



12 Pages

1. Please give the information requested in the boxes below.
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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.
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1	Student Number	WIL18847411
2	Title of Examination Paper	ELECTRICAL PRINCIPLES THEORY
3	Module Code	GOEE5001
4	Date and Time of Examination	2/5/2023
5	Examination Venue	GOWER COLLEGE SWANSEA
6	Seat Number	8
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	27
2	10
3	21
4	22
Total	80/100

Complete, fold and seal
(see note 2 below)

SURNAME: Williams

FORENAME(S): MATTHEW
DAVID

G.M

①

a)

$$L \frac{di}{dt} + Ri = v$$

$$60 \left[\frac{di}{dt} \right] + 12 [i] = 60 [e^{-t}] \quad \checkmark$$

$$60sI(s) - i(0) + 12I(s) = \frac{60}{s+1} \quad \checkmark$$

$$60sI(s) + 12I(s) = \frac{60}{s+1} \quad \checkmark$$

$$I(s) = \frac{60/6}{6s + 12/6(s+1)} = \frac{10}{(s+2)(s+1)}$$

$$\frac{10}{(s+2)(s+1)} = \frac{A}{s+2} + \frac{B}{s+1} \quad \checkmark$$

$$10 = A(s+1) + B(s+2) \quad \checkmark$$

$$s = -1$$

$$10 = A(-1+1) + B(-1+2)$$

$$10 = A(0) + B(1) \quad \checkmark$$

$$10 = 1 \cdot B \quad \therefore \frac{10}{1} = 10 \quad \therefore B = 10$$

$$\text{if } s = -2$$

$$10 = A(-2+1) + B(-2+2) \quad \checkmark$$

$$10 = A(-1) + B(0) \quad \checkmark$$

$$10 = -1A \quad \therefore \frac{10}{-1} = -10 \quad \therefore A = -10$$

$$\therefore \frac{10}{(s+2)(s+1)} = \left[\frac{-10}{s+2} \right] + \left[\frac{10}{s+1} \right] \quad \checkmark$$

$$i(t) = -10e^{-2t} + 10e^{-t} \quad \checkmark$$

$$i(t) = 10e^{-t} - 10e^{-2t} \quad \checkmark$$

Q2

27/30Q1a20/20

$$b) e^{3t} + 12 = \frac{1}{s-3} + \frac{12}{s} \quad \underline{2}$$

$$\cos(5t) = \frac{s}{s^2+5^2} \Rightarrow \frac{s}{s^2+25} \quad \underline{1}$$

$$(t^3 + 4t + 2)e^{3t} = \underline{2?} \quad \underline{0}$$

$$5e^{5t} \cos(2t) - e^{3t} = \frac{5(s-5)}{(s-5)^2 + 2^2} \Rightarrow \frac{5(s-5)}{(s-5)^2 + 4} - \frac{1}{s-3} \quad \underline{2}$$

$$= \frac{5(s-5)}{(s-5)^2 + 4} - \frac{1}{s-3} \quad \underline{2}$$

$$2e^{-2t} \sin 4t = 2 \frac{4}{(s+2)^2 + 4^2} = \frac{8}{(s+2)^2 + 16} \quad \underline{2}$$

Q1b

7/10

Question No.

(2)

$$a) Z_T = \frac{Z_1 * Z_2}{Z_1 + Z_2} + R = \frac{(-j10) * (60 + j30)}{(-j10) + (60 + j30)} + 20\Omega$$

$$\frac{(-j10) * (60 + j30)}{60 + j20} + 20\Omega = \frac{(10 \angle -90^\circ) * (67.08 \angle 26.57^\circ)}{63.246 \angle 18.43^\circ}$$

$$\frac{670.8 \angle -63.43^\circ}{63.246 \angle 18.43^\circ} = 10.6 \angle -81.86^\circ$$

$$Z_T = 10.6 \angle -81.86^\circ \Rightarrow 1.5 - j10.5 + 20\Omega$$

$$Z_T = 20.5 - j10.5 \Omega \text{ or } 23.93 \angle -26^\circ \Omega$$

$$b) I_T = \frac{V_T}{Z_T} = \frac{240 \angle 0^\circ}{23.93 \angle -26^\circ} = 10 \angle 26^\circ$$

$$I_T = 10 \angle 26^\circ \text{ A or } 9 + j4.4 \text{ A}$$

$$c) V_{j30} = \frac{60 + j30}{(60 + j30) + (-j10)} \times 240 \angle 0^\circ \text{ V}$$

$$V_{j30} = \frac{60 + j30}{60 + j20} \times 240 \angle 0^\circ$$

$$V_{j30} = \frac{67.08 \angle 26.57^\circ}{63.25 \angle 18.43^\circ} \times 240 \angle 0^\circ$$

$$V_{j30} = (1.06 \angle 8.14^\circ) \times (240 \angle 0^\circ)$$

$$V_{j30} = 254 \angle 8.14^\circ \text{ V or } 251.44 + j36$$

Q2

10/20

$$V_{-j10} = \frac{-j10}{(60 + j30) + (-j10)} \times 240 \angle 0^\circ \quad \checkmark$$

$$V_{-j10} = \frac{-j10}{60 + j20} \times 240 \angle 0^\circ$$

$$V_{-j10} = \frac{10 \angle -90^\circ}{63.25 \angle 18.43^\circ} \times 240 \angle 0^\circ$$

$$V_{-j10} = (0.158 \angle -108.43^\circ) \times (240 \angle 0^\circ)$$

$$V_{-j10} = 37.92 \angle -108.43^\circ$$

$$V_{-j10} = 37.92 \angle -108.43^\circ \text{ V or } 12 - j36 \text{ V}$$

d) $P = I^2 R$

$$P = (9^2)(21.5) = 1.74 \text{ kWatt}$$

(1741.5 Watts)

$$(3) \quad f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} [a_n \cos nx + b_n \sin nx]$$

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

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

$$a_0 = \frac{1}{\pi} \int_{-\pi}^0 -3 dx + \frac{1}{\pi} \int_0^{\pi} 3 dx$$

$$a_0 = \frac{-3}{\pi} [x]_{-\pi}^0 + \frac{3}{\pi} [x]_0^{\pi}$$

$$a_0 = \frac{-3}{\pi} (0 - \pi) + \frac{3}{\pi} (\pi - 0)$$

$$a_0 = \frac{-3}{\pi} (\pi) + \frac{3}{\pi} (\pi)$$

$$a_0 = -3 + 3$$

$$\therefore a_0 = 0$$

→

Q3

21/25

(3) cont..

$$a_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \cos nx \, dx \quad \checkmark$$

$$a_n = \frac{1}{\pi} \int_{-\pi}^0 f(x) \cos nx \, dx + \frac{1}{\pi} \int_0^{\pi} f(x) \cos nx \, dx \quad \checkmark$$

$$a_n = \frac{1}{\pi} \int_{-\pi}^0 -3 \cos nx \, dx + \frac{1}{\pi} \int_0^{\pi} 3 \cos nx \, dx$$

$$a_n = \frac{-3}{\pi} \int_{-\pi}^0 \cos nx \, dx + \frac{3}{\pi} \int_0^{\pi} \cos nx \, dx \quad \checkmark \quad \checkmark$$

$$a_n = \frac{-3}{\pi} \left[\frac{\sin nx}{n} \right]_{-\pi}^0 \quad \checkmark + \frac{3}{\pi} \left[\frac{\sin nx}{n} \right]_0^{\pi} \quad \checkmark$$

$$a_n = \frac{-3}{n\pi} (\sin nx)_{-\pi}^0 \quad \checkmark + \frac{3}{n\pi} (\sin nx)_{0}^{\pi} \quad \checkmark$$

$$a_n = \frac{-3}{n\pi} (\sin(0) - \sin(-\pi)) \quad \checkmark + \frac{3}{n\pi} (\sin(\pi) - \sin(0)) \quad \checkmark$$

$$a_n = \frac{-3}{n\pi} (0 - 0) \quad \checkmark + \frac{3}{n\pi} (0 - 0) \quad \checkmark$$

$$a_n = \frac{-3}{n\pi} (0) \quad \checkmark + \frac{3}{n\pi} (0) \quad \checkmark \quad \neq$$

$$-3 \times 0 = 0 \quad + \quad 3 \times 0 = 0$$

$$\therefore a_n = 0 \quad \checkmark$$

(3) cont.

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

$$b_n = \frac{1}{\pi} \int_{-\pi}^0 f(x) \sin nx \, dx + \frac{1}{\pi} \int_0^{\pi} f(x) \sin nx \, dx$$

$$b_n = \frac{1}{\pi} \int_{-\pi}^0 -3 \sin nx \, dx + \frac{1}{\pi} \int_0^{\pi} 3 \sin nx \, dx$$

$$b_n = \frac{-3}{\pi} \int_{-\pi}^0 \sin nx \, dx + \frac{3}{\pi} \int_0^{\pi} \sin nx \, dx$$

$$b_n = \frac{-3}{\pi} \left[-\frac{\cos nx}{n} \right]_{-\pi}^0 + \frac{3}{\pi} \left[-\frac{\cos nx}{n} \right]_0^{\pi}$$

$$b_n = \frac{3}{n\pi} (\cos nx)_{-\pi}^0 + \frac{-3}{n\pi} (\cos nx)_{0}^{\pi}$$

$$b_n = \frac{3}{n\pi} (\cos(0) - \cos(-\pi)) + \frac{-3}{n\pi} (\cos(\pi) - \cos(0))$$

$$b_n = \frac{3}{n\pi} (1 - -1) + \frac{-3}{n\pi} (-1 - 1)$$

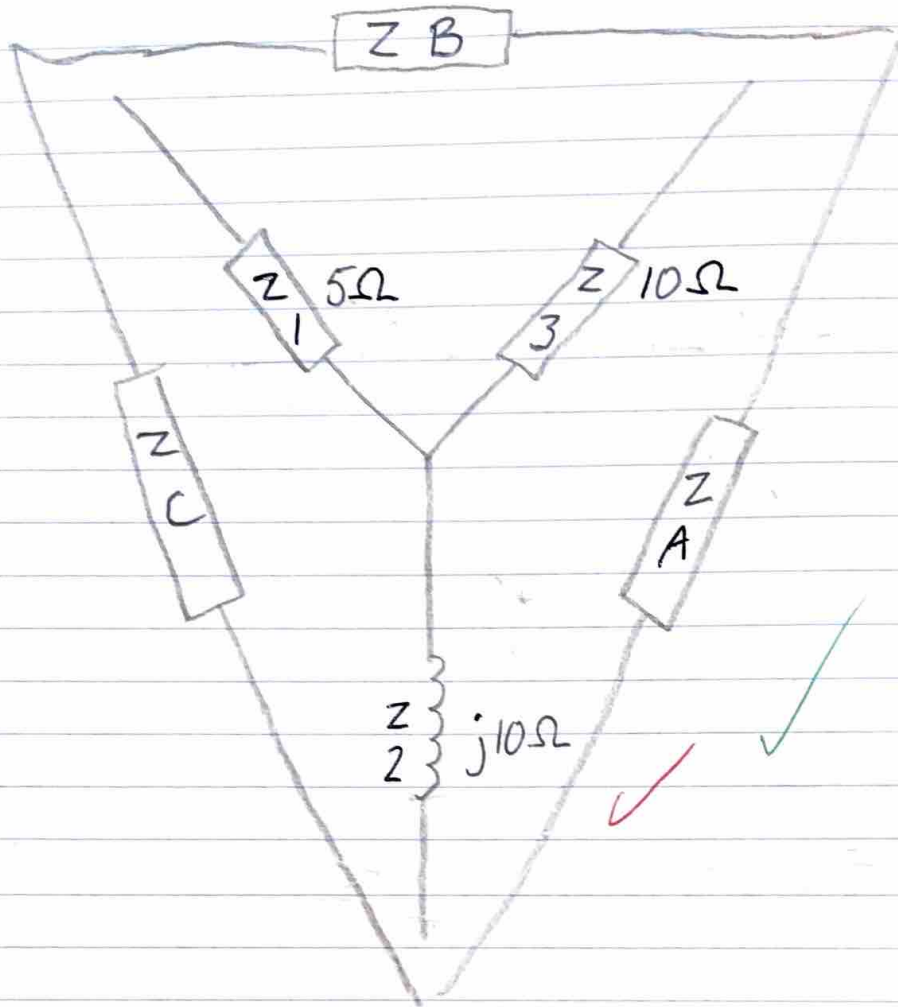
$$b_n = \frac{3}{n\pi} (2) + \frac{-3}{n\pi} (-2)$$

$$3 \times 2 = 6 + -3 \times -2 = 6$$

$$\therefore b_n = \frac{12}{n\pi} \text{ when odd}$$

$$b_n = 0 \text{ when even}$$

(4)
a)



Q4

22/25

Q4a

10/10

$$Z_A = \frac{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}{Z_1} = \frac{5(j10) + j10(10) + 10(5)}{5\Omega}$$

$$Z_A = \frac{(j50) + (j100) + (50)}{5} = \frac{50 + j150}{5}$$

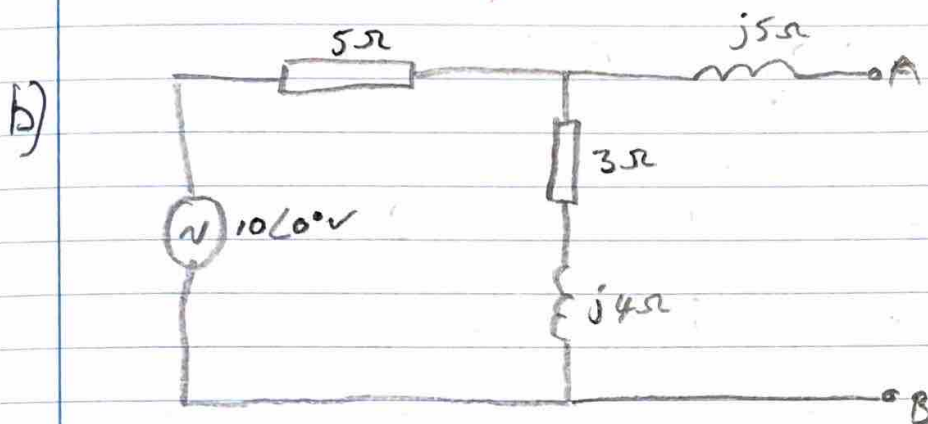
$$Z_A = 10 + j30$$

$$Z_B = \frac{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}{Z_2} = \frac{50 + j150}{j10}$$

$$Z_B = 15 - j5$$

$$Z_C = \frac{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}{Z_3} = \frac{50 + j150}{10\Omega}$$

$$Z_C = 5 + j15$$

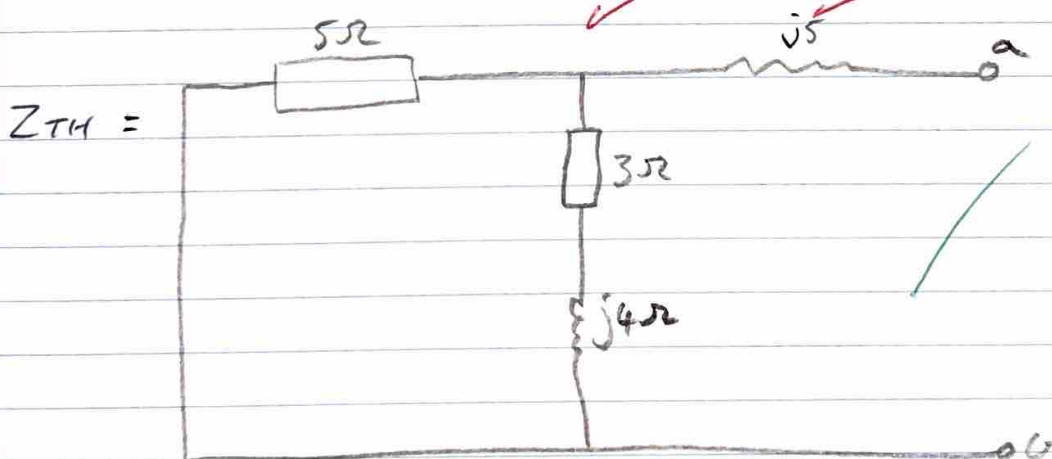


$$V_{TH} = \frac{3 + j4}{(3 + j4) + (5)} \times V$$

$$V_{TH} = \frac{3 + j4}{8 + j4} \times V = \frac{5 \angle 53.13^\circ}{8.94 \angle 26.57^\circ} \times 10 \angle 0^\circ$$

$$V_{TH} = (0.56 \angle 26.56^\circ) \times (10 \angle 0^\circ)$$

$$V_{TH} = 5.6 \angle 26.56^\circ \text{ V or } 5 + j2.5 \text{ V}$$



$$Z_{TH} = \frac{(3 + j4) \parallel 5}{3 + j4 + 5} + j5 = \frac{(3 + j4) \times 5}{8 + j4} + j5$$



Q4b

12/15

4 b) cont.:

$$Z_{TH} = \frac{(3+j4) \times 5}{8+j4} + j5$$

$$Z_{TH} = \frac{5 \angle 53.13^\circ}{8.94 \angle 26.57^\circ} = 0.56 \angle 26.56^\circ$$

$$Z_{TH} = 0.56 \angle 26.56^\circ + j5$$

$$Z_{TH} = 0.5 + j0.25 + j5$$

error carried forward

$$Z_{TH} = 0.5 + j5.25 \Omega \text{ or } 5.27 \angle 84.56^\circ \Omega$$

