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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.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
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1	Student Number	DAN19848477
2	Title of Examination Paper	Electrical Principles Theory
3	Module Code	GOEES001
4	Date and Time of Examination	02/05/2023 13:20
5	Examination Venue	Gower college Swansea.
6	Seat Number	9
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	28
2	12
3	25
4	23
Total	88/100

88% ✓

GM

$$1a) L \frac{di}{dt} + Ri = V$$

$$6 \left[\frac{di}{dt} \right] + 12 [i] = 60 e^{-t}$$

$$6s I(s) - I(0) + 12 I(s) = 60 \frac{1}{s+1}$$

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

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

$$10 = \frac{a}{(s+2)} + \frac{b}{(s+1)}$$

$$10 = \frac{a(s+2)(s+1)}{s+2} + \frac{b(s+2)(s+1)}{s+1} \checkmark$$

$$10 = a(s+1) + b(s+2) \checkmark$$

Set s to -1

$$10 = a(-1+1) + b(-1+2) \checkmark$$

$$10 = a(0) + b(1) \checkmark$$

$$10 = 1b \quad b = \frac{10}{1} \checkmark$$

$$b = 10 \checkmark$$

Q1

28/30

Q1 a

20/20

1 a) cont. Set s to -2

$$10 = a(-2+1) + b(-2+2)$$

$$10 = a(-1) + b(0)$$

$$10 = -1a$$

$$a = -\frac{10}{1}$$

$$a = -10$$

$$I(s) = \frac{-10}{(s+2)} + \frac{10}{(s+1)}$$

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

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

1 b)

i. $e^{3t} + 12 = \frac{1}{s-3} + \frac{12}{s}$

ii. $\cos(5t) + 2 \sin(2t) = \frac{s}{s^2+5^2} + 2 \frac{2}{s^2+2^2}$

$$= \frac{s}{s^2+5^2} + \frac{4}{s^2+2^2}$$

iii. $(t^3+4t+2)e^{3t} = t^3e^{3t} + 4te^{3t} + 2e^{3t}$

$$= \frac{3!}{(s-3)^4} + \frac{4 \times 1}{2^2 (s-3)} + \frac{2}{s-3}$$

Question No.

1b

$$iv) \mathcal{L}^{-1}\{s e^{3t} \cos(2t) - e^{3t}\}$$

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

Q4b

$$v) 2e^{-2t} \sin 4t = 2 \frac{4}{(s+2)^2 + 4^2}$$

8/10

$$= \frac{8}{(s+2)^2 + 4^2}$$

Q2

$$a) Z_T = \left(\frac{-j10(j30+60)}{-j10+60+j30} \right) + 20\Omega = \left(\frac{300 - j600}{60 + j20} \right) + 20\Omega$$

$$Z_T = \frac{670.82 \angle -63.43}{63.25 \angle 18.43} + 20\Omega$$

$$Z_T = 10.61 \angle -81.86 + 20\Omega$$

$$Z_T = 1.5 - j10.5 + 20\Omega$$

$$Z_T = 21.5 - j10.5\Omega \text{ or } 23.93 \angle -26^\circ \Omega$$

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

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

$$c) V = \left(\frac{-j10}{-j10+j30+60} \right) \times V_T = \left(\frac{10 \angle -90^\circ}{63.25 \angle 18.43^\circ} \right) \times 240 \angle 0^\circ$$

$$V = 0.16 \angle -108.43^\circ \times 240 \angle 0^\circ = 38.4 \angle -108.43^\circ \text{ V}$$

$$V = \left(\frac{60 + j30}{63.25 \angle 18.43^\circ} \right) \times 240 \angle 0^\circ = \left(\frac{67.1 \angle 26.57^\circ}{63.25 \angle 18.43^\circ} \right) \times 240 \angle 0^\circ$$

$$V = 1.06 \angle 8.14^\circ \times 240 \angle 0^\circ = 254.4 \angle 8.14^\circ \text{ V}$$

$$d) P = I^2 R$$

$$P = (10)^2 (60)$$

$$P = 6000 \text{ W}$$

2d)

Cont.

$$P = I^2 R$$

$$P = (10)^2 (20)$$

$$P = 2000 \text{ W}$$

Q3 $f(x) = -3$ if $-\pi \leq x < 0$ and $f(x+2\pi) = f(x)$
 3 if $0 \leq x < \pi$

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

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

$$a_0 = \frac{1}{\pi} [-3]_{-\pi}^0 + \frac{1}{\pi} [3]_0^{\pi} \quad \checkmark \quad \checkmark$$

$$a_0 = \frac{1}{\pi} [0 - 3\pi] + \frac{1}{\pi} [3\pi - 0] \quad \checkmark$$

$$a_0 = \frac{1}{\pi} (-3\pi) + \frac{1}{\pi} (3\pi) \quad \checkmark$$

$$a_0 = 1(-3) + 1(3) \quad \checkmark$$

$$a_0 = -3 + 3 \quad \checkmark$$

$$a_0 = 0 \quad \checkmark$$

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

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

$$a_n = \frac{1}{\pi} -3 \left[\frac{\sin nx}{n} \right]_{-\pi}^0 \quad \checkmark + \frac{1}{\pi} 3 \left[\frac{\sin nx}{n} \right]_0^{\pi} \quad \checkmark$$

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

Question No.

Q3
Cont

$$\frac{-3}{n\pi} [0-0] + \frac{3}{n\pi} [0-0]$$

Q3

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

25/25

$$a_n = 0 + 0$$

$$a_n = 0$$

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

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

$$b_n = \frac{1}{\pi} -3 \left[-\frac{\cos nx}{n} \right]_{-\pi}^0 + \frac{1}{\pi} 3 \left[-\frac{\cos nx}{n} \right]_0^{\pi}$$

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

$$b_n = \frac{3}{n\pi} [1-1] + \frac{-3}{n\pi} [-1-1]$$

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

$$b_n = \frac{6}{n\pi} + \frac{6}{n\pi} = \frac{12}{n\pi}$$

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

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

Q3 $a_0 = 0$ ✓ $a_n = 0$ ✓ $b_n = \frac{12}{n\pi}$

Cont

$b_n = \frac{12}{n\pi}$ when odd ✓

0 when even. ✓

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

$$f(x) = \frac{0}{2} + 0 \cdot 0 \cdot 0 + \frac{12}{\pi} \left(\sin x + 0 + \frac{1}{3} \sin 3x + \dots \right)$$

$$f(x) = \frac{12}{\pi} \left(\sin x + \frac{1}{3} \sin 3x + \frac{1}{5} \sin 5x + \frac{1}{7} \sin 7x + \dots \right)$$

4 ✓

Q4
a)
$$Z_a = \frac{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}{Z_1}$$

$$Z_a = \frac{5(j10) + j10(10) + 10(5)}{5}$$

$$Z_a = \frac{j50 + j100 + 50}{5}$$

$$Z_a = \frac{50 + j150}{5}$$

$$Z_a = 10 + j30 \Omega \quad \checkmark$$

$$Z_b = \frac{50 + j150}{Z_2} = \frac{50 + j150}{j10}$$

$$Z_b = \frac{158.11 \angle 71.57^\circ}{10 \angle 90^\circ} = 15.811 \angle -18.43^\circ$$

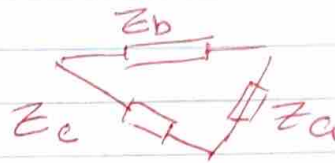
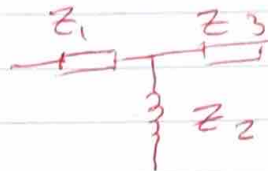
$$Z_b = 15 - j5 \Omega \quad \checkmark$$

$$Z_c = \frac{50 + j150}{Z_3} = \frac{50 + j150}{10}$$

$$Z_c = 5 + j15 \Omega \quad \checkmark$$

8

Provide sketch

Q4
23/25

Q4a

8/10

Q4
b)

$$V_{TH} = \left(\frac{3+j4}{5+3+j4} \right) \times 10 \angle 0^\circ = \left(\frac{3+j4}{8+j4} \right) \times 10 \angle 0^\circ$$

$$V_{TH} = \left(\frac{5 \angle 53.13^\circ}{8.94 \angle 26.57^\circ} \right) \times 10 \angle 0^\circ$$

$$V_{TH} = 0.559 \angle 26.56^\circ \times 10 \angle 0^\circ$$

$$V_{TH} = 5.6 \angle 26.56^\circ \text{ V} \quad \checkmark \quad \text{Q}$$

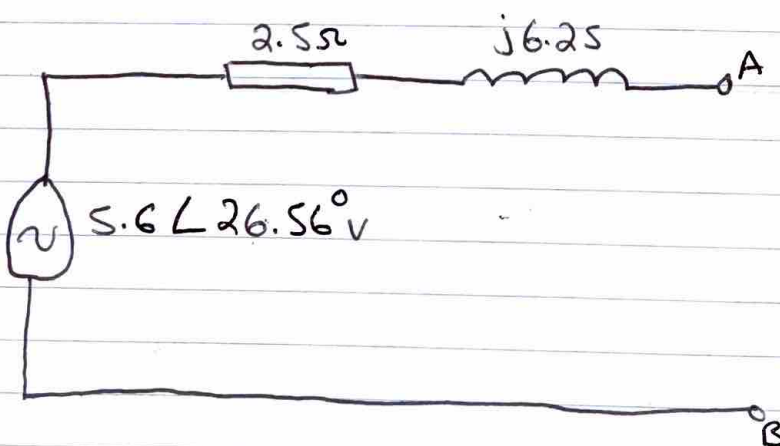
$$Z_{TH} = \left(\frac{5(3+j4)}{5+3+j4} \right) + j5 = \left(\frac{15+j20}{8+j4} \right) + j5$$

$$Z_{TH} = \frac{25 \angle 53.13^\circ}{8.94 \angle 26.57^\circ} + j5 \quad \checkmark$$

$$Z_{TH} = 2.8 \angle 26.56^\circ + j5 \quad \checkmark$$

$$Z_{TH} = 2.5 + j1.25 + j5 \quad \checkmark$$

$$Z_{TH} = 2.5 + j6.25 \Omega \quad \checkmark \quad \text{G}$$



Q4b

15/15