



Complete, fold and seal
(see note 2 below)

SURNAME: DAVIS

FORENAME(S): RLH

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.

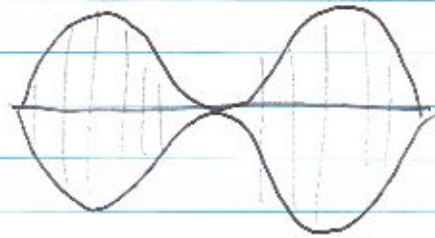
1	Student Number	1809809
2	Title of Examination Paper	SIGNALS & DIG COMMS
3	Module Code	SGEE5005
4	Date and Time of Examination	12/05/22
5	Examination Venue	COLLEGE SIR GARR
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
A	30 $\frac{1}{2}$
B2	18 $\frac{1}{2}$
B3	18
Total	67%

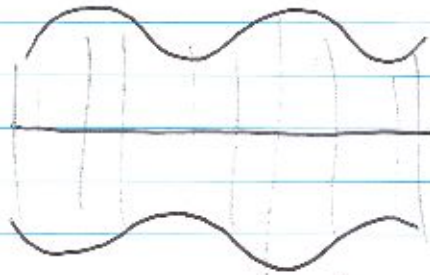
Mark confirmed as 67

A1.

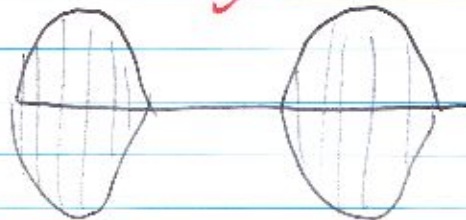
MODULATION FACTOR 1



MODULATION FACTOR 0.5:



MODULATION FACTOR 1.5:



3

A2.

$$m = \frac{V_{\text{MAX}} - V_{\text{MIN}}}{V_{\text{MAX}} + V_{\text{MIN}}}$$

$$= \frac{35 - 9}{35 + 9} = \frac{26}{44} = 0.59$$

2

A3.

1. AS FM MODULATION IS FREQUENCY BASED, ANY
2. INTERFERENCE AFFECTS AMPLITUDE, THEREFORE
- IT IS RESISTIVE TO INTERFERENCE ✓

2. F.M HAS THE ADVANTAGE OF A MUCH WIDER BANDWIDTH ~~OVER~~ THE FREQUENCY SPECTRUM

3. F.M HAS GREATER EFFICIENCY THAN A.M DUE TO THE CHANGES IN FREQUENCY RATHER THAN AMPLITUDE TO THE CARRIER.

2½

A4. $E_c = 4V$ $f_c = 250MHz$ $f_d = 60kHz$
 $f_m = 10kHz$

$$e = E_c \cos(\omega_c t + m_f \sin \omega_m t)$$

$$\omega_c = 2\pi f_c = 2 \times \pi \times 250 \times 10^6 = 1570 \times 10^6$$

$$\omega_m = 2\pi f_m = 2 \times \pi \times 10 \times 10^3 = 62831.85$$

$$e = 4 \cos(1570 \times 10^6 t + \sin 62831.85 t)$$

3

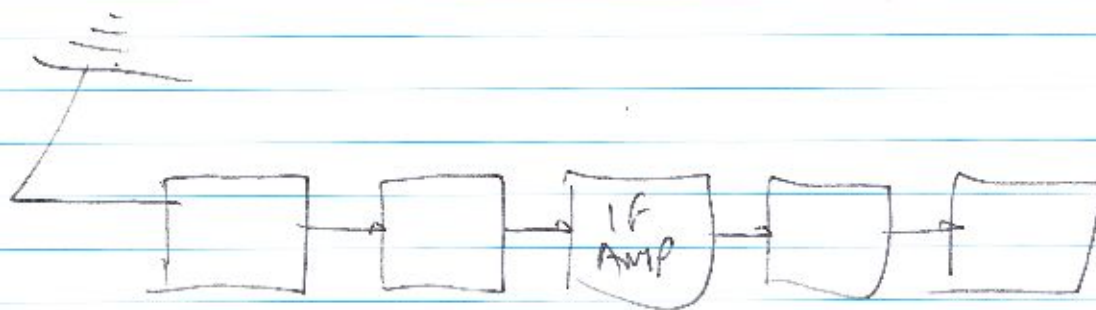
A5. $V_i = 10V$ $V_R = 4V$

$$V_{SWR} = \frac{|V_i| + |V_R|}{|V_i| - |V_R|} = \frac{10 + 4}{10 - 4} = \frac{14}{6} = 2.3$$

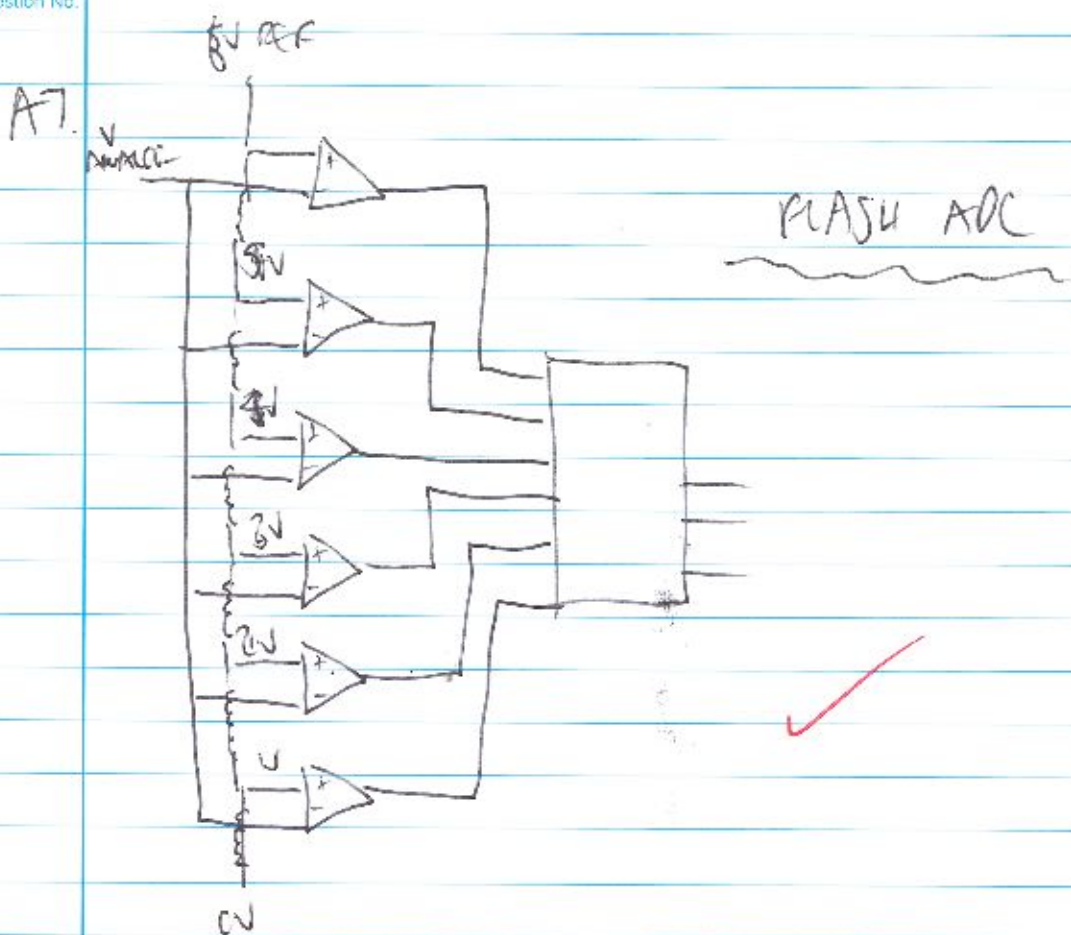
$$p_v = \frac{V_R}{V_i} = \frac{4}{10} = 0.4$$

4

A6.



1



A FLASH ADC WORKS ON THE PRINCIPLE OF MULTIPLE COMPARATORS, ALL COMPARING THE INPUTTED ANALOG VOLTAGE AGAINST DEFINED VOLTAGE STEPS, CREATED BY A SERIES OF MATCHING RESISTOR VALUES TO CREATE THE SAME VOLTAGE STEPS THROUGHOUT THE NETWORK. THE COMPARATORS OUTPUT TO AN ADC MODULE WHERE THE HIGHEST VOLTAGE STEP IS CONVERTED TO A DIGITAL OUTPUT, WHICH IS RETAINED UNTIL THE VOLTAGE CHANGES.

ALTHOUGH THIS TYPE OF ADC IS FAST IN OPERATION, ITS PHYSICAL MAKE UP LIMITS ITS VOLTAGE RANGE.

MORE QUANTISATION STEPS REQUIRE MORE COMPARATORS

WHERE NO OF COMPARATORS = 2^n
 (n = NO OF QUANTISATION STEPS)
 COMPARATORS

4

4

1.E 256 QUANTISATION STEPS REQUIRE 2^8
= 8 COMPARATORS

A8.

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

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

$$75 = \frac{138}{1.46} \log \frac{D}{0.4}$$

$$75 = \text{anti log } 94.52 = \frac{D}{0.4}$$

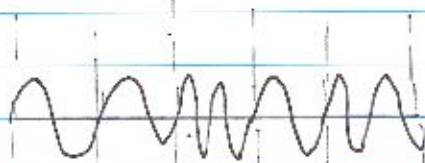
$$D = (10^{9.452}) \times 0.4$$

2

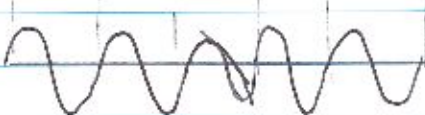
A9.



DIGITAL SIGNAL



RESULTANT OUTPUT WAVE



INPUT FREQUENCY (F_c)

USING A DIGITAL INPUT SIGNAL AS AN ACTIVATION, THE INPUT FREQUENCY IS CHANGED TO A HIGHER OR LOWER FREQUENCY, AS THE ABOVE FIG SHOWS, WHEN THE DIGITAL INPUT IS '1' THE RESULTANT OUTPUT WAVE COULD BE DEFINED AS $(F_c + F_a)$ WHERE AS THE DIGITAL INPUT AT '0' COULD BE DEFINED AS $(F_c - F_a)$

3

WHERE f_a IS THE FREQUENCY INCREASE RANGE.

A10

$$\bar{p}_1 = \frac{\bar{Z}_L - Z_0}{\bar{Z}_L + Z_0}$$

$$= \frac{120 + j60 - 50}{120 + j60 + 50}$$

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

$$= \frac{\sqrt{70^2 + 60^2}}{\sqrt{170^2 + 60^2}} = \frac{92.195}{180.277} \quad \tan^{-1}\left(\frac{60}{70}\right) = 40.601^\circ \quad \tan^{-1}\left(\frac{60}{170}\right) = 19.440^\circ$$

$$= \frac{92.195 \angle 40.601^\circ}{180.27 \angle 19.440^\circ}$$

$$\bar{p}_1 = 0.51 \angle 21.161^\circ$$

6

B2 (a) iii. $DR = 20 \log_{10} (N)$

WHERE $N = 2^{10} = 1024$

$DR = 20 \log 1024 = 60.206 \text{ dB}$

(ii) $q = \frac{\text{VOLTAGE RATIO}}{N}$

$= \frac{32}{1024} = 0.031$

$V_{\text{rms}} = \frac{q}{\sqrt{12}} = \frac{0.031}{\sqrt{12}} = 0.0026$

$SQNR = 4.7 / 0.0026 = 1807.69$

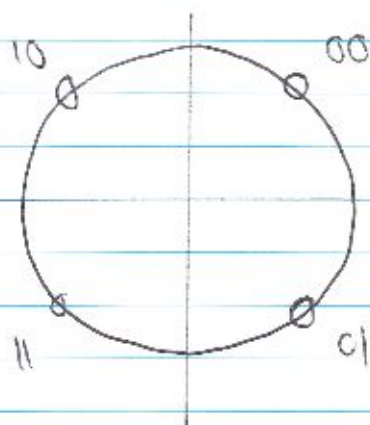
$20 \log (1807.69) = 65.142 \text{ dB}$

CARRIED
FORWARDS.

5
1/2

(b)

(c)



USING A 'SINUSOIDAL CARRIER', THE PHASE MODULATION IS SHIFTED 90° USING 2 BI-PHASE MODULATORS

WHERE '00' = 45° PHASE SHIFT

'01' = 135° PHASE SHIFT

'11' = 225° PHASE SHIFT

'10' = 315° PHASE SHIFT

4

(d)

0000 0	0100 0	1100 0	1000 0
0001 0	0101 0	1101 0	1001 0
0011 0	0111 0	1111 0	1011 0
0010 0	0110 0	1110 0	1010 0

USING 'I' AND 'Q' QUANTITIES IN VARIOUS FORMS, ALLOWS THE PHASE AND AMPLITUDE TO BE VARIED AT THE SAME TIME. USING DIFFERENT COMBINATIONS CREATES A POSSIBILITY OF '16' DIFFERENT VARIATIONS OF THE SIGNAL.

WHERE '1000' IS 45° PHASE SHIFT AND V_{MAX} AND '1100' IS A 135° PHASE SHIFT AND $0.75 \times V_{MAX}$

'1111' IS A 225° PHASE SHIFT AND $0.3 \times V_{MAX}$ ON THE ABOVE FIGURE

8

5

(2) QUANTISATION IS THE DIGITAL REPRESENTATION OF AN ANALOG VOLTAGE, AN ANALOG VALUE CONVERTED INTO A DIGITAL NUMBER, REPRESENTED AS A BOOLEAN NUMBER. ✓

QUANTISATION ERROR IS REPRESENTED AS THE DIFFERENCE IN THE RESULTANT VOLTAGE FROM THE CONVERSION COMPARED WITH THE INPUT ANALOG VOLTAGE. THIS ERROR IS USUALLY ATTRIBUTED TO A LOWER THAN DESIRED RESOLUTION AND RESULTANT LOWER QUANTISATION STEPS. ✓

4

4

Q3. (b.) LAYERS OF THE OSI NETWORK MODEL

- APPLICATION LAYER
- PRESENTATION LAYER
- SESSION LAYER
- TRANSPORT LAYER
- NETWORK LAYER
- DATA LINK LAYER
- PHYSICAL LAYER ✓

APPLICATION LAYER - RECEIVES AND DISPLAYS DATA TO THE ~~END~~ USER OF A NETWORK

PRESENTATION LAYER - CONVERTS THE DATA ~~INFO~~ INTO A USEABLE FORMAT READY FOR ~~TRANSMISSION~~

SESSION LAYER - ESTABLISHES A CONNECTION BETWEEN A SOURCE AND DESTINATION DEVICES / APPLICATIONS

TRANSPORT LAYER - IDENTIFIES THE CONTAINER IN WHICH TO CONVEY THE DATA I.E. ~~TCP, UDP~~

NETWORK LAYER - RESPONSIBLE FOR THE ADDRESS OF THE SOURCE AND DESTINATION SO THAT IT CAN BE SENT AND RECEIVED ~~CORRECTLY~~ AND SUCCESSFULLY

DATA LINK LAYER - ✗

13

PHYSICAL LAYER - SPECIFICATION OF THE DATA TRANSFER TO BE USED AND PORT TYPES ✓

(c) $567412 / 99 = 5731.43$

AS THE REMAINDER '43' MATCHES THE CHECK DIGIT '43' THEN WE CAN ASSUME NO ERRORS

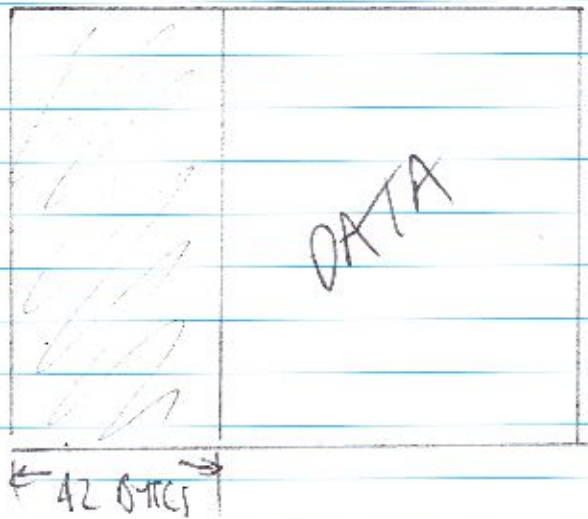
$985314 / 99 = 9952.6$

AS THE REMAINDER '6' DOES NOT MATCH THE CHECK DIGIT '55' THEN WE CAN SEE ~~THAT~~ THERE MUST BE ERRORS.

3

(d)

STM-1 FRAME



2