



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 photocopy 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	2218703
2	Title of Examination Paper	Advanced Radio Frequency Systems
3	Module Code	ACDA6014
4	Date and Time of Examination	01/05/2025
5	Examination Venue	116
6	Seat Number	N/A
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1.6	6 ✓
1.C	4 ✓
2.a	8 ✓
2.b	12 ✓
2.C	0 ✓
3.a	3 ✓
3.b	11 ✓
3.C	0 ✓
4.a	4 ✓
Total	48 ✓

1.

a.

b.

$$f = 1.2\text{GHz} = 1.2 \times 10^9\text{Hz}$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.2 \times 10^9} = 0.25\text{m}$$

$$D = 12\text{cm} = 0.12\text{m}$$

$$D_{TD} = \frac{2 \times D^2}{\lambda} = \frac{2 \times 0.12^2}{0.25} \text{m}$$

$$D_{TD} = \frac{18}{15625} \text{m} = \frac{144}{125} \text{cm}$$

$$D_{TD} = 1.152\text{cm}$$

Near-field regions are where the signal is constructively interfering with itself to form the far-field region and is not yet formed properly. Far-field regions are where the signal has been formed and can be usefully received by another antenna. In this case, the near field is quite small; the receiver would only experience reception problems when it's less than around 1cm from the transmitter.

- C. Side lobes are typically undesirable as they reduce the antenna's directivity, impacting reception and/or transmission gain. Back lobes present a similar deficiency, wasting some gain in the opposite direction of the antenna's main lobe. They should both be minimised for optimum efficiency.

2.

a.

$$f = 1.5\text{GHz} = 1.5 \times 10^9\text{Hz}$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.5 \times 10^9} = 0.2\text{m}$$

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

$$f = 0.9\text{GHz} = 0.9 \times 10^9\text{Hz}$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{0.9 \times 10^9} = \frac{1}{3}\text{m} \approx 0.333\text{m}$$

$$L = \frac{\lambda}{2} = \frac{1}{6}\text{m} \approx 0.167\text{m}$$

?

b.

$$f = 180\text{MHz} = 180 \times 10^6\text{Hz}$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{180 \times 10^6} = \frac{5}{3}\text{m} \approx 1.667\text{m}$$

$$L_{\text{driven}} = \frac{\lambda}{2} = \frac{5}{6}\text{m} \approx 0.833\text{m}$$

$$L_{\text{reflector}} = L_{\text{driven}} \times 1.05 = \frac{7}{8}\text{m} = 0.875\text{m}$$

$$L_{\text{director}} = L_{\text{driven}} \times 0.95 = \frac{19}{24}\text{m} \approx 0.792\text{m}$$

$$D_{\text{reflector}} = 0.15 \times \lambda = \frac{1}{4}\text{m} = 0.25\text{m}$$

$$D_{\text{director}} = 0.2 \times \lambda = \frac{1}{3}\text{m} \approx 0.333\text{m}$$

c.

$$[S] = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

X

(20)

3.

a.

$$\begin{aligned}
 D &= \frac{4\pi U}{P_{rad}} \\
 &= \frac{4\pi \times 80}{100} \\
 &= \frac{16}{5}\pi \approx 10.053
 \end{aligned}$$

b.

i. In a reciprocal network, any port must match

$$|S_{21}| = 0.5 \angle 30^\circ$$

$$|S_{12}| = 0.5 \angle -30^\circ$$

$$0.5 \angle 30^\circ \neq 0.5 \angle -30^\circ$$

These are not equal; therefore, the network is not reciprocal.

ii. Sum of squares of first column should equal 1

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

$$0.4^2 + 0.5^2 + 0.7^2 = 0.16 + 0.25 + 0.49 = 0.9$$

$$0.9 \neq 1$$

The result does not equal 1; therefore, this network has losses.

iii.

$$\text{Return loss} = -20 \log_{10} |S_{11}|$$

$$= -20 \log_{10}(0.4)$$

$$\approx 7.959 \text{ dB}$$

c.

4.

a.

i.

$$\bar{Z}_L = \frac{Z_{in}}{Z_0}$$

ii.

$$f = 140 \text{ MHz} = 140 \times 10^6 \text{ Hz}$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{140 \times 10^6} = \frac{15}{7} \text{ m} \approx 2.143 \text{ m}$$

iii.

$$\bar{Y}_{in} = \frac{Y_{in}}{Y_0}$$

iv.

v.

vi.

(4)

Paper

$$Q_{1a} - 0$$

$$Q_{1b} \Rightarrow 6$$

$$Q_{1c} - 4$$

$$Q = 10$$

Paper

$$Q_{2a} = 8$$

$$Q_{2b} = 12$$

$$Q_{2c} = 0$$

$$Q_2 = 20$$

Paper

$$Q_{3(a)} - 3$$

$$(b) - 11$$

$$Q_3 = 14$$

$$Q_4 = 4$$