

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 read the script or have it typed and the expense of typing is 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	2214885
2	Title of Examination Paper	Advanced RF Systems
3	Module Code	ACPA6019
4	Date and Time of Examination	09:00 to 11:30 1/5/25
5	Examination Venue	USTSD Waterport Swire.
6	Seat Number	
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
Q1	18+2
Q2	18 ✓
Q3	18 ✓
Q4	12 ✓
Total	68 ✓

(Gweler yr ochr arall am y fersiwn Cymraeg)

Q1

rounded to 3
decimal places

Examiner Only

$$a) L = 12 \mu H/m$$

$$C = 18 pF/m$$

$$R_L = 1200 \Omega$$

Standing Wave / Reflection Coefficient

Reflection Coefficient:

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

~~$$28.284 \times 10^{-3}$$~~

$$Z_0 = \sqrt{\frac{12 \times 10^{-6}}{18 \times 10^{-12}}}$$

~~$$\sqrt{\frac{12 \times 10^{-6}}{18 \times 10^{-9}}}$$~~

~~$$Z_0 = 816.497$$~~

~~$$Z_0 = 25.82$$~~

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

$$\Gamma = \frac{12 \times 10^{-6} - 816.497}{12 \times 10^{-6} + 816.497}$$

$$\Gamma = -999.999 \times 10^{-3}$$

Standing Wave

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

$$S = \frac{1 + -999.999 \times 10^{-3}}{1 - -999.999 \times 10^{-3}}$$

~~$$S = 5 \times 10^{-4}$$~~

G 9

M 0

K 3

M -3

M -6

P -9

By Minimizing the standing wave within the connection between a antenna and its source, allows for better transmission power and less interference.

- If this is not done, Bad power distribution & more interference will occur in the signal.

↑ Rewritten at the *

b) 1.2 GHz
12 cm
3 cm

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

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

$$\lambda = 250 \text{ mm}$$

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

$$D_{TD} = \frac{2 \times 12 \times 10^{-2}^2}{250 \times 10^{-3}}$$

$$D_{TD} = 115.2 \times 10^{-3}$$

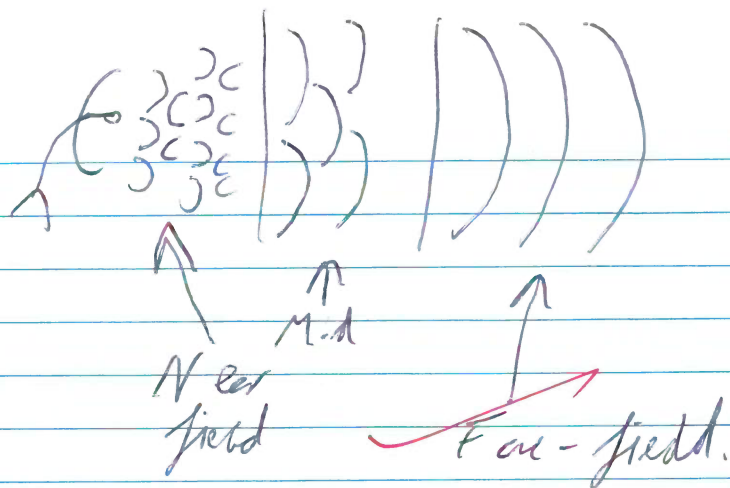
$$D_{TD} = 115.2 \text{ mm}$$

Near field:

Here the transmission waves have not fully formed, there is lots of nulls where readings can't be taken. It can be used for RFID tags.

Far-field:

This is the Main transmission zone, here is where receiving devices will be placed such as other antennas.



c) Side lobe impact:

These are unwanted ~~transmissions~~ located to the sides of the main lobe.

They reduce power to the main transmission.

Can cause interference to the transmission.

And can cause false readings in devices like RADAR.

2 ✓

Back lobes:

Are located opposite to the main lobe. They are a result of reflection within the ~~antenna~~ which is unwanted.

3 ✓

They reduce Gain in the main transmission along with power reduction.

Q1 (18)

Q 2

a) Dipole 1, 1.5 GHz
Dipole 2, 0.9 GHz

Dipole 1:

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

$$\lambda = \frac{3 \times 10^8}{1.5 \times 10^9}$$

Wave length.

$$\lambda = 200 \text{ mm}$$

2 ✓

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

$$L = \frac{200 \times 10^{-3}}{2}$$

Length of dipole 1

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

Dipole 2:

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

$$\lambda = \frac{3 \times 10^8}{0.9 \times 10^9}$$

Wavelength of dipole 2

$$\lambda = 333.333 \text{ mm}$$

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

$$L = \frac{333.333 \times 10^{-3}}{2}$$

$$L = 166.667 \text{ mm}$$

Length of dipole 2

The larger the dipole antenna, the smaller the dipole operation frequency will be.

This results in larger dipoles having narrower operation fields compared to the smaller counterparts.

b) op f 180 MHz
 Drive to reflector 0.15 A
 Drive to director 0.2 A
 5%

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

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

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

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

$$L = \frac{1.6}{2}$$

$$L = 800 \text{ mm}$$

$$0.95 \times 800 \times 10^{-3}$$

$$= 760 \times 10^{-3}$$

$$1.05 \times 800 \times 10^{-3}$$

$$= 840 \times 10^{-3}$$

$$0.15 \times 760 \times 10^{-3}$$

$$= 114 \times 10^{-3}$$

$$= 114 \text{ mm}$$

$$\begin{aligned}
 &0.2 \times 840 \times 10^{-3} \\
 &= 168 \times 10^{-3} \\
 &= 168 \text{ mm}
 \end{aligned}$$

c) $S_{11} = S_{22} = 0$

$$|S| = \begin{vmatrix} 0 & S_{12} \\ S_{21} & 0 \end{vmatrix}$$

Q3

a) ~~Total~~ Total power 100 W
Max radiates 80 W/sr

$$D = \frac{U}{U_0} = \frac{4\pi U}{P_{\text{rad}}}$$

$$D = \frac{4 \times \pi \times 80}{100}$$

$$D = 10.053$$

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

$$D_{\text{dB}} = 10 \log_{10}(10.053)$$

$$D_{\text{dB}} = 10.023 \text{ dB}$$

$$b) |S| = \begin{vmatrix} 0.4 \angle 0^\circ & 0.5 \angle -30^\circ & 0.7 \angle 60^\circ \\ 0.5 \angle 30^\circ & 0.2 \angle 0^\circ & 0.9 \angle -90^\circ \\ 0.7 \angle -60^\circ & 0.9 \angle 90^\circ & 0.1 \angle 0^\circ \end{vmatrix}$$

$$i) \quad \cancel{S_{12} = S_{21}} \quad S_{12} = S_{21}$$

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

$$S_{12} \neq S_{21}$$

This is NOT reciprocal.

$$ii) \quad |S_{11}|^2 + |S_{21}|^2 + |S_{31}|^2 = 1$$

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

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

This is NOT a lossless network

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

$$\text{Return loss} = -20 \log_{10} |0.4|$$

$$\text{Return loss} = 7.959$$

$$c) \quad R = 0.006 \, \Omega / m$$

$$L = 2.5 \, \mu H / m$$

$$C = 4.4 \, pF / m$$

$$\text{or } f = 10 \, MHz$$

$$i) \quad Z_0 = \sqrt{\frac{L}{C}}$$

$$Z_0 = \sqrt{\frac{2.5 \times 10^{-9}}{4.45 \times 10^{-12}}}$$

$$Z_0 = 23.702$$

ii)

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

$$\lambda = \frac{3 \times 10^8}{10 \times 10^6}$$

$$\lambda = 30$$

iii)

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

$$\beta = 209.44 \times 10^{-3}$$

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

$$\text{Where, } \omega = 2\pi f$$

$$\beta = 62.832 \times 10^6 \sqrt{2.5 \times 10^{-9} \times 4.45 \times 10^{-12}}$$

$$\beta = 662.72$$

iv)

Q3 (18)

Q4

- a) 50 Ω transmission line
 140 MHz op for transmission line
 $Z_L = 25 + j50 \Omega$

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

$$\bar{Z}_L = \frac{25 + j50}{50}$$

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

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

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

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

iii) ~~$\bar{Z}_L = \frac{Z_L}{Z_0}$~~

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

$$\bar{Y}_{in} = \frac{0.5 + j1}{50}$$

$$\bar{Y}_{in} = 0.01 + j0.02$$

iv)

$$(dA) = 0.322 \leftarrow \text{upper intercept}$$

$$(dA) = 0.18 \leftarrow \text{Lower intercept}$$

$$V) \quad (L_A) = 0.142 \checkmark$$

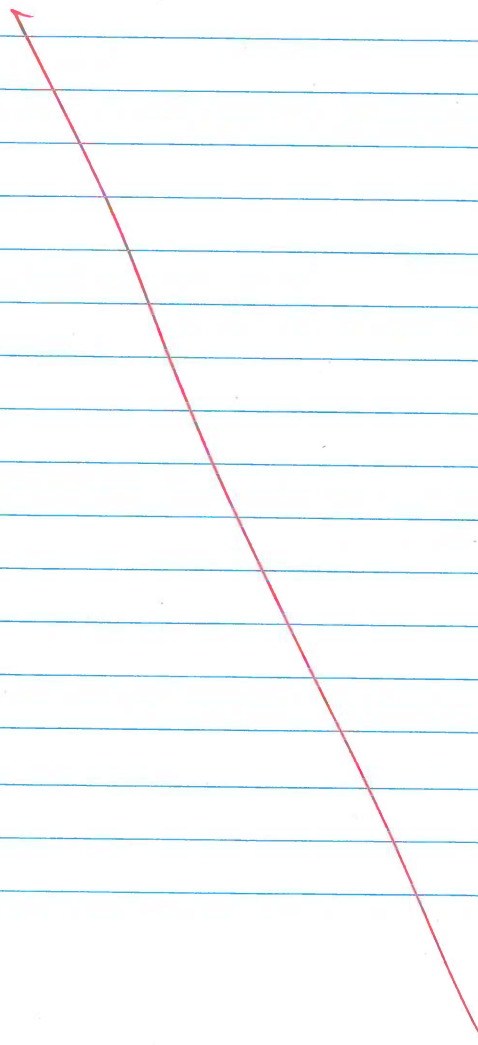
Q1 a) * By Minimising standing waves in an antennas transmission, you are improving the signal and preventing interference.

- Standing waves effect the transmission by
- Causing ripples
- Causing interference
- Reducing transmission power & Gain.

Chatt = 7
24 = (122)

2

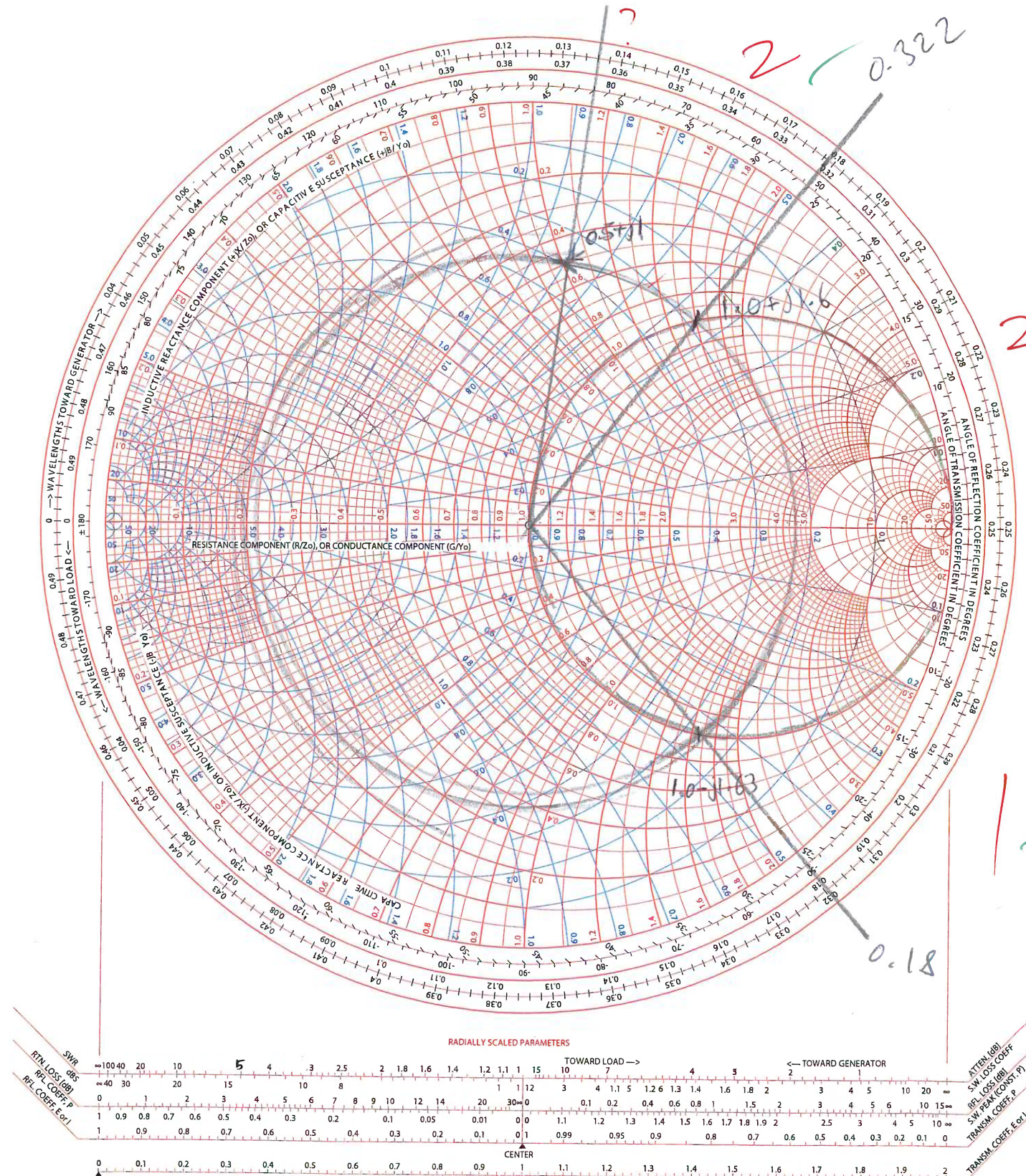
Q1 = (20)



Q4

2 ✓
2 ✓ 0.322

2 ✓





Question No.

Examiner Only

