

PRIFYSGOL CYMRU

Y Drindod Dewi Sant

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	P148567
2	Title of Examination Paper	ELECTROMAGNETIC RADIATION.
3	Module Code	MSX00941
4	Date and Time of Examination	23/06/17 1000hrs.
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	68
3	50
4	72
Total	$\frac{190}{292} = 65\%$

1050

Complete
section,
remove
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Please complete this section and SEAL before the examination starts.

Forename(s)

Surname:

$$2. a) f = 10 \text{ GHz} \therefore c = f\lambda \therefore \lambda = \frac{c}{f} = \frac{3 \times 10^8}{10 \times 10^9}$$

$$\therefore \lambda = 0.03 \text{ m}$$

$$P_{\text{min}} = \text{Total system noise} + \text{Minimum detectable signal}$$

$$= -90 + 10$$

$$= -80 \text{ dBW}$$

$$\text{Convert to ratio} = 1 \times 10^{\frac{\text{dBW}}{10}}$$

$$= 1 \times 10^{(-80/10)}$$

$$= 1 \times 10^{-8}$$

$$\therefore r_{\text{max}} = \sqrt[4]{\frac{P_T \cdot G_T \cdot G_R \cdot \sigma \cdot \lambda^2}{(4\pi)^3 \cdot P_{\text{min}} \cdot L_{\text{ges}}}}$$

$$\text{Where } P_T = 30 \text{ kW}$$

$$G_T = 30 \text{ dB}$$

$$G_R = 30 \text{ dB}$$

$$\sigma = 200 \text{ m}^2$$

$$\lambda = 0.03 \text{ m}$$

$$P_{\text{min}} = 1 \times 10^{-8}$$

$$L_{\text{ges}} = 0.9$$

As the system is monostatic, $G_T = G_R$. As a ratio, $30 \text{ dB} = 1 \times 10^{\frac{30}{10}} = 1000$

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

$$= \sqrt[4]{\frac{1.8 \times 10^{11}}{(1984.4) \times (1 \times 10^{-8}) \times 0.9}}$$

$$= \sqrt[4]{\frac{1.8 \times 10^{11}}{1.786 \times 10^{-5}}}$$

$$= \sqrt[4]{1 \times 10^{16}}$$

$$= 10,019.6 \text{ m}$$

Carles error in the calculation.

56
80

2. b) An X-band radar of this type is small & relatively high powered. A high frequency ~~is~~ requires a ~~for~~ short wavelength for better small (floating) object discrimination at sea.

Utilising such a frequency also results in a relatively large detection range of that radar systems by larger ~~vessels~~ - radar equipped vessels - who can then take collision avoidance actions if required.

12
6

68
102

3. a). Power flow = $\frac{1}{2}(EH)$ and $\frac{E}{H} = 377 \Omega$.

$$\therefore \text{Power flow} = \frac{1}{2} \left(E \cdot \frac{E}{377} \right) \quad \Rightarrow H = \frac{E}{377}$$

$$= \frac{1}{2} \left(\frac{E^2}{377} \right)$$

$$\Rightarrow 2 \cdot P_f = \frac{E^2}{377}$$

$$\Rightarrow 2 \cdot 377 \cdot P_f = E^2$$

$$\therefore E = \sqrt{2 \cdot 377 \cdot P_f}$$

When the Power flow is 1 W/m^2 ,

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

$$= \underline{27.46 \text{ Vm}^{-1}}$$

50
10

3. b)

$$\frac{0}{50}$$

$$\frac{50}{100}$$

4. a) Red light $n = 1.51$, $\lambda = 400 \text{ nm}$
Blue light $n = 1.49$, $\lambda = 600 \text{ nm}$.

$$n_{\text{avg}} = 1.50, \quad \lambda_{\text{avg}} = 500 \text{ nm}.$$

$$V_g = V_p \left(1 + \frac{\lambda}{n} \frac{dn}{d\lambda} \right) \text{ where } V_p = \frac{c}{n_{\text{avg}}} = \frac{3 \times 10^8}{1.50}$$

$$= 2 \times 10^8$$

$$\therefore V_g = 2 \times 10^8 \left(1 + \frac{200 \times 10^{-9}}{0.02} \right)$$

$$= 2 \times 10^8 (1 + 1 \times 10^{-5})$$

$$\therefore V_g = 2 \times 10^8 \left(1 + \left(\frac{500 \times 10^{-9}}{1.5} \cdot \frac{0.02}{200 \times 10^{-9}} \right) \right)$$

$$= 2 \times 10^8 (1 + (1/30))$$

$$= 2 \times 10^8 \cdot 1.0333$$

$$= 206.66 \times 10^6 \text{ ms}^{-1}$$

$$10 + 12$$

$$\frac{22}{30}$$

b) $V_p = \frac{c}{n} \Rightarrow V_p = \frac{3 \times 10^8}{1.51} \Rightarrow V_p = 198.675 \times 10^6 \text{ ms}^{-1}$

$$V_p = \frac{c}{n} \Rightarrow V_p = \frac{3 \times 10^8}{1.49} \Rightarrow V_p = 201.342 \times 10^6 \text{ ms}^{-1}$$

$$\frac{50}{10}$$

c) Blue light refracts less than red. Therefore it has less distance to travel through the glass. ~~before~~ It therefore appears to have travelled faster but has merely travelled less distance.

$$\frac{22}{30}$$

$$\frac{22}{30}$$