UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	ELECTRIC CIRCUITS II
COURSE CODE	:	BEJ10403
PROGRAMME CODE	:	BEJ
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 **SEVEN (7)** PAGES

Q1 (a) Referring to **Figure Q1.1**,

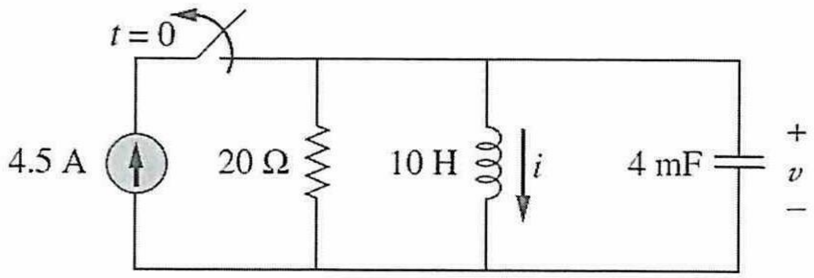


Figure Q1.1

(i) calculate $i(0)$, $v(0)$, and $\frac{dv\ (0)}{dt}$.

(5 marks)

(ii) determine the characteristic roots, s_1 and s_2.

(5 marks)

(iii) find $v(t)$ for $t > 0$.

(5 marks)

(b) Based on **Figure Q1.2**, calculate $i(t)$ for $t > 0$.

(10 marks)

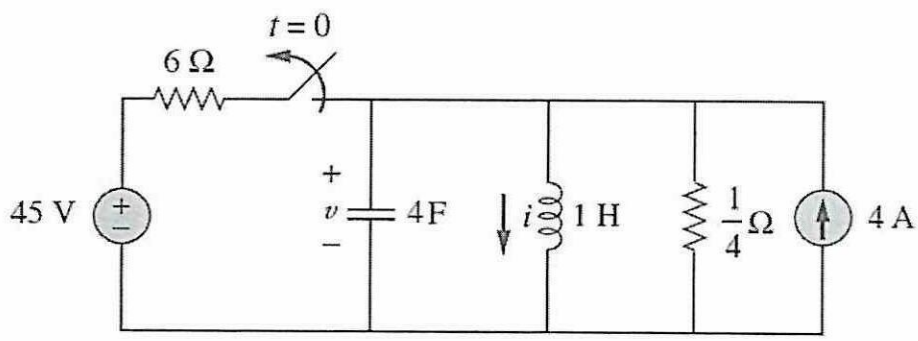


Figure Q1.2

Q2 (a) Given $i_S(t) = 4\cos(10t + 45°)A$ for the circuit in **Figure Q2.1**.

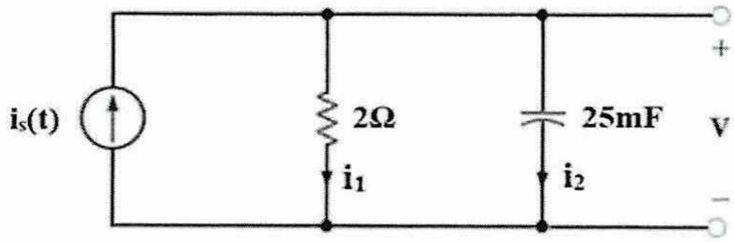


Figure Q2.1

(i) Determine and draw the equivalent circuit in the frequency domain.
(3 marks)

(ii) Determine the voltage, V, and currents i_1 and i_2.
(6 marks)

(iii) Draw a phasor diagram to illustrate all currents and voltages for the circuit.
(3 marks)

(b) For the circuit shown in **Figure Q2.2**, assume that the circuit operates at $\omega = 100\ rad/s$,

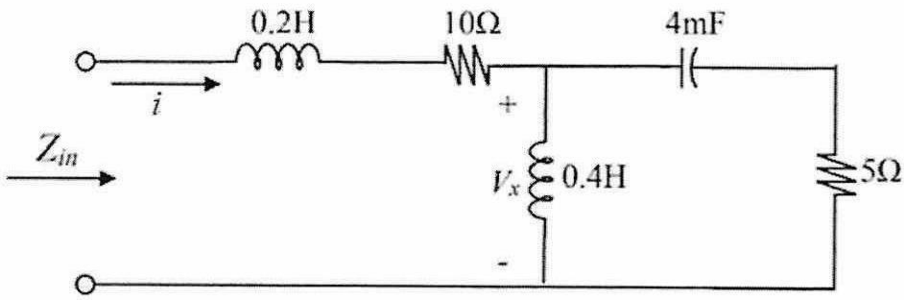


Figure Q2.2

(i) find the input impedance, Z_{in} of the circuit.
(6 marks)

(ii) if an input voltage, $V_i = 10\cos(100t - 15°)\ V$ is applied to the circuit in **Figure Q2.2**, determine the input current, $i(t)$.
(3 marks)

(iii) calculate the voltage, V_x in the time domain.
(4 marks)

Q3 (a) One cycle of a periodic voltage waveform is depicted in **Figure Q3.1**. Find the effective value of the voltage. Note that the cycle starts at t = 0 and ends at t = 6 s.

(7 marks)

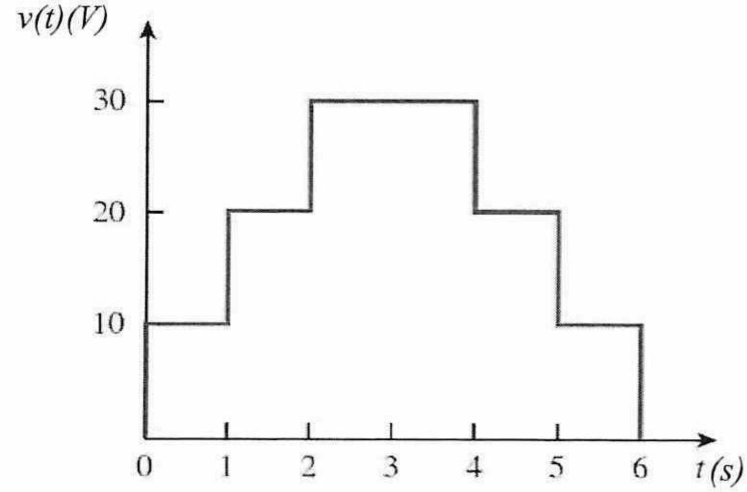


Figure Q3(a)

(b) A factory has the following four major loads:

- A motor rated at 5 hp, 0.8 pf lagging (1 hp = 0.7457 kW).
- A heater rated at 1.2 kW, 1.0 pf.
- Ten 120-W lightbulbs.
- A synchronous motor rated at 1.6 kVAR, 0.6 pf leading.

(i) Calculate the total real and reactive power.

(6 marks)

(ii) Find the overall power factor.

(2 marks)

(c) An air conditioner operates at $240V_{rms}$ at a frequency of 60 Hz. It absorbs an average power of 9 kW at a lagging power factor, *pf* of 0.75.

(i) Determine the complex power of the load.

(3 marks)

(ii) Determine the capacitive element required to raise the power factor to 0.88.

(5 marks)

(iii) Analyze the effect of power factor correction in **part Q3(c)(ii)** on the effective current, I_{rms}.

(2 marks)

Q4 (a) For the circuit in **Figure Q4.1**,

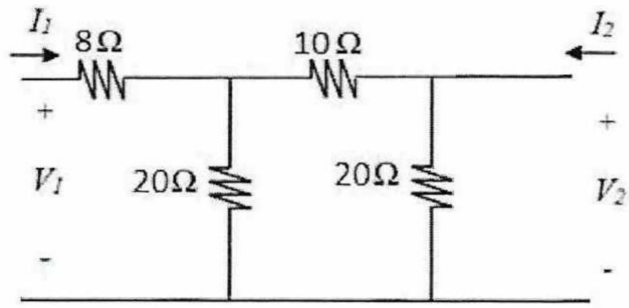


Figure Q4.1

(i) find the Z-parameters.

(8 marks)

(ii) draw the equivalent circuit for the Z-parameters obtained in part **Q4(a)(i)**.

(4 marks)

(b) For the circuit in **Figure Q4.2**,

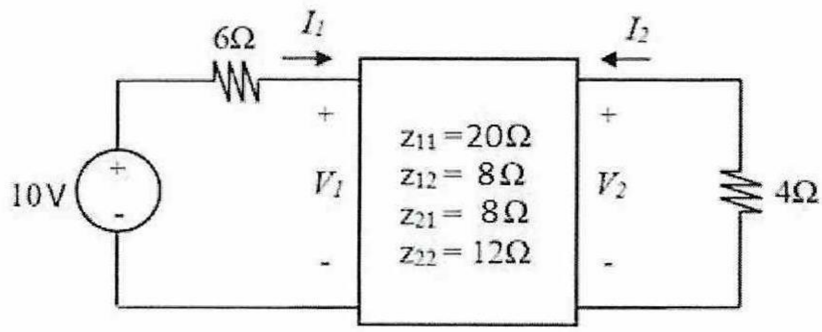


Figure Q4.2

(i) Calculate I_1, I_2, V_1 and V_2.

(10 marks)

(ii) Determine the power dissipated in the 4 Ω resistor.

(3 marks)

- END OF QUESTIONS -

APPENDIX 1: Formulae

$sin(-x) = -sin\,x$	$\cos(\text{-x}) = \cos\text{x}$
$sec\,x = \dfrac{1}{cos\,x}$	$csc\,x = \dfrac{1}{sin\,x}$
$tan\,x = \dfrac{sin\,x}{cos\,x}$	$cot\,x = \dfrac{1}{tan\,x}$
$sin(x \pm 90°) = \pm cos\,x$	$sin(x \pm 180°) = -sin\,x$
$cos(x \pm 90°) = \mp sin\,x$	$cos(x \pm 180°) = -\,cos\,x$
$sin(x \pm y) = \sin x \cos y \pm cos\,x \sin y$	$cos(x \pm y) = \cos\,x \cos y \mp sin\,x \sin y$
$2 \sin x \sin y = \cos(x-y) - \cos(x+y)$	$2 \cos x \cos y = cox\,(x+y) + \cos\,(x-y)$
$2 \sin x \cos y = \sin(x-y) + \sin\,(x-y)$	$sin\,2x = 2\,sin\,x\,cos\,x$
$\dfrac{d}{dx}\left(\dfrac{U}{V}\right) = \dfrac{V\dfrac{dU}{dx} - U\dfrac{dV}{dx}}{V^2}$	$\dfrac{d}{dx}(aU^n) = nU^n - 1$
$\dfrac{d}{dx}(a^U) = a^U ln\,a \dfrac{dU}{dx}$	$\dfrac{d}{dx}(e^U) = e^U \dfrac{dU}{dx}$
$\dfrac{d}{dx}(\sin U) = \cos U \dfrac{dU}{dx}$	$\dfrac{d}{dx}(\cos U) = -\sin U \dfrac{dU}{dx}$
$If\ U = U(x), V = V(x), and\ a = constant:$	
$\int a\,dx = ax + C$	$\int a\,dx = ax + C$
$\int U^n\,dU = \dfrac{U^{n+1}}{n+1} + C \quad n \neq 1$	$\int \dfrac{dU}{U} = \ln U + C$
$\int e^{ax}\,dx = \dfrac{1}{a}e^{ax} + C$	$\int xe^{ax}\,dx = \dfrac{e^{ax}}{a^2}(ax-1) + C$
$\int \ln x\,dx = x \ln x - x + C$	$\int \sin ax\,dx = -\dfrac{1}{a}\cos ax + C$
$\int \cos ax\,dx = \dfrac{1}{a}\sin ax + C$	
$z = x + jy \quad (x = r\,cos\,\theta, y = r\,sin\,\theta)$ $z = r\angle\theta \quad (r = \sqrt{x^2+y^2},\ \theta = tan^{-1}\dfrac{y}{x}$ $z = re^{j\theta} \quad (r = \sqrt{x^2+y^2},\ \theta = tan^{-1}\dfrac{y}{x}$ $e^{-j\theta} = cos\theta - jsin\theta\ ,\ e^{j\theta} = cos\theta + jsin\theta$ $j^2 = -1$	
$x(t) = A_1e^{s_1t} + A_2e^{s_2t}$ $x(t) = e^{-\alpha t}(A_1 + A_2t)$ $x(t) = e^{-\alpha t}(A_1 \cos\omega_d t + A_2 \sin\omega_d t)$	$x(t) = X_s + A_1e^{s_1t} + A_2e^{s_2t}$ $x(t) = X_s + e^{-\alpha t}(A_1 + A_2t)$ $x(t) = X_s + e^{-\alpha t}(A_1 \cos\omega_d t + A_2 \sin\omega_d t)$
$i_C = C\dfrac{dv}{dt} \qquad v_C = \frac{1}{C}\int_{t_0}^{t} i(t)dt + v(t_0)$	$v_L = L\dfrac{di}{dt} \qquad i = \frac{1}{L}\int_{t_0}^{t} v(t)dt + i(t_0)$
$\dfrac{dv(0)}{dt} = -\dfrac{(V_0 + RI_0)}{RC}$	$\dfrac{di(0)}{dt} = -\dfrac{1}{L}(RI_0 + V_0)$
$p(t) = v(t).i(t) \qquad P = \frac{1}{2}V_mI_m\cos(\theta_v - \theta_i) \qquad P_{max} = \frac{{V_{Th}}^2}{8R_{Th}}$	

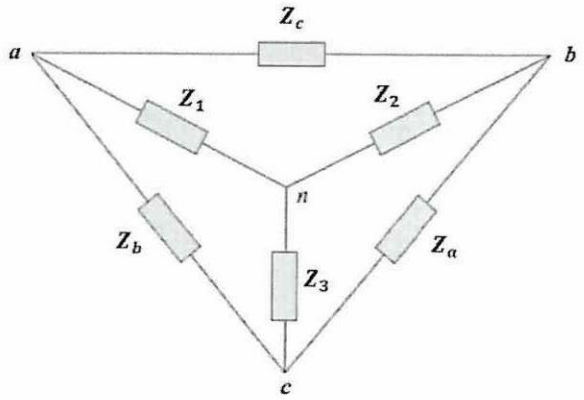
$X_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2\, dt}$ $\qquad P = {I_{rms}}^2 R = \frac{{V_{rms}}^2}{R}$

$|S| = V_{rms} I_{rms}$ $\qquad pf = \frac{P}{|S|} = \cos(\theta_v - \theta_i)$

$S = \frac{1}{2} V . I^* = V_{rms} {I_{rms}}^* = P + jQ$

$S_T = S_1 + S_2 + S_3 \ldots + S_N$

$C = \frac{Q_C}{\omega {V_{rms}}^2}$



Y − Δ Conversion

$$Z_a = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_1}$$

$$Z_b = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_2}$$

$$Z_a = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_3}$$

Δ − Y Conversion

$$Z_1 = \frac{Z_bZ_c}{Z_a + +Z_b + Z_c}$$

$$Z_2 = \frac{Z_cZ_a}{Z_a + +Z_b + Z_c}$$

$$Z_3 = \frac{Z_aZ_b}{Z_a + +Z_b + Z_c}$$

$V_1 = z_{11}I_1 + z_{12}I_2$
$V_2 = z_{21}I_1 + z_{22}I_2$

$I_1 = Y_{11}V_1 + Y_{12}V_2$
$I_2 = Y_{21}V_1 + Y_{22}V_2$

$V_1 = h_{11}I_1 + h_{12}V_2$
$I_2 = h_{21}I_1 + h_{22}V_2$

$V_1 = AV_2 - BI_2$
$I_1 = CV_2 - DI_2$