

**Complete, fold and seal
(see note 2 below)**

FORENAME(S): John Steven

12 Pages

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.**

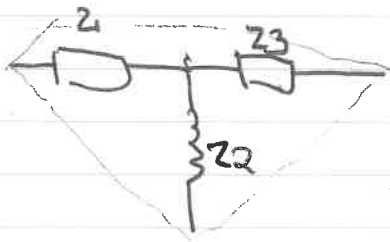
List the numbers of the questions you have attempted	Office Use
Q1	2
Q2	8
Q3	0
Q4	2
Total	120%

$$\tan^{-1} \theta = \frac{X_L - X_C}{R}$$

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

Question One:

a) Star - Delta



$$Z_1 = 5 \Omega \quad (R_3)$$

$$Z_2 = 10j \Omega \quad (R_2)$$

$$Z_3 = 10 \Omega \quad (R_1)$$

Q1
a1
2

$$R_a = \frac{(R_1 R_2) + (R_2 R_3) + (R_3 R_1)}{R_1} = \frac{(10 \times 10j) + (10j \times 5) + (5 \times 10)}{10} = \frac{20j + 50 + 50}{10} = \frac{100 + 20j}{10} = 10 + 2j$$

$$\frac{20j + 50}{10} = \frac{20j}{10} + \frac{50}{10} = 2j + 5 = 5 + 2j$$

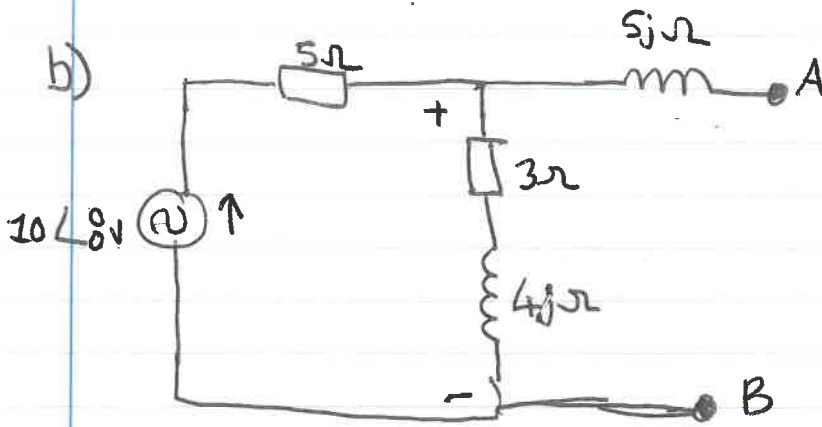
$$R_b = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2} = \frac{(10 \times 10j) + (10j \times 5) + (10 \times 5)}{10j} = \frac{20j + 50 + 50}{10j} = \frac{100 + 20j}{10j} = \frac{10 + 2j}{j} = \frac{10}{j} + \frac{2j}{j} = -10j + 2 = 2 - 10j$$

$$\frac{20j + 15 + 50}{10j} = \frac{65 + 20j}{10j} = \frac{65}{10j} + \frac{20j}{10j} = \frac{6.5}{j} + 2 = -6.5j + 2 = 2 - 6.5j$$

$$R_c = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3} = \frac{(10 \times 5) + (10j \times 5) + (10 \times 10j)}{5} = \frac{50 + 50j + 100j}{5} = \frac{50 + 150j}{5} = 10 + 30j$$

$$\frac{50 + 20j + 15}{5} = \frac{65 + 20j}{5} = 13 + 4j$$

Question One



$$R_{TH} = 5 + (3 \parallel 4j) = 5 \parallel 53.10 + 5 = 10 \parallel 53.10$$

$$\frac{5+3+4j}{5j} = \frac{8+4j}{5j} = \frac{8.94 \angle 26.56}{5.09 \angle 11.30} = 1.76 \angle 15.26$$

$$V_{TH} = 1.76 \angle 15.26 \times 10 \angle 0 = 17.6 \angle 15.26$$

$$x_c = 16.97$$

$$y = 4.63$$

Q1

b

0

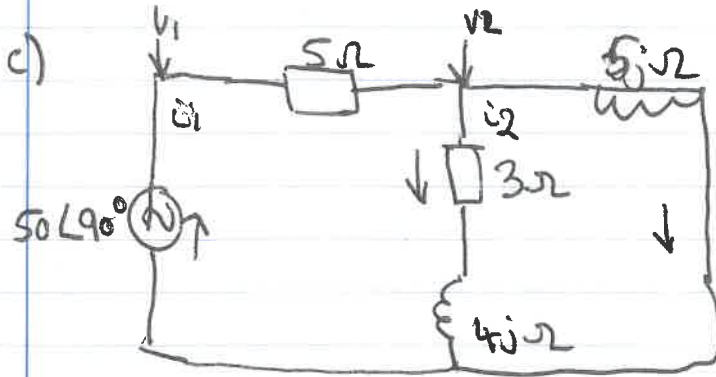
Question One

$$V = I \times R$$

$$\frac{V}{R} = I$$

Examiner Only

• Remove one source



$$R_{TH} = 5 + 3 + 4j = \frac{8 + 4j}{5j} = \frac{8.94 \angle 26.56}{5.09 \angle 11.30} = 1.76 \angle 15.26 \Omega$$

$$V_{TH} = \frac{1.76 \angle 15.26}{50 \angle 90} = 0.0352 \angle -74.74 \text{ V}$$

$$V_2 = \frac{1.76 \angle 15.26}{50 \angle 0} = 0.0352 \angle 15.26 \text{ V}$$

$$I_6 = i_1 - i_2$$

$$Z_{eq} = 5 + 3 + 4j = 8 + 4j \Omega$$

$$V_T = 0.0352 \times 2 = 0.0704 \angle -59.48 \text{ V}$$

$$= 8.944 \angle 26.56 \Omega \rightarrow I = \frac{V}{R} = \frac{0.0704 \angle -59.48}{8.944 \angle 26.59}$$

$$= 7.87 \times 10^{-3} \angle -86.07 \text{ A}$$

Q1

C1

Q2

Question Two

$$f(x) = \begin{cases} -3 & \text{if } -\pi \leq x < 0 \\ 3 & \text{if } 0 \leq x < \pi \end{cases} \quad \text{and } f(x)(x+2\pi) = f(x)$$

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

$$a_0 = \frac{1}{2\pi} \int_{-\pi}^{\pi} f(x) dx \quad \checkmark$$

$$a_0 = \frac{1}{2\pi} \int_{-\pi}^0 -3 dx + \frac{1}{2\pi} \int_0^{\pi} 3 dx \quad \checkmark$$

$$a_0 = \frac{-3}{2\pi} \int_{-\pi}^0 -3 dx + \frac{3}{2\pi} \int_0^{\pi} 3 dx$$

$$a_0 = \frac{-3}{2\pi} [x]_{-\pi}^0 + \frac{3}{2\pi} [x]_0^{\pi} \quad \checkmark$$

$$a_0 = \frac{-3}{2\pi} (x) + \frac{3}{2\pi} (x)$$

$$a_0 = -1.5(x) + 1.5(x) =$$

$$a_0 = 3 \quad \checkmark$$

Q2

8

3

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

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

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

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

$$a_n = \frac{-3}{n\pi} \left[\sin(n\pi) + \frac{3}{n\pi} \sin(n\pi) \right] \quad ?$$

$$a_n = \frac{-3}{n\pi} \left[\sin(n\pi) + \frac{3}{n\pi} \sin(n\pi) \right] \quad ?$$

$$a_n = -3 \left[\sin + \frac{3}{n\pi} \sin \right] \quad \checkmark$$

$$a_n = 1 \quad \checkmark$$

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

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

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

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

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

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

$$b_n = \begin{cases} \text{if even} = 0 \\ \text{if odd} = \frac{6}{n\pi} \end{cases}$$

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

$$a_0 = 3, \quad a_n = 1, \quad b_n = 0 \text{ if even} \\ \frac{6}{n\pi} \text{ if odd}$$

Question Three

a)

$$(i) 1 + 2t - \frac{1}{3}t^4 = \frac{\cancel{1}}{\cancel{3}} + \frac{\cancel{1}}{\cancel{3}} = \frac{\cancel{2}}{\cancel{3}}$$

Q3aQ

$$(ii) 5e^{2t} - 3e^{-t} = L[$$

X

QQ3QQ

a)

$$V(t) = 30 + 20 \cos(120\pi t + 45^\circ) + 10 \cos(120\pi t - 45^\circ) \text{ Volts}$$

$$I(t) = 6 + 4 \cos(120\pi t + 10^\circ) - 2 \cos(120\pi t - 60^\circ) \text{ Amps}$$

(i) The rms value of the voltage?

Voltage rms value =

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

$$V(t) =$$

?

Q4

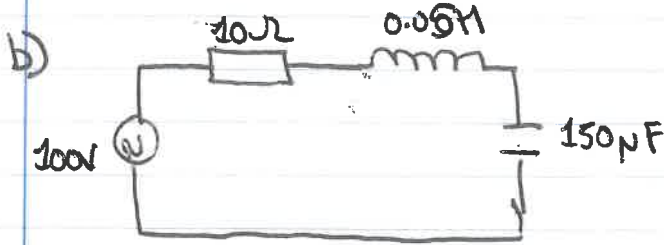
a

0



Question Four

50Hz



$$V = I \times R \quad \frac{V}{R} = I$$

$$(i) X_L = j2\pi f L = j \times 2 \times \pi \times 50 \times 0.05$$

$$= j15.70 \Omega$$

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

$$\tan^{-1} \left(\frac{X_L - X_C}{R} \right)$$

$$X_C = \frac{1}{j2\pi f C} = \frac{1}{j \times 2 \times \pi \times 50 \times 150 \times 10^{-6}}$$

$$= j424.41$$

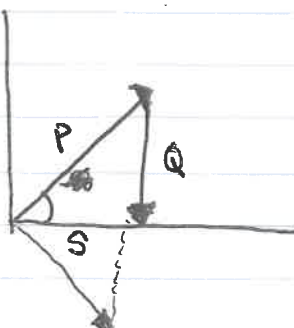
$$Z = \sqrt{(10)^2 + (j15.70 - j424.41)^2} = 4087.1 \Omega$$

$$I = \frac{100}{4087.1} = 0.024 A$$

$$\tan^{-1} \left(\frac{15.70 - 424.41}{10} \right) = -88.59^\circ$$

$$= 4088.06 \angle -2.24^\circ$$

(ii)



P = Real power

Q =

S =