

PRIFYSGOL CYMRU

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UNIVERSITY OF WALES

Trinity Saint David

Examination Answer Book

24 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 and seal 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	P148324
2	Title of Examination Paper	electromagnetiz Radiation
3	Module Code	MSX00941
4	Date and Time of Examination	23rd June 17
5	Examination Venue	
6	Seat Number	

7	Number of Answer Books handed in	
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List the numbers of the questions you have attempted	Office Use
2	~~80~~ 48
3	100
4	80
Total	<u>228</u> = 76%

FOLD

Complete
section,
remove
strip, fold as
indicated
and SEAL

Please complete this section and SEAL before the examination starts.

Forename(s)

Surname

4860000

Q2

a) $P_t = 30 \text{ kW}$ $G_t = 30 \text{ dB}$ $f = 10 \text{ GHz}$
 $\text{SNR}_{\text{fordet}} = 10 \text{ dB}$ $l_{\text{ges}} = 0.9$ $P_{\text{min}} = ?$
 Total system noise power = -90 dBW
 $\sigma = 200 \text{ m}^2$

$$r_{\text{max}} = \sqrt[4]{\frac{P_t G_t B_R \sigma \lambda^2}{(4\pi)^3 P_{\text{min}} l_{\text{ges}}}}$$

Noise floor

$$-90 \text{ dBW} + 10 \text{ dB} = -80 \text{ dBW}$$

$$10^{\left(\frac{-80}{10}\right)} = 1 \times 10^{-8} = P_{\text{min}}$$

$$r_{\text{max}} = \sqrt[4]{\frac{30 \times 10^3 \times 30 \times 30 \times 200 \times \lambda^2}{(4\pi)^3 \times 1 \times 10^{-8} \times 0.9}}$$

$$c = f\lambda \quad \lambda = \frac{c}{f} = \frac{3 \times 10^8}{10 \times 10^9}$$

$$\lambda = 0.03$$

$$r_{\text{max}} = \sqrt[4]{\frac{30 \times 10^3 \times 30 \times 30 \times 200 \times (0.03)^2}{(4\pi)^3 \times 1 \times 10^{-8} \times 0.9}}$$

$$= \sqrt[4]{\frac{4860000}{1.785961537 \times 10^{-5}}}$$

$$= \underline{\underline{722.26 \text{ m.}}}$$

30 dB = x1000!

Comm

48
80

Q2

b)

It has^a wavelength of 3cm.

0
—
20

50
—
100

Q3

a)

$$\text{Power flow} = 1 \text{ W/m}^2$$

$$P = \frac{1}{2} \times E \times H$$

$$\frac{E}{H} = 377 \text{ } \Omega$$

$$H = \frac{E}{377}$$

$$P = \frac{1}{2} \times E \times \frac{E}{377} = \frac{1}{2} \times \frac{E^2}{377}$$

$$P = \frac{E^2}{754} \quad \therefore P = \frac{E^2}{754}$$

$$754 \times P = E^2$$

$$\sqrt{754 \times P} = E$$

$$\sqrt{754 \times 1} = 27.45906044$$

$$E = 27.46 \text{ V/m}$$

Q3

b)

$$E = 10^7 \text{ V/m}$$

Pulse

$$\text{duration} = 2 \mu\text{s}$$

diameter
spot

$$= 11 \mu\text{m}$$

$$P = \frac{1}{2} \times E \times H = \frac{E^2}{754}$$

$$\frac{(10^7)^2}{754} = \text{Power density}$$

$$= 1.326 \dots \times 10^8$$

$$= 1.33 \times 10^8$$



50
50

Q3 b) Power den = 1.33×10^{11}

Power density $\times$ pulse duration = ^{Pulse} energy
 $1.33 \times 10^{11} \times 2 \times 10^{-6} = 266000$

Pulse energy = 266000

Pulse energy $\times$ area = ^{Pulse energy} on ~~11 μ m~~ ^{Spot}

πr^2 diameter = $11 \mu\text{m}$
radius = $5.5 \mu\text{m}$

$\pi \times (5.5 \times 10^{-6})^2 = \text{area of spot}$

$9.5033177 \times 10^{-11} =$ " "

$9.5 \times 10^{-11} \text{ m}^2 = \text{area of spot}$

Pulse energy $\times$ area = ^{Pulse energy} on spot

$266000 \times 9.5 \times 10^{-11}$

$= 25.27 \times 10^{-6}$

$= 25.27 \mu\text{J}$

Q19337

0.96666667

Q4
a)red light: $n=1.51$ at 400nm blue light: $n=1.49$ at 600nm Average $n=1.50$ at 500nm

$$V_{p_{\text{average}}} = \frac{c}{n_{\text{average}}} = \frac{3 \times 10^8}{1.50} = 200 \times 10^6$$

$$V_g = V_p \left(1 + \frac{500 \times 10^{-9}}{1.50} \times \frac{-0.02}{200 \times 10^{-9}} \right)$$

$$V_g = 200 \times 10^6 \times \left(1 + \frac{500 \times 10^{-9}}{1.50} \times \frac{-0.02}{200 \times 10^{-9}} \right)$$

to check

$$\left[\begin{array}{l} \frac{500 \times 10^{-9}}{1.50} = 3.33 \dots \times 10^{-7} \\ \frac{-0.02}{200 \times 10^{-9}} = -100000 \end{array} \right]$$

$$V_g = 193333333.3 \text{ m/s}$$

$$V_g = 193333 \text{ km/s}$$

$$V_g = 193333 \text{ km/s}$$

Q4 b)

red : $n = 1.51$ at 400nm
blue : $n = 1.49$ at 600nm

$$V_p = \frac{c}{n}$$

Red

$$V_p = \frac{3 \times 10^8}{1.51} = 198.65... \times 10^6$$
$$V_p = \frac{3 \times 10^8}{1.51} = 198.68 \times 10^6 \text{ m/s}$$

Blue

$$V_p = \frac{3 \times 10^8}{1.49} = 201.342... \times 10^6$$
$$= 201.34 \times 10^6 \text{ m/s}$$

Q4 c)

0
20

80
100