

SURNAME: STONELAVE

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.
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[illegible]

Question 1b.

$$X_{Th} = \left(\frac{3 + j4}{5 + 3 + j4} \right) 10 \angle 0^\circ \quad \checkmark$$

$$X_{Th} = \left(\frac{3 + j4}{8 + j4} \right) 10 \angle 0^\circ \quad \checkmark$$

convert to polar

$$\frac{(3, 4)}{(8, 4)} = \frac{5 \angle 53.13^\circ}{8.9 \angle 26.56^\circ} \quad \checkmark$$

$$= 0.56 \angle -26.57^\circ$$

$$= 0.56 \times 10 \angle 0^\circ = \underline{\underline{5.6}}$$

$$V_{Th} = 5.6 \angle -26.57^\circ \quad \checkmark$$

convert back to rectangular

$$\underline{\underline{5.14 - j2.55}}$$

$Z_{Th}?$

Q2
b1
b2

5

$$F = 50 \text{ Hz}$$

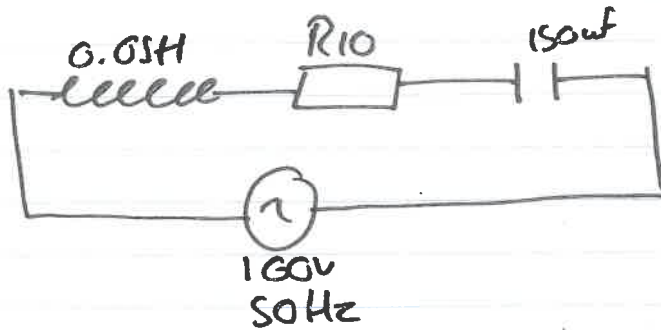
$$C = 150 \text{ } \mu\text{F}$$

$$V = 100 \text{ V}$$

Question No.

Question 4 (b).

Coil - 0.05 H + $R 10 \Omega$



$$X_C = \frac{1}{j2\pi fC}$$

X_L
 $2\pi fL$

$$X_L = \frac{1}{j2\pi \times 50 \times 150 \times 10^{-6}}$$

$$X_C = -j21.22 \Omega$$

$$X_L = j2 \times \pi \times f \times L$$

$$X_L = j2 \times \pi \times 50 \times 0.05$$

$$= j15.70 \Omega$$

$$\text{total impedance} = 10 + j15.70$$

$$= 10 + j5.52 \Omega$$

$$I = \frac{V}{Z} = \frac{100}{10 + j5.52}$$

convert to Polar

$$= \frac{100 \angle 0^\circ}{11.29 \angle 28^\circ}$$

$$= 8.85 \angle -8^\circ$$

Question 2

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

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

$$a_0 = \frac{1}{2\pi} \int_{-\pi}^0 f(x) dx + \frac{1}{2\pi} \int_0^{\pi} f(x) dx \checkmark$$

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

$$a_0 = 1 = \frac{-3}{2\pi} \left(\left[\cancel{\cos nx} \right]_0^{\pi} \right)$$

$$a_0 = 1 = \frac{1}{2} \quad a_0 = 0 \text{ if } n \text{ is even.}$$

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

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

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

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

$$a_n = 1 = \frac{3}{2\pi} \left(\left[\frac{\sin nx}{n} \right]_0^{\pi} \right) \quad \text{?}$$

$$a_n = 1 = \frac{1}{\pi} \left(\left[\sin nx \right]_0^{\pi} \right) \quad \text{?}$$

$$a_n = \frac{1}{2} \text{ if } n \text{ is odd} \quad \text{?}$$

Q2

10

4

3

Question 2

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

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

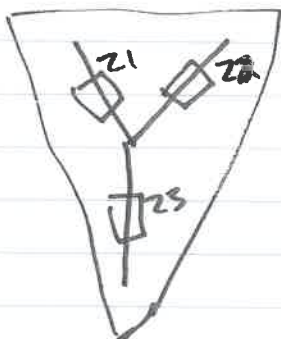
$$b_n = \frac{1}{\pi} \int_{-\pi}^0 -3nx \, dx + \frac{1}{\pi} \int_0^{\pi} 3nx \, dx \quad \checkmark$$

$$b_n = \frac{3}{\pi} \left(\left[-\frac{\cos nx}{n} \right]_0^{\pi} \right) \quad \text{per } +? \quad \underline{\underline{3}} \quad \checkmark$$

$$b_n = \frac{1}{\pi} \left([\cos nx]_0^{\pi} \right) \quad b_n = \begin{cases} 0 & \text{if } n \text{ is even} \\ \frac{1}{2} & \text{if } n \text{ is odd} \end{cases}$$

Question 1a

$$Z_1 = 5 \Omega \quad Z_2 = j10 \Omega \quad Z_3 = 10 \Omega$$

Q1
9

3

$$R_a = \frac{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}{Z_1}$$

$$R_a = \frac{(5 \times j10) + (j10 \times 10) + (10 \times 5)}{5} \quad \checkmark$$

$$R_a = \frac{j50 + j100 + 50}{5} \quad \checkmark$$

$$R_a = \frac{200}{5} = 40 \quad \times$$

$$R_b = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2} \quad \checkmark$$

$$R_b = \frac{(5 \times j10) + (j10 \times 10) + (10 \times 5)}{j10} \quad \checkmark$$

$$R_b = \frac{j50 + j100 + 50}{j10} \quad \checkmark$$

$$R_b = \frac{200}{j10} = 20 \quad \times$$

Question 1a

$$R_c = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3} \quad \checkmark$$

$$R_c = \frac{(5 \times j10) + (j10 \times 10) + (10 \times 5)}{10} \quad \checkmark$$

$$R_c = \frac{j50 + j100 + 50}{10} \quad \checkmark$$

$$R_c = \frac{200}{10} = 20 \quad \times$$

Question 3 b

$$\mathcal{L}\left[\frac{dF(t)}{dt}\right] = sF(s) - f(0)$$

Examiner Only

$$\frac{dy}{dt} + 2y = 12$$

$$\text{with } y = 10 \\ \text{at } t = 0$$

Q3
b

$$Fs = sY(s) - Y(0) + 2Y(s) = \frac{12}{s} \checkmark$$

$$sY(s) - 10 + 2Y(s) = \frac{12}{s} \checkmark$$

$$sY(s) + 2Y(s) = \frac{12}{s} + 10 \checkmark$$

$$Ys = \frac{12}{s+2} + \frac{12}{s+2} \times$$

$$= \frac{16}{s(s+4)}$$

$$A + sB \times$$

5

Question 3a

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

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

$$iii - 6\sin(3t) - 4\cos(5t) = \frac{3}{(s+6)^2 + 3^2} - \frac{s+4}{(s+4)^2 + 5^2} \quad \times$$

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

$$v - \cos(2t) + 3e^{-4t} = \left(\frac{s}{s^2 + 2^2} \right) + \left(\frac{3}{s+4} \right) \quad (2)$$

Q3
a7

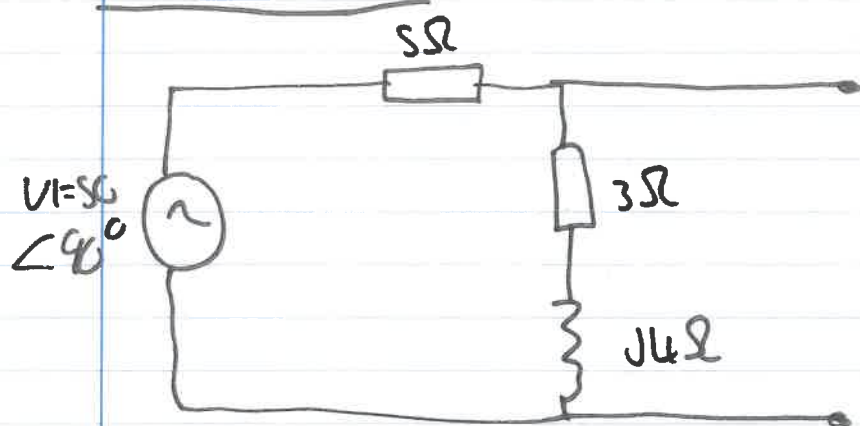
Question 4 A.

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

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

Q4
9

1



$$I = \frac{V}{R} = \frac{50}{(5+3+j4)} = \left(\frac{50}{8+j4} \right) 50 \angle 90^\circ$$

✗

✗

Q1
C

10