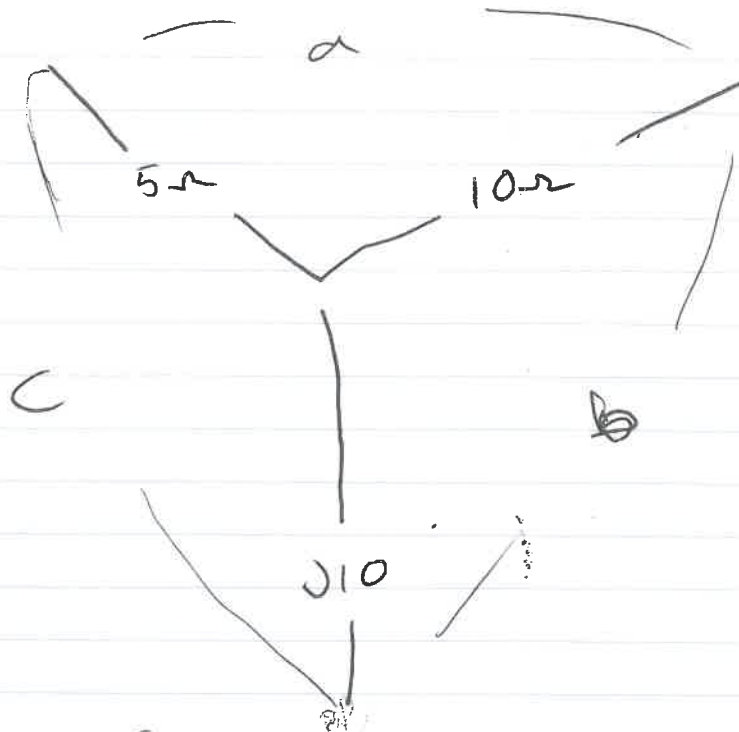


## 12 Pages

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.**

[illegible]



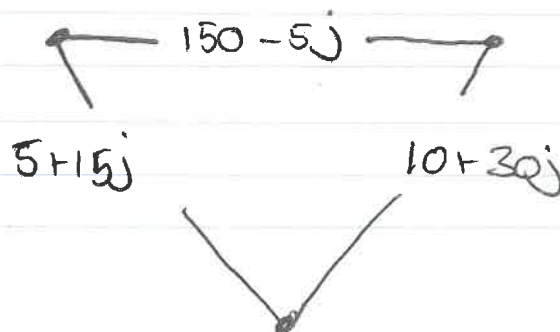
$$R_a = \frac{(5 \times 10j) + (5 \times 10) + (10 \times 10j)}{j10} \quad \checkmark$$

$$= 50j + 50 + 100j = \frac{50 + 150j}{j10} \times \frac{-10j}{-10j} \quad \checkmark$$

$$= \frac{500j + 1500}{100} = 15 - 5j \quad \checkmark$$

$$R_b = \frac{50 + 150j}{5} = 10 + 30j \quad \checkmark$$

$$R_c = \frac{50 + 150j}{10} = 5 + 15j \quad \checkmark$$



Q1  
Q2  
S

553  
 $8.9\% \cdot \frac{3+j4}{8+j5} = 0.96 \angle 22.62^\circ$   
 $47 \angle 0^\circ$

b)

$$V_{th} = \frac{(3 \angle 0^\circ)(3+j4)}{(3+j4) + (5)} \cdot 10 \angle 0^\circ$$

$$= \frac{12j}{12j+5} \cdot \frac{-12j+5}{-12j+5}$$

Pol =  $\frac{12 \angle 90^\circ}{13 \angle 67.38^\circ} = 0.92 \angle 22.62^\circ \cdot 10 \angle 0^\circ$

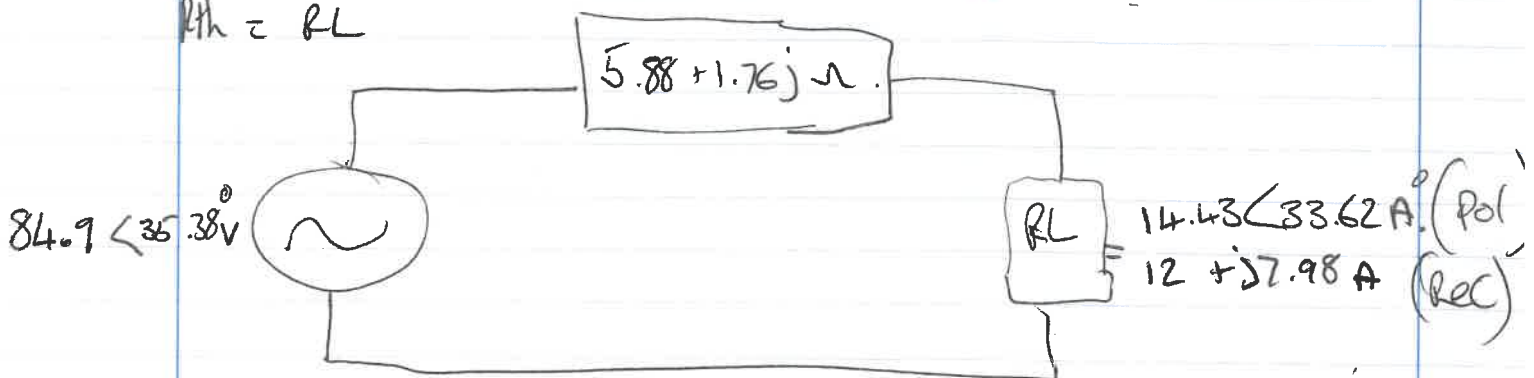
$V_{th} =$  Pol =  $9.2 \angle 22.62^\circ$   
 Rec =  $84.9 + 35.38j$  V

$$R_{th} = \frac{(3+j4)(j5)}{(3+j4) + j5} + 5$$

$$= \frac{15j - 20}{12j + 5} = \frac{-20 + 15j}{17j} \cdot \frac{-17j}{-17j} = \frac{340j + 255}{289}$$

$$= (0.88 + 1.176j) + 5 = 5.88 + 1.176j$$

$R_{th} = R_L$



$5.88 + 1.176j$   $\cdot \frac{84.9 \angle 35.38^\circ}{5.88 \angle 1.76^\circ} = 14.43 \angle 33.62^\circ$

$$c) Z_L = \frac{j5 \times (3 \times j4)}{j5 + (3 \times j4)} + 5.$$

$$= \frac{15j - 20}{-17j} \times \frac{-17j}{-17j} = \frac{340j + 255}{289}$$

$$= 0.88 + 1.176j + 5 = 5.88 + 1.176j$$

$$\downarrow$$

$$I_L = \frac{50 \angle 90^\circ}{5.99 \angle 11.3^\circ} = 8.34 \angle 78.7^\circ$$

$$\times R_{oc} = 1.634 + 8.17j \text{ A.}$$

$$I_1 = \frac{3 \times j4}{(3 \times j4) \times (5j)} = \frac{12j}{15j - 20} \times \frac{-15j - 20}{-15j - 20}$$

$$= \frac{180 - 240j}{225 - 400} = \frac{180 - 240j}{-175} = -1.02 + 1.37j$$

$$I_2 = \frac{5j}{(3 \times j4) \times (5j)} = \frac{5j}{15j - 20} \times \frac{-15j - 20}{-15j - 20} = \frac{75 - 100j}{225 - 400}$$

$$= 0.294 + 0.25j \quad \times$$

Q.L  
C  
Q

2.

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

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

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

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

$$= \frac{1}{2\pi} [-3x]_{-\pi}^0 + \frac{1}{2\pi} [3x]_0^{\pi} \checkmark$$

$$= \frac{1}{2\pi} [-3 \times 0 - (-3 \times -\pi)] + \frac{1}{2\pi} [3\pi - 0] \checkmark$$

$$= \frac{1}{2\pi} [0 - 3\pi] = \frac{1}{2\pi} [3\pi] \checkmark$$

$$= \frac{1}{2\pi} [-3\pi] = 1.5 \checkmark$$

$$= -1.5$$

$$a_0 = -1.5 + 1.5 \checkmark$$

$$= 0 \checkmark$$

Q223

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

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

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

$$= \frac{1}{n\pi} \left[ -3 \sin 0 - (-3 \sin(-n\pi)) \right] + \frac{1}{n\pi} \left[ 3 \sin n\pi - 0 \right] \quad \checkmark$$

$$= \frac{1}{n\pi} [0 - 0] = \frac{1}{n\pi} [0 - 0] \quad \checkmark$$

$$= 0 \quad \checkmark$$

$$\underline{\underline{a_n = 0}} \quad \checkmark$$

0

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

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

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

$$= \frac{1}{n\pi} \left[ +3 \cos 0 - (+3 \cos(-\pi)) \right] + \frac{1}{n\pi} \left[ -3 \cos(\pi) - (-3 \cos(0)) \right]$$

$$= \frac{1}{n\pi} \left[ +3 + (3) \right] + \frac{1}{n\pi} \left[ 3 + 3 \right]$$

$$= \frac{1}{n\pi} [6] + \frac{1}{n\pi} [6] = 0.$$

$$a_0 = 0$$

$$a_n = 0$$

$$f(x) = 0 + 0 + -6 \sin nx$$

Q3

$$i) \frac{1}{s} + \frac{2}{s^2} - \frac{(4!)}{s^5} = \text{scribbled out}$$

$$\frac{1}{s} + \frac{2}{s^2} - \frac{24}{s^5}$$

$$ii) \frac{5}{s-2} - \frac{3}{s+1}$$

$$iii) \frac{6 \times 3}{s^2 + 3^2} - \frac{4s}{s^2 + 5^2} = \frac{18}{s^2 + 9} - \frac{4s}{s^2 + 25}$$

$$iv) \frac{4}{(s+2)^2 + 4^2} = \text{scribbled out}$$

$$v) \frac{s}{s^2 + 2^2} + \frac{(3)(4)}{s+4} = \frac{s}{s^2 + 4} + \frac{12}{s+4}$$

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

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

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

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

$$s^2 Y(s) + 2s Y(s) = 12 + 10s$$

$$Y(s)(s^2 + 2s) = 12 + 10s$$

$$Y(s) = \frac{12}{s^2 + 2s} + ?$$

$$Y(s) = \frac{12}{s(s+2)} + ?$$

Q3

9

10

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

$$\frac{A}{s} + \frac{B}{(s+2)} \checkmark$$

$$12 = (s+2)A + (s)B \checkmark$$

if  $s = -2$

$$12 = (0-2+2)A + (-2)B$$

$$12 = 0 + -2B$$

$$\frac{12}{-2} = B \checkmark$$

$$B = -6 \checkmark$$

if  $s = 0$

$$12 = (0+2)A + 0B$$

$$\frac{12}{2} = A$$

$$A = 6 \checkmark$$

$$? + \frac{6}{s} + \frac{-6}{(s+2)} = \frac{-36}{s^2 + 2s}$$

$$= \frac{-36}{s(s+2)}$$

Q3

b

10

④

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

$$= \sqrt{30^2 + \frac{20^2 + 10^2}{2}} = 37.4 \text{ V} \quad \checkmark$$

$$i) I_{RMS} = \sqrt{I_0^2 + \sum_{n=1}^{\infty} \left( \frac{I_n^2}{2} \right)} \quad \checkmark$$

$$= \sqrt{6^2 + 4^2 + 2^2} = 7.48 \text{ A.} \quad \checkmark$$

$$ii) \frac{V}{IR} \quad R = \frac{37.4}{7.48} = 5 \Omega.$$

$$P = I^2 R = 279.75 \text{ W} \quad \checkmark$$



B).

$$R = 10 \Omega, L = 0.05 \text{ H}, C = 150 \mu\text{F}, 100 \text{ V}, 50 \text{ Hz}$$

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 150 \times 10^{-6}} = -21.22 \text{ j} \quad \checkmark$$

$$X_L = 2\pi f L = 15.7 \text{ j} \Omega \quad \checkmark$$

$$Z_T = R + X_L - X_C$$

$$= 10 + 15.7 \text{ j} - 21.22 \text{ j}$$

$$= 10 - 5.52 \text{ j} \Omega \quad \checkmark$$

$$\text{mag} = \sqrt{(10)^2 + (5.52j)^2}$$

$$Z = \sqrt{(10)^2 + (5.52)^2}$$

$$Z = 11.42 \Omega$$

Q4

b

11

$$\text{Phase Angle} = 28.89^\circ$$

$$I = \frac{100}{10 - 5.52j} \times \frac{5.52j + 10}{5.52j + 10}$$

$$= \frac{552j + 1000}{100 + 30.16} = \frac{552j + 1000}{130.16}$$

$$I = 7.6 + j4.23 \text{ A}$$

$$I = \sqrt{7.6^2 + 4.23^2}$$

$$\text{Total Power} = (7.6^2 + 4.23^2) \times 10$$

$$58.6 - 17.89$$

$$40.78 \times 10 = 407 \text{ W}$$