

EXAMINATION INTERNAL VERIFICATION FORM (2017-2018)

MODULE :	PSDE 4001 Electrical and Electronic Principles	LEVEL:	4
PROGRAMME :	HNC Electrical and Electronic Engineering	TERM OF EXAM: (SPRING OR SUMMER)	Summer
LEARNING OUTCOME(S) BEING ASSESSED:	All	EXAM PAPER:	Main
		EXAMINATION AUTHOR :	R Jenkins

VERSION:	DATE SUBMITTED FOR VERIFICATION:	INTERNAL VERIFIER COMMENTS (Approval or detail of amendments required):	DATE:
1.	19/03/2018	Amendments to be considered as per attached printout.	21/03/2018
2.	27/03/2018	Exam conforms to the assessment strategy and is ready to be sent for external moderation.	27/03/2018

INTERNAL VERIFIER PLEASE TICK TO INDICATE THAT THE EXAMINATION:	
✓	Conforms to the assessment pattern described in the module syllabus
✓	Tests the module learning outcome(s) appropriately

SIGNATURES OF FINAL APPROVAL:	SIGNATURE	DATE
INTERNAL VERIFIER: I confirm that this version of the exam paper is ready to be sent to the external examiner		27/03/2018
EXAM AUTHOR: I confirm that internal verifier and external examiner approval have been received and that this version of the exam paper is ready for printing.		

**UNIVERSITY OF WALES:
TRINITY SAINT DAVID**



**PRIFYSGOL CYMRU:
Y DRINDOD DEWI SANT**

LOCATION: COLEG SIR

LLEOLIAD: COLEG SIR GAR

LEVEL 4

LEFEL 4

EXAMINATION PERIOD

CYFNOD ARHOLIADAU

MAY 2018

MAI 2018

MODULE CODE: PSDE4001
Electrical and Electronic Principles

TIME: 2 HOURS

ANSWER THREE QUESTIONS

Equipment or materials required – Calculators are permitted

Adnoddau neu ddefnyddiau sydd eu hangen – Caniateir cyfrifiannell

Main Paper

Question 1A

For the circuit shown in figure Q1A:

- (a) Draw the equivalent circuit. [4]
- (b) If the capacitor is initially discharged, determine the:
 - i. Time constant. [1]
 - ii. Time taken for the capacitor to fully charge. [2]
- (c) Determine the time taken for the capacitor to reach 3V when the capacitor is:
 - i. Charging from a fully discharged state. [5]
 - ii. Discharging from a fully charged state. [5]

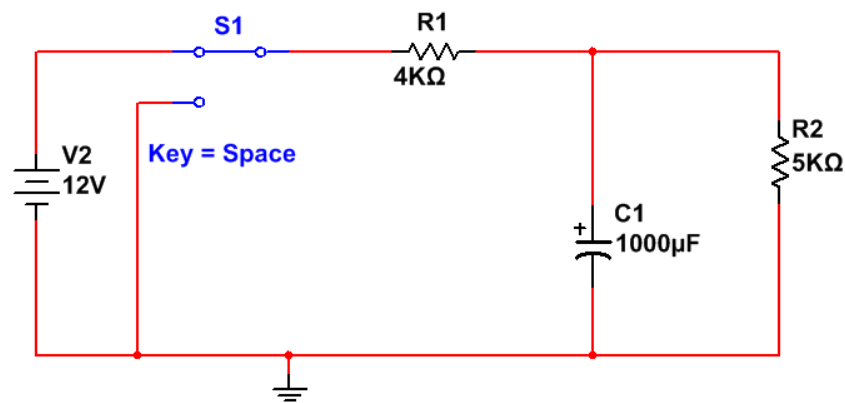


Figure Q1A

Question 1B

For the circuit given in Figure Q1B determine the:

- (a) Time constant for the circuit [3]
- (b) Steady state current flowing in the circuit immediately before the switch is changed. [2]
- (c) Time taken after the switch is changed over for the current to fall to:
 - (i) 25mA [6]
 - (ii) 30mA [6]

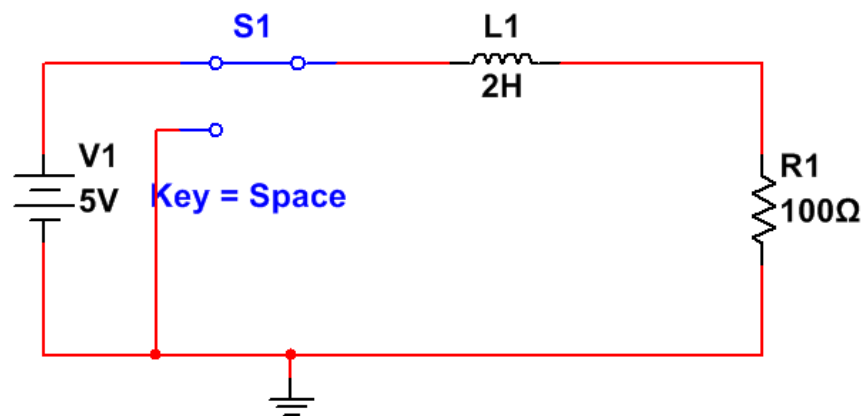


Figure Q1B

Total: [34 marks]

Question 2

A series resonant circuit comprises a coil of inductance 60mH and internal resistance 100 Ω connected in parallel with a variable capacitor across a 20V, 2KHz supply.

- (a) Calculate the required capacitance and draw the circuit arrangement. [6]
- (b) Determine for the resonant condition:
- i. The dynamic resistance. [4]
 - ii. The supply current. [3]
 - iii. The Q factor. [2]
 - iv. The bandwidth. [3]
 - v. The upper and lower -3dB frequencies. [12]
- (c) Sketch the graph of impedance against frequency illustrating the resonant frequency, upper and lower -3dB frequencies and the dynamic resistance. [4]

Total: [34 marks]

Question 3A

A load with impedance $Z = [6 + j8]$ is connected to an EMF source of 50V @ 2KHz with a phase angle of 30° .

Determine the:

- (a) Supply current [3]
- (b) Active, apparent and reactive powers [4]
- (c) VA rating of the capacitor to be connected in parallel with impedance Z to improve the power factor of the circuit to 0.966 lagging. Draw the power triangle showing the correction angle. [10]
- (d) Value of the capacitance needed to improve the p.f to 0.966 lagging. [4]

Question 3B

A 3 phase system has a balanced Delta connected load of 24KW operating at a power factor of 0.8 lagging.

If the system has a 415V, 50Hz supply, determine:

- (a) The current in each phase [6]
- (b) The current in each line [7]

Total: [34 marks]

Question 4A

An electrical circuit has a total impedance Z_T given by:

$$Z_T = \frac{Z_1 \times Z_2}{Z_1 + Z_2} + Z_3$$

Determine Z_T in $(a + jb)$ form to two decimal places if:

$$Z_1 = 6 - j4, Z_2 = 6 + j8 \text{ and } Z_3 = 4.6 - j8.2 \quad [15]$$

Question 4B

In the circuit shown in figure Q4B, a 200V 50Hz supply is connected across an ideal coil with inductance 0.4H in series with a 25Ω resistor.

- (a) Determine the:
- i. Impedance of the circuit [3]
 - ii. Current in the circuit [2]
 - iii. P.D across the 25Ω resistor [3]
 - iv. P.D across the coil [3]
- (b) Prove that the supply voltage equals the phasor sum of the P.Ds [4]
- (c) Draw the phasor diagram. [4]

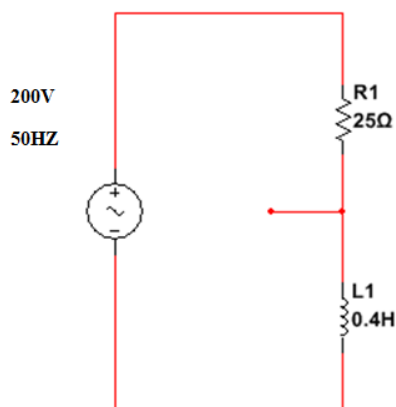


Figure Q4B

Total: [34 marks]

END OF PAPER

UNIVERSITY OF WALES:

TRINITY SAINT DAVID



PRIFYSGOL CYMRU:

Y DRINDOD DEWI SANT

LOCATION: COLEG SIR

LEVEL 4

EXAMINATION PERIOD

AUGUST 2018

LLEOLIAD: COLEG SIR GAR

LEFEL 4

CYFNOD ARHOLIADAU

AWST 2018

MODULE CODE: PSDE4001

Electrical and Electronic Principles

TIME: 2 HOURS

ANSWER THREE QUESTIONS

Equipment or materials required – Calculators are permitted

Adnoddau neu ddefnyddiau sydd eu hangen – Caniateir cyfrifiannell

Resit paper Solutions

Question 1 A

(a) Equivalent CCT:

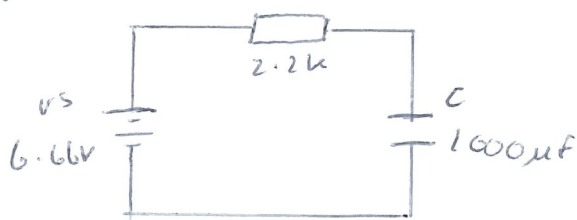
Using CCT reduction method, the resistors are in parallel:

$$\frac{R_1 \times R_2}{R_1 + R_2} = \frac{4 \times 5}{4 + 5} = 2.2 \text{ k}\Omega$$

New V_S from V-divider:

$$\frac{R_2}{R_1 + R_2} \times V_S = \frac{5}{4 + 5} \times 12 = 6.66 \text{ V}$$

Equivalent CCT



[4]

(b) Time constant $\tau = C \times R = 1000\mu\text{F} \times 2.2\text{k} = 2.2 \text{ s}$

[1]

(c) Time taken for capacitor to fully charge $= 5 \times \tau = 5 \times 2.2 = 11 \text{ s}$

[2]

(d) Time taken for capacitor to reach 3V charging:

(i) $V_S = 6.66\text{V}$ $\tau = 2.2 \text{ s}$ $V_C = 3\text{V}$

$$V_C = V_S [1 - e^{-\frac{t}{\tau}}]$$

$$3 = 6.66 [1 - e^{-\frac{t}{\tau}}]$$

$$\frac{3}{6.66} - 1 = -e^{-\frac{t}{\tau}}$$

$$\ln[0.55] = e^{-\frac{t}{\tau}} \quad \text{using log rules:}$$

$$-0.6 = -\frac{t}{\tau}$$

$$t = 0.6 \times 2.2 = 1.32 \text{ seconds}$$

[5]

d) Time for Capacitor to reach 3V discharging:

ii). $V_S = 6.66$ $T = 2.2$ $V_C = 3V$

$$V_C = V_S [e^{-\frac{t}{T}}]$$

$$3 = 6.66 [e^{-\frac{t}{T}}]$$

$$\frac{3}{6.66} = e^{-\frac{t}{T}}$$

$$\ln [0.45] = e^{-\frac{t}{T}} \quad \text{using log rules:}$$

$$-0.8 = -\frac{t}{T}$$

$$t = 0.8 \times T = 0.8 \times 2.2 = 1.76s$$

[5]

Question 1B

(a) Time Constant = $\frac{L}{R} = \frac{2}{100} = 0.02$

[3]

(b) Steady state Current $I = \frac{V}{R} = \frac{5}{100} = 0.05A$ or 50mA.

[2]

(c) I at 25mA:

(i) $I_L = I_{max} [e^{-\frac{t}{T}}]$

$$I_{max} = 50mA, \quad I_L = 25mA, \quad T = 0.02s$$

$$\frac{t}{R} = T \quad \text{and} \quad \frac{R}{L} = \frac{1}{T} \rightarrow \text{Re-arranging}$$

$$t = T \left[\ln \left[\frac{I_L}{I_{max}} \right] \right]$$

$$t = 0.02 \left[\ln \left[\frac{25mA}{50mA} \right] \right]$$

$$t = 13.8ms$$

[6]

(ii)

I at 30mA

$$I_L = 30mA$$

$$t = T \left[\ln \left[\frac{I_L}{I_{max}} \right] \right]$$

$$t = 0.02 \left[\ln \left[\frac{30mA}{50mA} \right] \right]$$

$$t = 10.2ms$$

[6]

Question 2

3

(a) The supply current is at a minimum when the parallel network is at resonance.

$$\text{Resonant frequency } f_r = \frac{1}{2\pi} \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

The value of the Variable capacitor is needed for the CCT:

$$[2\pi f_r]^2 = \frac{1}{LC} - \frac{R^2}{L^2}$$

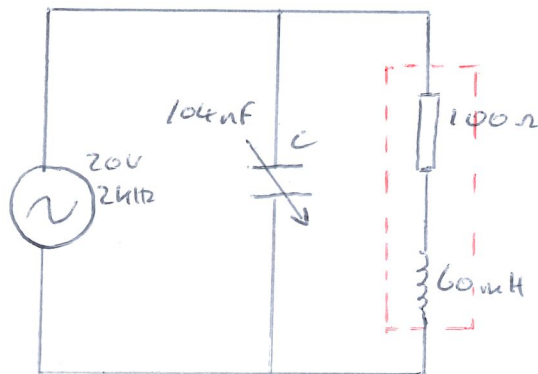
$$\frac{1}{LC} = [2\pi f_r]^2 + \frac{R^2}{L^2}$$

$$\therefore C = \frac{1}{L \left[[2\pi f_r]^2 + \left[\frac{R^2}{L^2} \right] \right]}$$

$$= \frac{1}{60 \times 10^{-3} \left[[2\pi \times 2000]^2 + \left[\frac{100^2}{(60 \times 10^{-3})^2} \right] \right]}$$

$$= \frac{1}{0.06 [160.7 \times 10^6]}$$

$$C = 104.16 \text{ nF}$$



[6]

$$(b) \text{ Dynamic } R_D = \frac{L}{CR} = \frac{60 \times 10^{-3}}{[104 \times 10^{-9}] [100]} = 5760 \Omega \text{ or } 5.76 \text{ k}\Omega$$

[4]

$$(c) \text{ Supply current at resonance } I_r = \frac{V}{5760} = 3.47 \text{ mA}$$

[3]

$$(d) \text{ Q factor at resonance } Q_r = \frac{\omega_r L}{R}$$

$$= \frac{[2\pi \times 2000] [60 \times 10^{-3}]}{100}$$

[2]

$$Q_r = 7.54$$

(e) The upper and lower -3 dB frequencies are f_1 and f_2 .

$$\text{Bandwidth} = [f_2 - f_1]$$

$$Q_r = \frac{f_r}{[f_2 - f_1]}$$

$$\therefore \text{Bandwidth } [f_2 - f_1] = \frac{f_r}{Q_r} = \frac{2000}{7.54} = 265 \text{ Hz}$$

[3]

(f) upper and lower -3 dB frequencies

$$\text{Resonance } f_r = \sqrt{[f_1 \cdot f_2]}$$

$$\begin{aligned} \text{So } \div f_1 \cdot f_2 &= f_r^2 & - (1) \\ &= 2000^2 \\ &= 4 \times 10^6 \text{ Hz} \end{aligned}$$

$$\text{from (e)} \quad f_2 - f_1 = 265 \text{ Hz}$$

$$\text{from (1)} \quad f_1 = \frac{f_r^2}{f_2}$$

$$\therefore \text{Bandwidth} = f_2 - \frac{f_r^2}{f_2}$$

$$265 = f_2 - \frac{4 \times 10^6}{f_2}$$

$$\left[\text{Since } f_1 = \frac{f_r^2}{f_2} \right]$$

$$\therefore f_2^2 - 4 \times 10^6 = 265 f_2$$

$$f_2^2 - 265 f_2 - 4 \times 10^6 = 0$$

This is now a quadratic equation:

$$f_2 = \frac{265 \pm \sqrt{[265]^2 - 4[-4 \times 10^6]}}{2}$$

$$f_2 = \frac{265 \pm 4008.8}{2}$$

$$f_2 = 2132 \text{ Hz}$$

* Neglect the -ve value

$$\rightarrow \text{upper -3 dB frequency } f_2 = 2132 \text{ Hz}$$

$$\rightarrow \text{Lower -3 dB frequency } f_1 = \frac{f_r^2}{f_2} = \frac{4 \times 10^6}{2132}$$

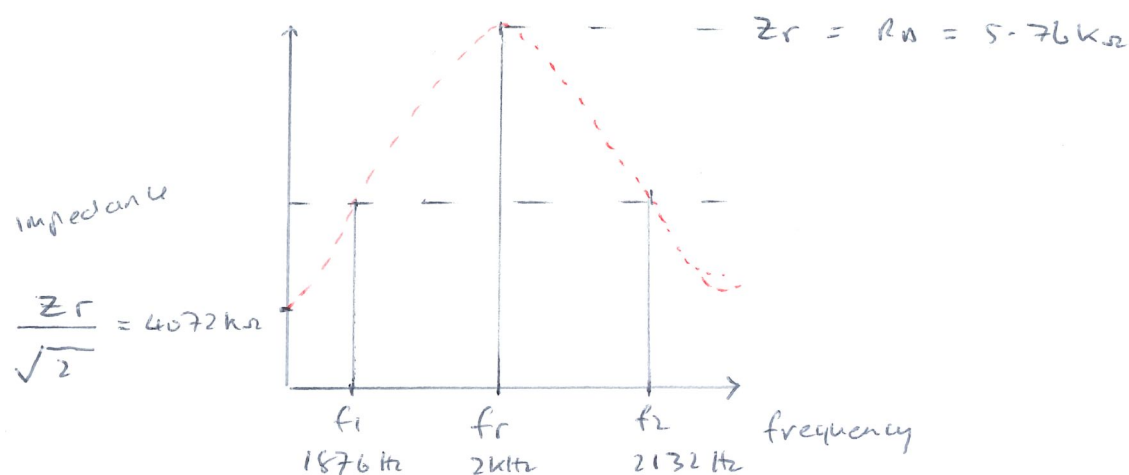
$$f_1 = 1876 \text{ Hz}$$

[12]

Question 2 Continued

⑤

g) f_1 and f_2 are equally displaced about the resonant frequency f_r :



[4]

Question 3 A

(a) Supply current $I = \frac{V}{Z} = \frac{50 \angle 30^\circ}{6 + j8} = \frac{50 \angle 30^\circ}{10 \angle 53.1^\circ} = 5 \angle -23.1^\circ \text{ A}$

[3]

(b) Apparent power $S = VI = [50 \angle 30^\circ] [5 \angle -23.1^\circ] = 250 \angle 53.1^\circ \text{ VA}$

$$S = [150 + j200] \text{ VA} = P + jQ$$

$$\therefore S = \sqrt{[\text{True Power}]^2 + [\text{Reactive Power}]^2}$$

$$S = \sqrt{150^2 + 200^2} = 250 \text{ VA.}$$

Hence: Active True Power $P = 150 \text{ W}$

Apparent Power $S = 250 \text{ VA}$

Reactive Power $Q = 200 \text{ VAR lagging.}$

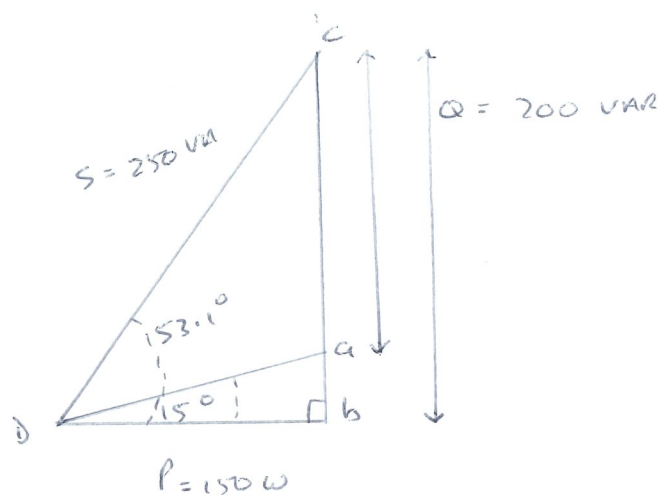
[4]

(c) original p.f. = $\cos \phi = \cos [53.1] = 0.6$

p.f. of 0.966 means that $\cos \phi = 0.966$

Hence: angle $\phi = \text{Arc Cos } 0.966 = 15^\circ$

(c) Power Triangle



The Power triangle will need to change from $\triangle Zb$ to $\triangle ab$. The length ca is the rating representation of the capacitor in parallel.

from the power triangle and using Pythagoras's theorem:

$$\tan 15^\circ = \frac{ab}{150}$$

$$\rightarrow \tan = \frac{\text{opp}}{\text{Adj}}$$

$$ab = 150 \tan 15^\circ = 40.2 \text{ VAR} = Q$$

The rating of the capacitor $Q_c = Q_b - ab$

$$Q_c = 200 - 40.2 = 159.8 \text{ VAR Leading.}$$

$$\text{New rating} \rightarrow Q_c = 159.8 \text{ VAR.}$$

[Because capacitor]

[10]

(d) value of capacitor:

$$\text{Current in capacitor} = \frac{Q_c}{V} = \frac{159.8}{50} = 3.2 \text{ A}$$

$$\text{using ohms law} \rightarrow \text{capacitive reactance } X_c = \frac{V}{I_c} = \frac{50}{3.2} = 15.625 \Omega$$

$$\therefore 15.625 \Omega = \frac{1}{2\pi f c}$$

$$\therefore c = \frac{1}{2\pi f X_c} = \frac{1}{2\pi [2000] [15.625]}$$

$$\text{Required Capacitance } C = 5.1 \mu\text{F.}$$

[4]

Question 3B

7

(a) Current in each phase:

$$\text{Power per phase} = \frac{24}{3} = 8 \text{ kW} \quad \text{balanced load.}$$

$$\text{kVA per phase} = \frac{8000}{0.8} = 10 \text{ kVA}$$

$$I_{ph} = \frac{10,000}{415} = 24.1 \quad \text{at P.f. } 0.8 \text{ lagging}$$

$$I_{ph} = 24.1 \angle \cos^{-1}[0.8]$$

$$I_{ph} \phi = \angle \cos^{-1}[\text{P.f.}]$$

$$I_{ph} = 24.1 \angle -36.9^\circ \text{ A}$$

-ve because lagging

Use Ry as reference 0° :

$$\text{Phase currents: } I_{Ry} = 24.1 \angle -36.9^\circ \text{ A} = [19.25 - j14.5] \text{ A}$$

$$I_{yB} = 24.1 \angle -120 - 37 = 24.1 \angle -157^\circ = [-22.2 - j9.4] \text{ A}$$

$$I_{BR} = 24.1 \angle 120 - 37 = 24.1 \angle 83^\circ = [2.94 + j24] \text{ A}$$

[6]

(b) Line currents:

$$I_R = I_{Ry} - I_{BR} = [19.25 - j14.5] - [2.94 + j24]$$

$$I_R = [16.31 - j38.5] = 41.8 \angle -67^\circ \text{ A}$$

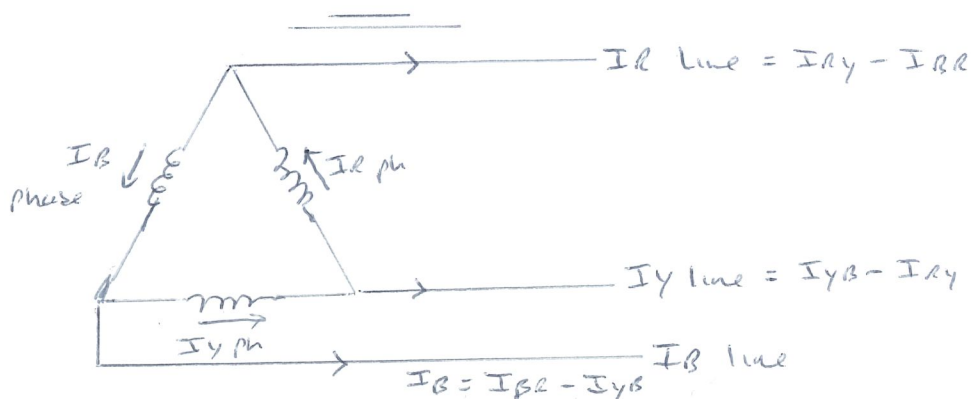
$$I_Y = I_{yB} - I_{Ry} = [-22.2 - j9.4] - [19.25 - j14.5]$$

$$I_Y = [-41.45 + j5.1] = 41.7 \angle 7^\circ \text{ A}$$

$$I_B = I_{BR} - I_{yB} = [2.94 + j24] - [-22.2 - j9.4]$$

$$I_B = [25.14 + j33.4] = 41.8 \angle 53^\circ \text{ A.}$$

using:



[7]

Question 4A

8

$$Z_T = \frac{Z_1 Z_2}{Z_1 + Z_2} + Z_3$$

$$Z_1 \cdot Z_2 = [6 - j4][6 + j8] = 36 + j48 - j24 - j^2 32$$

$$= 36 + j48 - j24 + 32$$

$$= 68 + j24$$

$$\text{if } j^2 = -1 \text{ then } -j^2 = +1$$

$$Z_1 + Z_2 = [6 - j4] + [6 + j8] = [12 + j4]$$

[5]

$$\text{Then: } \frac{Z_1 Z_2}{Z_1 + Z_2} = \frac{68 + j24}{12 + j4} = \frac{[68 + j24][12 - j4]}{[12 + j4][12 - j4]} \quad \begin{array}{l} \text{using} \\ \text{complex} \\ \text{conjugate} \end{array}$$

$$= \frac{816 - j272 + j288 - j^2 96}{12^2 + 4^2}$$

$$= \frac{912 + j16}{160} = 5.7 + j0.10$$

[7]

$$\therefore \frac{Z_1 Z_2}{Z_1 + Z_2} + Z_3 = [5.7 + j0.1] + [4.6 - j8.2]$$

$$Z_T = \underline{\underline{[10.3 - j8.10]}}$$

[3]

Question 4B

$$V = 200V \text{ at } 50\text{Hz}, R = 25\Omega, L = 0.4H$$

$$(a) \text{ Inductive reactance } X_L = 2\pi fL = 2\pi[50][0.4] = 125.7\Omega$$

$$\text{Impedance } Z = [R + jX_L]$$

$$Z = [25 + j125.7]\Omega$$

$$\text{or } 128 \angle 78.8^\circ \Omega$$

[3]

$$(b) \text{ Current } I = \frac{V}{Z} = \frac{200 \angle 0^\circ}{128 \angle 78.8^\circ} \quad \text{Assume } V_s = 0^\circ$$

$$I = 1.56 \angle -78.8^\circ \text{ A}$$

[2]

i.e. The current is $1.56 \angle -78.8^\circ$ lagging the voltage

(c) P.d across 25Ω resistor:

$$V_R = IR = [1.56 \angle -78.8^\circ][25 \angle 0^\circ]$$

$$V_R = 39 \angle -78.8^\circ$$

[3]

(d) P.d across the coil:

$$V_L = I X_L = [1.56 \angle -78.8^\circ][125.7 \angle 90^\circ] \quad \text{* Pure inductor,}$$

$$V_L = 196 \angle 11.2^\circ \text{ V}$$

[3]

(e) Proof: The phasor sum of V_R and $V_L = V_{\text{supply}}$.

$$V_R = 39 \angle -78.8^\circ = [7.6 - j38.26]$$

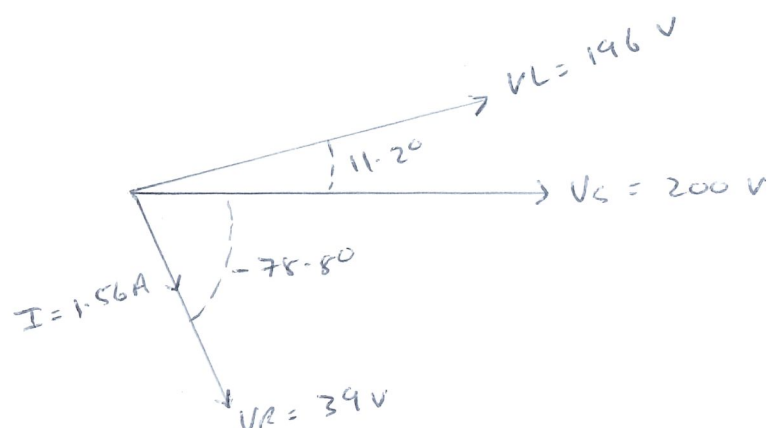
$$V_L = 196 \angle 11.2^\circ = [192.3 + j38.1]$$

$$V_R + V_L = [7.6 - j38.26] + [192.3 + j38.1]$$

$$= 199.9 + j0 \quad \text{Approx} = 200 \angle 0^\circ$$

[4]

(f) Phasor diagram:



The phasor diagram shows V_s at 0° , I and V_R lag V_s by -78.8° and V_L leads V_s by 11.2° . The reference is V_s at 0° . [4]
