 $1200 \, \Omega$

12 Pages

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.**

1	Student Number	221 8326
2	Title of Examination Paper	Advanced Radio Frequency Systems
3	Module Code	ACDA6019
4	Date and Time of Examination	1/5/25 9:00am
5	Examination Venue	3 ¹⁰ ~~01~~ IQ
6	Seat Number	21
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
Q1	12 ✓
Q2	17 ✓
Q3	12 ✓
Q4	3 ✓
Total	116 ✓

(Gweler yr ochr arall am y fersiwn Cymraeg)

1a) $L = 12 \mu\text{H/m}$, $C = 18 \text{ pF/m}$ $R_L = 1200 \Omega$

Reflection Coefficient

$$\Gamma = \frac{S-1}{S+1}$$

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$$

$$= \frac{|E_{\max}| - |E_{\min}|}{|E_{\max}| + |E_{\min}|} = \frac{18 - 12}{18 + 12} = 0.2$$

$$\Gamma = 0.2 \text{ pF/m}$$

$$\text{SWR} = \frac{|E_{\max}|}{|E_{\min}|} = \frac{|I_{\max}|}{|I_{\min}|}$$

$$S = \frac{R_0}{R_L}, R_L < R_0$$

$$S = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

$$S = \frac{R_L}{R_0}, R_L > R_0$$

$$F = 1.2 \text{ GHz} \quad d = 12 \text{ cm} \quad \text{pitch} = 3 \text{ cm}$$

b

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.2 \times 10^9}$$

$$\lambda = 0.25 \text{ m}$$

$$D_{TD} = \frac{2D^2}{\lambda}$$

$$D_{TD} = \frac{2 \times 12^2}{\lambda}$$

$$= 0.96 \text{ m}$$

Near and far field regions in an antenna help to ensure that it propagates correctly at both short and longer ranges. They help to manage the spread of propagation evenly.

C Side lobes take efficiency and power away from the main lobe. The larger the side lobe the more resources + power it uses.

Back lobes take away from the main lobes radiation as ~~if~~ in back lobes look to transmit in the opposite direction. Meaning they work ~~against~~ against the main lobe.

Q1 = (12)

2a 1.5 GHz, 0.9 GHz

$$\lambda = \frac{c}{f}$$

$$\frac{3 \times 10^8}{1.5 \times 10^9} = 0.2 \text{ m} = 200 \text{ mm}$$

$$\frac{3 \times 10^8}{0.9 \times 10^9} = 0.3 \text{ m} = 300 \text{ mm}$$

$$L = \frac{\lambda}{2}$$

$$L = \frac{\lambda}{2}$$

$$L = \frac{0.2}{2} = 0.1 \text{ m}$$

$$L = \frac{0.3}{2} = 0.15 \text{ m}$$

$$L = 100 \text{ mm}$$

$$L = 150 \text{ mm}$$

Increasing the length of an antenna ~~with~~ will increase the size of the wavelength but will lower the frequency.

2b

$$f = 180 \text{ MHz}$$

$$r = 0.15$$

$$d = 0.2$$

$$\lambda = \frac{c}{f} \quad \lambda = \frac{3 \times 10^8}{180 \times 10^6}$$

$$\lambda = 1.6 \text{ m}$$

$$L = \frac{\lambda}{2} = 0.8 \text{ m} = 80 \text{ cm}$$

$$\begin{aligned} \text{length of director} & 95 \times 0.8 = 0.76 \text{ m} = 76 \text{ cm} \\ \text{length of reflector} & 105 \times 0.8 = 0.84 \text{ m} = 84 \text{ cm} \end{aligned}$$

3a

D.

$$D = \frac{4\pi}{\Omega_A}$$

$$D_{\text{dB}} = 10 \log_{10}(D)$$

$$D = \frac{U}{P_{\text{rad}}} = \frac{4\pi U}{P_{\text{rad}}}$$

b) i) reciprocal network $= |S_{12}| = |S_{21}|$

this network $= |0.5 \angle -30^\circ| \neq |0.5 \angle 30^\circ|$

there for this network is not reciprocal.

ii)

Lossless Network =

$$|S_{11}|^2 + |S_{21}|^2 + |S_{31}|^2 = 1$$

$$|0.4|^2 + |0.5|^2 + |0.7|^2 = 0.9 \neq 1 \text{ Not lossless}$$

iii)

c) i) $L = 2.5 \mu\text{H/m}$ and $C = 4.45 \text{ pF/m}$

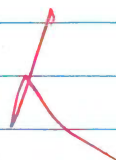
10 MHz

$R = 0.006 \Omega/\text{m}$

$$Z_0 = \sqrt{\frac{L}{C}}$$

$$Z_0 = \sqrt{\frac{2.5}{4.45}} = 0.750$$

ii)

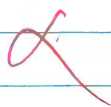


iii) Phase Constant =

$$\beta = \omega \sqrt{LC}$$

$$\beta = \frac{2\pi}{\lambda}$$

$$\beta = \omega \sqrt{(2.5)(4.45)}$$

iv) $u = r^2 W \text{ rad}$ 

Q3 = 12

4ai)

$$\bar{Z}_L = \frac{Z_L}{Z_0}$$

$$\bar{Z}_L = \frac{25 + j50 \Omega}{140} = 0.18 + j0.36$$

ii)

$$\lambda = \frac{c}{f}$$

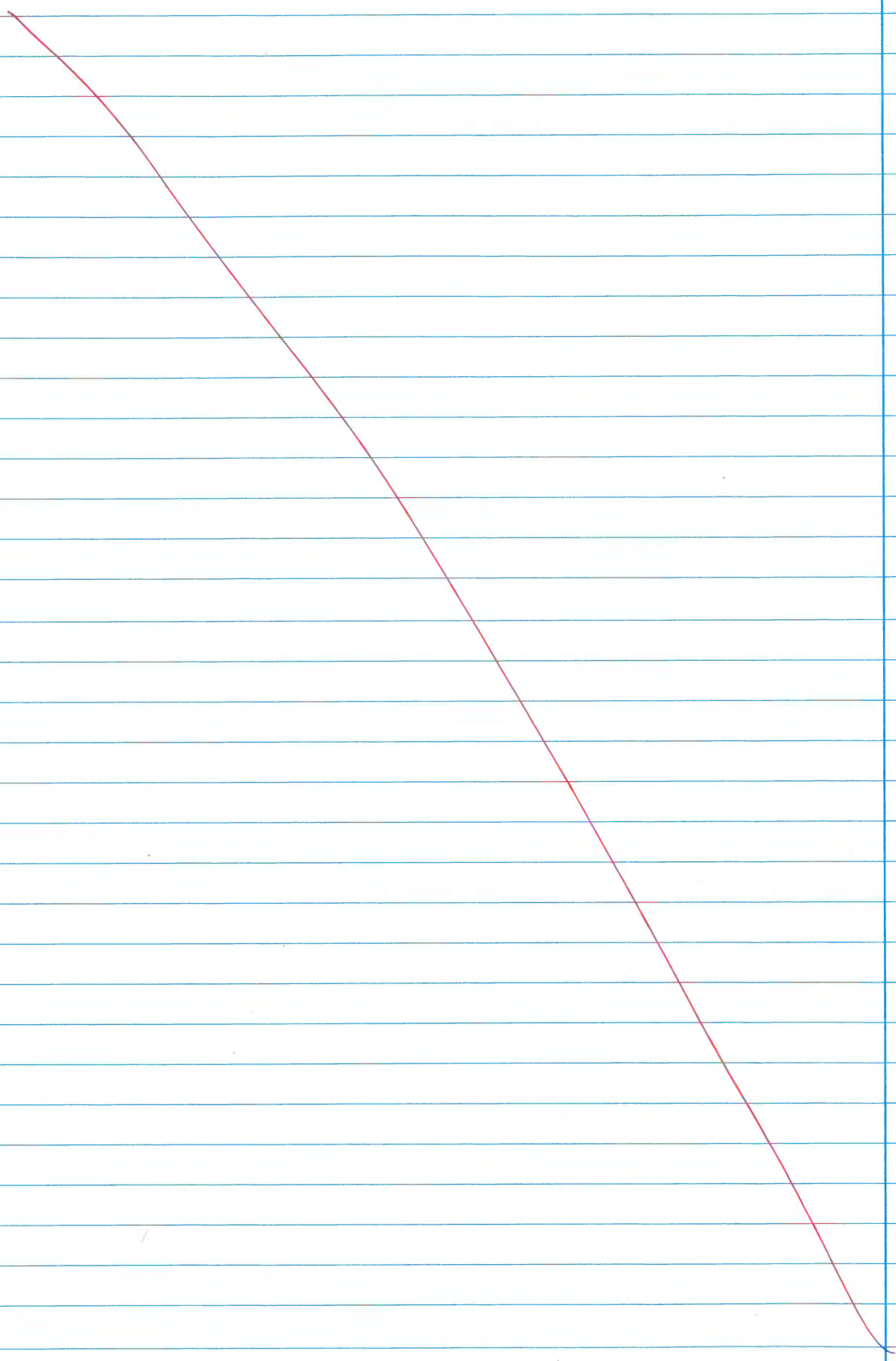
$$\lambda = \frac{3 \times 10^8}{140 \times 10^6} = 2.14 \text{ m}$$

Q4 = (3)



Question No.

Examiner Only



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Rhif y Cwestiwn