
$$\frac{1 \times 2}{2}$$

20

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 the cover of the answer book and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore a scribbled-out 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	2113123
2	Title of Examination Paper	electromagnetic radiation (OME)
3	Module Code	ACDC 5009
4	Date and Time of Examination	15:00 08/05/2023
5	Examination Venue	1 Q 310
6	Seat Number	24
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
Q1	13
Q2	4+1
Q3	11
Q4	9
Total	38

$\frac{38}{100}$

PL 1

Q 1

A) $v = \frac{\lambda f dp}{2}$ $fdp = \frac{\lambda \times v}{2}$

$\lambda = f/c = 6.66 \times 10^{14}$ $3 \times 10^{20} ?$

B) Signal modulation is when a ~~communication~~ ^{message} ~~system~~ signal is combined with carrier signal. by combining these two signals together a greater range can be achieved whilst also reducing the number of signal losses. The modulation aspect is akin to encoding where demodulation is like decoding the message.

C) $c = f \times \lambda$
 $f = \lambda \times c$
 $f = 800 \times 10^8 = 8 \times 10^{10} \text{ Hz}$

d) ?

$$e) \phi_c = \sin^{-1} \left(\frac{n_2}{n_1} \right)$$

$$\phi_c = \sin^{-1} \left(\frac{1.5}{1.6} \right)$$

$$\phi_c = 69.64^\circ$$

f) Electromagnetic waves travel through free space by radiation. The speed of the signal is dependent on the medium. i.e. in a vacuum they travel at the speed of light. However in air this velocity can lower.

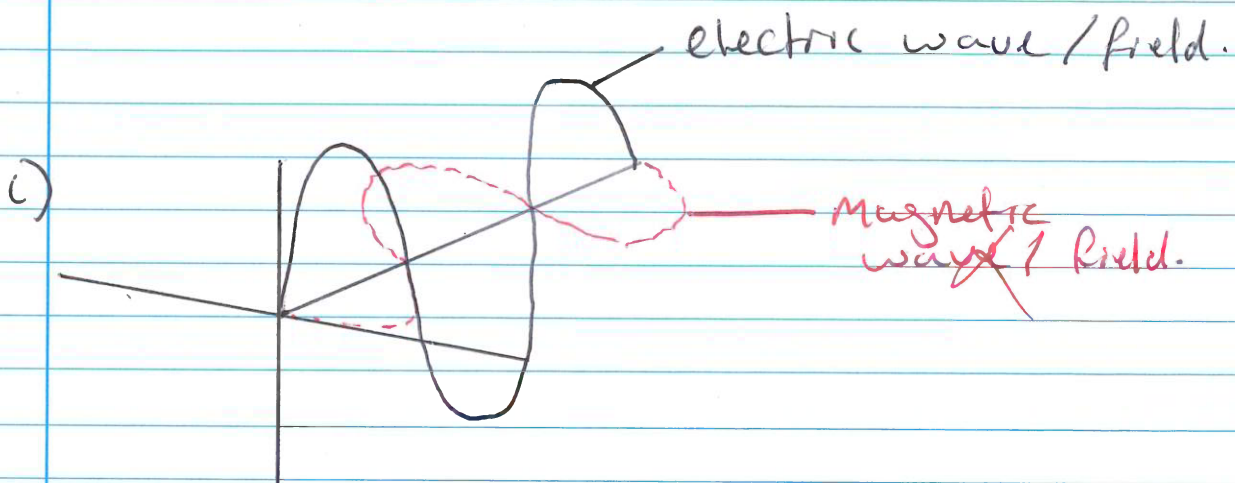
Q2

a)

i) Passive radar homing systems lock onto emitted signals from the source. i.e. Anti radiation missiles or heat seeking missiles.

ii) Active RADAR Homing missiles work on the principle where the system itself produces a radar signal, and receives the bounced back signal.

b) ?



As governed by Maxwell's principles electrical waves and magnetic waves induce one another. This induction is always on perpendicular planes; and always originates and terminates together.

Q2 = 5

3)

A) 40mm x 20mm

$$i) f_c = \frac{c}{2} \sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

$$f_c = \frac{3 \times 10^8}{2} \sqrt{\left(\frac{1}{40}\right)^2 + \left(\frac{1}{20}\right)^2}$$

$$\lambda_c = \frac{c}{f_c} \quad \lambda = \frac{3 \times 10^8}{f_c}$$

B) $NA = \sqrt{n_1^2 - n_2^2}$ $n_1^2 = NA^2 + n_2^2$

$0.48^2 + 1.45^2 = 1.8721$ at end of paper

$\sqrt{1.8721} = N_0 = 1.368$

$\phi_c = \sin^{-1}$

6) TE - Transverse electric
 TM - Transverse magnetic

Both propagate from origin perpendicularly

5) An isolator in principle isolates a bandwidth or signal. in microwave communication systems an isolator is used to reduce noise from an input/received signal.



Q4

a)

$$F = \left(\frac{Q_1 Q_2}{4\pi \epsilon_0 d^2} \right) \text{ N.m.}$$

Solve for.

$$Q_1 A = (-5, 4, 6) \text{ C}$$

$$Q_2 B = (4, 8, -2) \text{ C}$$

$$\therefore \text{ (vector difference) } \rightarrow$$

$$\therefore (4 - (-5) \text{ m}) + (8 - 4 \text{ m}) + (-2 - 6 \text{ m})$$

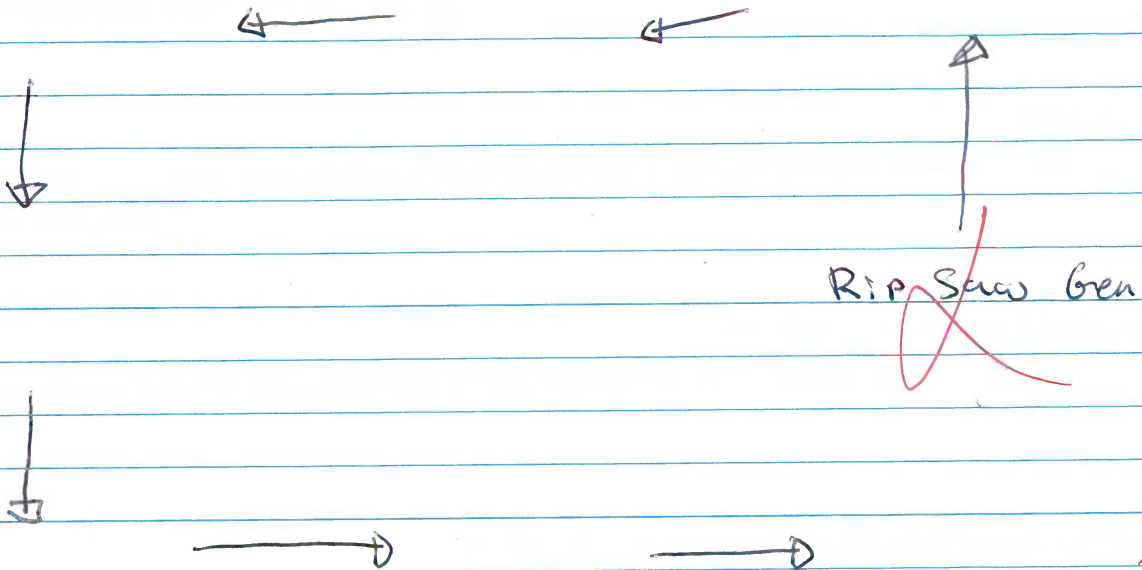
$$d = \sqrt{(4)^2 + (4)^2 + (8)^2}$$

$$d = 12.64$$

$$F = \left(\frac{-20 \times 10^{-6} \cdot 40 \times 10^{-6}}{1.7417 \times 10^{-8}} \right) \times$$

$$\begin{array}{l} \nearrow 4 = \\ \rightarrow 4 = \\ \searrow 8 = \end{array}$$

4B) Reception transmission



Rip Saw Gen

Q42 (a)

Q3

b) $NA = 0.48$

$n_1 = 1.45$

numerical aperture:

$$NA = \sqrt{n_1^2 - n_2^2}$$

$$NA^2 = n_1^2 - n_2^2$$

$$NA^2 + n_2^2 = n_1^2$$

$$0.48^2 + 1.45^2 = 2.3329$$

$$\sqrt{2.3329} = 1.527$$

$$\sin^{-1} \left(\frac{0.48}{1.527} \right) = \phi_a$$

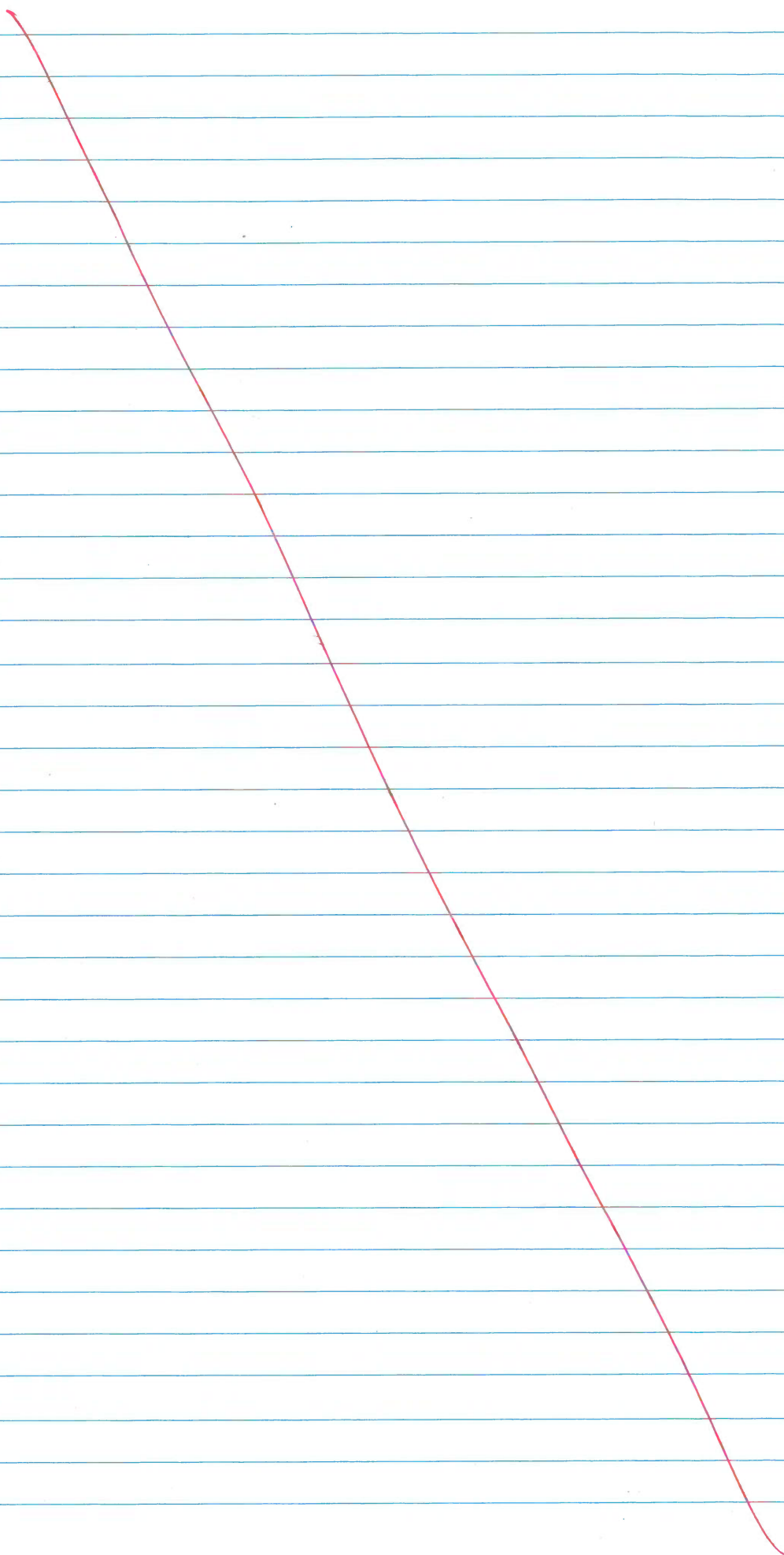
$$\phi_a = 18.32^\circ$$

Q3 = 11



Question No.

Examiner Only



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Arholwr yn unig