



Complete, fold and seal
(see note 2 below)

SURNAME: PARRY.

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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	1102216
2	Title of Examination Paper	SIGNALS AND DIGITAL COMMS
3	Module Code	SGEE 5005
4	Date and Time of Examination	12/05/2022 9:30 - 12.
5	Examination Venue	COLLEGE SIR CAR.
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
A1-A10	17
B1	~~32~~
B3.	20
Total	39%

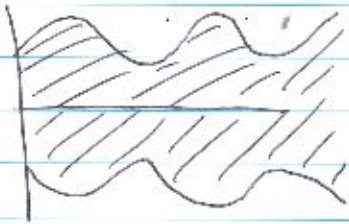
Part A.

A1.

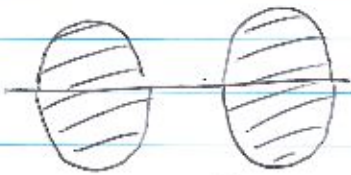
$$m = 1.$$



$$m = 0.5$$



$$m = 1.5$$



3

A2.

$$M = \frac{V_{\max} - V_{\min}}{V_{\max} + V_{\min}} \text{ meters.}$$

$$M = \frac{17.5 - 4.5}{17.5 + 4.5} = 0.596 \text{ meters.}$$

2

A3.

Frequency Modulation and Amplitude Modulation.

(i) ~~Provides an accurate frequency value.~~~~Frequency modulation as you can see the frequency~~~~1. Has lower levels.~~~~1. Has fewer~~

1. Provides accurate frequency values.

it can determine or provide a more accurate frequency to that of amplitude modulation.

2. Can have fewer levels.

This means frequencies are easier to read or determine at lower levels, to that of AM, which has more levels.

3. Provides accurate peak to peak voltages.

Due to the fewer levels, the peak to peak voltages are easier to understand and read. When amplitude is increased, ~~the~~ above a certain frequency in dB. Peak to peak values and frequencies are not readable.

0

A4.

$$V = \frac{m \epsilon c}{2}$$

$$V = \frac{10k \times 4}{2}$$

$$V = 20 \text{ kV.}$$

0

2

A5. (i) $VSWR = \frac{1 + |\bar{P}_V|}{1 - |\bar{P}_V|} = \frac{|\bar{V}_I| + |\bar{V}_R|}{|\bar{V}_I| - |\bar{V}_R|}$

$VSWR = \frac{|\bar{10V}| + |\bar{4V}|}{|\bar{10V}| - |\bar{4V}|} = 2.3 \checkmark$

2

(ii) $\bar{P}_V = \frac{\bar{V}_R}{\bar{V}_I} \checkmark$

$\bar{P}_V = \frac{\bar{4V}}{\bar{10V}} \checkmark$
 $10 \times 2.3V \times$

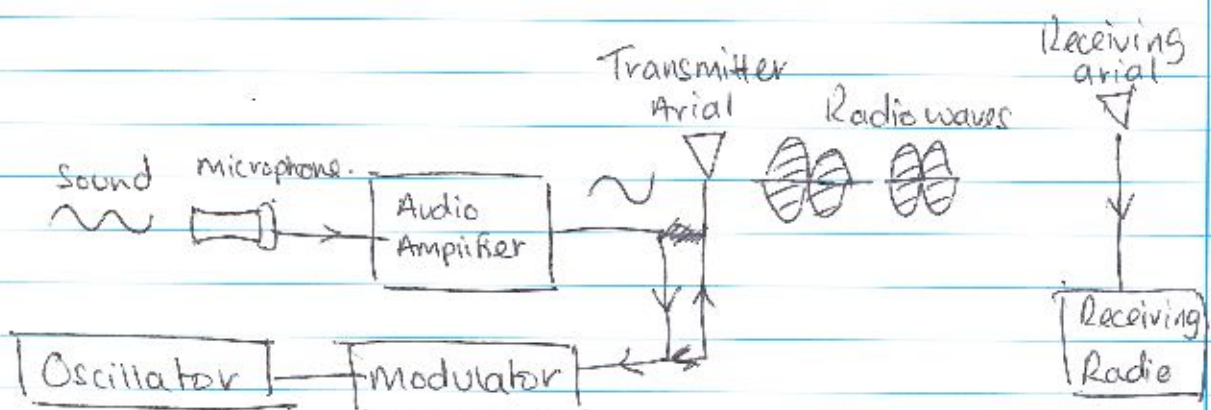
$VSWR = \frac{1 + |\bar{1.7391}|}{1 - |\bar{1.7391}|}$

1

$VSWR =$

$\bar{P}_V = 1.7391 V$

A6.



$\frac{1}{2}$

Microphone receives sound. Audio amplifier the amplifies the sound to the transmitter aerial, which transmits the signal. Oscillator, oscillates the signal, while modulator modulates the oscillation. Transmitted via radio waves to receiving aerial, which is then received by the receiving device, which could be a radio.

$2\frac{1}{2}$

A7. ADC.

Analogue to digital converter.

Flash ADC, like a normal ADC, will convert an analogue signal into digital. Flash ADC has an advantage as it can convert from analogue to digital on a faster or greater scale, which a greater range.

2

A8.

$$Z_0 = \frac{138}{\sqrt{k}} \log \frac{D}{d} \quad \checkmark$$

$$Z_0 = \frac{138}{\sqrt{k}} \log \frac{D}{0.4 \text{ mm.}}$$

$$Z_0 = 94.12 \log \frac{D}{0.4} \quad \checkmark$$

$$D = \frac{94.12}{0.4} \log$$

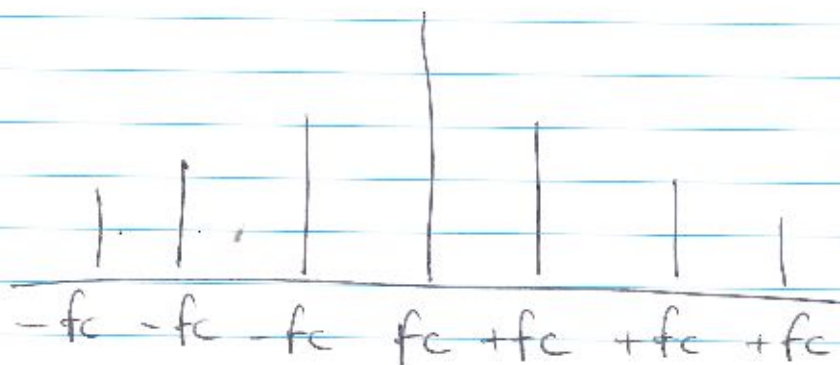
$$D = 2.37 \quad \times$$

$$Z_0 = \frac{138}{\sqrt{2.15}} \log \frac{2.37}{0.4}$$

$$Z_0 = 72.72 \Omega. \text{ nearly } 75 \Omega.$$

3

- A9. Frequency Shift keying is where frequency is shifted from one key point to the next, ~~cont.~~
 Depending on the frequency signal given.
 The frequency carrier will be in the centre and will increase and decrease based on the given frequency value.



A.10 $\bar{P}_V = \frac{\bar{Z}_L - Z_0}{\bar{Z}_L + Z_0}$ ✓

$$\bar{P}_V = \frac{120 - j60 - 50}{120 + j60 + 50} = 1 - j120.$$

$$\sqrt{1^2 + 120^2} \quad \angle \tan^{-1} \left(\frac{120}{1} \right).$$

$$= 120 \angle -89.52^\circ$$

PART B.

Question B1.

$$a. \quad = E_c \cos \omega_c t + \frac{m E_c}{2} \cos (\omega_c + \omega_s) t + \frac{m E_c}{2} \cos (\omega_c - \omega_s) t$$

$$e = E_c \cos (\omega_c t + m f \sin \omega_s t) \quad \text{FM.}$$

$$e = E_c \cos \omega_c t + E_c \cos m f \sin \omega_s t.$$

$$V = \frac{M E_c}{2} \quad m f = \frac{M E_c}{2}$$

$$\therefore e = E_c \cos \omega_c t + \frac{M E_c}{2} \cos \sin \omega_s t.$$

$$e = E_c \cos \omega_c t + \frac{M E_c}{2} \cos (\omega_c + \omega_s) t.$$

$$e = E_c \cos \omega_c t + \frac{M E_c}{2} \cos (\omega_c + \omega_s) t + \frac{M E_c}{2} \cos t$$

$$\therefore e = E_c \cos \omega_c t + \frac{M E_c}{2} \cos (\omega_c + \omega_s) t + \frac{M E_c}{2} \cos (\omega_c - \omega_s) t.$$

b. $V = 14 (1 + 0.65 \cos 25120t) \sin (5.027 \times 10^6 t)$ volts.

(i) $E_s = \frac{V_{\max} - V_{\min}}{2}$

$V = 14 \times 1 + 0.65 \cos 25120t \times \sin 5.027 \times 10^6 t$

$V = 14.11 \times -0.6428$

$\max = 14.11 \quad \min = -0.6428$

$E_s = \frac{14.11 - (-0.6428)}{2} \quad E_s = 7.38 V$

0

(ii) frequency in Hz, Voltage V.

(iii) $1 + 0.65 \cos 25120$
in Hz $1 + 0.65 \cos (2\pi \times 10000t)$
 $\sin 5.027 \times 10^6 (2\pi \times 20000t)$

0

c. $e = 18 \cos (5 \times 10^8 t + 6 \sin (3000t))$

(i) $f_c = \frac{f_{\max} + f_{\min}}{2} = \frac{500000000 + 5.196}{2}$

$f_c = 250000002.6$

(ii) $\Delta f_c = f_{\max} - f_c$
 $\Delta f_c = 5 \times 10^8 - 250000002.6$
 $\Delta f_c = 249999997.4$

(iii) modulation index $= \beta = \frac{\Delta f_c}{f_s} \quad \beta = \frac{249999997.4}{250000002.6}$
 $\beta = 1$

iv. $e = 18 \cos(5 \times 10^8 t) + 6 \sin(3000t)$

in Hz.

$$18 \cos(5 \times 10^8 t) + 6 \sin(3000t) \cos \pi$$

$$e = 18 \cos(5 \times 10^8 t) + 6 \sin(3000t)$$

$$e = 14.78.$$

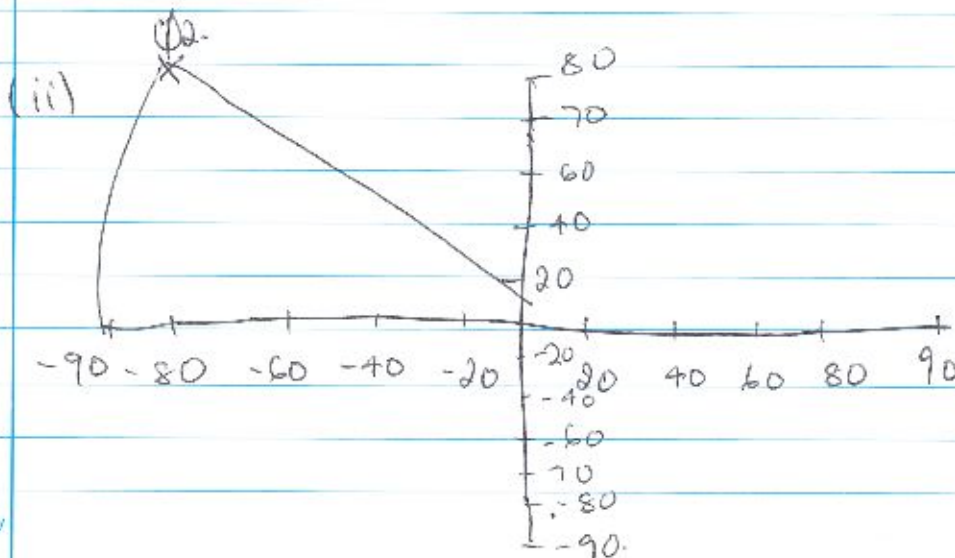
v. $18 \times 10 = 180 \text{ W.}$

d. (i) $\bar{P}_V = \frac{\bar{Z}_L - Z_0}{\bar{Z}_L + Z_0}$ ✓

$$\bar{P}_V = \frac{90 - j40 - 50}{90 + j40 + 50} = 1 - j80.$$

$$\sqrt{1^2 + 80^2} \quad \angle \tan^{-1}\left(\frac{80}{1}\right).$$

$$= 80. \quad \angle -89.^\circ$$





$$\begin{aligned}
 (ii) \quad 90 + j40 &= 90 \cos 40 \\
 &90 \sin 40 \\
 &= \cancel{69} + j57.85 \quad \times
 \end{aligned}$$

Question B1 b.

Part (iii) expanded.

$$V = 14 (1 + 0.65 \cos 25120t) \sin (5.027 \times 10^6 t) \text{ Volts.}$$

$$\begin{aligned}
 E_c &= 14 \\
 \omega_c &= 2\pi f.
 \end{aligned}$$

$$14 \times 1 + 0.65 \cos (25120t) \times \sin (5.027 \times 10^6 t).$$

in Hz.

$$14 \times 1 + 0.65 \cos (2\pi \times 10000) \times \sin (2\pi \times 20000t)$$

amplitude of 10kHz for first component.
amplitude of 20kHz for second component. ✓

Question B3.

a.

Depending on the values of C, V, TU, VC, AU.

It would be multiplexed from STM-N to AUG then to AU-4. Aligning with VC-4. Multiplexing to TUG-2 through x7 to TUG-2 then to TU-12 via x3, aligning to VC-12 and multiplexing to C-12.

2

b. OSI Network model.

1. Data link layer.

- Allows a device to access the network to send and receive messages.
- Offers a physical address for sending data over the network.
- Works with network software for sending and receiving messages.
- Provides error detection compatibility.

2

4



2. Network layer.

Offers an end-to-end logical address, so that a packet of data can be sent over several layer 2 networks. (Ethernet, Token Ring, Frame Relay).

2

3. Transport layer.

Offers an end-to-end communication to the other end. Depending on the device, the transport layer offers reliable, connection-oriented or connectionless best effort communications.

2

4. Session layer.

Provides various features, such as tracking data for devices to acknowledge receiving from the other end of the session. Depending on the device, the session layer ~~allows~~ ~~offers~~ ~~offers~~ ~~its user~~ allows users to establish, manage or terminate dialog through the network.

2

5. Presentation layer.

The presentation layer formats the data on the network. The presentation layer basically enables an application to read (or understand) a message.

2

6. Application layer.

The application layer offers a user interface for its end user. This is what the user sees in terms of loading (web browser, e-mail).

This is ~~with~~ the data the user sees when operating an application on a particular device.

2

- C. Message 567412, check digits 43
 Message 985314, check digits 55.

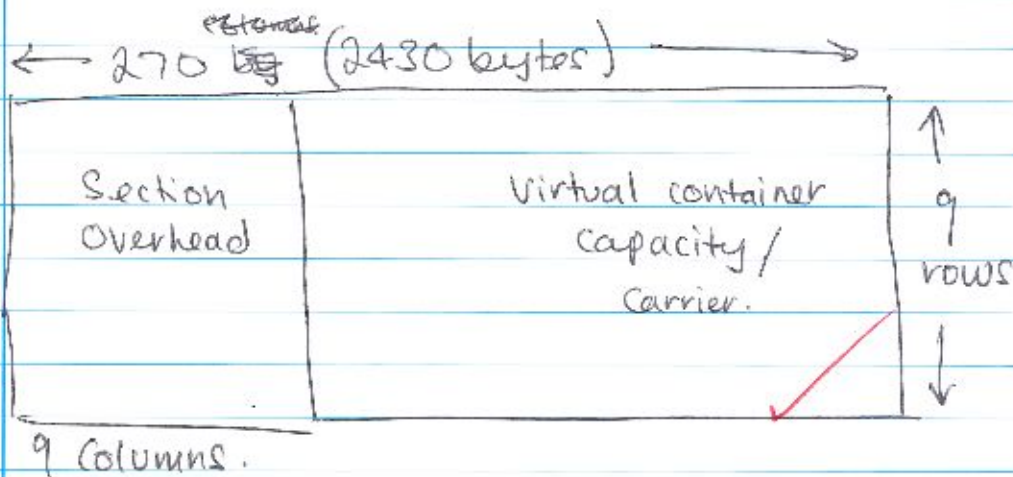
$$\frac{567412}{99} = 5731.43$$

$$\frac{985314}{99} = 9952.(6)$$

Error is in message 985314 because the remainder after dividing it by 99 (value of 9) was not 55, it was 6. There is an error ~~here~~. It should have been 55 not 6.

3

- d. STM-1 Frame.



3

- e. VS = is the virtual container, where the Mbits and columns ~~are~~ are determined or outlined. It looks at the Vc values and derives a Mb for a certain number of columns. Looks at voltage.
 J2 = Looks at the modulation index value for J2 and uses that to calculate the Mbits and determines the columns.
 N = Is simply the number of ~~M~~ Mbits.
 K4 = Looks at the constant value to determine Mbits and column numbers.