



Prifysgol Cymru
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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.

Complete, fold and seal
(see note 2 below)

SURNAME: Roberts

FORENAME(S): Logan

1	Student Number	Rob24876064
2	Title of Examination Paper	Electrical Principles theory
3	Module Code	GOEE5001
4	Date and Time of Examination	15 th May 2025 1:35 PM
5	Examination Venue	Main hall
6	Seat Number	D1
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	
2	
3	
4	
Q2	3
Q2	4
Q3	0
Q4	5
Total	12/100

(Gweler yr ochr arall am y fersiwn Cymraeg)

12

120%

Q1.

b)

$$i) 3e^{3t} \cos(2t) + t^2 + 0.75$$

$$\frac{3}{s+3} \left(\frac{s+3}{(s+3)^2 + 2^2} \right) + \left(\frac{2!}{s^{2+1}} \right) + \left(\frac{0.75}{s} \right)$$

ii)

$$\sin(4t)e^t + 5e^{-3t}$$

$$= \left(\frac{4}{s^2+4^2} \right) \left(\frac{1}{s-a} \right) + \frac{5}{s+3} = \left(\frac{4}{s^2+4^2} \right) \left(\frac{1}{s-a} \right) + \frac{5}{s+3}$$

i)

$$3e^{3t} \cos(2t) + t^2 + 0.75$$

$$= \left(\frac{3}{s-3} \right) \left(\frac{s}{s^2+2^2} \right) + \left(\frac{2!}{s^{2+1}} \right) + \left(\frac{0.75}{s} \right) \quad \text{Repeat}$$

iii)

$$e^{2t} (3 - t^2) + \frac{3\pi}{2}$$

$$= \left(\frac{1}{s-2} \right) \left(3 - \frac{2!}{s^{2+1}} \right) + \pi \quad \times \quad 0$$

iv.)

$$t \cosh(2t) + e^{-2t}$$

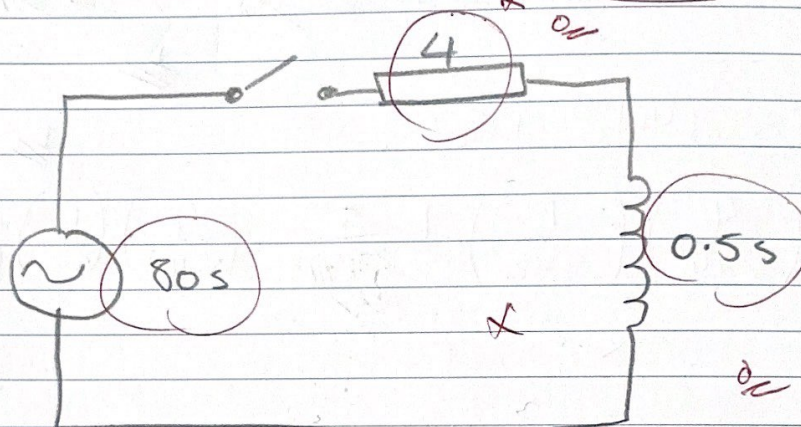
$$t \cosh(2t) + \frac{1}{s+2} \quad \checkmark \quad \underline{1}$$

Q1. b)

$$v. e^2 e^{-4t} t^3 - 3e^t \sin(e^2 t)$$

$$\left(\frac{1}{s-2} \right) \left(\frac{3!}{(s+4)^{3+1}} \right) \left(\frac{3!}{s^{3+1}} \right) - \left(\frac{3}{s-0} \right) \left(\frac{e^2}{s^2 + (e^2)^2} \right)$$

C.

Q1c0/15

$$A. \quad Z(s) = 2s + \frac{1000}{s} + 6$$

Q1a

$$Z(s) = 2f(t) + 1000 + 6f(t)$$

0/5

$$Z(s) = 8f(t) + 1000$$

Q2.

Q24/30Q2a0/5

$$b) \quad f(x) = \begin{cases} 1 & \text{if } -\pi \leq x < 0 \\ 0 & \text{if } 0 \leq x < \pi \end{cases}$$

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} [a_n \cos nx + b_n \sin nx]$$

$$a_0 = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) dx$$

3Q2b

$$a_0 = \frac{1}{\pi} \int_0^{\pi} 0 dx + \frac{1}{\pi} \int_{-\pi}^0 1 dx$$

4/25

$$a_0 = \left(\frac{1}{\pi} \int_0^{\pi} 0 dx \right) + \frac{1}{\pi} \int_{-\pi}^0 1 dx$$

$$a_0 = 1$$

show workings

show integration method

$$A_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \cos nx dx$$

$$a_n = \frac{1}{\pi} \int_0^{\pi} 0 \cos nx dx + \frac{1}{\pi} \int_{-\pi}^0 1 \cos nx dx$$

$$a_n = \left[\frac{\sin nx}{n} \right]_{-\pi}^0 + \frac{1}{\pi} \int_{-\pi}^0 \cos nx dx$$

$$a_n = 1$$

$$b_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \sin nx dx$$

$$b_n = \frac{1}{\pi} \int_0^{\pi} 0 \sin nx dx + \frac{1}{\pi} \int_{-\pi}^0 1 \sin nx dx$$

$$b_n = 1$$

Q2.

b)

$$\text{Real Fourier Series} = f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} [a_n \cos nx + b_n \sin nx]$$

$$f(x) = \frac{1}{2} + \sum_{n=1}^{\infty} [1 \cos nx + 1 \sin nx]$$

$$1^{\text{st}} \text{ term} = \frac{1}{2} + (\cos nx) + (1 \sin nx)$$

~~2nd term =~~

x

Q.4 A) $Z_A = 10 + j6 \Omega$

$Z_B = 8 + j4 \Omega$

$Z_C = 12 + j8 \Omega$

~~$Z_A = \frac{Z_B \times Z_C}{Z_A + Z_B + Z_C}$~~

~~$Z_A = \frac{(8+j4)(12+j8)}{(10+j6)+(8+j4)+(12+j8)} = \frac{96+j64+j48+j^2 32}{30+j18}$~~

~~$\frac{96+j64+j48+j^2 32}{30+j18} = \frac{96+j112+j^2 32}{30+j18}$~~

Delta

Q.4 A) $Z_A = \frac{(Z_A Z_B) + (Z_B Z_C) + (Z_C Z_A)}{Z_A}$

$(Z_A Z_B) = (10+j6)(8+j4) = 80 + j48 + j40 + j^2 24$

$(Z_B Z_C) = (8+j4)(12+j8) = 96 + j64 + j48 + j^2 32$

$(Z_C Z_A) = (12+j8)(10+j6) = 120 + j72 + j80 + j^2 48$

$(Z_A Z_B) = 80 + j88 + j^2 24 = 56 + j88$

$(Z_B Z_C) = 96 + j112 + j^2 32 = ???$

$(Z_C Z_A) = 120 + j152 + j^2 48 = ???$

Q4

5/20

Q4a

4/10

$$(Z_a Z_b) + (Z_b Z_c) + (Z_c Z_a) = 296 + j352 + j^2 104$$

$$Z_a = \frac{296 + j352 + j^2 104}{(10 + j6)} \quad \begin{matrix} \div 2 \\ \div 2 \end{matrix}$$

divide both by 2 to get rid of j^2

$$Z_a = \frac{148 + j176 + j52}{(5 + j3)}$$

$$Z_a = \frac{148 + j228}{5 + j3} = \frac{148}{5} + \frac{j228}{3}$$

$$Z_a = 29.6 + j76 \quad \text{and} \quad 81.56 \Omega \angle 68.7^\circ$$

$$Z_b = \frac{(Z_a Z_b) + (Z_b Z_c) + (Z_c Z_a)}{(Z_b)}$$

$$Z_b = \frac{296 + j352 + j^2 104}{8 + j4} \quad \text{E.C.F} \quad \underline{1}$$

divide both by 2

$$Z_b = \frac{148 + j176 + j52}{4 + j2}$$

$$Z_b = \frac{148 + j228}{4 + j2} = \frac{148}{4} + \frac{j228}{2}$$

$$Z_b = 37 + j114 \quad \text{and} \quad 119.9 \Omega \angle 72^\circ$$

$$Z_c = \frac{(Z_a Z_b) + (Z_b Z_c) + (Z_c Z_a)}{Z_c}$$

$$Z_c = \frac{296 + j352 + j^2 104}{Z_c}$$

$$Z_c = \frac{296 + j352 + j^2 104}{12 + j8}$$

Divide by 2 to get rid of j^2

$$Z_c = \frac{148 + j176 + j52}{6 + j4}$$

$$Z_c = \frac{148 + j228}{6 + j4} = \frac{148}{6} + \frac{228}{4}$$

$$Z_c = 24.66 + j57 \quad \text{and} \quad 62.11^\circ < 66.6^\circ$$

Q.4

b)

 ~~i rms of V and I~~

~~$$V_{rms} = \frac{V}{\sqrt{2}}$$~~

~~$$I_{rms} = \frac{I}{\sqrt{2}}$$~~

~~$$V(t) = 300 \cos(2\pi 120t) + 100 \cos(4\pi 120t)$$~~

~~$$V(t) = 286.28$$~~

~~$$V_{rms} = \frac{286.28}{\sqrt{2}}$$~~ $V_{rms} =$

~~$$V_{rms} = \sqrt{V_0^2 + \sum_{n=1}^{\infty} \left(\frac{V_n^2}{2} \right)}$$~~ ✓

~~$$Current \ rms = \sqrt{I_0^2 + \sum_{n=1}^{\infty} \left(\frac{I_n^2}{2} \right)}$$~~ ✓

$$V(t) = 300 \cos(2\pi 120t) + 100 \cos(4\pi 120t)$$

$$V(t) = 286.28$$

~~$$V_{rms} = \sqrt{0 + \left(\frac{(286.28)^2}{2} \right)}$$~~ ✗

~~$$V_{rms} = \sqrt{40978.12}$$~~ ✗

$$V_{rms} = 202.43 \text{ V}$$
 ✗

Q4b

1/10

$$I(t) = 15 \cos(2\pi 120t - 30^\circ) + 5 \cos(6\pi 120t + 60^\circ)$$

$$I(t) = 10.21 \text{ A}$$

$$\text{Current RMS} = \sqrt{I_0^2 + \sum_{n=1}^{\infty} \left(\frac{I_n^2}{2}\right)}$$

$$I_{\text{RMS}} = \sqrt{0 + \left(\frac{10.21^2}{2}\right)} \quad \times$$

$$I_{\text{RMS}} = 5.212$$

$$I_{\text{RMS}} = 7.22 \text{ A}$$

$$\text{ii) Real power} = \frac{P}{S} = \frac{\text{Power}}{(V_{\text{RMS}} \times I_{\text{RMS}})} \quad \underline{\underline{0}}$$

$$S = 202.43 \times 7.22$$

$$S = 1461.54$$

$$R = (10 + j6) + (8 + j4) + (2 + j8)$$

$$R = 30 + j18$$

$$P = I^2 R$$

$$R = 34.99 \angle 30.31^\circ$$

$$P = 7.22^2 \times R$$

$$P = 7.22^2 \times 34.99$$

$$P = 1823.97 \text{ W} \quad \underline{\underline{0}}$$

$$\text{Real power} = \frac{1823.97}{1461.54}$$

$$\text{Real power} = 1.25 \text{ VAR} \quad \times$$

$$\text{Power factor} =$$

Q.3

$$A) V_{TH} = \frac{(4 + 8 - j6)}{8 - j6} \times 10$$

$$V_{TH} = \frac{(12 - j6)}{8 - j6} \times 10$$

$$V_{TH} = \left(\frac{12}{6} \right) \times 10$$

$$V_{TH} = 1.5 \times 10$$

$$V_{TH} = 15 \text{ Volts}$$

$$Z_{TH} = \frac{4 + 8 + j5 - j6}{j5}$$

$$Z_{TH} = \frac{(12 - j1)}{j5}$$

$$Z_{TH} = 12 \times 0.2$$

$$Z_{TH} = 2.4 \Omega$$

$$b) Z_L = 8 \text{ load}$$

$$c) \text{ average power} = r = \frac{P}{S}$$

$$S = V_{rms} \times I_{rms}$$

$$P = I^2 \times R$$

$$I_{rms} = \frac{V}{\sqrt{2}} = \frac{15}{\sqrt{2}} = 10.6 \text{ V}$$

Q3

0/20

Q3a

0/10

Q3b

0/3

Q3c

0/7

$$I_{rms} = \frac{I}{\sqrt{2}}$$

$$I = \frac{\text{Voltage}}{\text{resistance}} = \frac{15}{2.4} = I = 6.25 \text{ A.}$$

$$I_{rms} = \frac{6.25}{\sqrt{2}} = 4.42 \text{ A}$$

$$S = \frac{10.6 \times 4.42}{P}$$

$$S = 10.6 \times 4.42$$

$$S = 46.9 \text{ VA}$$

$$P = I^2 \times R$$

$$P = 6.25^2 \times 2.4$$

$$P = 93.75 \text{ W}$$

$$\text{average (real) power} = \frac{P}{S}$$

$$\text{average power} = \frac{93.75 \text{ W}}{46.9 \text{ VA}}$$

$$\text{average power} = 1.9989 \text{ VAR}$$