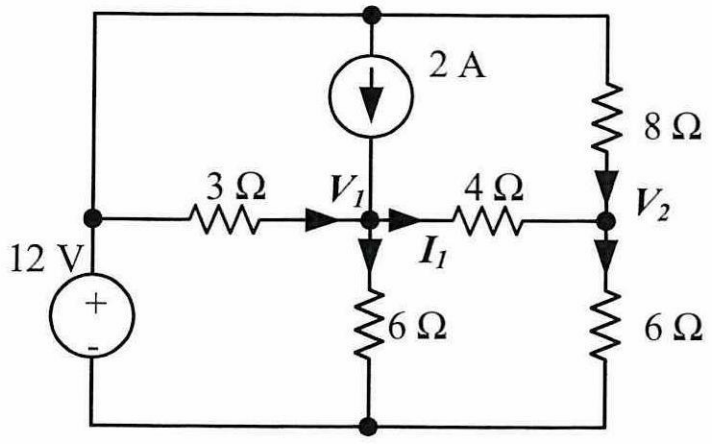


Figure Q2 (c)

Q3 (a) Explain the maximum power transfer theorem by the aid of appropriate diagram.

(2 marks)

(b) For the circuit in Figure **Q3 (b)**, R_L is connected across terminal A-B.

(i) Construct the Norton equivalent circuit at terminal A-B.

(6 marks)

(ii) Determine the maximum power delivered to R_L.

(2 marks)

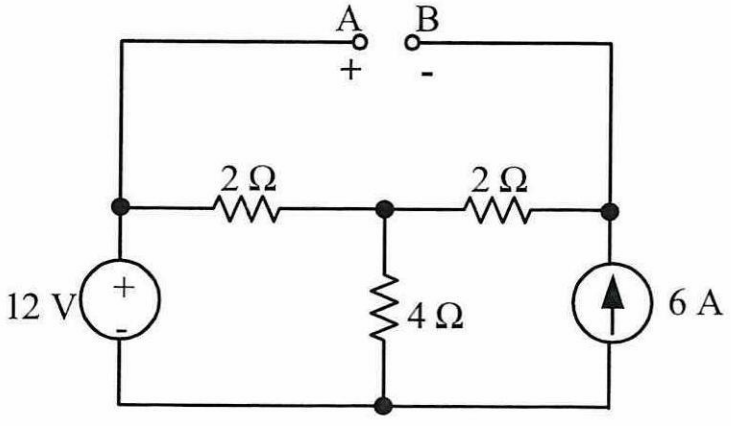


Figure Q3 (b)

(c) In **Figure Q3 (c)**, find the items below using Thevenin's theorem.

(i) the equivalent circuit to the left of the terminals (V_{TH}, R_{TH})

(5 marks)

(ii) current, I.

(5 marks)

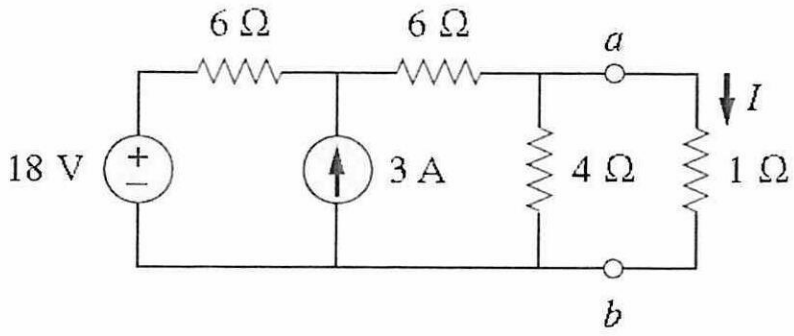


Figure Q3 (c)

Q4 (a) The voltage across a 6μF capacitor is given as $v(t) = 60 \sin 600t$ V. Calculate the current, $i(t)$ through it.

(3 marks)

(b) If the current through a 2 mH inductor is $i(t) = 20e^{-20t}$ A, find the voltage across the inductor and the energy stored in it.

(5 marks)

(c) Analyse the circuit shown in **Figure Q4 (c)** under DC condition to obtain the energy stored in each capacitor in μJ.

(6 marks)

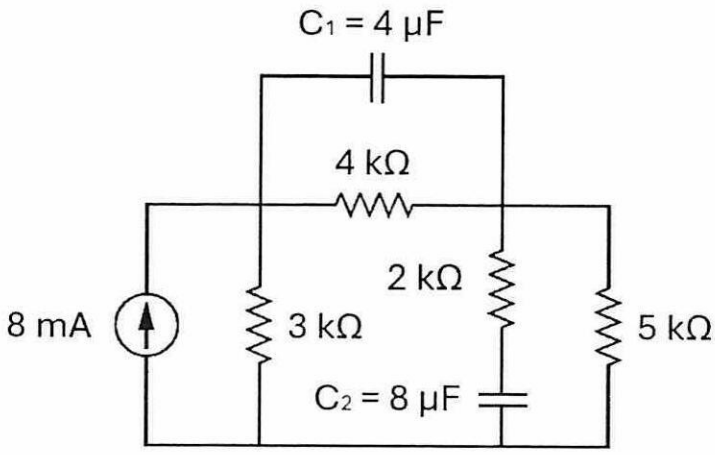


Figure Q4 (c)

(d) The switch in the **Figure Q4 (d)** has been closed for a long time. It opens at $t = 0$. Find $i(t)$ for $t > 0$.

(6 marks)

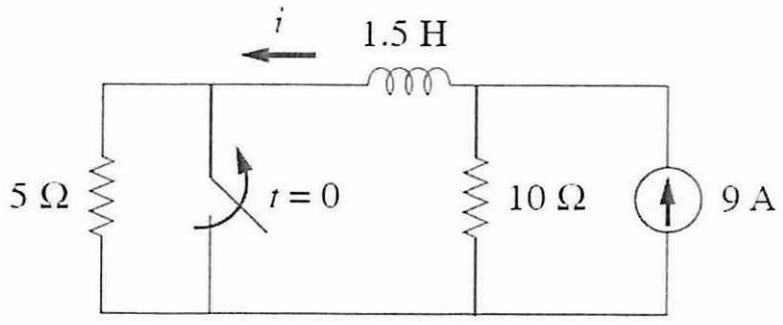


Figure Q4 (d)

Q5 (a) In a linear circuit, the voltage source is $V_s = 10 \sin (10^2 t + 30^\circ)$ V.

(i) What is the angular frequency of the voltage?

(1 mark)

(ii) What is the frequency of the source?

(2 marks)

(iii) Find the period of the voltage.

(2 marks)

(iv) Express v_s in cosine form.

(2 marks)

(v) Determine v_s at $t = 2$ ms.

(3 marks)

(b) For the circuit shown in **Figure Q5 (b)**:

(i) Find the total impedance Z_T.

(7 marks)

(ii) Determine the current I.

(3 marks)

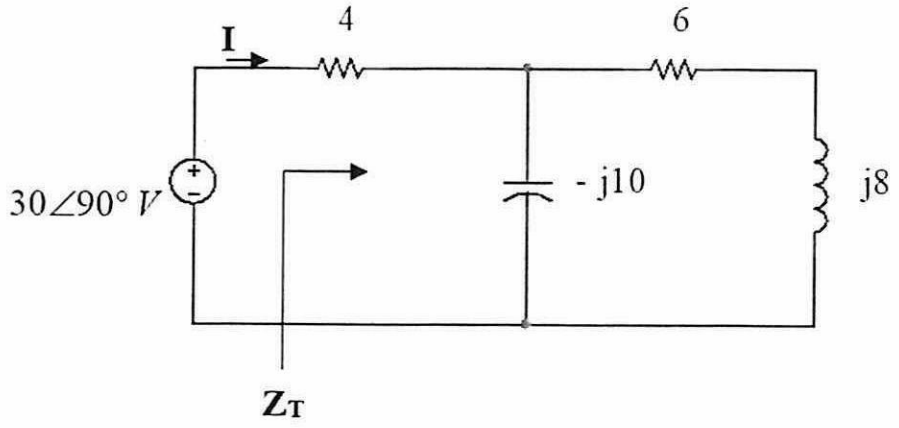


Figure Q5 (b)

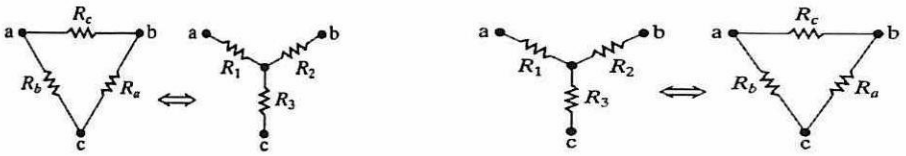
- END OF QUESTIONS -

APPENDIX A

List of Formulae

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

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



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

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

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

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

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

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

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

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

$$z = x + jy = r\angle\varphi$$

$$z_1 = x_1 + jy_1 = r_1\angle\varphi$$

$$z_2 = x_2 + jy_2 = r_2\angle\varphi$$

$$z_3 = x_3 + jy_3 = r_3\angle\varphi$$

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

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