



Examination Answer Books

12 Pages

Instructions to Candidates

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.

Complete, fold and seal
(see note 2 below)

SURNAME: HARDING

FORENAME(S): CALLUM JAMES

1	Student Number	2117902
2	Title of Examination Paper	ENGINEERING SCIENCE
3	Module Code	PCP04001
4	Date and Time of Examination	11/5/2022 12:00
5	Examination Venue	PEMBROKESHIRE COLLEGE.
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	20
2	20
3	20
4	20
5	5
Total	85

✓
✓
✓
✓
✓
85
✓

1)
a) $\left(\frac{1}{16} + \frac{1}{25}\right)^{-1} = 9.76 \Omega$

$$9.76 + 15 = 24.76$$

$$\left(\frac{1}{24.76} + \frac{1}{20} + \frac{1}{12}\right)^{-1} = 5.76 \Omega$$

$$5.76 + 10 + 15 = \underline{30.76 \Omega} \quad \checkmark$$

5

b) $80 + 15 = 95 \text{ nF}$

i) $\left(\frac{1}{95} + \frac{1}{35 \times 10^{-3}} + \frac{1}{220}\right)^{-1} = \underline{34.98 \times 10^{-12} \text{ F or } 34.98 \text{ pF}}$

5

ii) $Q = CV$

$$Q = 34.98 \times 10^{-12} \times 12$$

$$Q = \underline{4.20 \times 10^{-10} \text{ C}}$$

5

iii) $E = \frac{CV^2}{2} \quad E = \frac{34.98 \times 10^{-12} \times 144}{2} \quad E = \underline{2.52 \times 10^{-9} \text{ J}}$

5

2) $R = 24$

a) $r = 0.25 \text{ mm} \therefore 2.5 \times 10^{-4} \text{ m} \quad A = \pi \times (2.5 \times 10^{-4})^2 = 1.96 \times 10^{-7} \text{ m}^2$
 $l = 6.2 \text{ m}$

$$R = \frac{\rho l}{A} \therefore A \rho = \frac{RA}{1} \quad \rho = \frac{24 \times 1.96 \times 10^{-7}}{6.2}$$

$$\rho = 7.59 \times 10^{-7} \Omega \text{ m}^{-1}$$

5 length and $2r$

$$A \text{ when } 2r = \pi \times (2 \times 2.5 \times 10^{-4})^2 = 7.85 \times 10^{-7} \text{ m}^2$$

$$l \text{ when } \times 5 = 6.2 \times 5 = 31 \text{ m}$$

10

$$R = \frac{\rho l}{A}$$

$$R = \frac{7.59 \times 10^{-7} \times 31}{7.85 \times 10^{-7}}$$

$$\underline{R = 29.97 \Omega} \quad \checkmark$$

b) Field winding...

$$R = R_0 (1 + \alpha \theta)$$

$$R = 100 (1 + (0.00392 \times 40))$$

$$R = 115.68 \Omega$$

10

3) $h_o = 7 \text{ cm}$

a) $f = \text{~~20 cm~~ 20 cm}$

$$d_o = 40 \text{ cm}$$

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o} \right)^{-1} = \left(\frac{1}{20} - \frac{1}{40} \right)^{-1} = \frac{40 \text{ cm}}{\text{~~20 cm~~}}$$

$$h_i = \frac{-d_i}{d_o} \times h_o = \frac{-40}{40} \times 7 = -7 \text{ cm}$$

~~20 cm~~ and ~~20 cm~~

10

$$\underline{h_i = -7 \text{ cm}} \quad \underline{d_i = 40 \text{ cm}}$$

~~25 cm~~

b) $h_o = 5 \text{ cm}$

$$d_o = 30.5 \text{ cm}$$

$$f = -15.2 \text{ cm}$$

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o} \right)^{-1} = \left(\frac{1}{-15.2} - \frac{1}{30.5} \right)^{-1} = -10.14 \text{ cm}$$

$$h_i = \frac{-d_i}{d_o} \times h_o = \left(\frac{10.14}{30.5} \right) \times 5 = 1.66 \text{ cm}$$

$$\underline{h_i = 1.66 \text{ cm}} \quad \underline{d_i = -10.14 \text{ cm}}$$

4) $d_o = 18\text{cm}$
 a) $f = 38\text{cm}$

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o} \right)^{-1}$$

$$d_i = \left(\frac{1}{38} - \frac{1}{18} \right)^{-1}$$

$$d_i = -34.2\text{cm} \quad d_i \text{ is negative } \therefore \text{virtual image}$$

5

b) $1.5 \sin(48^\circ) = 1.33 \sin \theta$ where $\theta = \text{angle of refraction.}$

$$\theta = \sin^{-1} \left(\frac{1.5 \sin(48^\circ)}{1.33} \right)$$

$$\theta = 56.94^\circ$$

10

c) $h_o = 4\text{cm}$
 $d_o = 25\text{cm}$

$f = -35\text{cm}$ as diverging.

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o} \right)^{-1}$$

$$d_i = \left(\frac{1}{-35} - \frac{1}{25} \right)^{-1}$$

$$d_i = -14.58\text{cm}$$

$$h_i = \frac{-d_i}{d_o} \times h_o$$

$$h_i = \left(\frac{14.58}{25} \right) \times 4$$

$$h_i = 2.33\text{cm}$$

5

- 5) brick (refractory) = 1.6 W/mk 0.12 m leaves 0.48 m
 brick (insulating) = 0.3 W/mk 0.18 m of free
 plaster = 0.14 W/mk 0.22 m space.

$$U_1 = 1100^\circ\text{C}$$

$$\Delta U = 1050^\circ\text{C}$$

$$U_2 = 50^\circ\text{C}$$

$$\frac{0.12}{1.6}$$

$$\text{Area} = 1 \times 4 = 4 \text{ m}^2$$

$$1.6 \times 0.12 = 0.192$$

$$0.3 \times 0.18 = 0.054$$

$$0.14 \times 0.22 = 0.0308$$

$$\dot{Q} = \frac{KA \Delta T}{x}$$

a) thermal resistance?
~~total thermal resistance~~

$$\dot{Q} = \frac{\Delta T \times A}{0.192 + 0.054 + 0.0308}$$

$$\dot{Q} = \frac{1050 \times 4}{0.192 + 0.054 + 0.0308}$$

$$\dot{Q} = 15,173.41 \text{ W}$$