



Examination Answer Books

12 Pages

Complete, fold and seal
(see note 2 below)

SURNAME: DAVIES

FORENAME(S): MATTHEW

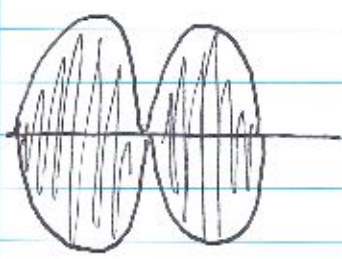
Instructions to Candidates

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 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.

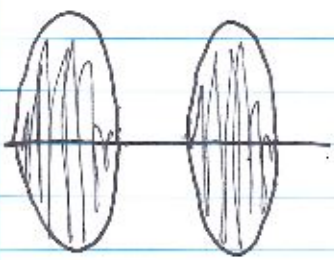
1	Student Number	1909365
2	Title of Examination Paper	SIGNALS & DIGITAL COMMUNICATIONS
3	Module Code	SGEE 5005
4	Date and Time of Examination	12/5/2022 09:30
5	Examination Venue	COLEG SIR GÂR
6	Seat Number	
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
A	29
B1	11
B2.	10
Total	50%.

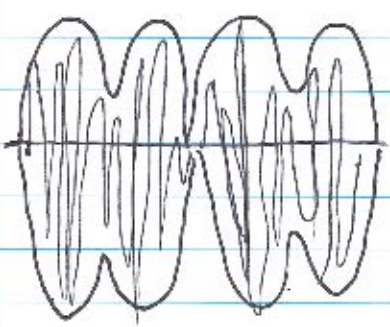
A1. modulation factor = 1



modulation factor = 0.5



modulation factor = 1.5



~~2~~
 $1\frac{1}{2}$

$1\frac{1}{2}$ ~~2~~

A2. Max P-P = 35mV
Min P-P = 9mV.

~~$\frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{35 - 9}{35 + 9}$~~

~~modulation factor = $\frac{35 - 9}{35 + 9}$~~

~~$\frac{26}{74}$~~

$m = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$

$m = 0.59$ ✓

2

A5. $V_I = 10V$
 $V_R = 4V$

i) VSWR.

$VSWR = \frac{|V_I| + |V_R|}{|V_I| - |V_R|} = \frac{10 + 4}{10 - 4}$

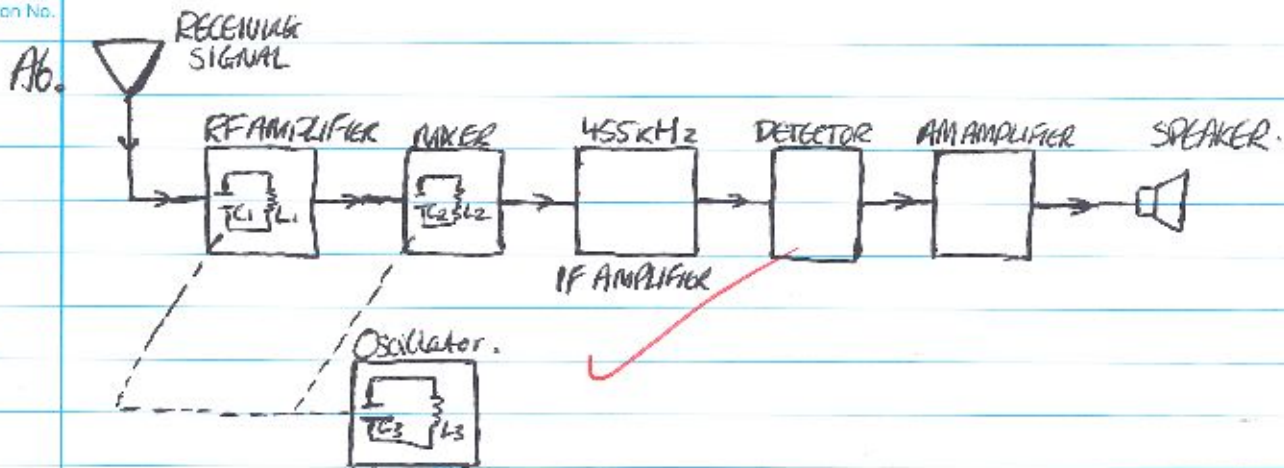
$VSWR = \frac{14}{6} = 2.3$ ✓

ii) Magnitude of reflection coefficient p_v

$p_v = \frac{V_R}{V_I} = \frac{4}{10}$ ↗

$p_v = 0.4$

5 $\frac{1}{2}$



Aerial: This is where the receiving signal is received.

RF Amplifier: This takes the frequency from the aerial and amplifies it with 450kHz from the oscillator. ~~Then gets~~ Both of these signals get mixed together in the ~~am~~ mixer. ✓

Detector: This is essentially a diode, to ensure that the signal is only going in the ~~correct~~ direction, which is towards the speaker. ✓ →

AM Amplifier: This modulates the amplitude depending on what is selected by the ~~user~~. ✓

Speaker: Releases the radio signal to the ~~user~~. ✓

A8. $d = 0.4 \text{ mm}$.

$K = 2.15$

$$Z_0 = \frac{138}{\sqrt{K}} \log \frac{D}{d}$$

$$75 = \frac{138}{\sqrt{2.15}} \log \frac{D}{0.4}$$

$$75 = 94.12 \log \frac{D}{0.4} \quad \checkmark$$

Continued on next page...

$$\text{Antilog} \frac{75}{94.12} = \frac{D}{0.4}$$

$$10^{\frac{75}{94.12}} \times 0.4 = D$$

$$D = \underline{2.5 \text{ mm}}$$

4

A9.



Carrier Signal

Modulated Signal

Frequency Shift Keying alters the frequency of the modulated signal by using a digital signal. At logic 0, the modulated frequency stays the same as the carrier frequency, whereas at logic 1, the modulated frequency increases.

3

A10. 50Ω - T/Line (Z_0)

Load Impedance - $120 + j60 \Omega$ (Z_L).

$$P_r = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{120 + j60 - 50}{120 + j60 + 50}$$

$$P_r = \frac{70 + j60}{170 + j60}$$

$$P_r = \frac{70 + j60}{170 + j60} = \frac{92.2/40.6^\circ}{180.28/19.44^\circ}$$

$$P_r = \underline{0.51/21.16^\circ}$$

6

13

A7. The flash ADC takes analogue signals in ~~and~~ to a series of parallel comparators. It latches the sample instantly when it comes in, then provides the digital output (binary value). After a specific period, the shift register clears and takes another sample. The number of bits in the ADC will determine the quantisation ~~to~~ intervals, as the greater the bit number, the better the resolution and the smaller the quantisation intervals.

2

2

B2

- a) Speech signal - $4.7 \text{ V}_{\text{rms}}$
 Max Frequency - 3.4 KHz
 Bit number - 10
 Voltage Range - $-16 \text{ to } 16 \text{ V}$ (32V range).

i) DR of system in dB

$$\text{DR} = 20 \log_{10}(N)$$

$$N = 2^n$$

$$n = 10$$

$$N = 2^{10}$$

$$N = 1024$$

$$\text{DR} = 20 \log_{10}(1024)$$

$$\text{DR} = 60.21 \text{ dB}$$

2

ii) Signal to quantisation noise ratio for this signal in dB.

$$q = \frac{V_{\text{Range}}}{N}$$

$$q = \frac{32}{1024}$$

$$q = 0.031$$

1

$$V_{\text{an}} = \frac{q}{\sqrt{12}}$$

$$V_{\text{an}} = \frac{0.031}{\sqrt{12}}$$

$$V_{\text{an}} = 8.95 \text{ mV}$$

1

$$\text{SQNR} = \frac{\text{Signal Voltage}_{\text{rms}}}{V_{\text{an}}}$$

$$\text{SQNR} = \frac{4.7 \text{ V}}{8.95 \text{ mV}}$$

$$\text{SQNR} = 525.14$$

1



In dB :

$$20 \log_{10}(N)$$

$$20 \log_{10}(525.14)$$

$$\text{SQNR} = \underline{54.4 \text{ dB}}$$



16.

e) Quantisation is the approximation of a continuous range of values and converting them into a binary number. Quantisation error is introduced when there's a difference between the input voltage and the output binary number. This depends on the resolution of the ADC.

4

5

~~16~~

B1

d) 5m Length.

$$50\Omega = Z_0$$

$$90 + j40 = Z_L$$

50 Ω signal generator on open circuit gives a 10V_{rms} sinusoid at frequency of 14MHz.

i) Reflection coefficient in polar form.

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

$$\rho_r = \frac{90 + j40 - 50}{90 + j40 + 50}$$

$$\rho_r = \frac{40 + j40}{140 + j40}$$

$$\rho_r = \frac{56.57/45^\circ}{145.6/15.95^\circ}$$

$$\rho_r = 0.39/29.05^\circ$$



4

ii) $V_i = 10V$

$$\rho_r = 0.39/29.05^\circ$$

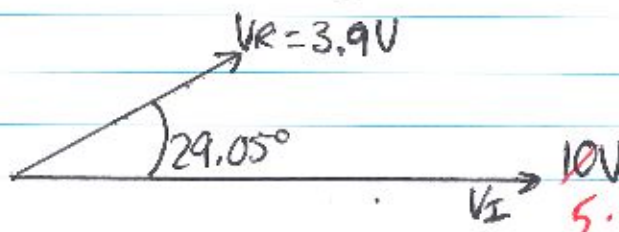
$$\rho_r = \frac{V_r}{V_i}$$

$$\therefore V_r = \rho_r \times V_i$$

$$V_r = 0.39/29.05^\circ \times 10$$

$$V_r = 3.9/29.05^\circ V$$

3 1/2



iii) $V_L = V_E + V_R$. $V_E = 10/0^\circ \text{ V}$.
 $V_R = 3.9/29.05^\circ \text{ V}$.
 $V_E = 10 + j0$.
 $V_R = 3.41 + j1.9$

3 1/2

$V_L = 10 + j0 + 3.41 + j1.9$.
 $V_L = 13.41 + j1.9 \text{ V}$

✓ Corrected answer.

c) i) Carrier frequency (f_c) = 18

3 1/2