UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	ELECTRIC CIRCUITS II
COURSE CODE	:	BEV10403
PROGRAMME CODE	:	BEV
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 **SIX (6)** PAGES

Q1 (a) An electrical system is modelled by a series second-order RLC circuit with a capacitor valued at 47 nF and an inductor valued at 47 mH. Determine the range of resistor values for the circuit to exhibit an underdamped response.

(4 marks)

(b) Consider the second-order circuit shown in **Figure Q1.1**.

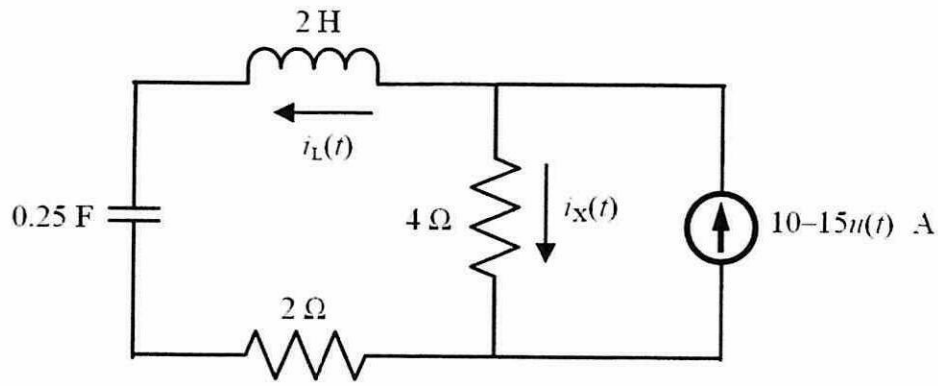

Figure Q1.1

(i) Apply source transformation and determine the mathematical equation of the voltage supply for $t < 0$ and $t > 0$.

(2 marks)

(ii) Determine the roots, s_1 and s_2, of the characteristic equation for the RLC circuit during $t > 0$.

(5 marks)

(iii) Based on the results in **Q2(b)(ii)**, determine the general mathematical expression of the inductor current $i_L(t)$ for $t > 0$. Represents the unknown constant coefficients accordingly, as A_1 and A_2.

(2 marks)

(iv) Solve for the unknown constant coefficient values of the $i_L(t)$ expression in **Q2(b)(iii)** using the initial and final conditions.

(9 marks)

(v) Determine the complete expression for the current $i_X(t)$ for $t > 0$.

(3 marks)

Q2 (a) A circuit consisting of a resistor and an inductor is connected in parallel with a capacitor across a supply voltage (V_S) with a frequency (f), as shown in **Figure Q2.1**.

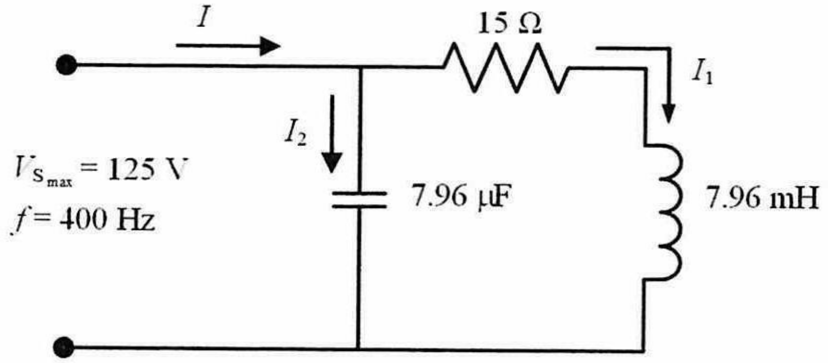

Figure Q2.1

(i) Convert and draw the circuit into a phasor domain equivalent circuit.

(3 marks)

(ii) Determine the current in each branch (I_1 and I_2) and the current from the supply (I) with its phase relative to the supply voltage (V_S).

(7 marks)

(iii) Sketch the phasor diagram of the circuit that includes the supply voltage (V_S), the supply current (I), and the current in each branch (I_1 and I_2). Point out the power factor angle.

(5 marks)

(b) Solve the current I_O in the circuit of **Figure Q2.2** using any analysis technique.

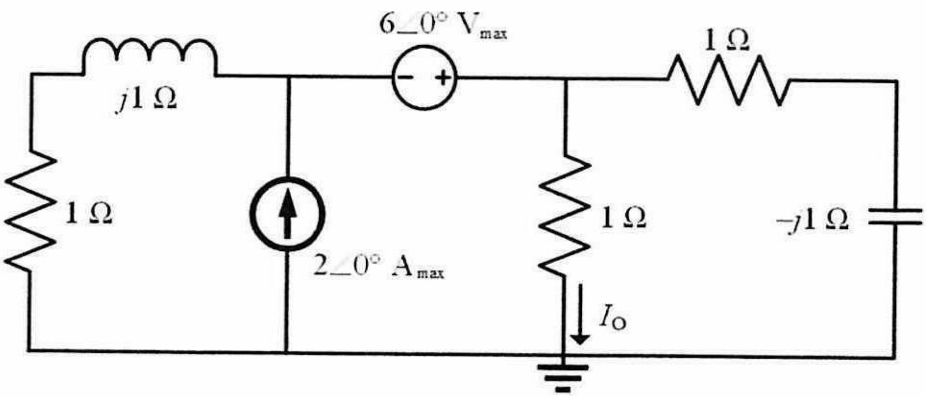

Figure Q2.2

(10 marks)

Q3 (a) Based on the circuit shown in **Figure Q3.1**.

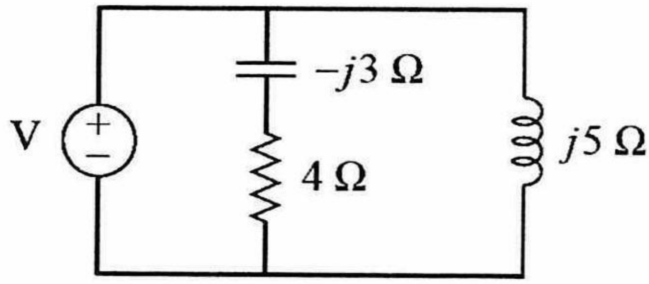

Figure Q3.1

(i) Calculate the complex power (S), real power (P) and reactive power (Q), supplied by the source, $V = 230\angle 15^\circ\ V_{rms}$.

(6 marks)

(ii) Calculate and draw the power triangle of the loads.

(4 marks)

(b) Three loads consisting of 20 kW (resistive), 25 kVAR (inductive) and 10 kVAR (capacitive) are connected to a 230 V_{rms}, 50 Hz source. Calculate,

(i) The total complex power and power factor of the loads.

(3 marks)

(ii) The current drawn from the supply.

(2 marks)

(iii) The value of capacitance required to improve the power factor to 0.95 lagging.

(7 marks)

(iv) The current drawn from the supply after improving the power factor to 0.95 lagging.

(3 marks)

Q4 (a) Define the two-port network.

(2 marks)

(b) Determine the z parameters for the circuit in **Figure Q4.1**.

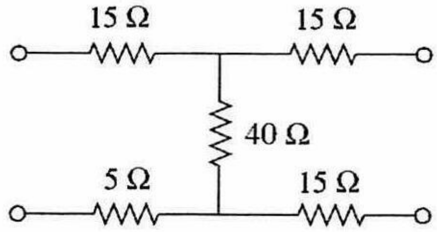

Figure Q4.1

(7 marks)

(c) Refer to the circuit shown in **Figure Q4.2**.

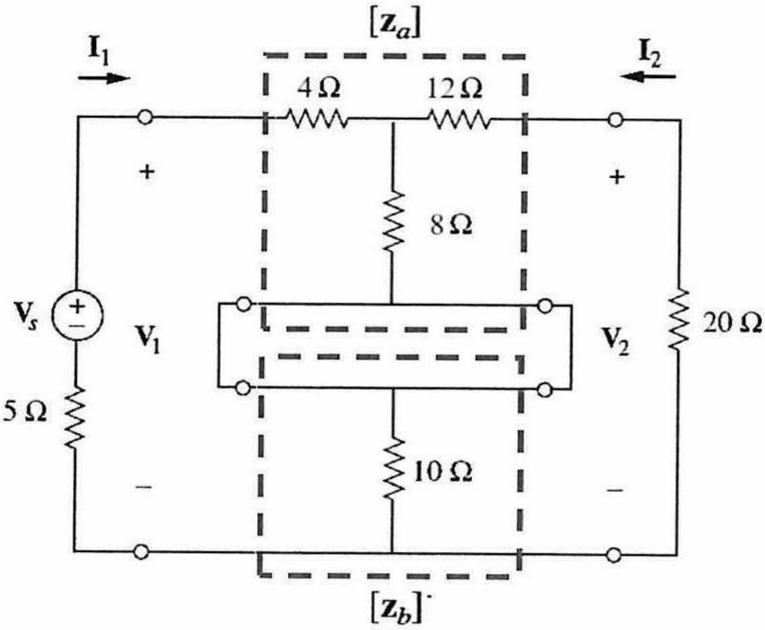

Figure Q4.2

(i) State the types of two-port interconnection configurations of the circuit.

(1 mark)

(ii) Determine $\frac{V_S}{V_2}$.

(15 marks)

- END OF QUESTIONS -

APPENDIX A

Table APPENDIX A.1

System parameter	Type of RLC circuit	
	Series RLC circuit	**Parallel RLC circuit**
Damping factor	$\alpha = \frac{R}{2L}$	$\alpha = \frac{1}{2RC}$
Resonant frequency	$\omega_o = \frac{1}{\sqrt{LC}}$	$\omega_o = \frac{1}{\sqrt{LC}}$
Damping frequency	$\omega_d = \sqrt{\omega_o^2 - \alpha^2}$	$\omega_d = \sqrt{\omega_o^2 - \alpha^2}$
Roots of the characteristic equation	$s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_o^2}$	$s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_o^2}$

Table APPENDIX A.2

Type of response	Condition
Overdamped	$\alpha > \omega_o$
Critically Damped	$\alpha = \omega_o$
Underdamped	$\alpha < \omega_o$

Table APPENDIX A.3

The z parameters for series connection of two two-port networks	$[z] = [z_a] + [z_b]$
The y parameters for parallel connection of two two-port networks	$[y] = [y_a] + [y_b]$
The T parameters for cascade connection of two two-port networks	$[T] = [T_a][T_b]$