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University of Wales  
Trinity Saint David

## Examination Answer Books

12 Pages

### Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.

|   |                                  |                       |
|---|----------------------------------|-----------------------|
| 1 | Student Number                   |                       |
| 2 | Title of Examination Paper       | TCA1                  |
| 3 | Module Code                      | PCEE4000/<br>PCPO4000 |
| 4 | Date and Time of Examination     | 4 pm<br>25/1/23       |
| 5 | Examination Venue                | Pembroke College      |
| 6 | Seat Number                      |                       |
| 7 | Number of Answer Books handed in | 1                     |

Complete, fold and seal  
(see note 2 below)

SURNAME: RAYMOND

FORENAME(S): HEATHER GLORIA  
JANE

| List the numbers of the questions you have attempted | Office Use |
|------------------------------------------------------|------------|
| 1                                                    | 4          |
| 2                                                    | 16         |
| 3                                                    | 12         |
| 4                                                    | 12         |
| 5                                                    | 15         |
| 6                                                    | 14         |
| 7                                                    | 12         |
| 8                                                    | 4          |
| 9                                                    | 8          |
|                                                      |            |
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|                                                      |            |
|                                                      |            |
|                                                      |            |
|                                                      |            |
| Total                                                | 97 ✓       |

Second Marker  
SDM  
02/02/23

1. Expression for  $m$

$$f_{res} = \frac{1}{2} \sqrt{\frac{k}{m}} \quad (x2)$$

$$2 f_{res} = \sqrt{\frac{k}{m}} \quad (2)$$

$$4 f_{res}^2 = \frac{k}{m} \quad (x m)$$

$$m 4 f_{res}^2 = k \quad (\div)$$

$$m = \frac{k}{4 f_{res}^2}$$

4

2. (i)  $5(x-1) - 4(3x-1) + 15 = 0$

$$5x - 5 - 12x + 4 + 15 = 0$$

$$-7x + 14 = 0 \quad (-14)$$

$$-7x = -14 \quad (\div -7)$$

$$x = \frac{-14}{-7}$$

$$x = 2$$

4

(ii)  $2x^2 - 5x - 3 = 0$

~~$$(2x+1)(x-3) = 0$$~~

$$\begin{array}{r} 2 \\ -2 \quad -1 \\ \hline 2 \quad 1 \end{array}$$

$$\begin{array}{r} -3 \\ +3 \quad -1 \\ \hline +1 \quad -3 \end{array}$$

$$(2x+1)(x-3) = 0$$

$$\begin{array}{r} -5 \\ -2 \quad -3 \end{array}$$

$$2x+1 = 0 \quad (-1)$$

$$2x = -1 \quad (\div 2)$$

$$x = -\frac{1}{2}$$

$$x-3 = 0 \quad (+3)$$

$$x = 3$$

6

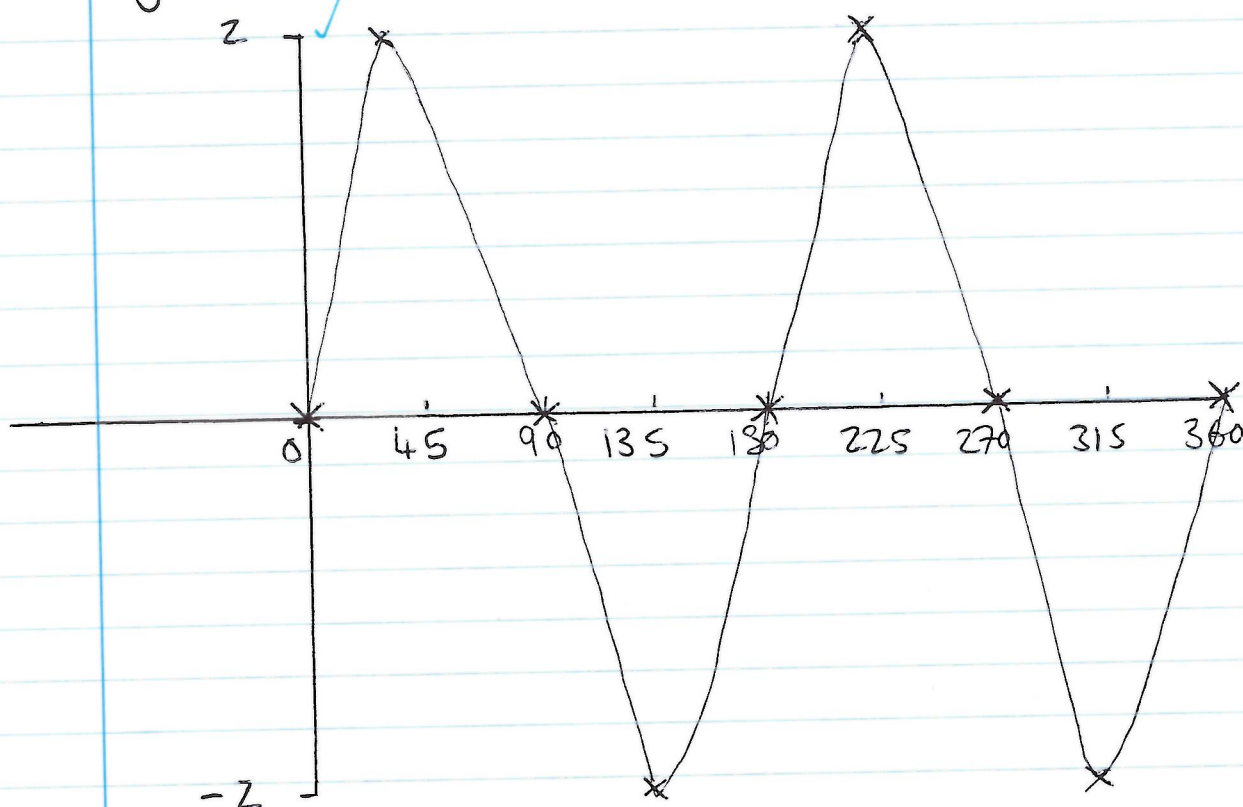
2(ciii)  $7.5 \times 10^{x-5} = 255 \quad (\div 7.5) \quad \log(x^y) = y \log x$

$$10^{x-5} = 34 \quad (\text{Log})$$

$$x-5 = \log_{10} 34 \quad (+5)$$

$$x = \log_{10} 34 + 5 \quad \underline{\underline{x = 6.53}}$$

3(i)  $y = 2 \sin(2x)$  for  $0 \leq x \leq 360$



(double the frequency of  $x$ ) ( $2x$ )

$$x = 0 \times 2 = 0$$

$$x = 90 \div 2 = 45$$

$$x = 180 \div 2 = 90$$

$$x = 270 \div 2 = 135$$

$$x = 360 \div 2 = 180$$

$$x = 450 \div 2 = 225$$

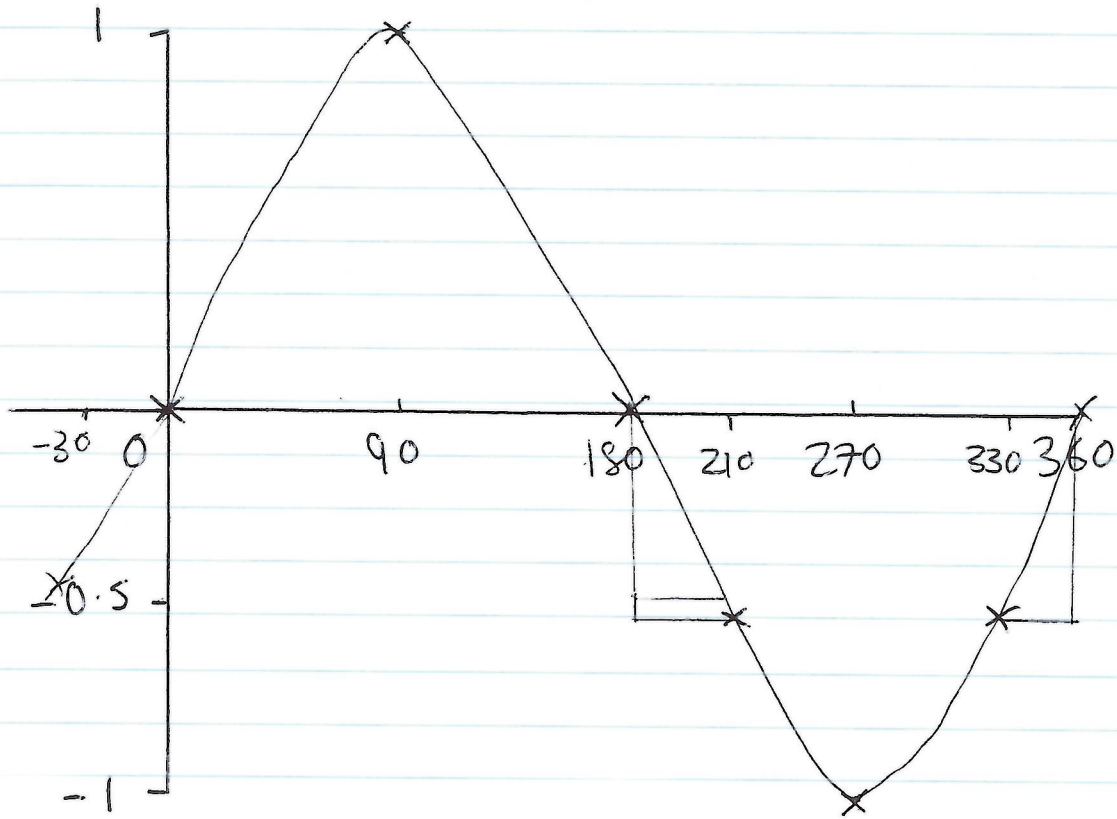
$$x = 540 \div 2 = 270$$

$$x = 630 \div 2 = 315$$

$$x = 720 \div 2 = 360$$

3(ii)  $\sin 2x = -0.5$  for  $0 < x \leq 360$

$$2x = \sin^{-1}(-0.5) = -30^\circ \quad \checkmark$$



$$180 + 30 = 210^\circ \quad \checkmark \quad 360 - 30 = 330^\circ \quad \checkmark$$

$$360 + 330 = 690^\circ \quad \checkmark \quad 360 + 210 = 570^\circ \quad \checkmark$$

$$2x = 210^\circ, 330^\circ, 690^\circ, 570^\circ \quad (\div 2)$$

$$\underline{\underline{x = 105^\circ, 165^\circ, 285^\circ, 345^\circ}} \quad \checkmark$$

6

$$Z_1 - Z_2 \quad 4(i) \quad (-1 + j2) - (5 + j3) = \boxed{-6 - j} \quad \checkmark$$

(2)

$$(ii) \quad Z_1 Z_2 \quad (-1 + j2)(5 + j3) \quad \checkmark$$

$$= -5 - j3 + j10 + j^2 6 \quad \checkmark$$

$$= -5 + j7 + (-1)6 \quad \checkmark$$

$$Z_1 Z_2 = \underline{\underline{-11 + j7}} \quad \checkmark$$

(3)

$$(iii) \quad \frac{Z_1}{Z_2} \quad \frac{-1 + j2}{5 + j3} \times \frac{5 - j3}{5 - j3} \quad \checkmark$$

$$(-1 + j2)(5 - j3) = -5 + j3 + j10 - j^2 6$$

$$= -5 + j13 + (-1)6$$

$$= 1 + j13 \quad \checkmark$$

$$(5 + j3)(5 - j3) = 25 - 15j + j15 - j^2 9$$

$$= 25 + (-1)9 = 34 \quad \checkmark$$

$$\boxed{\frac{Z_1}{Z_2} = \frac{1}{34} + \frac{j13}{34}} \quad \checkmark$$

(5)

4(civ)  $(Z_2)^4$ 

$$(S+j3)^4$$

$$a^2 + b^2 = c^2$$

$$5^2 + 3^2 = 34$$

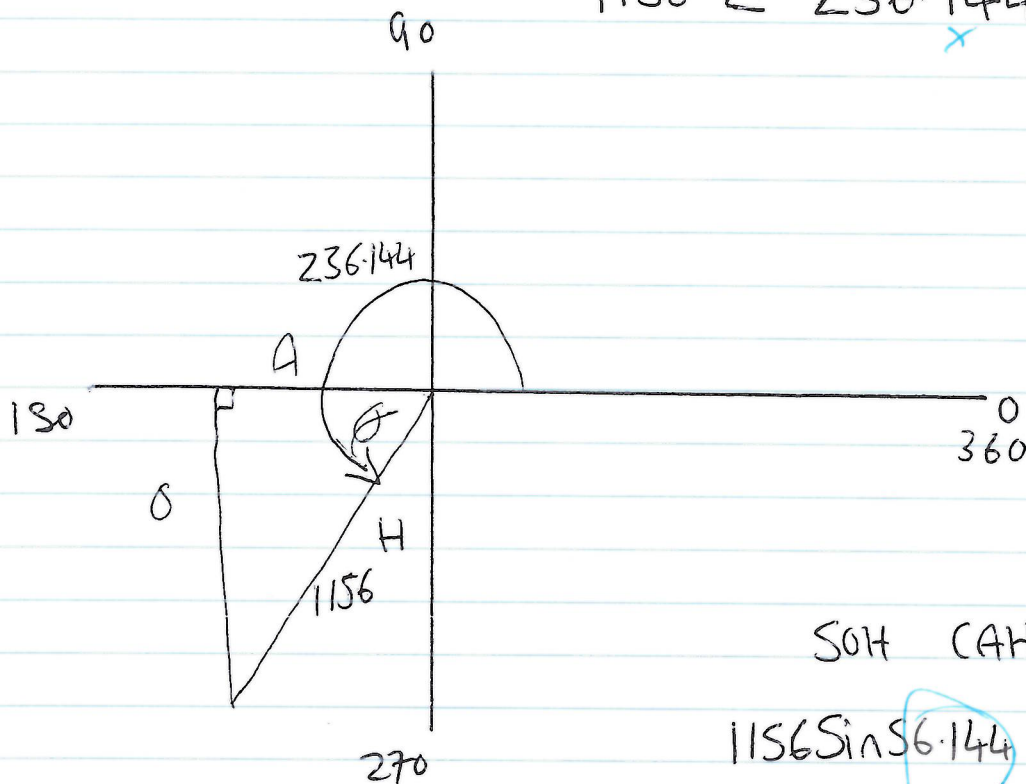
To A

$$\tan^{-1} \frac{O}{A}$$

$$\tan^{-1} = \frac{5}{3} = 59.036$$

$$\sqrt{34} < 59.036^\circ = \sqrt{34}^4 < 59.036 \times 4$$

$$= 1156 < 236.144$$



SOH CAH

$$1156 \sin 56.144 = 959.99$$

$$236.144 - 180 = 56.144^\circ \quad 1156 \cos 56.144 = 644.02$$

$$(Z_2)^4 = -644.02 - j959.99$$

558521

S(i)  $4B - 2A$

$$4B = 4 \begin{pmatrix} 6 & -3 \\ 3 & -1 \end{pmatrix} = \begin{pmatrix} 24 & -12 \\ 12 & -4 \end{pmatrix}$$

$$2A = 2 \begin{pmatrix} 1 & 0 \\ -2 & 5 \end{pmatrix} = \begin{pmatrix} 2 & 0 \\ -4 & 10 \end{pmatrix}$$

$$4B - 2A = \begin{pmatrix} 24 & -12 \\ 12 & -4 \end{pmatrix} - \begin{pmatrix} 2 & 0 \\ -4 & 10 \end{pmatrix} = \begin{pmatrix} 22 & -12 \\ 16 & -14 \end{pmatrix} \quad \checkmark \quad (3)$$

(ii)  $AB$   $\begin{pmatrix} 1 & 0 \\ -2 & 5 \end{pmatrix} \begin{pmatrix} 6 & -3 \\ 3 & -1 \end{pmatrix}$

|       | $C_1$                      | $C_2$                        |
|-------|----------------------------|------------------------------|
| $R_1$ | $1 \times 6 + 0 \times 3$  | $1 \times -3 + 0 \times -1$  |
| $R_2$ | $-2 \times 6 + 5 \times 3$ | $-2 \times -3 + 5 \times -1$ |

$$= \begin{pmatrix} 6 & -3 \\ 3 & 1 \end{pmatrix} \quad \checkmark \quad (3)$$

(iii)  $AB \neq BA$

$$\begin{pmatrix} 6 & -3 \\ 3 & -1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ -2 & 5 \end{pmatrix}$$

|       | $C_1$                       | $C_2$                      |
|-------|-----------------------------|----------------------------|
| $R_1$ | $6 \times 1 + -3 \times -2$ | $6 \times 0 + -3 \times 5$ |
| $R_2$ | $3 \times 1 + -1 \times -2$ | $3 \times 0 + -1 \times 5$ |

$$= \begin{pmatrix} 12 & -15 \\ 5 & -5 \end{pmatrix} = BA \quad \checkmark$$

$$AB = \begin{pmatrix} 6 & -3 \\ 3 & 1 \end{pmatrix}$$

Sc(v) inverse Matrix B

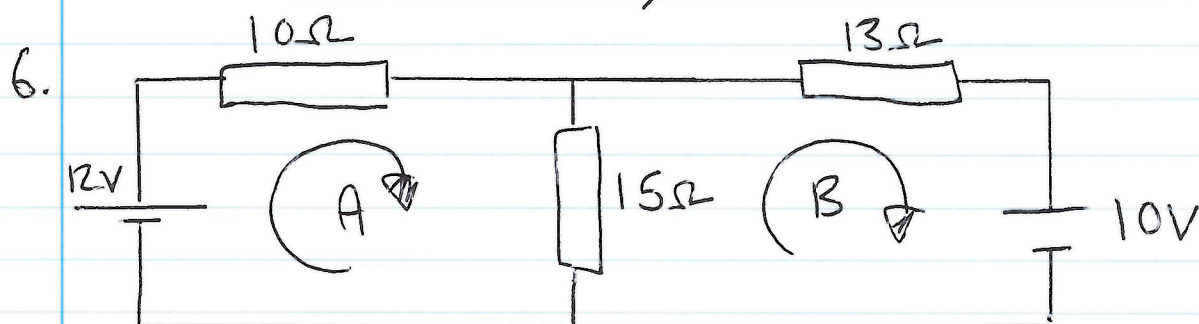
$$\underline{\underline{\det B}} = \begin{pmatrix} 6 & -3 \\ 3 & -1 \end{pmatrix} = (6 \times -1) - (3 \times -3) = 3 \checkmark$$

det =  $\frac{1}{3}$

$$\frac{1}{3} \begin{pmatrix} -1 & 3 \\ -3 & 6 \end{pmatrix} = \begin{pmatrix} -\frac{1}{3} & 1 \\ -1 & 2 \end{pmatrix}$$

$$\text{inverse} = \begin{pmatrix} -\frac{1}{3} & 1 \\ -1 & 2 \end{pmatrix} \checkmark$$

6



$V = IR$  Circuit A

$$12 = I_1 \times 10 + (I_1 + I_2) 15$$

$$12 = 10I_1 + 15I_1 + 15I_2$$

$$12 = 25I_1 + 15I_2 \checkmark$$

Circuit B

$$10 = I_2 \times 13 + (I_1 + I_2) 15$$

$$10 = 13I_2 + 15I_1 + 15I_2$$

$$10 = 15I_1 + 28I_2 \checkmark$$

Continued overleaf  $\rightarrow$

$$6. \begin{bmatrix} 25 & 15 \\ 15 & 28 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 12 \\ 10 \end{bmatrix}$$

$$\text{Inverse} = (25 \times 28) - (15 \times 15) = 475 = \frac{1}{475} \checkmark$$

$$\begin{bmatrix} 28 & -15 \\ -15 & 25 \end{bmatrix} \begin{bmatrix} 12 \\ 10 \end{bmatrix} \quad \begin{array}{c|c} & C_1 \\ \hline R_1 & 28 \times 12 + (-15) \times 10 \\ \hline R_2 & -15 \times 12 + 25 \times 10 \end{array}$$

$$= \begin{bmatrix} 186 \\ 70 \end{bmatrix} \times \frac{1}{475} = \begin{bmatrix} \frac{186}{475} \\ \frac{70}{475} \end{bmatrix} \checkmark$$

$$\text{Current through } 10\Omega \text{ resistor} = \frac{186}{475} \text{ A} \checkmark$$

$$\text{Current through } 15\Omega \text{ resistor} = \frac{70}{475} \text{ A} \checkmark$$

$$\text{Current through } 15\Omega \text{ resistor} = \frac{186}{475} + \frac{70}{475} = \frac{256}{475} \text{ A} \checkmark$$

$$7.(i) \quad y = mx + c \quad \begin{matrix} x & y \\ (0, 3) & (2, -1) \end{matrix}$$

$$m = \frac{y_a - y_b}{x_a - x_b} = \frac{3 - (-1)}{0 - 2} = -2 \checkmark \quad y = -2x + c$$

$$-1 = -2 \times 2 + c$$

$$-1 = -4 + c \quad (+4)$$

$$c = 3 \checkmark$$

$$\boxed{y = -2x + 3} \checkmark$$