

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 a poor 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	2216419
2	Title of Examination Paper	ADVANCED RADIO FREQUENCY SYSTEMS
3	Module Code	ACDA6019
4	Date and Time of Examination	01/05/2025 09:00
5	Examination Venue	IQ 112
6	Seat Number	
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	19 ✓
2	16 ✓
3	17 ✓
4	6
Total	58 ✓

(Gweler yr ochr arall am y fersiwn Cymraeg)

1a) ~~$L = 12 \mu H/m$~~ $C = 18 pF/m$ $R_L = 1200 \Omega$
 ~~$Z_0 = \sqrt{\frac{L}{C}} = 25.82$~~ $Z_L = Z_0 = 25.82 > 1200 = 30983.87$
 ~~$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{30983.87 - 25.82}{30983.87 + 25.82} = 0.998$~~

$SWR = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.998}{1 - 0.998} = 999$

See typed sheet

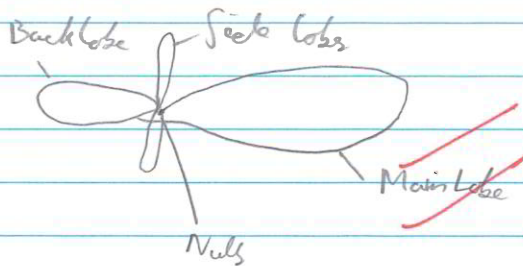
free form paper - 3 marks

1b) $f = 1.2 GHz$
 $D_{TD} = \frac{2D^2}{\lambda}$
 $\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.2 \times 10^9} = 0.25 m$
 $D = 12 cm = 0.12 m$
 $D_{TD} = \frac{2(0.12)^2}{0.25} = \frac{2 \times 0.0144}{0.25} = \frac{0.0288}{0.25} = 0.1152$
 $D_{TD} = 0.1152 m = 11.52 cm$

See typed sheet

free paper - 3 marks

1c) See typed sheet



free paper - 5 marks

$Q_1 = 19$

2a) $f = 1.5 GHz$
 $L = \frac{\lambda}{2}$
 $\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.5 \times 10^9} = 0.2 m$
 $L = \frac{\lambda}{2} = \frac{0.2}{2} = 0.1 m$

$f = 0.99 MHz$

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

$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{0.99 \times 10^6} = 0.33 m$

$L = \frac{\lambda}{2} = \frac{0.33}{2} = 0.167 m$

See typed sheet

Paper - 2 marks

2b) $f = 180 \text{ MHz}$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.8 \times 10^8} = 1.667 \text{ m}$$

Distance from driven element to reflector $= 0.15 \lambda = 0.15 \times 1.667 = 0.25 \text{ m}$

Distance from driven element to director $= 0.2 \lambda = 0.2 \times 1.667 = 0.33 \text{ m}$

2c) $S = \begin{bmatrix} x & y \\ y & x \end{bmatrix}$

3a) $D = \frac{4\pi}{\Omega A}$ $P_{dh} = 10 \log_{10}(D)$
 $D = \frac{4\pi U}{P_{rad}}$ $U = 80 \text{ W/sr}$ $P_{rad} = 100 \text{ W}$
 $D = \frac{4\pi \times 80}{100} = \frac{320\pi}{100} = 10.053$
 $D = 10.053$

$$P_{dh} = 10 \log_{10}(10.053) = 10.023$$

3b) $S_{21} = S_{12}$ if ~~lossless~~ reciprocal

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

Network is not reciprocal

3bii) If lossless $0.4^2 + 0.5^2 + 0.7^2 = 1$

$$0.4^2 + 0.5^2 + 0.7^2 = 0.9$$

Network is not lossless

3biii) Return loss $= 20 \log_{10} S_{11}$

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

$$= -7.959$$

3ci) $Z_0 = \sqrt{\frac{L}{C}}$

$$L = 2.5 \mu\text{H/m} \quad C = 4.4 \text{ pF/m}$$

$$L = 2.5 \times 10^{-3} \quad C = 4.4 \times 10^{-6}$$

$$\frac{L}{C} = \frac{2.5 \times 10^{-3}}{4.4 \times 10^{-6}} = 561.797$$

$$\sqrt{\frac{L}{C}} = \sqrt{561.797} = 23.7$$

$$Z_0 = 23.7$$

3cii)

X

0

$$3cii) \beta = \frac{2\pi}{\lambda} \quad f = 10\text{MHz}$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1 \times 10^7} = 30\text{m}$$

$$\beta = \frac{2\pi}{\lambda} = \frac{2\pi}{30} = 0.209$$

$$\beta = 0.209$$

2

3ciy)

X

0

Q3 = (17)

$$4ai) \bar{Z}_L = \frac{Z_L}{Z_0} = \frac{25 + j50\Omega}{50\Omega} = 0.5 + j1$$

$$\bar{Z}_L = 0.5 + j1$$

1

$$4aii) f = 140\text{MHz}$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.4 \times 10^8} = 2.143\text{m}$$

$$\lambda = 2.143\text{m}$$

2

4aiii)

X

$$4aiv) \bar{Z}_L = 0.5 + j1$$

See smith chart

Chart: 3a.1k.

Q4 = 6

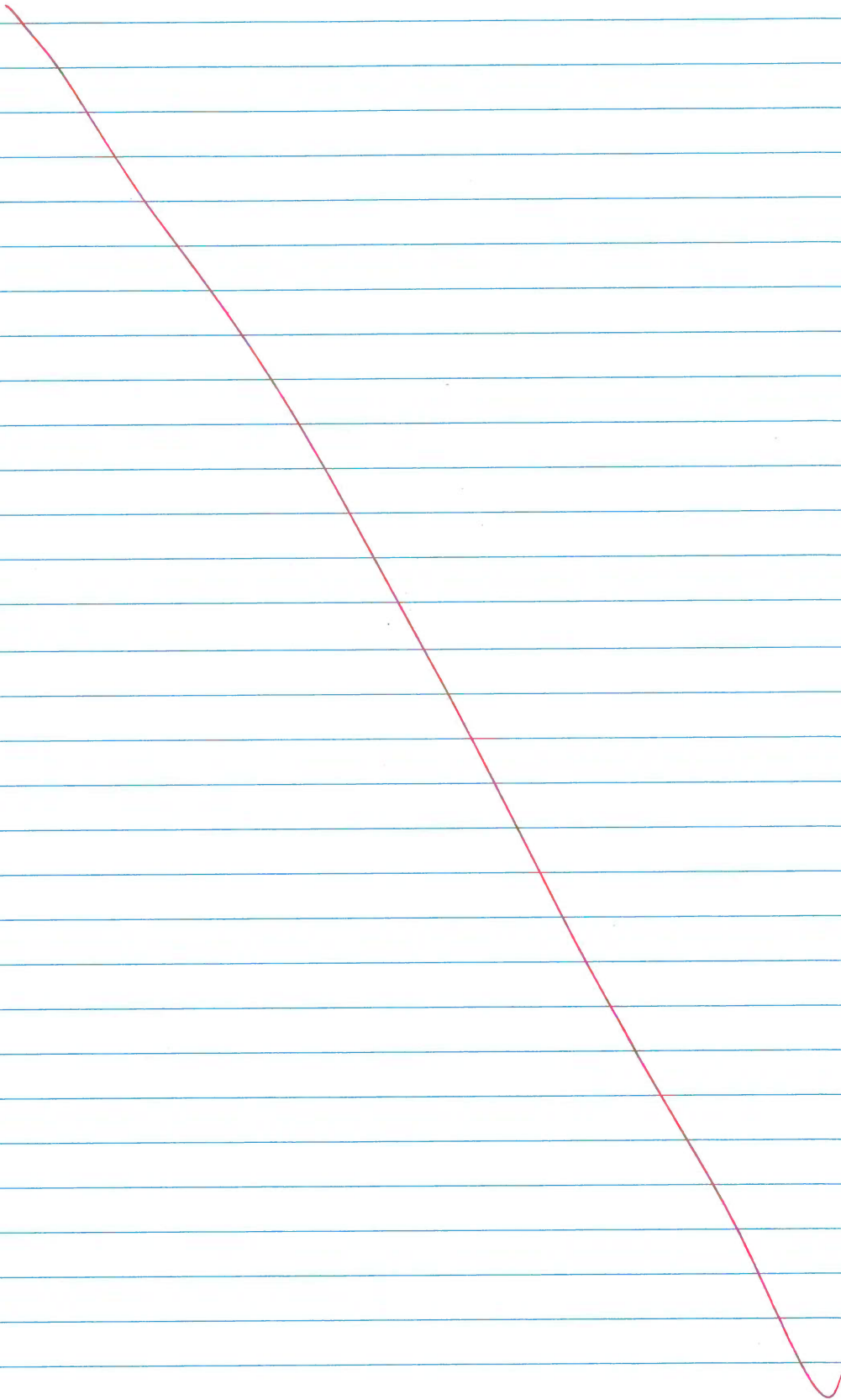
4av)

X



Examiner Only

Question No.



Rhif y Cwestiwn

Arholwr yn unig

Scaullz

2216419/ACDA6019/1st May 2025

1a) See written booklet for equations.

Standing wave ratio (SWR) and reflection coefficient both influence signal transmission. The reflection coefficient is the number which tells us how much of the transmitted signal is reflected or not. With a high reflection coefficient we can tell that most of the signal is reflected due to the load at the end terminating the transmission line and therefore the terminator is good at blocking the load.

3 ✓

1b) See written booklet for equations.

The near-field region is the region in which the electromagnetic radiation is significantly more turbulent and unpredictable and is the closer region to the antenna, appearing at first when the antenna radiates. The far-field region is the region after the near-field region, and it is a lot more organised and predictable and is also the main region that radio frequency emission through antennas is designed for. If the receiver is within the near-field region of the transmitter, then the performance of the transmission will be a lot lower.

3 ✓

1c) The side lobes on an antenna's radiation pattern are additional lobes on the side of the main lobe where electromagnetic radiation may be transmitted or received. They are typically created by reflections and harmonics within the main lobe. The back lobe appears on the opposite side as the main lobe and is another additional point at which electromagnetic radiation may be received/transmitted from/to an antenna. Both lobes increase the range of angles at which the antenna may transmit or receive electromagnetic radiation from, which may be more useful if multi-directional operation is desired. However, if a more focused and directed pattern is desired these lobes may affect the performance as they will take away power that could be radiated out of the main lobe.

2 ✓
3 ✓

See written booklet for diagram.

2a) See written booklet for equations.

The antenna operating at a lower frequency has a higher length than the antenna operating at a higher frequency. By increasing the length of a half-wave dipole antenna, we increase the wavelength that is transmitted from the antenna. Therefore, the frequency at which the antenna transmits is reduced. Therefore, increasing the length of a half-wave dipole antenna decreases the frequency at which it operates.

2 ✓

2b) See written booklet for equations.

2c) See written booklet for equations.

3a) See written booklet for equations.

3bi) See written booklet for equations.

3bii) See written booklet for equations.

Seadur

3biii) See written booklet for equations.

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3ci) See written booklet for equations. ✓

3cii) See written booklet for equations.

3ciii) See written booklet for equations.

3civ) See written booklet for equations.

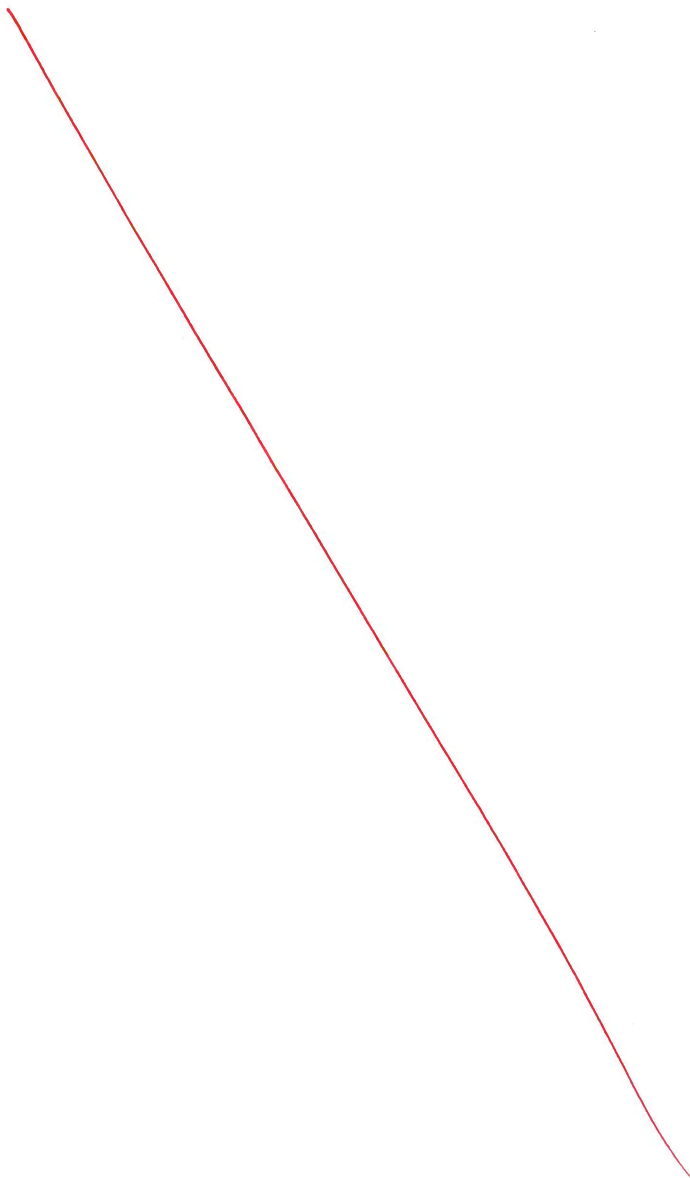
4ai) See written booklet for equations.

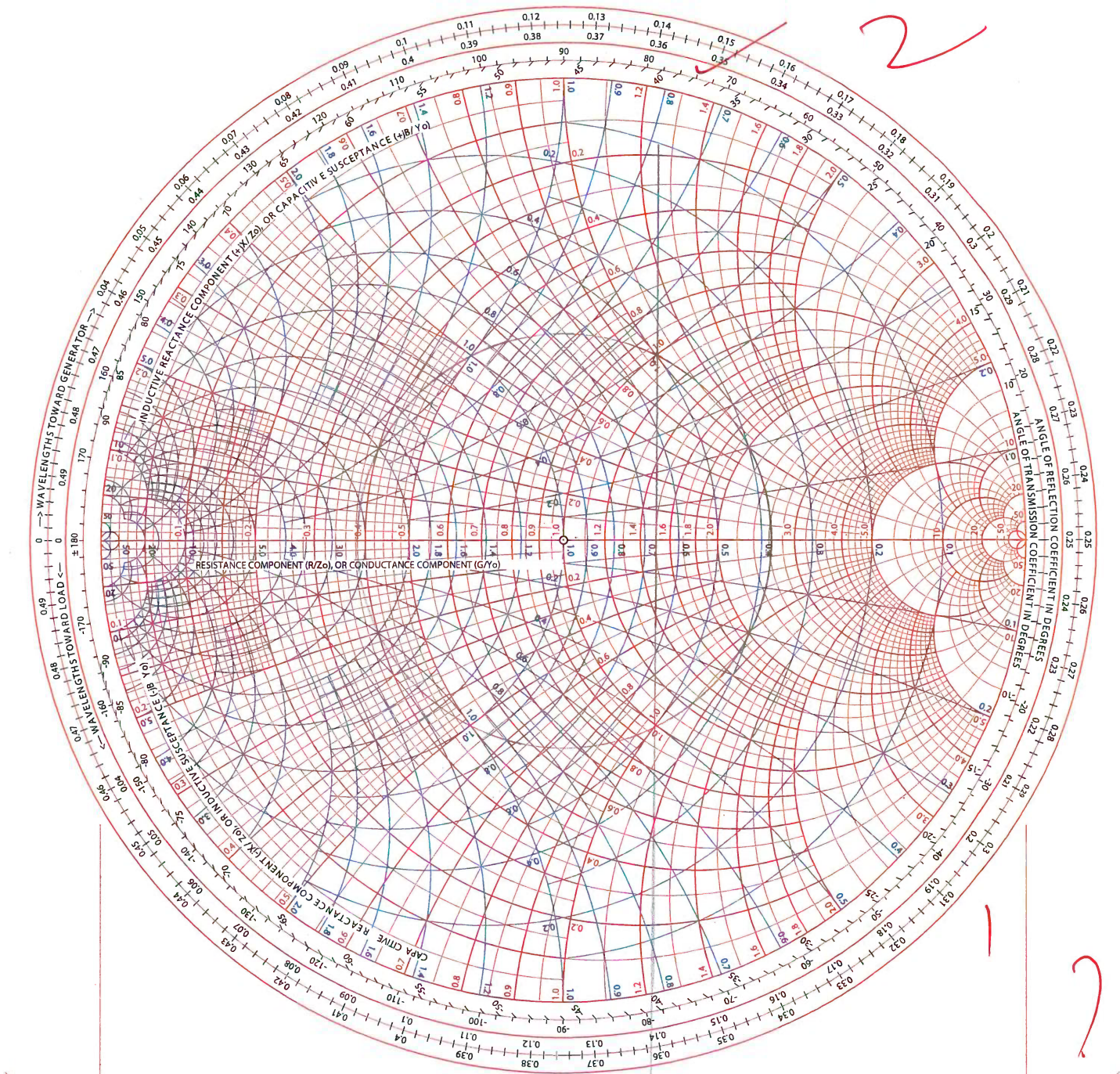
4aii) See written booklet for equations.

4aiii) See written booklet for equations.

4aiv) See written booklet for equations.

4av) See written booklet for equations.





RADIALLY SCALED PARAMETERS

