

12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The candidate is 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]

(Gweler yr ochr arall am y fersiwn Cymraeg)

85%

$\frac{85}{100}$

~~Her-~~

1)

$$a) \rho = \frac{RA}{L}$$

$$\rho = \frac{2 \times 25}{15} = 3.33 \text{ } \Omega \text{ cm}$$

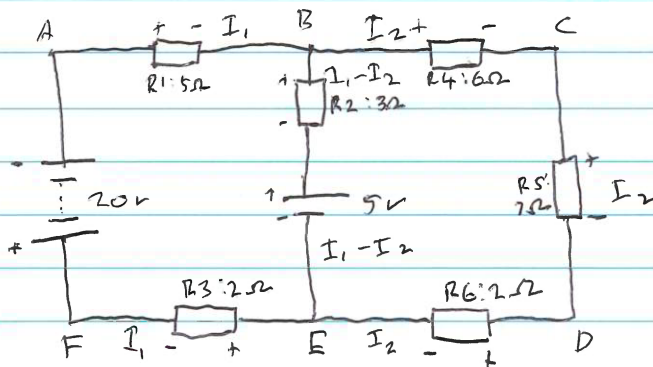
$$\rho = \frac{2 \times 0.25}{0.15} = 3.33 \text{ } \Omega \text{ m}$$

$$b) \frac{75}{80} = 0.9375 = 93.75\% \quad \text{efficiency} = \frac{P_{out}}{P_{in}}$$

$$\text{power loss} = P_{in} - P_{out}$$

$$= 80 - 75 = 5 \text{ W}$$

c)



A B E F A

$$-5I_1 - 3(I_1 - I_2) - 5 - 2I_1 + 20 = 0$$

$$-7I_1 - 3I_1 + 3I_2 + 15 = 0$$

$$-10I_1 + 3I_2 = -15 \quad (1)$$

B C D E B

$$-6I_2 - 7I_2 - 2I_2 + 5 + 3(I_1 - I_2) = 0$$

$$-15I_2 + 5 + 3I_1 - 3I_2 = 0$$

$$-18I_2 + 3I_1 = -5 \quad (2)$$

$$(1) \times 6 =$$

$$-60I_1 + 18I_2 = -90 \quad (3)$$

$$\begin{aligned}
 (2) + (3) & \quad 3I_1 - 18I_2 = -5 + \\
 & \quad -60I_1 + 18I_2 = -90 \\
 & \quad -57I_1 = -95 \\
 & \quad I_1 = 1.67 \text{ A}
 \end{aligned}$$

$$\begin{aligned}
 I_2 & \quad -10(1.67) + 3I_2 = -15 \\
 & \quad -16.7 + 3I_2 = -15 \\
 & \quad 3I_2 = 1.7 \\
 & \quad I_2 = 0.57 \text{ A}
 \end{aligned}$$

$$I_1 - I_2$$

$$1.67 - 0.57 = 1.1 \text{ A}$$

Across R_1 and R_3 is 1.67 A

Across R_2 is 1.1 A

Across R_4 , R_5 and R_6 is 0.57 A

2)

$$a) \quad i) \quad \frac{1}{R_{eq1}} = \frac{1}{R_4} + \frac{1}{R_3}$$

$$\frac{1}{R_{eq1}} = \frac{1}{5} + \frac{1}{20}$$

$$\frac{1}{R_{eq1}} = \frac{1}{4}$$

$$R_{eq1} = 4 \Omega$$

$$R_{eq2} = R_{eq1} + R_2$$

$$R_{eq2} = 4 + 20$$

$$R_{eq2} = 24 \Omega$$

$$\frac{1}{R_{eq3}} = \frac{1}{R_{eq2}} + \frac{1}{R_5}$$

$$\frac{1}{R_{eq3}} = \frac{1}{24} + \frac{1}{10} = \frac{17}{120}$$

$$R_{eq3} = 7.06 \Omega$$

$$Q_1 = 29.57 \text{ W}$$

$$Q_1 = 24 \text{ W}$$

$$R_{eq4} = R_{eq3} + R_1$$

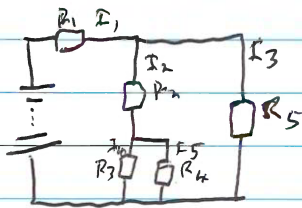
$$R_{eq4} = 7.06 + 15 = 22.06 \Omega$$

total resistance in the circuit is 22.06Ω

ii) ~~total resistance~~ $I = \frac{V}{R}$

$$I = \frac{50}{22.06} = 2.27 A$$

iii)



$$I_1 = 2.27 A$$

$$I_2 = I_1 \frac{R_5}{R_2 + R_5}$$

$$I_2 = 2.27 \frac{10}{20+10} = 0.76 A$$

$$I_3 = I_1 - I_2 = 2.27 - 0.76 = 1.51 A$$

$$I_4 = I_2 \frac{R_4}{R_3 + R_4} = 0.76 \frac{5}{20+5} = 0.152 A$$

$$I_5 = I_2 - I_4 = 0.76 - 0.152 = 0.61 A$$

Current across R_1 is $2.27 A$

Current across R_2 is $0.76 A$

Current across R_3 is $0.15 A$

Current across R_4 is $0.61 A$

Current across R_5 is $1.51 A$

iv) V across R_1

$$V_1 = I_1 \times R_1$$

$$V_1 = 2.27 \times 15 = 34.05 V$$

V across R_2

$$V_2 = R_2 \times I_2$$

$$V_2 = 20 \times 0.76 = 15.2 \text{ V}$$

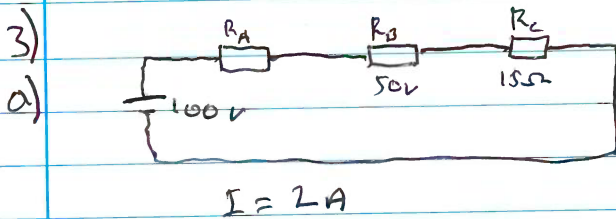
V across R_3

$$V_3 = R_3 \times I_4$$

$$V_3 = 20 \times 0.15$$

$$V_3 = 3 \text{ V}$$

$$Q_2 = 18$$



i) $V_C = R_C \times I$

$$V_C = 15 \times 2$$

$$V_C = 30 \text{ V}$$

ii) $V_A = 100 \text{ V}$

iii) $R_A = \frac{V_A}{I}$

$$R_A = \frac{100}{2}$$

$$R_A = 50 \Omega$$

$$R_B = \frac{V_B}{I}$$

$$R_B = \frac{50}{2} = 25 \Omega$$

b) Maximum power transfer theory states that the maximum theoretical power a component can take before it breakdown or is permanently damaged.

0

c)

i) Reactance is the opposition to the ~~flow~~ ^{in an AC circuit} change of flow of current measured in ohms Ω .

2

ii) impedance is the ~~op~~ ^{in an AC circuit} ~~total~~ opposition to the change of flow of current measured in ohms Ω .

2

iii) An intrinsic semiconductor is a pure form semiconductor.

2

d)

i) 75 V

1

ii) $75 \times 2 = 150 \text{ V}$

2

iii) $V_{\text{rms}} = \frac{V_m}{\sqrt{2}}$

2

$$V_{\text{rms}} = \frac{75}{\sqrt{2}} = 53.03 \text{ V}$$

iv) $\omega = 2\pi f$

$$200\pi = 2\pi f$$

$$100 \text{ Hz} = f$$

$$f = 100 \text{ Hz}$$

2

v) $f = \frac{1}{T}$

$$100 = \frac{1}{T}$$

$$100T = 1$$

$$T = \frac{1}{100} = 10 \text{ ms}$$

1

$$Q3 = 4 + 1 + 6 + 8 = 19$$

4)

a)

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

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 55 \times 10^{-6}} = 57.87 \Omega$$

$$X_L = 2\pi f L = 2\pi \times 50 \times 47 \times 10^{-3} = 14.77 \Omega$$

$$|Z| = \sqrt{200^2 + (14.77 - 57.87)^2} = 204.59 \Omega$$

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

$$\tan^{-1} \left(\frac{14.77 - 57.87}{200} \right) = -12.16^\circ$$

$$iii) V = IR$$

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

$$I = \frac{240}{204.59} = 1.17 \text{ A}$$

iv) across R

$$V = IR$$

$$V = 1.17 \times 200$$

$$V_R = 234 \text{ V}$$

across L

$$V = 14.77 \times 1.17$$

$$V_L = 17.28 \text{ V}$$

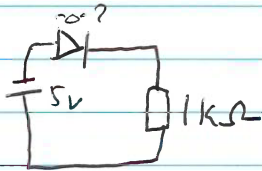
across C

$$V = IR$$

$$V = 1.17 \times 57.87$$

$$V = 67.71 \text{ V}$$

b)



$$V_D = V_S - V_D$$

$$V_D = 5 - 0.7$$

$$V_D = 4.3 \text{ V}$$

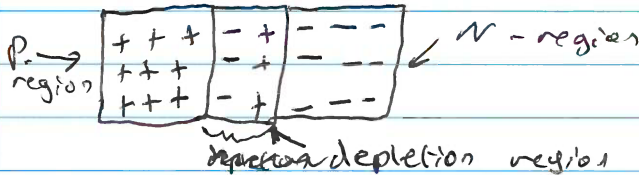
$$V = I R$$

$$4.3 = I \times 1000$$

$$\frac{4.3}{1000} = I$$

$$I = 4.3 \text{ mA}$$

c)



When a PN Junction diode is forward biased and a voltage over 0.7 V is applied the depletion region is overcome and current will flow through the diode.

The depletion region is overcome by the greater electro motive force coming from the supply.

When it is connected in forward bias that means the anode of the diode is connected to the + of the supply and the cathode to the - of the supply.

The PN Junction diode will now have a path of the positive region to the negative region, hence current flow.

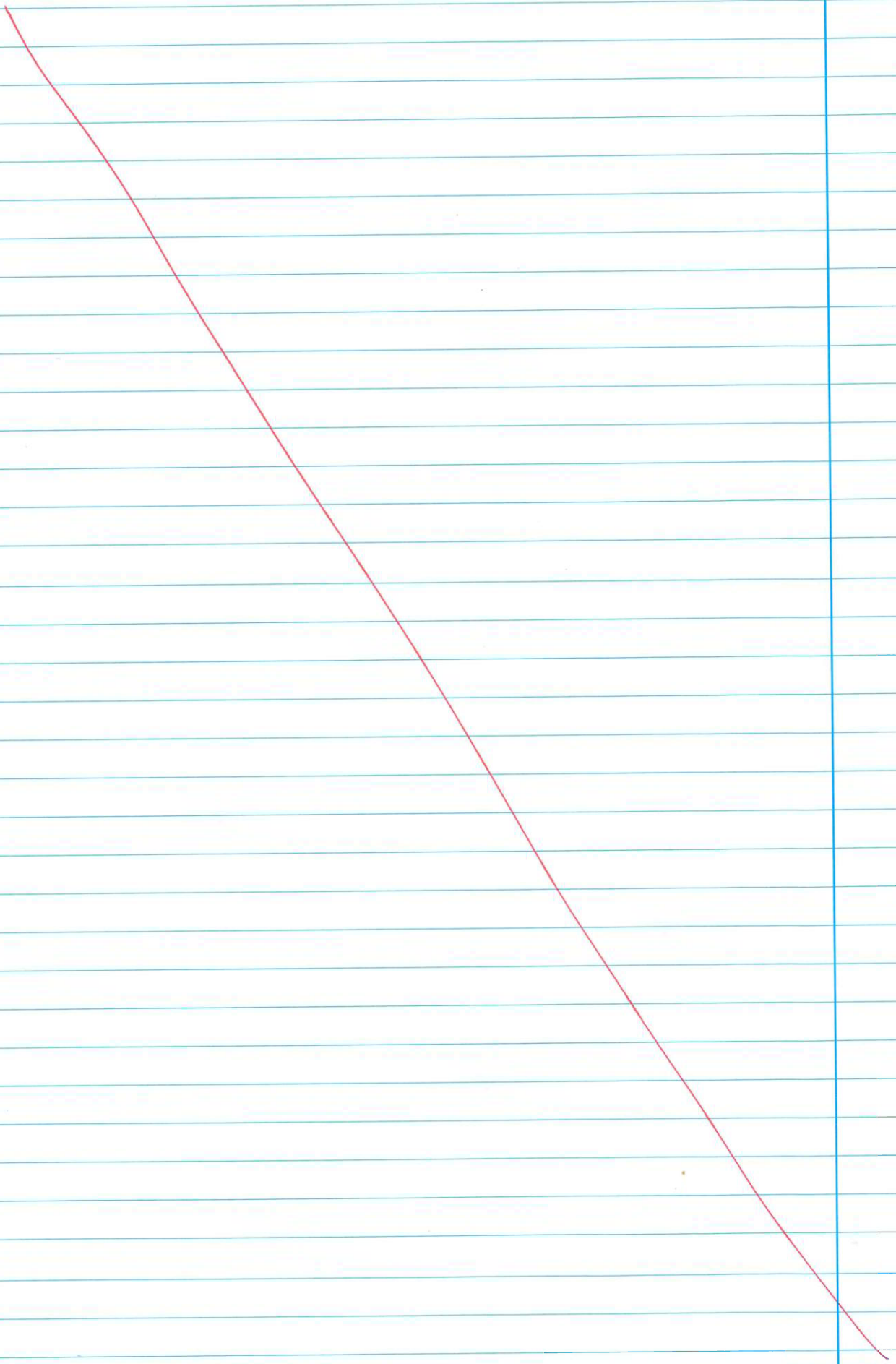


$$Q_4 = 16 + 4 + 5 = 25$$



Examiner Only

Question No.



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