

Complete, fold and seal
(see note 2 below)

SURNAME: Woods

FORENAME(S): Thomas

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.**

1	Student Number	
2	Title of Examination Paper	Electrical + Electronic Principles
3	Module Code	SGEE 4000
4	Date and Time of Examination	23/5/22 09:30-11:30
5	Examination Venue	Coleg Sir Gwr Breig Gym
6	Seat Number	5
7	Number of Answer Books handed in	1

[illegible]

77%
AGREED.

Q2

$$a.) Z_T = \left(\frac{Z_1 Z_2}{Z_1 + Z_2} \right) + Z_3$$

$$Z_1 = 3 - j4 \quad \text{or} \quad 5 \angle -53.13^\circ$$

$$Z_2 = 6 + j7 \quad \text{or} \quad 9.22 \angle 49.4^\circ$$

$$Z_3 = 2.5 - j6.5$$

$$Z_1 = \sqrt{3^2 + 4^2} = 5$$

$$\phi = \tan^{-1}\left(\frac{-4}{3}\right) = -53.13^\circ$$

$$Z_2 = \sqrt{6^2 + 7^2} = 9.22$$

$$\phi = \tan^{-1}\left(\frac{7}{6}\right) = 49.4^\circ$$

$$Z_1 \times Z_2 = 5 \angle -53.13^\circ \times 9.22 \angle 49.4^\circ$$

$$= 46.1 \angle -3.73^\circ$$

$$Z_1 + Z_2 = 3 - j4 + 6 + j7$$

$$= 9 + j3 \quad \text{or} \quad 9.49 \angle 18.43^\circ$$

$$Z_1 \times Z_2 = \sqrt{9^2 + 3^2} = 9.49$$

$$\phi = \tan^{-1}\left(\frac{3}{9}\right) = 18.43^\circ$$

$$\frac{Z_1 \times Z_2}{Z_1 + Z_2} = \frac{46.1 \angle -3.73^\circ}{9.49 \angle 18.43^\circ} = 4.86 \angle -22.16^\circ \quad \text{or} \quad 4.5 - j1.83$$

$$\# Z_T = 4.5 - j1.83 + 2.5 - j6.5$$

$$= 7 - j8.33$$

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$$b.) i.) X_L = 2\pi fL$$

$$X_L = 2\pi \times 60 \times 0.4$$

$$X_L = 150.8 \, \Omega$$

$$Z = R + jX_L$$

$$Z = 40 + j150.8 \, \Omega \quad \text{or} \quad 156 \angle 75.1^\circ$$

1

11

11

$$ii.) I = \frac{V}{Z}$$

$$I = \frac{200 \angle 0^\circ}{156 \angle 75.1^\circ}$$

$$\underline{I = 1.28 \angle -75.1^\circ \text{ A}}$$



2

$$iii.) V_R = IR$$

$$V_R = 1.28 \angle -75.1^\circ \times 40 \angle 0^\circ$$

$$\underline{V_R = 51.2 \angle -75.1^\circ \text{ V}}$$



3

$$iv.) V_L = I \times X_L$$

$$V_L = 1.28 \angle -75.1^\circ \times 150.8 \angle 90^\circ$$

$$\underline{V_L = 193 \angle 14.9^\circ \text{ V}}$$



3

c.)

$$V_S = V_R + V_L$$

$$V_S = 51.2 \angle -75.1^\circ + 193 \angle 14.9^\circ$$

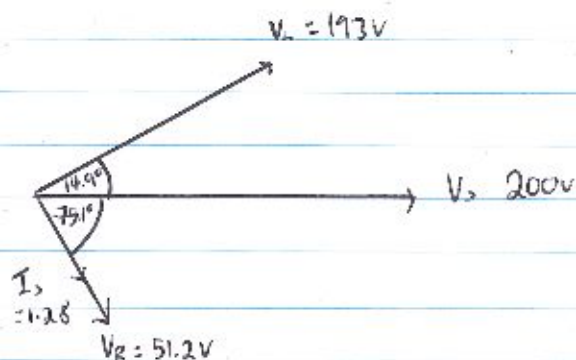
$$V_S = 13.17 - j49.5 + 186.5 + j49.6$$

$$V_S = 199.67 + j0.1 \text{ V approx } 200 + j0 \text{ V}$$



3

d.)



3

Q1

a) new $R_T = \frac{R_1 \times R_2}{R_1 + R_2}$

$$R_T = \frac{47k \times 56k}{47k + 56k}$$

$$\underline{R_T = 25.6k\Omega}$$

new $V_s = \left(\frac{R_2}{R_1 + R_2} \right) \times V_s$

$$V_s = \left(\frac{56k}{47k + 56k} \right) \times 12$$

$$\underline{V_s = 6.5V}$$

new Circuit



b) i) Time constant $= R \times C$
 $\tau = 25.6 \times 10^3 \times 10 \times 10^{-6}$
 $\underline{\tau = 0.256s}$

ii) Fully charge $= 5\tau$

$$5\tau = 5 \times 0.256$$

$$\underline{= 1.28s}$$

5

c.) i.) $V_c = V_s(1 - e^{-t/\tau})$

$$\frac{V_c}{V_s} = 1 - e^{-t/\tau}$$

$$e^{-t/\tau} = 1 - \frac{V_c}{V_s}$$

$$\frac{-t}{\tau} = \ln\left(1 - \frac{V_c}{V_s}\right)$$

$$t = -\tau \ln\left(1 - \frac{V_c}{V_s}\right)$$

$$t = -0.256 \times \ln\left(1 - \frac{3}{6.5}\right)$$

$$t = 0.16s$$

ii.) $V_c = V_s(e^{-t/\tau})$

$$\frac{V_c}{V_s} = e^{-t/\tau}$$

$$\frac{-t}{\tau} = \ln\left(\frac{V_c}{V_s}\right)$$

$$t = -\tau \ln\left(\frac{V_c}{V_s}\right)$$

$$t = -0.256 \times \ln\left(\frac{3}{6.5}\right)$$

$$t = 0.198s$$

d.)

$$i.) \text{ time constant} = \frac{L}{R}$$

$$\tau = \frac{200 \times 10^{-3}}{1000}$$

$$\tau = 0.2 \text{ ms}$$

2

$$ii.) I = \frac{V}{R}$$

$$I = \frac{24}{1000}$$

$$I = 24 \text{ mA}$$

2

iii.)

$$i = I(e^{-t/\tau})$$

$$\frac{i}{I} = e^{-t/\tau}$$

$$\frac{-t}{\tau} = \ln\left(\frac{i}{I}\right)$$

$$t = -\tau \ln\left(\frac{i}{I}\right)$$

$$t = -0.2 \times 10^{-3} \times \ln\left(\frac{20 \times 10^{-3}}{24 \times 10^{-3}}\right)$$

$$t = 36.46 \times 10^{-6} \text{ s or } 36.46 \mu\text{s}$$

6

$$i = I(e^{-t/\tau})$$

$$t = -\tau \ln\left(\frac{i}{I}\right) \quad t = -0.2 \times 10^{-3} \times \ln\left(\frac{5 \times 10^{-3}}{24 \times 10^{-3}}\right) \quad t = 313.7 \times 10^{-6} \text{ s or } 313.7 \mu\text{s}$$

6

16

Q 4

$$a) f_r = \frac{1}{2\pi} \sqrt{\left(\frac{1}{LC} - \frac{R^2}{L^2}\right)}$$

$$2\pi f_r = \sqrt{\left(\frac{1}{LC} - \frac{R^2}{L^2}\right)}$$

$$(2\pi f_r)^2 = \frac{1}{LC} - \frac{R^2}{L^2}$$

$$(2\pi f_r)^2 + \frac{R^2}{L^2} = \frac{1}{LC}$$

$$C = \frac{1}{L \left[(2\pi f_r)^2 + \left(\frac{R^2}{L^2}\right) \right]}$$

$$C = \frac{1}{0.04 \times \left[(2\pi \times 2000)^2 + \left(\frac{100}{0.04^2}\right) \right]} = \frac{1}{0.04 \left[(2\pi \times 2000)^2 + \left(\frac{100}{0.04^2}\right) \right]}$$

$$C = 152.29 \times 10^{-9} F$$

$$b) R_0 = \frac{L}{CR}$$

$$R_0 = \frac{0.04}{152.29 \times 10^{-9} \times 100} = \frac{0.04}{1.5229 \times 10^{-5}}$$

$$R_0 = \frac{0.04}{152.29 \times 10^{-9} \times 100} = 2.63 k\Omega$$

$$c) I_r = \frac{V}{R_0}$$

$$I_r = \frac{24}{2.63k} = 9.13 mA$$

d.) $Q = \frac{2\pi f_r L}{R}$

$$Q = \frac{2\pi \times 2000 \times 0.04}{100}$$

$$Q = 5.03$$

$$B.W = f_2 - f_1$$

and

$$Q = \frac{f_r}{(f_2 - f_1)}$$

$$\therefore Q = \frac{f_r}{B.W}$$

$$B.W = \frac{f_r}{Q}$$

$$B.W = \frac{2000}{5.03}$$

$$= 397.6 \text{ Hz}$$

f.) $f_r = \sqrt{f_2 \times f_1}$

$$f_r^2 = f_2 \times f_1$$

$$f_2 = \frac{f_r^2}{f_1}$$

$$f_2 = \frac{4 \times 10^6}{f_1}$$

$$B.W = f_2 - f_1$$

$$397.6 = f_2 - f_1$$

$$f_1 = f_2 - 397.6$$

$$f_2^2 = \frac{4 \times 10^6}{f_1}$$

$$f_1 = f_2 - 397.6$$

$$f_2 = \frac{4 \times 10^6}{f_2 - 397.6}$$

$$f_2 + 397.6 = \frac{4 \times 10^6}{f_2}$$

$$f_2^2 + 397.6 f_2 = 4 \times 10^6$$

$$f_2^2 + 397.6 f_2 - 4 \times 10^6 = 0$$

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$f_2 = 1811.1 \text{ Hz} \quad \text{or} \quad \underline{f_2 = -2208.7 \text{ Hz}}$$

Can't have -ve frequency

$$\therefore \underline{f_2 = 1811.1 \text{ Hz}}$$

$$B.W = f_2 - f_1$$

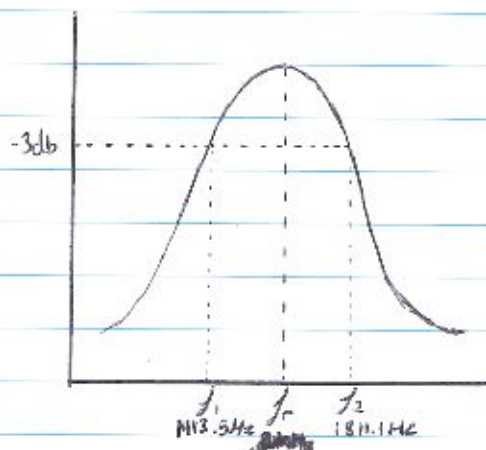
$$f_1 = f_2 - B.W$$

$$f_1 = 1811.1 - 397.6$$

$$f_1 = 1413.5 \text{ Hz}$$

g) $0.707 \times R_0$
 $= 0.707 \times 2.63 \times 10^3$
 $= 1859.41 \Omega$

h.)



3

Q3

$$Z = 3 + j4 \text{ or } 5 \angle 53.13^\circ$$

$$r = \sqrt{3^2 + 4^2} = 5$$

$$\phi = \tan^{-1}\left(\frac{4}{3}\right) = 53.13^\circ$$

$$\text{Supply current} = I = \frac{V}{Z}$$

$$I = \frac{60 \angle 30^\circ}{5 \angle 53.13^\circ}$$

$$\underline{I = 12 \angle -23.13^\circ \text{ A}}$$

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⑤