



INTERNAL ASSESSMENT APPROVAL FORM (INCLUDING COLLABORATIVE PROVISION)

This form is used to ensure that assessment specifications have been through an internal review process prior to external examination/approval and release to students. It should be completed for each assessment for a particular module. The assessment tasks, criteria and marking scheme should accompany this form.

PARTNER (and taught location if relevant):	Coleg Sir Gar				
EXTERNAL EXAMINER NAME:	Dr Alison Griffiths				
ASSESSMENT AUTHOR :	Robert Jenkins				
MODULE TITLE:	Further Principles				
MODULE CODE:	SGEE4000		MODULE LEVEL:	4	
COMPONENT NO. (e.g. 1 of 2):	2 of 2		COMPONENT WEIGHTING (e.g. 50% of the module):	50%	
ASSESSMENT PERIOD	☐ Semester 1	☐ Semester 1 <i>Re-sit</i>	☒ Semester 2	☐ Semester 2 <i>Re-sit</i>	<i>Other, please state</i>
TYPE OF ASSESSMENT:	☐ Coursework		☒ Examination		☐ Practical
LANGUAGE OF ASSESSMENT:	English		TRANSLATION REQUIRED (Y/N):	N	
FOR EXAMINATIONS ONLY. SPECIFY BELOW ANY ADDITIONAL MATERIAL(S) TO BE USED IN THE EXAMINATION					
<i>This box will expand as you type</i>					

INTERNAL MODERATOR PLEASE TICK TO INDICATE THAT THE ASSESSMENT INCLUDES:		Please ☒ YES ☐ NO		Comments
1	Tasks that are specified clearly, accurately and comprehensibly, with appropriate use of language and neat presentation	☒	☐	
2	Tasks which enable the module learning outcomes to be demonstrated (as per the module syllabus)	☒	☐	
3	Tasks which conform to the assessment described in the module syllabus	☒	☐	
4	Tasks which are written at the appropriate level of the Framework for Higher Education Qualifications (see http://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf?sfvrsn=170af781_14).	☒	☐	
5	Clear criteria for assessment and guidance about how marking/grading will be applied	☒	☐	
6	Guidance about expected evidence for submission, e.g. essay or report, word count, bibliography and references	☒	☐	
7	Reference to good academic conduct, for example referencing, plagiarism and Turnitin	☒	☐	
8	Actions to complete <i>This box will expand as you type</i>			
SIGNATURE OF APPROVAL:		SIGNATURE		DATE
INTERNAL MODERATOR: I confirm that this version of the assessment specification is ready to be sent to the Partnership Team Leader				2/4/2019

ONLY TO BE COMPLETED IF THE ASSESSMENT IS LINKED TO A COLLABORATIVE PARTNER

PARTNERSHIP TEAM LEADER PLEASE TICK TO INDICATE THAT THE ASSESSMENT INCLUDES:		Please ✓		Comments
		YES	NO	
1	Tasks that are specified clearly, accurately and comprehensibly, with appropriate use of language and neat presentation			
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SIGNATURE OF APPROVAL:		SIGNATURE		DATE
PTL: I confirm that this version of the assessment specification is ready to be sent to the External Examiner				

UWTSD PROVISION: please submit the completed document to the appropriate Programme Director.

COLLABORATIVE PROVISION: please submit the completed document (or make available electronically) to the Partnership Team Leader. This must be in accord with specific arrangements for sharing electronic documents (e.g. via SharePoint or similar).

The assessment tasks, criteria and marking scheme should accompany this form



LOCATION: COLEG SIR GAR

LLEOLIAD: COLEG SIR GAR

LEVEL 4

LEFEL 4

EXAMINATION PERIOD

CYFNOD ARHOLIADAU

MAY 2019

MAI 2019

HNC ELECTRICAL AND ELECTRONIC ENGINEERING

MODULE CODE: PSDE4001 / SGEE4000

ELECTRICAL AND ELECTRONIC PRINCIPLES

TIME: 2.5 HOURS

ANSWER ANY FOUR OUT OF FIVE QUESTIONS

TOTAL MARKS = 100

NUMBER OF PAGES = 8

Equipment or materials required – Calculators are permitted

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Question 1A

For the circuit in figure Q1A, calculate:

- (a) The time constant for the circuit [2]
- (b) The steady state current flowing in the circuit immediately before the switch S1 is changed over. [2]
- (c) The time that has elapsed after switching over for the current in the circuit to fall to:
 - (i) 200mA [4]
 - (ii) 400mA [4]

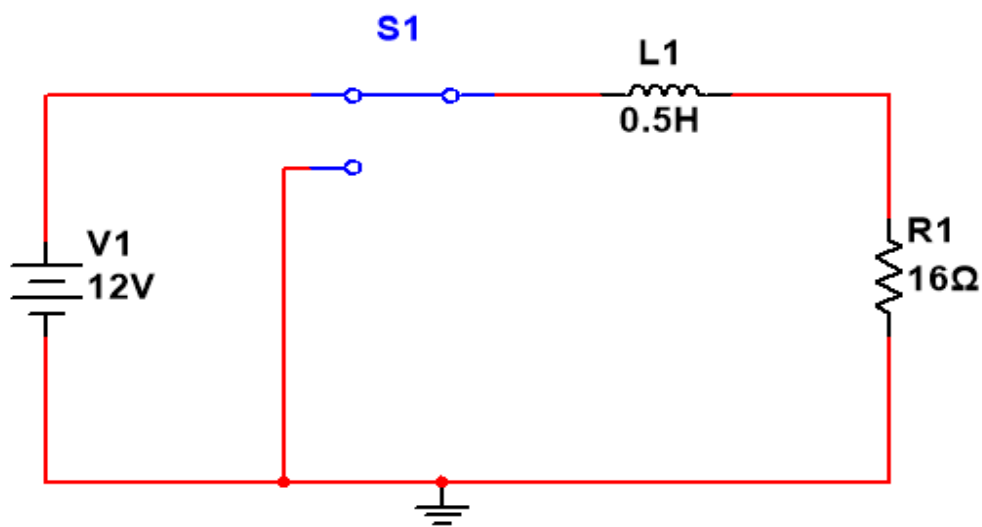


Figure Q1A

Question 1B

In the circuit shown in figure Q1B, if the capacitor is initially discharged, calculate:

- (a) The time taken for the capacitor to fully charge [3]
- (b) The time taken for the capacitor voltage to reach 6V when the capacitor is:
 - (i) Charging from a discharged state [5]
 - (ii) Discharging from a charged state [5]

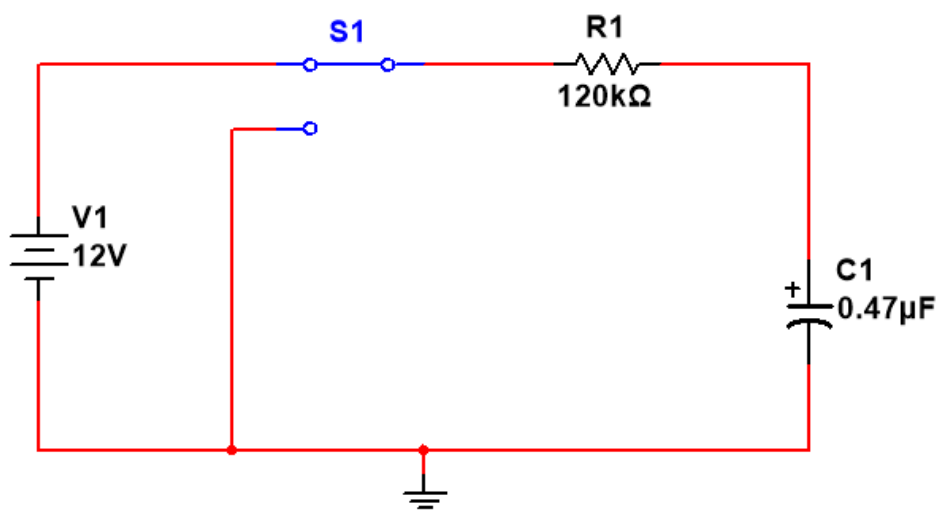


Figure Q1B

[25 marks]

Question 2A

An electrical circuit has a total impedance Z_T and is given by:

$$Z_T = [Z_1 Z_2 / Z_1 + Z_2] + Z_3$$

Determine Z_T to two decimal places if:

$$Z_1 = 6 - j4, Z_2 = 6 + j6 \text{ and } Z_3 = 2.5 - j5.6 \quad [10]$$

Question 2B

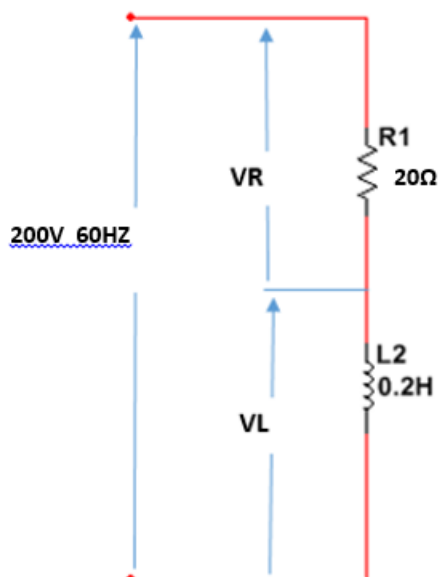
In the circuit shown in figure Q2B, a 200V 60HZ supply is connected across a coil of inductance 0.2H in series with a 20Ω resistor.

(a) Determine:

- (i) The impedance of the circuit [1]
- (ii) The current in the circuit [2]
- (iii) The P.D across the 20Ω resistor [3]
- (iv) The P.D across the coil [3]

(b) Prove that the supply voltage equals the phasor sum of the P.D's [3]

(c) Draw the phasor diagram [3]



[25 marks]

Figure Q2B

Question 3

A load with impedance $Z = [4 + j8]$ is connected to an EMF source of 50V at frequency of 2KHZ with a phase angle of 20°

(a) Calculate the:

(i) The supply current [3]

(ii) Active, Apparent and Reactive power [7]

(b) Draw the power triangle showing the correction angle. [6]

(c) Determine the VA rating of the capacitor to be connected in parallel with impedance Z that will improve the power factor to 0.966 lagging.

[5]

e) Calculate value of the capacitance needed to improve the P.F. to 0.966 lagging. [4]

[25 marks]

Question 4A

In the Delta connected load shown in figure Q4A, determine the:

- a) Phase currents [4]
- b) Line currents [2]
- c) Power triangle [4]

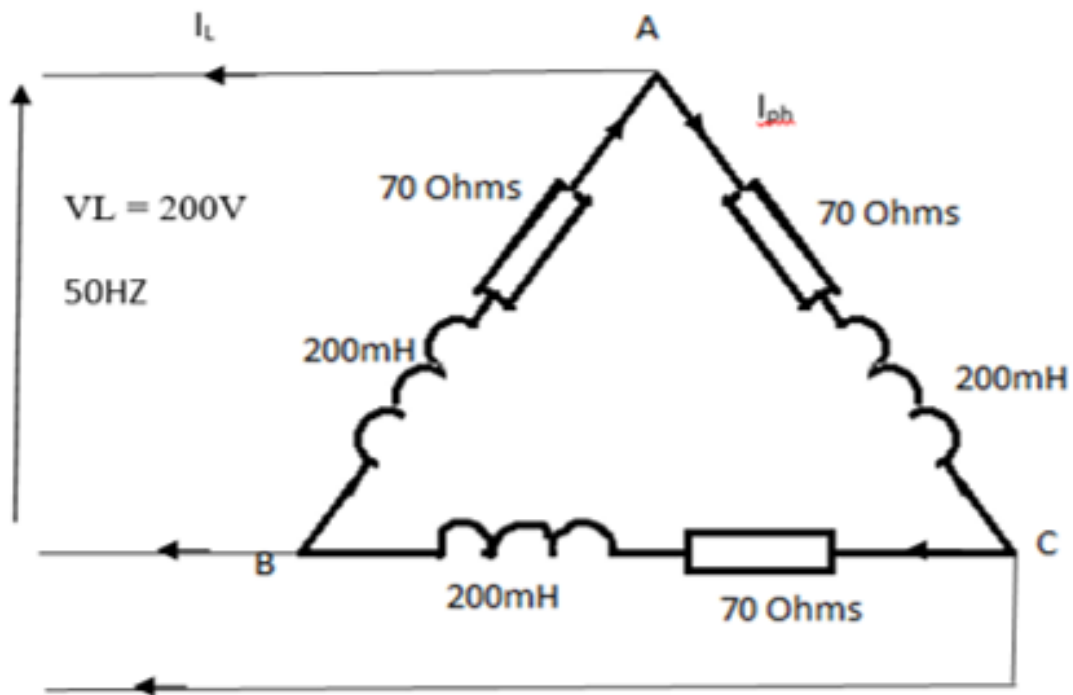


Figure Q4A

Question 4B

A series circuit consists of an inductor L , a capacitor C and a resistor R , with values of 100 mH, 0.318 mF and $20\ \Omega$ respectively. The circuit has an AC voltage of 10 V, 50 Hz.

a) For the circuit:

- (i) Calculate the circuit impedance. [4]
- (ii) Calculate the circuit current. [1]
- (iii) Calculate the power dissipated. [1]
- (iv) Draw and label the phasor diagram showing the current and source voltage. [2]

b) The capacitor is replaced with a variable capacitor.

- (i) Derive an expression for the resonant frequency (f_r) of an RLC series circuit. [3]
- (ii) Draw and label the circuit phasor diagram at resonance. [2]
- (iii) Since the supply frequency is fixed at 50 Hz, determine the capacitance required for circuit resonance. [2]

[25 marks]

Question 5

For the circuit shown in figure Q5, determine using mesh current analysis:

- a) The mesh currents I_1 and I_2 [18]
- b) The current flowing in the capacitor [3]
- c) The power delivered by the $100 \angle 0^\circ \text{ V}$ source and the total power dissipated by the resistors. [4]

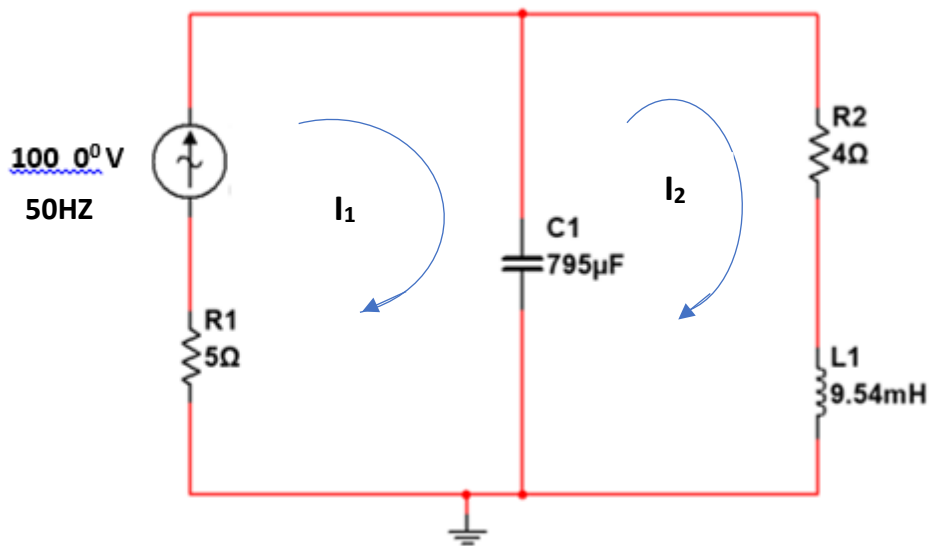


Figure Q5

[25 marks]



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MODULE CODE: PSDE4001 / SGEE4000

ELECTRICAL AND ELECTRONIC PRINCIPLES

SOLUTIONS

Question 1A

a) Time constant $= L / R = 0.5 / 16 = 0.03125\text{s}$ or 31.25ms [2]

b) Steady state current $I = V / R = 12 / 16 = 0.75\text{A}$ or 750mA [2]

c) Time elapsed: [4]

i) I at 200mA

$$I = I_{\text{max}} * e^{-(R/L) * t}$$

$$200 / 750 = e^{-32 * t}$$

$$\ln(0.27) = e^{-32 * t}$$

$$-1.3 = -32t$$

$$t = 1.3 / 32 = 40.6\text{ms}$$

ii) I at 400mA

[4]

$$I = I_{\text{max}} * e^{-(R/L) * t}$$

$$400 / 750 = e^{-32 * t}$$

$$\ln(0.53) = e^{-32 * t}$$

$$-0.63 = -32t$$

$$t = 0.63 / 32 = 19.6\text{ms}$$

Question 1B

a) Time constant $T = C \times R = [0.47 \times 10^{-6}] \times [120 \times 10^3] = 56.4\text{ms}$

Capacitor is fully charged after $5 \times T = 282\text{ms}$ [3]

b) Time for V_c to reach 6V when capacitor is charging from discharged state:

i) $V_c = V_s[1 - e^{-t/T}]$ [5]

$$6 = 12[1 - e^{-t/T}]$$

$$6/12 = [1 - e^{-t/T}]$$

$$\ln[0.5-1] = -e^{-t/T}$$

$$0.693 = t / T$$

$$t = 0.693 \times 56.4\text{ms} = 39\text{ms}$$

ii) V_c to reach 6V when discharging from a charged state: [5]

$$V_c = V_s e^{-t/T}$$

$$6/12 = e^{-t/T}$$

$$\ln[0.5] = -t / T$$

$$t = 0.693 \times 56.4\text{ms} = 39\text{ms}$$

Question 2A

$$\begin{aligned}Z_1 Z_2 &= [6 - j4] [6 + j6] = 36 + j36 - j24 - j^2 24 \\&= 36 + j12 + 24 \\&= 50 + j12\end{aligned}$$

$$Z_1 + Z_2 = [6 - j4] + [6 + j6] = [12 + j2]$$

$$\begin{aligned}Z_1 Z_2 / Z_1 + Z_2 &= [(50 + j12) / 12 + j2] * [(12 - j2) / (12 - j2)] \quad \text{using complex conjugate} \\&= (600 - j100 + j144 - j^2 24) / (12^2 + 2^2) \\&= (624 + j44) / 148 \\&= 4.22 + j0.3\end{aligned}$$

$$[Z_1 Z_2 / Z_1 + Z_2] + Z_3 = [4.22 + j0.3] + [2.5 - j5.6] = [6.72 - j5.3] \quad [10]$$

Question 2B

a) Impedance $Z = [R + jX]$ [1]

$$X_L = 2\pi fL = 75.4\Omega$$

$$Z = [20 + j75.4] \text{ or } 78 \angle 75.14^\circ \Omega$$

ii) Current $I = V / Z = 200 \angle 0^\circ / 78 \angle 75.14^\circ$ [2]

$$= 2.56 \angle -75.14^\circ \text{ A} \quad I \text{ lags } V \text{ by } 75.14^\circ$$

iii) P.D. across 20Ω resistor: [3]

$$V_R = IR = [2.56 \angle -75.14^\circ][20 \angle 0^\circ] = 51.2 \angle -75.14^\circ$$

iv) P.D. across the coil: [3]

$$V_L = I X_L = [2.56 \angle -75.14^\circ][75.4 \angle 90^\circ]$$

b) Proof: Phasor sum of $V_R + V_L = V_S$ [3]

$$V_R = 51.2 \angle -75.14^\circ = [13 - j50]$$

$$V_L = 193 \angle 14.86^\circ = [187 + j50]$$

$$V_R + V_L = [13 - j50] + [187 + j50]$$

$$= 200 + j0 = 200 \angle 0^\circ \text{ V}$$

C) Draw phasor diagram: [3]

V_L leads V_S by 14.86° and V_R & I lag V_S by -75.14°

Question 3

a) Supply current $I = V / Z = 50 \angle_{20^0} / [4 + j8] = 50 \angle_{20^0} / 9 \angle_{63.4^0} = 5.5 \angle_{-43.4^0} \text{ A}$

[3]

b) Apparent power $S = P + jQ$ and also $V \cdot I$

[7]

$$S = V \cdot I = [50 \angle_{20^0}] [5.5 \angle_{-43.4^0}] = 275 \angle_{-63.4^0} \rightarrow \text{ignore the -ve angle for power}$$

$$S = P + jQ$$

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

$$S = \sqrt{[123 + j246]} \rightarrow \text{converted } 275 \angle_{63.4^0}$$

$$S = 275 \text{ VA} \quad \text{proof of calc as value is the same}$$

$$\text{Hence: Active True power } P = 123 \text{ W}$$

$$\text{Apparent power } S = 275 \text{ VA}$$

$$\text{Reactive power } Q = 246 \text{ VAR} \quad \text{lagging because question tells us so}$$

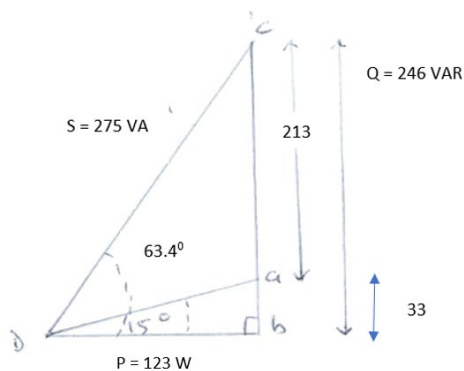
c) Original P.F = $\cos \phi = \cos[63.4] = 0.447$ or 0.5

[6]

$$\text{P.F of 0.966 is required. This means that } \cos \phi = 0.966$$

$$\text{Hence: angle } \phi = \text{Arc cos } [0.966] = 15^0$$

Power triangle



d) The power triangle will need to change from dcb to dab. The length ca is the rating representation of the capacitor in parallel.

[5]

Using Pythagoras:

$$\tan[15^0] = ab / 123 \rightarrow \tan = \text{opp} / \text{adj}$$

$$ab = 123 \tan 15^0 = 33 \text{ VAR} = Q$$

The rating of the capacitor $ca = cb - ab = 246 - 33 = 213 \text{ VAR}$ leading because it is a capacitor.

New rating $\rightarrow Q_c = 213 \text{ VAR}$

e) Value of capacitor needed:

[4]

current in capacitor $I_c = Q_c / V = \text{Power} / \text{volts}$ i.e. Ohms law

$$I_c = 4.26 \text{ A}$$

Using Ohms law:

$$\text{Capacitive reactance } X_c = V / I_c = 50 / 4.26 = 11.7 \Omega$$

$$11.7 = 1 / 2\pi f c$$

$$C = 1 / 2\pi [2000][11.7] = 6.8 \mu\text{F required}$$

Question 4A

a) In DELTA system $V_L = V_{ph} = 200V$ [4]

$$I_{ph} = V_{ph} / Z_{ph}$$

$$Z_{ph} = \sqrt{R^2 + X_L^2}$$

$$X_L = 2\pi fL = 62.83\Omega$$

$$Z_{ph} = \sqrt{70^2 + 62.83^2}$$

$$I_{ph} = V_{ph} / Z_{ph} = 200 / 94.06\Omega = 2.13A \quad \text{balanced loads}$$

b) I line in DELTA system = $\sqrt{3} * I_{ph} = \sqrt{3} * 2.13 = 3.7A$ [2]

c) True power $P = \sqrt{3} * 200 * 3.7 * \cos\phi$ [4]

$$\phi = \tan^{-1} [X_L / R] = 41.91^\circ$$

$$\text{True power } P = \sqrt{3} * 200 * 3.7 * \cos(41.91) = 953W$$

$$\text{Reactive power } Q = \sqrt{3} * 200 * 3.7 * \sin(41.91) = 556VAR$$

$$\text{Apparent power } S = \sqrt{P^2 + Q^2} = 1.28KVA$$

Power triangle must be drawn here showing the 3 powers and the phase angle.

Question 4B

a) i) $X_L = 2\pi fL = 31.4\Omega$ and $X_C = 1 / 2\pi fC = 10\Omega$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$Z = \sqrt{20^2 + (31.4 - 10)^2} = 29.29\Omega$$

$$\tan^{-1}[X_L - X_C / R] = -47^\circ$$

$$Z = 29.29 \angle -47^\circ \quad [4]$$

$$\text{ii) } I = V / Z = 10 \angle 0^\circ / 29.29 \angle -47^\circ = 0.341 \angle -47^\circ \text{ A} \quad [1]$$

$$\text{iii) } P = I^2 R = 0.341^2 \times 20 = 2.33 \text{ W} \quad [1]$$

iv) **Phasor diagram goes here** [2]

b) i) At resonance $X_L = X_C$ [3]

$$X_L = X_C$$

$$2\pi fL = 1 / 2\pi fC$$

$$f^2 = 1 / 4\pi^2 LC$$

$$f = 1 / 2\pi(\sqrt{LC})$$

ii) **Draw phasor diagram at resonance** [2]

$$\text{iii) } C = 1 / 4\pi^2(50^2)(0.1) = 1 / 4\pi^2 f^2 L \quad [2]$$

$$C = 101 \mu\text{F}$$

Question 5

a) $795\mu\text{F} = -j4\Omega$ and $9.54\text{mH} = j3\Omega$ [6]

Loop1: $[5 - j4]I_1 - [-j4]I_2 = 100 \angle 0^\circ$ *Note $100 \angle 0^\circ$ must be converted to Cartesian form

Loop2: $[4 + j3 - j4]I_2 - [-j4]I_1 = 0$

Apply Kirchoff's Law:

$$[5 - j4]I_1 + j4 I_2 - 100 = 0$$

$$j4 I_1 + [4 - j]I_2 + 0 = 0$$

Using determinants:

$$\frac{I_1}{\begin{vmatrix} j4 & -100 \\ [4 - j] & 0 \end{vmatrix}} = \frac{-I_2}{\begin{vmatrix} [5 - j4] & -100 \\ j4 & 0 \end{vmatrix}} = \frac{1}{\begin{vmatrix} [5 - j4] & j4 \\ j4 & [4 - j] \end{vmatrix}}$$

$$[j4 \times 0] - [[4 - j] \times [-100]] = 400 - j100 \quad [6]$$

$$[[5 - j4] \times 0] - [j4 \times [-100]] = j400$$

$$[[5 - j4] \times [4 - j]] - [j4 \times j4]$$

$$20 - j5 - j16 + j^2 4 - j^2 16$$

$$20 - j5 - j16 - 4 + 16 = 32 - j21$$

$$\frac{I_1}{400 - j100} = \frac{-I_2}{j400} = \frac{1}{32 - j21} \quad [6]$$

$$\text{Hence: } I_1 = \frac{400 - j100}{32 - j21} = \frac{412.31 \angle -14.04^\circ}{38.28 \angle -33.27^\circ} = 10.77 \angle -19.23^\circ \text{ A}$$

$$I_2 = \frac{-j400}{32 - j21} = \frac{400 \angle -90^\circ}{38.28 \angle -38.28^\circ} = 10.45 \angle -56.73^\circ \text{ A} \quad \text{*Note: Pure inductor}$$

b) Current flowing in capacitor: $= I_1 - I_2$ [3]

$$= 10.77 \angle -19.23^\circ - 10.45 \angle -56.73^\circ$$

$$[10.16 + j3.55] - [5.73 - j8.7]$$

$$= [4.43 + j12.25]$$

$$= 13.02 \angle -70.12^\circ \text{ A}$$

Current through capacitor = 13.02 A

$$\text{c) Source power } P = V I \cos \phi = 100 \times 10.77 \times \cos (19.23) = 1016 \text{ W} \quad [4]$$

This is because initially the capacitor acts as a short cct and bypasses 4Ω and inductor

$$\text{Power in } 5\Omega \text{ resistor} = I_1^2 R = I_1^2 (5) = (10.77)^2 (5) = 580 \text{ W}$$

$$\text{Power in } 4\Omega \text{ resistor} = I_2^2 R = I_2^2 (4) = (10.45)^2 (4) = 437 \text{ W}$$

$$= 1017 \text{ W}$$