

**Complete, fold and seal
(see note 2 below)**

SURNAME: Edge

FORENAME(S): Fled

Examination Answer Books

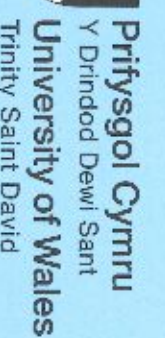
12 Pages

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	1602831
2	Title of Examination Paper	Signal + digital comms
3	Module Code	SEEE5005
4	Date and Time of Examination	9/5/19 9:30 - 12:00
5	Examination Venue	Coley Sir Gur G43
6	Seat Number	
7	Number of Answer Books handed in	1

(Gweler yr ochr arall am y fersiwn Cymraeg)



Llyfr Atebion Arholiadau

12 Tüdalen

Cyfarwyddiadau i Ymgeiswyr

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwch eich enw yn y lle a ddarparwyd ar y dde, plygwch ef a'i seilio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.
3. Rhaid i'r atebion fod mewn llawysgrifen ddarlennadwy. Gall yr Arholwyr nall ai anwybyddu sgrifft annarllennadwy, neu drefnu iddi gael ei thipio a chael yr ymgeisydd i dalu.
4. Ysgrifennwch eich atebion mewn inc.
5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw fras nodiadau yn y llyfr atebion a thymu llinell drwyddynt.
6. Ni ddylid rhwgo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.
7. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwyliwr/gwyliwyr.
8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

**Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)**

CYFENW:

ENW(AU) CYNTAF:

1	Rhif Myfyrwr	
2	Teitl y Papur Arholiad	
3	Cod y Modwl	
4	Dyddiad ac Amser yr Arholiad	
5	Lleoliad yr Arholiad	
6	Rhif Sedd	
7	Nifer y Llyfrau Atebion a gyflwynwyd	

(See the other side for English version)

A1

$$\frac{3 \times 10^8}{210 \times 10^6} = 1.43 \text{ m}$$

③ ✓

A2

$$m = \frac{V_{\text{modulation}}}{V_{\text{carrier}}} = \frac{2}{40} = 0.05 \text{ modulation factor}$$

③ ✓

A3

5.0003

$$\begin{aligned} \text{upper sideband} &= 5000 \text{ KHz} + 3 \text{ KHz} = 5003 \text{ KHz or } 5.003 \text{ MHz} \\ \text{lower sideband} &= 5000 \text{ KHz} - 3 \text{ KHz} = 4997 \text{ KHz or } 4.997 \text{ MHz} \end{aligned}$$

② ✓

A4

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

$$e = 6 \cos(60 \text{ MHz} + 2 \text{ KHz} \sin 40 \text{ KHz} t)$$

Convert to radians

$$e = 6 \cos(376991118.4 + 12566.37 \sin(251327.411))$$

$$e = 6 \cos(376991118.4 + 125 - 28.742)$$

$$e = 6 \cos(376991089.7)$$

① ✓

or

A5.

$$Z_0 = 50 \quad Z_L = 170 + j58$$

$$P_r = \frac{170 + j58 - 50}{170 + j58 + 50}$$

$$= \frac{120 + j58}{220 + j58}$$

Convert to polar to divide

$$= 133.28 \angle 0.45$$

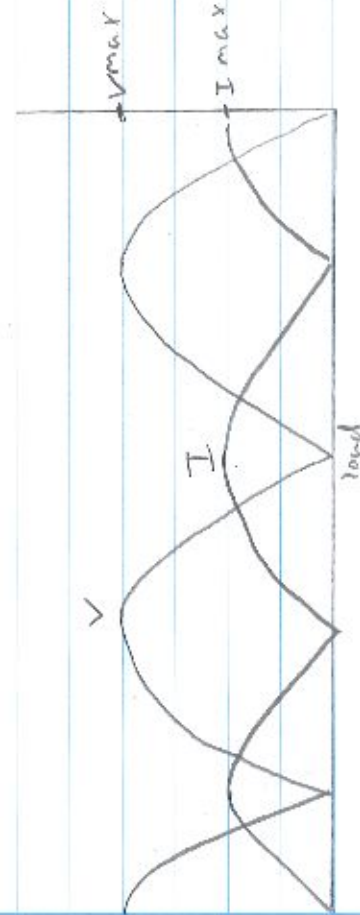
$$227.57 \angle 0.26$$

$$= 0.586 \angle 0.19 \quad \leftarrow \text{angle in radians is correct}$$

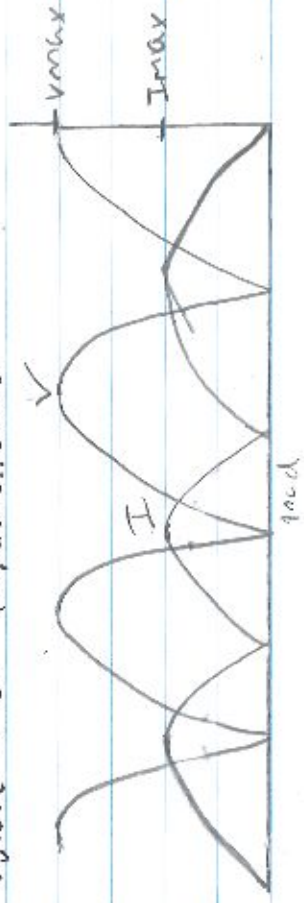
Convert back to Cartesian

$$= 0.575 + j0.11$$

A6.

Where $V_{SWR} = 0$ (Short circuit)

When at no load I is at max and V is at 0

Where $V_{SWR} = \infty$ (Open circuit)

When at no load I is at its lowest point while V is at its maximum

$$\text{where } V_{SWR} = 1$$

There is full reflection back

$$\text{where } V_{SWR} = 0$$

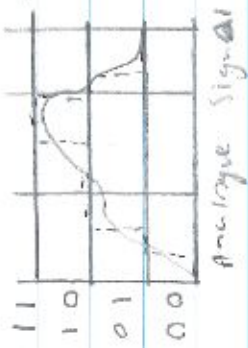
There is no reflection back

A7

A R/2R DAC uses resistors at 2 different values where the concept works based on the value through 2R in parallel being half of which is equal to R.

A8

Quantization is the allocation of bits to convert an analogue signal to digital the error of this comes from the rounding off of these analogue signal to the nearest quantization point which will result in values being rounded up or down. Shown below in the 2 bit system.



As can be seen the values have lost their shape to resemble square waves this can be improved and reduce the error by increasing resolution. ✓

③

B1

a)

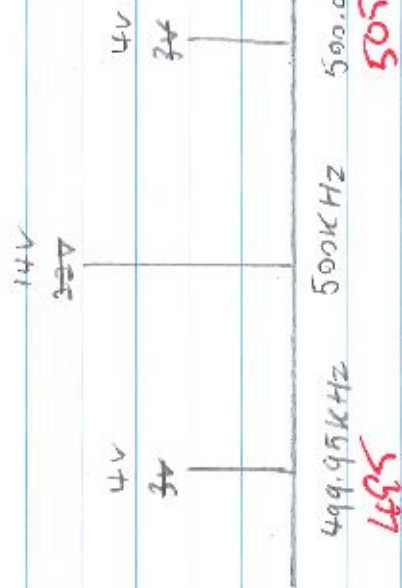
i)

$$m = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{22 - 6}{22 + 6} = 0.57 \quad \checkmark$$

ii)

upper sideband is

$$\text{upper sideband} = \frac{f_c + f_m}{2} = 3$$



$$f_c = \frac{22 + 6}{2} = 14 \quad \checkmark$$

$$f_s = \frac{22 - 6}{2} = 8 \quad \checkmark$$

$$\text{for sideband } f_s = \frac{8}{2} = 4 \quad \checkmark$$

505

495

500.05 kHz

500 kHz

499.95 kHz

4V

4V

4V

4V

(ii)

$$V = \frac{m E_c}{2} = \frac{0.57 \times 14}{2} = 3.99 \quad \checkmark$$

X

b)

i)

$$Z_0 = 75 \quad Z_L = 85 + j120$$

$$P_V = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{85 + j120 - 75}{85 + j120 + 75} = \frac{10 + j120}{160 + j120}$$

Convert to polar

$$\frac{120.416 \angle 1.488}{200 \angle 0.644} = 0.602 \angle 0.844^\circ$$

✓ $\times 200.1 \text{ mV}$

ii)

$$V_{SLR} = \frac{1 + P_V}{1 - P_V} = \frac{1 + 0.602 \angle 0.844}{1 - 0.602 \angle 0.844}$$

Convert to Cartesian

$$\frac{1 + 0.4 + j0.45}{1 - 0.4 + j0.45} = \frac{1.4 + j0.45}{0.6 + j0.45}$$

Convert back to polar

$$\frac{1.47 \angle 0.31}{0.75 \angle 0.64} = 1.96 \angle -0.33^\circ$$

✓

②

c)

i)

$$\text{hence } \Delta f_c = f_{\max} - f_c = 230 \text{ kHz} - 200 \text{ kHz} = 30 \text{ kHz}$$

215

15k.

ii)

$$\beta = \frac{\Delta f_c}{f_s} = \frac{30 \text{ kHz}}{10 \text{ kHz}} = 3 \quad \checkmark \text{ c.e.}$$

iii)

index factor
using the below table multiply the modulation index by each value in the line band using the index

$$f_0 = 7 \times 0.26 \times 0.13 \text{ mT } \frac{\text{modulation}}{\text{carrier}} \times \frac{75}{25} = 0.13$$

$$f_0 = -0.26 \times 0.13 = -0.078 \sim -0.78$$

$$f_1 = 0.34 \times 0.13 \times 3 = 1.02$$

$$f_2 = 0.49 \times 0.13 \times 3 = 1.47$$

$$f_3 = 0.31 \times 0.13 \times 3 = 0.93$$

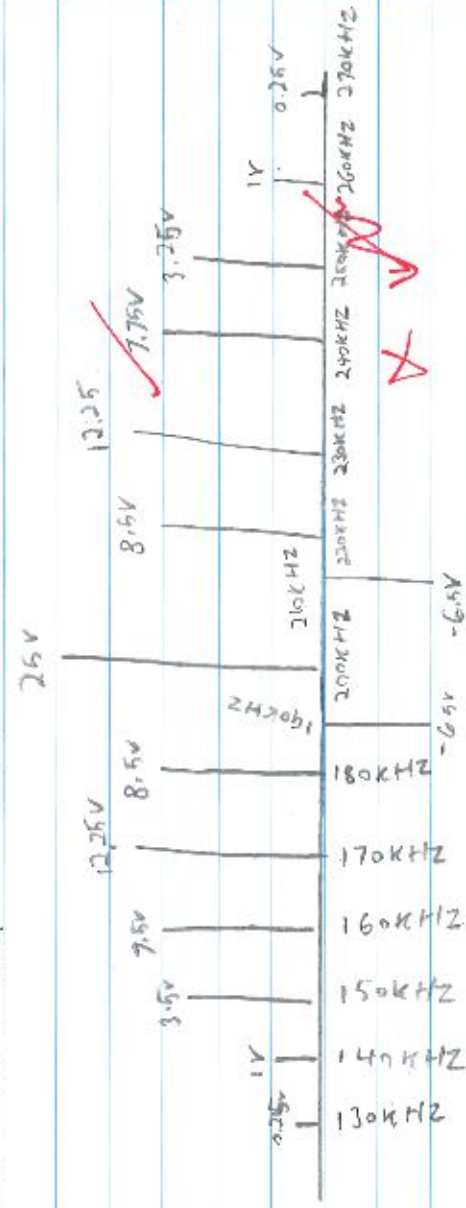
$$f_4 = 0.13 \times 0.13 \times 3 = 0.39$$

$$f_5 = 0.04 \times 0.13 \times 3 = 0.12$$

$$f_6 = 0.01 \times 0.13 \times 3 = 0.03$$

iii) Using theessel table multiply the values on the modulation index line by the peak voltage at the

$$\begin{aligned}
 f_0 &= 25 \times 0.26 = -6.5 \\
 f_1 &= 25 \times 0.34 = 8.5 \\
 f_2 &= 25 \times 0.44 = 12.25 \\
 f_3 &= 25 \times 0.31 = 7.75 \\
 f_4 &= 25 \times 0.13 = 3.25 \\
 f_5 &= 25 \times 0.04 = 1 \\
 f_6 &= 25 \times 0.01 = 0.25
 \end{aligned}$$



Bandwidth = 140 kHz

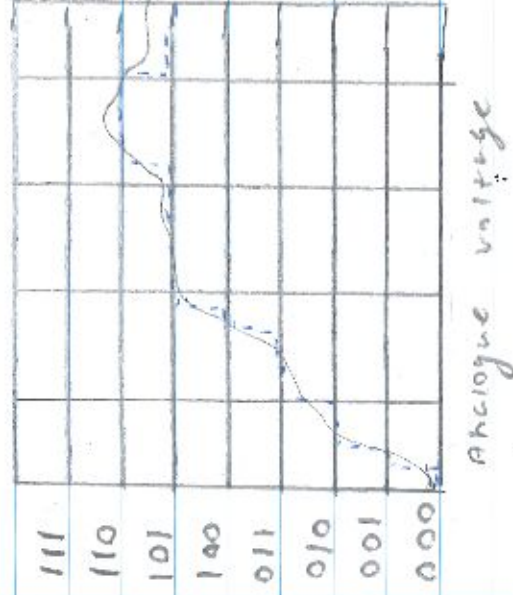
d)

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

$$75 = \frac{138}{\sqrt{2.1}} \log \frac{D}{0.2} = 95.23 \log \frac{D}{0.2}$$

$$\frac{D}{0.2} = \text{antilog} \frac{75}{95.23} = 6.132$$

$$D = 6.132 \times 0.2 = 1.23 \text{ mm}$$



Resolution is how many quantization values are used in the conversion reducing the error however more bits are necessary for high resolution which results in a high large amount of information to be processed

The graph shows how the analogue value will be assigned to the nearest bit (shown by dotted line)

b)

As PCM works in binary noise will only affect int when is very severe however an analogue signal that works on a much smaller and finer scale will be effected by even small amounts of noise

c)

i)

$$DR = 20 \log(N)$$

$$N = 2^8 = 256$$

$$DR = 20 \log(256) = 48.16 \text{ dB}$$

ii)

$$q = \text{voltage range} \div N = 32 \div 256 = 0.125$$

$$V_{QN} = q/\sqrt{12} = 0.125/\sqrt{12} = 0.036$$

$$SNR = \text{rms signal voltage} \div V_{QN} = 4.7 \div 0.036 = 130.5$$

$$\text{convert to dB} = 20 \log(130.5) = 42.31 \text{ dB}$$

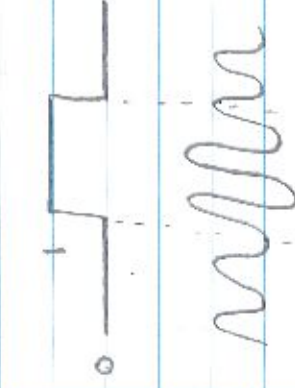
d)

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

A 16-QAM uses 3 phase changes from the original to transmit a signal 1 for each quadrant as shown above.

e)

ASK (Amplitude Shift Keying)



An ASK System increases the carrier frequencies Amplitude which is reflected in the digital signal as a 1 value.

FSK (Frequency Shift Keying)

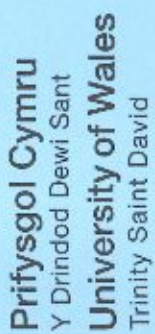


An FSK System increases the frequency of the carrier wave to show an output of 1 on the digital side.

PSK (Phase Shift Keying)



A PSK System shows a change in the digital output side by changing the phase of the carrier frequency for this the system must know the original phase to detect change.



Complete, fold and seal
(see note 2 below)

SURNAME: LNCE

FORENAME(S): DANIEL

Examination Answer Books

12 Pages

Instructions to Candidates

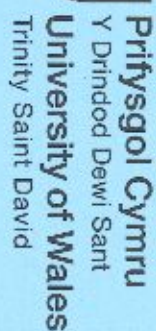
1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense 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.

8. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.

List the numbers of the questions you have attempted	Office Use
A1	39
A2	
A3	
A4	
A5	
A6	
A7	
A8	28
B1	30
B2	
Total	97%

1	Student Number	1602836
2	Title of Examination Paper	Signals and Digital Communication
3	Module Code	SGEE 5005
4	Date and Time of Examination	9/5/19 9:30
5	Examination Venue	G43
6	Seat Number	
7	Number of Answer Books handed in	

(Gweler yr ochr arall am y fersiwn Cymraeg)



Llyfr Atebion Arholiadau

12 Tudalen

Cyfarwyddiadau i Ymgeiswyr

1. Rhwngch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwngch eich enw yn y lle a ddarparwyd ar y dde, plygwch ef a'i sellio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.
3. Rhaid i'r atebion fod mewn llawysgrifen ddarlennadwy. Gall yr Arholiwr naill ai anwybyddu sgrifft annarlennadwy, neu drefnu lloidi gael ei theipio a chael yr ymgeisydd i dalu.
4. Ysgrifennwch eich atebion mewn inc.
5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw fras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.
6. Ni ddylid rhwngo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.
7. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwyliwr/gwyliwyr.
8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

CYFENWYBODAETHYD

ENW(AU) CYNTAF:

1	Rhif Myfyrwr	
2	Teitl y Papur Arholiad	
3	Cod y Modwl	
4	Dyddiad ac Amser yr Arholiad	
5	Lleoliad yr Arholiad	
6	Rhif Sedd	
7	Nifer y Llyfrau Atebion a gyflwynwyd	

[illegible]

(See the other side for English version)

A1

$$V = \frac{V}{\lambda} \rightarrow \lambda = \frac{V}{f} \rightarrow \frac{3 \times 10^8}{20 \times 10^6} = 1.43 \text{ m} \checkmark$$

3A2

$$m = \frac{V_{\text{mod}}}{V_{\text{carrier}}} \rightarrow 0.05 \checkmark$$

3A3

50 SMHz carrier

upper sideband 5000.3 kHz to 5.003 MHz
lower sideband 4999.7 kHz to 4.997 MHz

4A4 $E_c = 6$

$$f_c = 60 \text{ MHz} \quad 6V \rightarrow 60 \times 10^6 \times 2\pi = 376991118.4 \text{ rad/s}$$

$$f_s = 2 \text{ kHz} \rightarrow 2 \times 10^3 \times 2\pi = 12566 \text{ rad/s}$$

40 kHz dev

$$m = \frac{2}{4G} = 0.05 \quad \frac{40}{2} = 20$$

~~70000~~

$$e = E_c \cos(\omega_c t + m f_s \sin \omega_s t)$$

5

$$L = 6 \cos(376991118.4 t + 0.05 \sin(12566 t))$$

A5

$$50 \Omega \quad Z_o$$

$$170 + j58 \Omega \quad Z_L$$

$$\bar{P}_L = \frac{Z_L \cdot Z_o}{Z_L + Z_o} \checkmark$$

$$L \rightarrow \frac{170 + j58 - 50}{170 + j58 + 50} \rightarrow \frac{120 + j58}{220 + j58} \checkmark$$

convert to polar

$$\frac{133.28 / 25.8^\circ}{227.5 / 14.77^\circ} = 0.586 / 11.03^\circ = P_L \checkmark$$

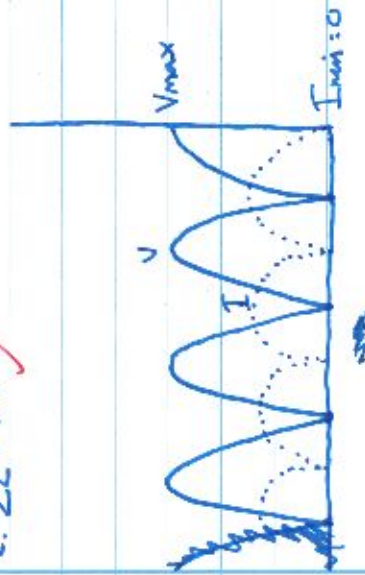
8

A6

1. $Z_L = 0$ Short circuit
2. $Z_L = \infty$ Open circuit
3. $Z_L = Z_0$ Characteristic impedance
4. $Z_L \neq Z_0$ Mismatched impedance

1. $Z_L = 0$ ✓

All power is reflected back ✓

2. $Z_L = \infty$ ✓

All power is reflected back ✓

3. $Z_L = Z_0$ ✓

The loads are characteristic and balanced, so no power is reflected back ✓

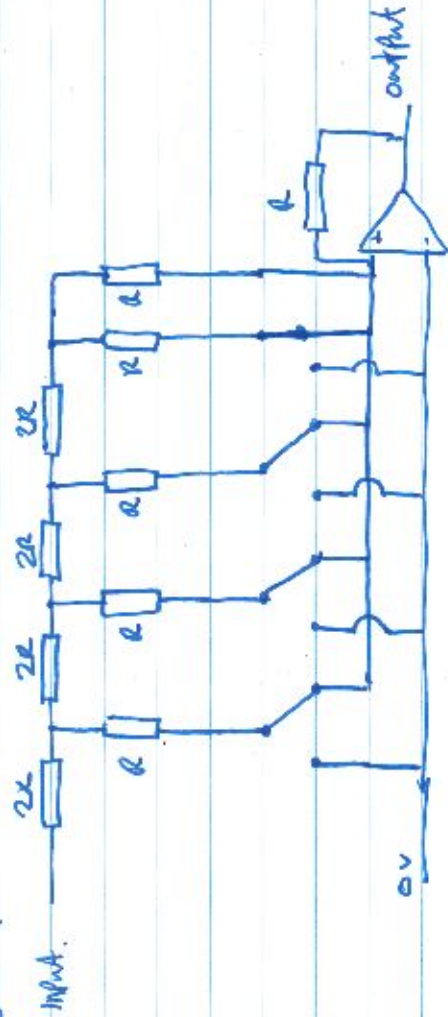
4. $Z_L \neq Z_0$ ✓

The loads are mismatched so some power is reflected back. ✓

A7

R/2R DAC

- Works on the principle that the two resistors in parallel equal half their individual resistances. There are two resistors in each stage and one is double the other.

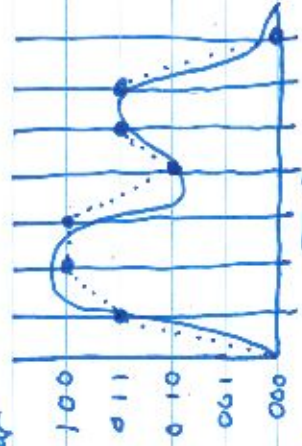


With each resistor stage the voltage is $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ and $\frac{1}{16}$ resulting in a step change which is ~~added~~ output as an ~~analogue~~ value, ~~defined~~ and amplified depending on the total after all resistor stages. ✓

A8

Quantisation is the level that the analogue value is set to when converted to digital. The amount of levels depends on the resolution. ✓

Quantisation error



error when

This is the information is lost due to the signal jumping to the nearest quantisation level during sampling. ✓

B1 a,

500Hz $V_{min} = 6V$ $V_{max} = 22V$ $\tau = 200\mu s$
 50 Ω load

$$M = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} \rightarrow \frac{22 - 6}{22 + 6} = 0.57$$

ii, $E_c = \frac{V_{max} + V_{min}}{2} \rightarrow \frac{22 + 6}{2} = 14V$

$$E_s = \frac{V_{max} - V_{min}}{2} \rightarrow \frac{22 - 6}{2} = 8V$$

$$V = \frac{ME_c}{2} \rightarrow \frac{0.57 \times 14V}{2} = 3.99V$$



$$d = S \times t \rightarrow 3 \times 10^8 \times 200 \times 10^{-6} = 60000 \quad f = \frac{V}{\lambda} \rightarrow \frac{3 \times 10^8}{60000}$$

$$f_s = 5000Hz$$

iii, $P = \sum \frac{E^2}{2R} \rightarrow \frac{14^2}{2 \times 50} + \frac{4^2}{2 \times 50} + \frac{4^2}{2 \times 50}$

$$= 1.96 + 0.16 + 0.16 = 2.28W$$

6 i,

25mV $Z_L = 85 + j120 \Omega$ $24V_{rms}$
 75Ω internal = 75Ω

$$P_V = \frac{Z_L - Z_0}{Z_L + Z_0} \rightarrow \frac{85 + j120 - 75}{85 + j120 + 75} \rightarrow \frac{10 + j120}{160 + j120}$$

current to $P_{L_{in}}$

$$\frac{120.4 / 85.24^\circ}{200 / 36.87^\circ} = 0.602 \angle 48.37^\circ$$

ii $V_{SWR} = \frac{1 + \beta_V}{1 - \beta_V} \rightarrow \frac{1.602}{0.398} = 4.025$

6 i,

$f_c = 200kHz$ $25V$
 $f_s = 10kHz$ $7.5V$

$$\Delta f_c = f_{max} - f_c \rightarrow 230k - 200k = 30kHz \times 215k$$

ii, $\beta = \frac{\Delta f_c}{f_s} \rightarrow \frac{30k}{10k} = 3 \checkmark CE$

iii, so $\beta = 3$

$j0 = 25 \times 0.26 = 6.5V$
 $j1 = 25 \times 0.34 = 8.5V$
 $j2 = 0.49 \times 25 = 12.25V$
 $j3 = 25 \times 0.31 = 7.75V$
 $j4 = 25 \times 0.13 = 3.25V$
 $j5 = 25 \times 0.04 = 1V$
 $j6 = 25 \times 0.01 = 0.25V$

$$\frac{10k}{2} = 5k$$



$$\text{Band width} = 60 \text{ kHz}$$

$$d, d = 0.2 \text{ mm} \quad D = ?$$

$$k = 2.1$$

$$Z = 75 \Omega$$

$$\text{So } Z_0 = \frac{138}{\sqrt{k}} \log \frac{D}{d}$$

$$\rightarrow 75 = \frac{138}{\sqrt{2.1}} \log \frac{D}{0.2 \times 10^{-3}}$$

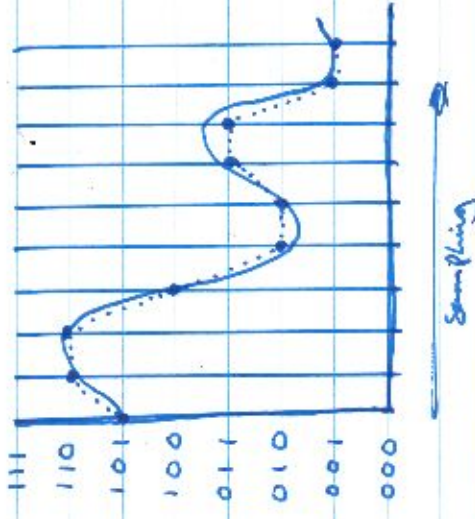
$$75 = 95.23 \log \frac{D}{0.2 \times 10^{-3}}$$

$$\text{antilog} \left(\frac{75}{95.23} \right) = \frac{D}{0.2 \times 10^{-3}}$$

$$\rightarrow 6.1316 = \frac{D}{0.2 \times 10^{-3}}$$

$$D = 1.226 \times 10^{-3} \rightarrow 1.226 \text{ mm}$$

82
a,



The analogue signal is assigned to the nearest quantisation level depending on the quantizer. Some information is lost as the quantisation level does not always match the analogue value exactly and so this jump loses information or sometimes adds information.

The number of quantisation levels determines the resolution. Higher bit quantisers have a higher resolution as there are more levels to be assigned. This means less information is lost and there is less quantisation error.



As shown, PCM only has to differentiate between a 0 and a 1, this is a large differential. As noise adds to the amplitude, it typically does not add enough to blur the boundaries between 0 and 1, meaning it has less effect.

With analogue noise adds to the amplitude and distorts the signal easily. The noise is also hard to remove and so has more effect on analogue than PCM overall.

$$c, 4.7 \text{ Vrms}$$

$$f_{\text{max}} 3.4 \text{ kHz}$$

$$8\text{-bit}$$

$$-16 \text{ to } +16 \text{ V}$$

$$N = 2^n \rightarrow 2^8 = 256$$

$$i, DR = 20 \log_{10}(N) \rightarrow 20 \log_{10}(256)$$

$$= 48.165 \text{ dB}$$

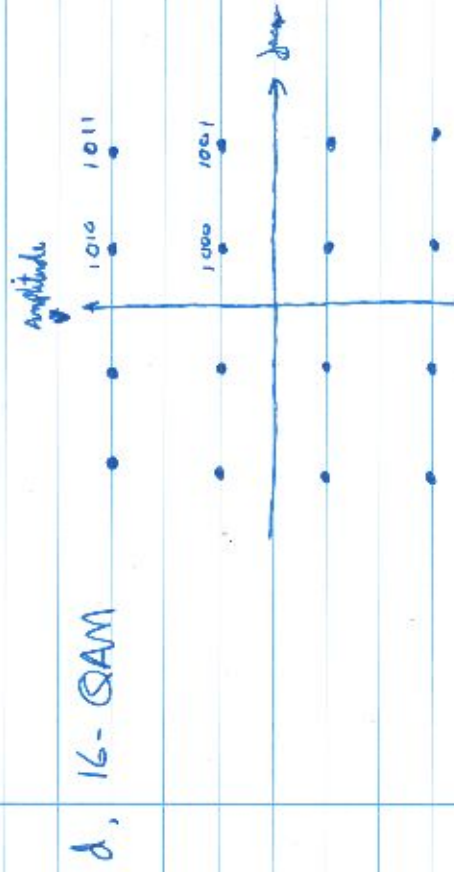
ii, $q = \frac{V_{\text{range}}}{N} \rightarrow \frac{32}{256} = 0.125$ ✓

$V_{\text{GN}} = \frac{q}{\sqrt{12}} \rightarrow \frac{0.125}{\sqrt{12}} = 0.036$ ✓

$\text{SQNR} = \frac{\text{Signal } V_{\text{rms}}}{V_{\text{GN}}} \rightarrow \frac{4.7}{0.036} = 130.25$ ✓

in dB

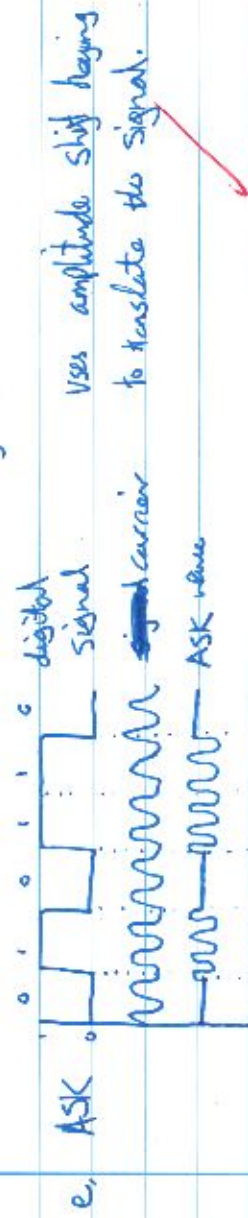
$\rightarrow 20 \log_{10}(130.25) = 42.296 \text{ dB}$ ✓



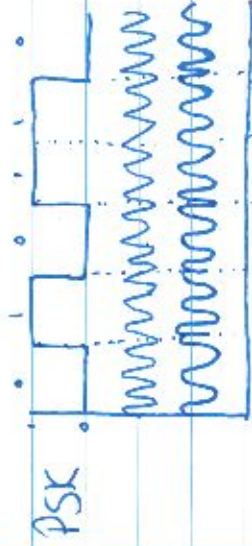
This form of modulation contains the phase and amplitude within the 4 bits.

for example 1000 is at 45° at a low amplitude
 1001 is at 15° at a low amp
 1010 is at 75° at a high amp
 1011 is at 45° at a high amp

Purpose is to contain the maximum amount of information across 16 bits.



Adjusts the frequency based on the signal.



Shifts the wave phase by 180° based on the 0 or 1 digital signal.



Complete, fold and seal
(see note 2 below)

SURNAME: Jones

FORENAME(S): Sean Ashley
Thomas

Examination Answer Books

12 Pages

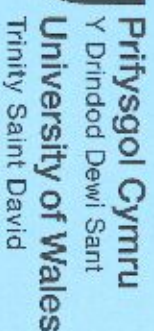
Instructions to Candidates

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.

List the numbers of the questions you have attempted	Office Use
A	8
B2	26
Total	346

1	Student Number	1602826
2	Title of Examination Paper	Signal & Digital Comms
3	Module Code	SGEE5005
4	Date and Time of Examination	4/5/19 9.30
5	Examination Venue	Colleg Sirgar 643
6	Seat Number	
7	Number of Answer Books handed in	

(Gweler yr ochr arall am y fersiwn Cymraeg)



Llyfr Atebion Arholiadau

12 Tudalen

Cyfarwyddiadau i Ymgeiswyr

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwch eich enw yn y lle a ddarparwyd ar y dde, plygwch ef a'i selio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.
3. Rhaid i'r atebion fod mewn llawysgrifen ddarllenadwy. Gall yr Arholwyr nall ai arwybyddu sgrifft annarllenadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.

Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

CYFENW

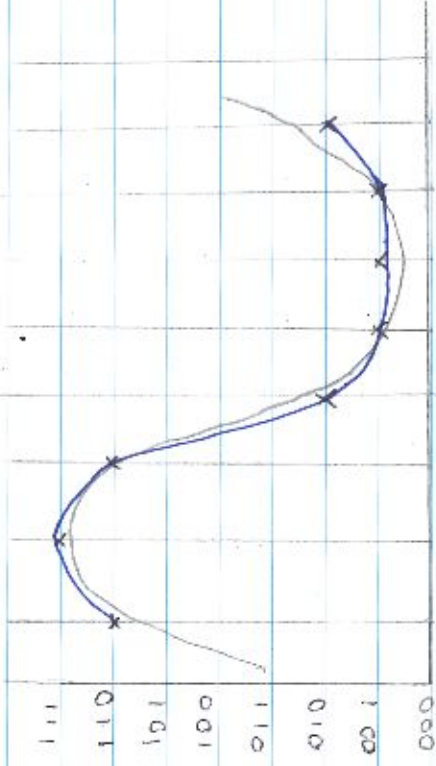
ENW(AU) CYNTAF-

(See the other side for English version)

1	Rhif Myfyriwr	
2	Teitl y Papur Arholiad	
3	Cod y Modwl	
4	Dyddiad ac Amser yr Arholiad	
5	Lleoliad yr Arholiad	
6	Rhif Sedd	
7	Nifer y Llyfrau Atebion a gyflwynwyd	

[illegible]

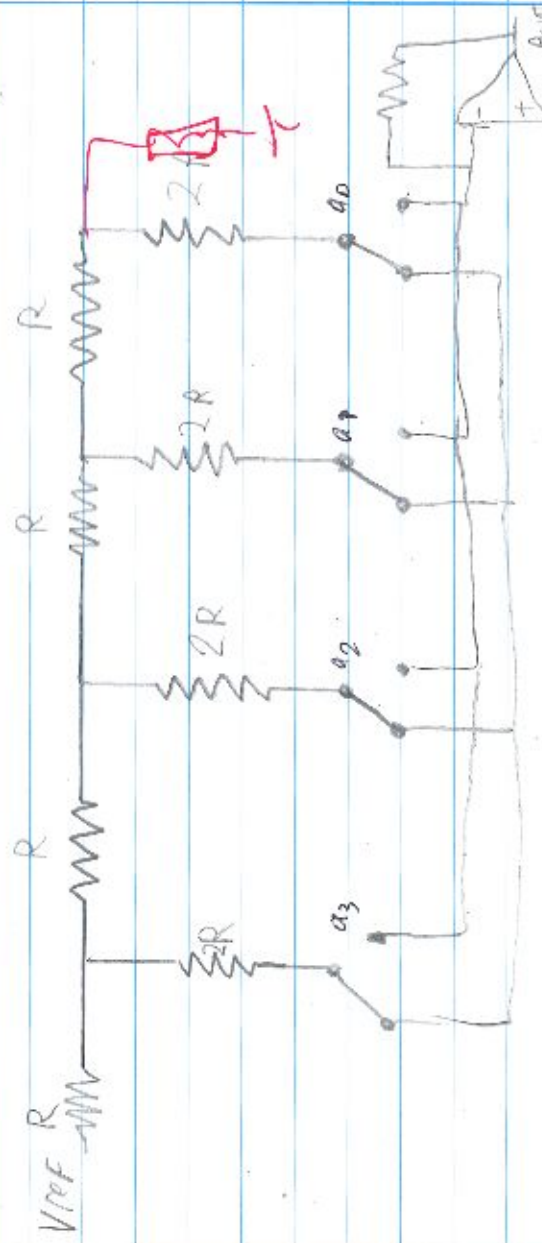
A8



The Vertical Levels are quantisation and a code is given when the signal is to that closest level, the error is obtained when the signal doesn't pass exactly through a level so the value gets rounded up or down. the error is dependent on the resolution

3

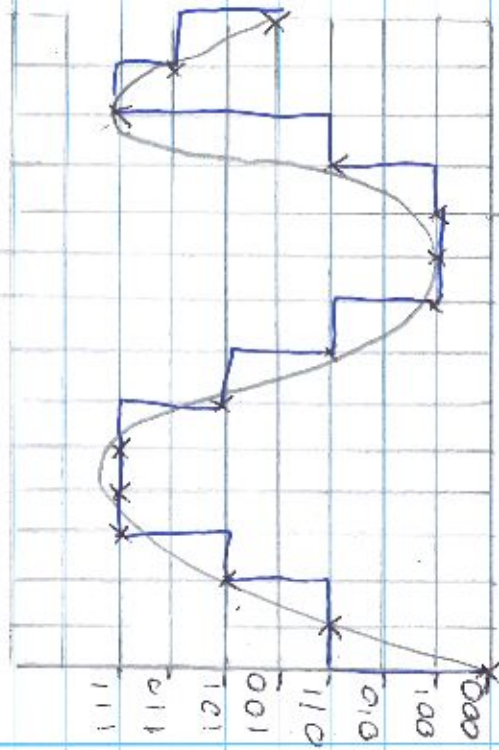
A7



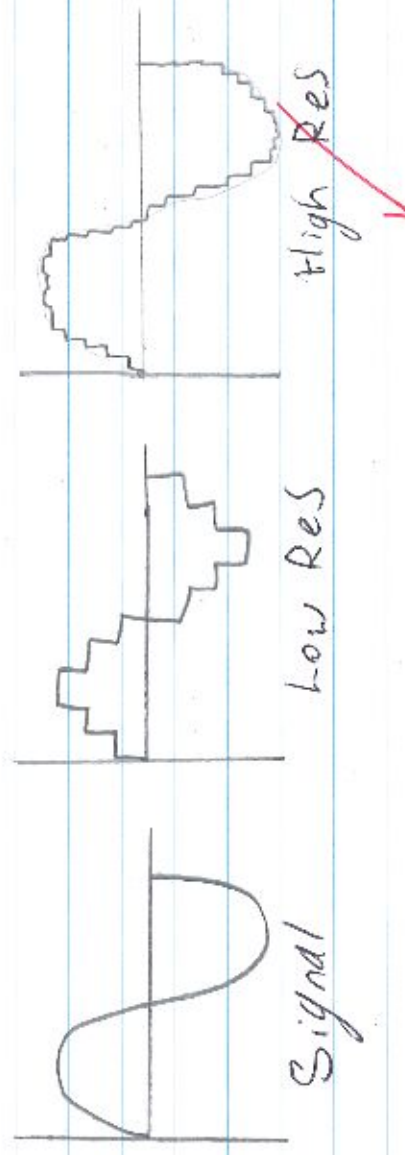
This works by having a value of R and $2R$ causing the voltage to half going through every one until the last one is an $\frac{1}{16}$ of the original voltage. a_3 is the MSP and a_0 is the LSP. If the max voltage was 15 and the digital signal was 1010 the output voltage would be $8 + 2 = 10$

5

B2 a)



the signal gets rounded to its nearest quantization level, the blue line represents the digital equivalent of the signal. the resolution is the amount of levels of quantisation, a higher resolution will increase the quality of the waveform as shown below.



b)

b)



As an analogue signal develops noise over distance the signal is varied and when used will be very unusable. With PCM it is resilient on a large change in the signal for each pulse so the slight noise on top of the signal won't effect what the end user sees.

2

c)

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

$$\text{Where } N = 2^n = 2^8 = 256$$

$$\text{in dB} = 20 \log(256) = 48.165 \text{ dB}$$

$$ii) q = \frac{\text{Voltage Range}}{N} = \frac{32}{256} = 0.125$$

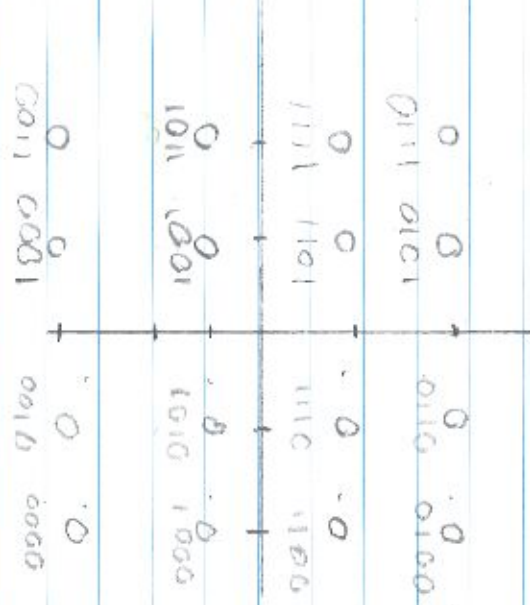
$$V_q = \frac{q}{\sqrt{12}} = \frac{0.125}{\sqrt{12}} = 0.036$$

$$SQNR = \frac{\text{RMS Signal Voltage}}{V_q} = \frac{4.7}{0.036} = 130.25$$

$$\text{in dB} = 20 \log 130.25 = 42.3 \text{ dB}$$

6

d



How will this modulates phase and Amplitude in a Single Code.

1101 will have a phase shift of 15° and reduces 0.75 of V_{max}
 1001 will have a phase shift of 45° and reduces 0.33 of V_{max}
 1000 will have a phase shift of 75° and reduces 0.75 of V_{max}
 1100 will have a phase shift of 45° and $1.5 V_{max}$

ASK



FSK



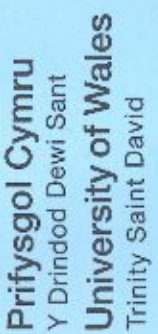
PSK



ASK - is amplitude Shift Keying this turns a bit if it goes over a Set Value

FSK - Frequency Shift Keying sets the bit high if there is a change in frequency

PSK - phase shift Keying sets a bit high if there is a change in phase



**Complete, fold and seal
(see note 2 below)**

SURNAME: MILNER

FORENAME(S): CHRIS

Examination Answer Books

12 Pages

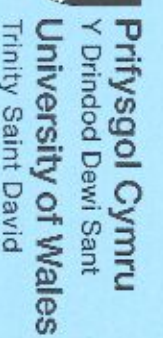
Instructions to Candidates

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.

[illegible]

1	Student Number	1602833
2	Title of Examination Paper	
3	Module Code	SGEE 5005
4	Date and Time of Examination	9/5/19 09:30
5	Examination Venue	G43
6	Seat Number	
7	Number of Answer Books handed in	

(Gweler yr ochr arall am y fersiwn Cymraeg)



Llyfr Atebion Arholiadau

12 Tüdalen

Cyfarwyddiadau i Ymgeiswyr

1. Rhwng yr holl wybodaeth y gofynnir amdani ym y blychau isod

3. Rhaid i'r atebion fod mewn llawysgrifen ddatllenadwy. Gall yr Arholwyr naill ai arwyddadu sgrïpt annatllenadwy, neu drefnu icddi gael ei theipio a chael yr ymgaisydd i dalu.
4. Ysgriennwch eich atebion mewn inc.
5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw fras nodiadau yn y llyfr atebion a thynnu llinell drowddynt.
6. Ni ddylid rhwyo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.
7. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda i' gilydd gan ddefnyddio i' tagiau sydd ar gael oddi wrth y gwyliwr/gwyliwyr.
8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd a llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliadau arholi o dan unrhyw amgylchiadau.

1	Rhif Myfyriwr	
2	Teitl y Papur Arholiad	
3	Cod y Modwl	
4	Dyddiad ac Amser yr Archoliad	
5	Lleoliad yr Arholiad	
6	Rhif Sedd	
7	Nifer y Llyfrau Atebion a gyflwynwyd	

[illegible]

(See the other side for English version)

**Llenwch, plygwch a seliwrch
(gweler nodyn 2 isod)**

CYFENW-

ENW(AU) CYNTAF:

Cyfanswm

(A) 1.

$$\lambda = \frac{3 \times 10^8}{210 \times 10^6} = 1.42 \text{ m} \quad \checkmark$$

(3)

2.

$$m = \frac{V_{\max} - V_{\min}}{V_{\max} + V_{\min}} = \frac{42 - 38}{42 + 38} = 0.05 \quad \checkmark$$

(3)

3.

$$5 \text{ MHz} \\ 300 \text{ kHz} - 3 \text{ kHz}$$

Upper side band ranges from 5.0003 MHz to 5.0031 MHz
Lower side band ranges from 4.9997 MHz to 4.997 MHz

(4)

4.

$$f_c = 60 \text{ MHz} \\ f_s = 2 \text{ kHz} \\ V_c = 6 \text{ V}$$

$$e = E_c \cos(\bar{\omega}_c t + m f_s \bar{\omega}_s t)$$

$$E_c = 6 \quad \bar{\omega}_c = 2\pi f_c = 2\pi \times 60 \times 10^6 = 376.99 \times 10^6 \text{ rad/s} \\ \bar{\omega}_s = 2\pi f_s = 2\pi \times 2 \times 10^3 = 12.56 \times 10^3 \text{ rad/s} \\ m f_s = \frac{40 \times 10^3}{2 \times 10^3} = 20 \quad \checkmark$$

(6)

$$\therefore e = 6 \cos(376.99 \times 10^6 t + 20 \sin 12.56 \times 10^3 t)$$

5.

$$50 \Omega \\ 170 + j58 \Omega$$

$$Z_0 = 50 \\ Z_L = 170 + j58$$

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

$$= \frac{170 + j58 - 50}{170 + j58 + 50} = \frac{120 + j58}{220 + j58}$$

$$120 + j58 \rightarrow \sqrt{120^2 + 58^2} \angle \tan^{-1} \frac{58}{120} = 133.3 \angle 25.8^\circ \\ 220 + j58 \rightarrow \sqrt{220^2 + 58^2} \angle \tan^{-1} \frac{58}{220} = 227.5 \angle 14.8^\circ$$

$$\therefore P_V = \frac{133.3 \angle 25.8^\circ}{227.5 \angle 14.8^\circ} = 0.59 \angle 11^\circ \quad \checkmark$$

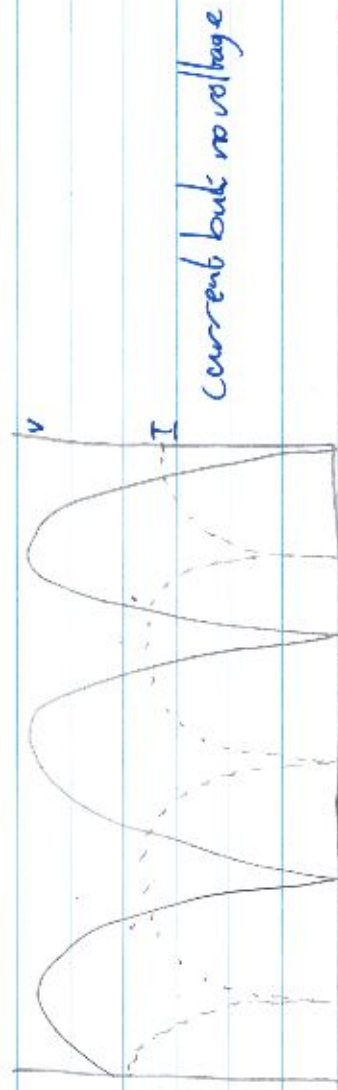
(8)

6.

The four special cases of load impedance on a transmission line are

- $Z_L = 0$ (short circuit)
- $Z_L = \infty$ (open circuit)
- $Z_L = Z_0$ (characteristic impedance)
- $Z_L \neq Z_0$ (not matched impedance)

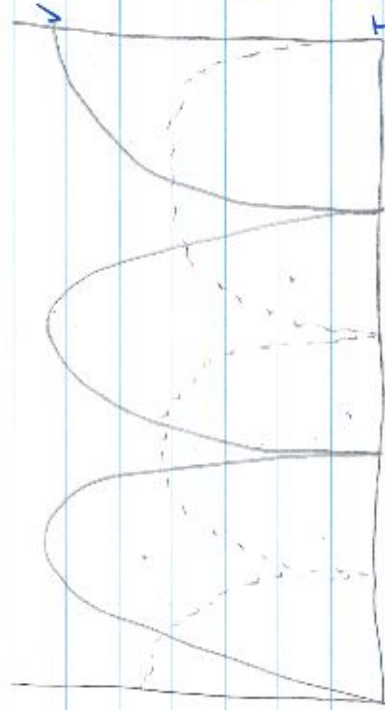
For $Z_L = 0$ ✓



current but no voltage

Short circuit = Power = 0 $\therefore$ All wave is reflected ✓

For $Z_L = \infty$ ✓



Voltage but no current

Open circuit = Power = 0 $\therefore$ All wave is reflected. ✓

For $Z_L = Z_0$ ✓

Impedances are matched $\therefore$ all energy is absorbed. ✓

For $Z_L \neq Z_0$ ✓

The load has an impedance but it doesn't match $\therefore$ some of the wave is reflected. ✓

$$\frac{1}{22.6} = 0.0625$$

(B1) ✓

91

ii

(8) ✓

$$b) PV = \frac{Z_L - Z_0}{Z_L + Z_0}$$

$$PV = \frac{85j120 - 75}{85j120 + 75}$$

$$= \frac{10j120}{160j120}$$

$$\frac{\sqrt{10^2 + 120^2} \angle \tan^{-1} \frac{120}{10}}{\sqrt{160^2 + 120^2} \angle \tan^{-1} \frac{120}{160}} = \frac{120.42 \angle 85.24^\circ}{200 \angle 36.87^\circ}$$

$$PV = 0.6 \angle 48.37^\circ$$

$$ii) VSWR = 1 + \frac{1}{PV} = 1.6 = 2.66$$

$$c) \Delta F_c$$

$$200 \text{ kHz}$$

$$10 \text{ kHz}$$

$$\text{For } 7.5 \text{ V message in - Carrier out} = 213 \text{ kHz}$$

$$\therefore \Delta F_c = 13 \text{ kHz}$$

$$ii) \beta = \frac{\Delta F_c}{f_s} = \frac{13}{10} = 1.3$$

iii)

b) An analogue signal is very susceptible to noise and once added the noise is difficult to remove resulting in signal degradation. With a PCM signal the system need only differentiate between a 1 and a 0. Making this simple distinction is much easier for a noisy signal.

$$c) DR = 20 \log_{10}(N) \quad N = 2^n = 256$$

$$1n \text{ dB} = 20 \log_{10} 256 = 48.16 \text{ dB}$$

$$i) q = \frac{32}{256} = 0.125$$

$$V_{QN} = \frac{q}{\sqrt{12}} = 0.0361$$

$$SQNR = \frac{4.7}{0.0361} = 130.19$$

$$ii) \text{indB } 20 \log 130.19 = 42.3 \text{ dB}$$

d.

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

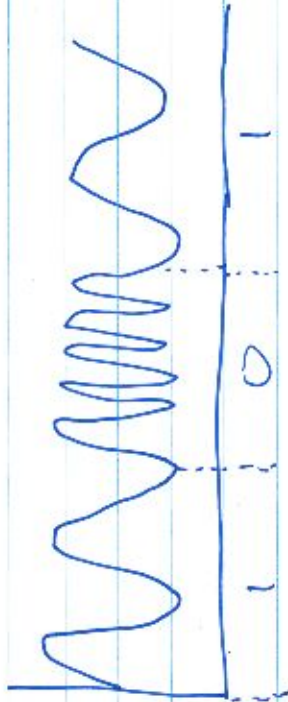
The 16-QAM system 4 '1' values & 4 '0' values are used to give 16 possible symbols from 0000 to 1111. It uses 3 phases & 3 amplitudes per quadrant. This means that QAM can shift amplitude & phase simultaneously.

e)

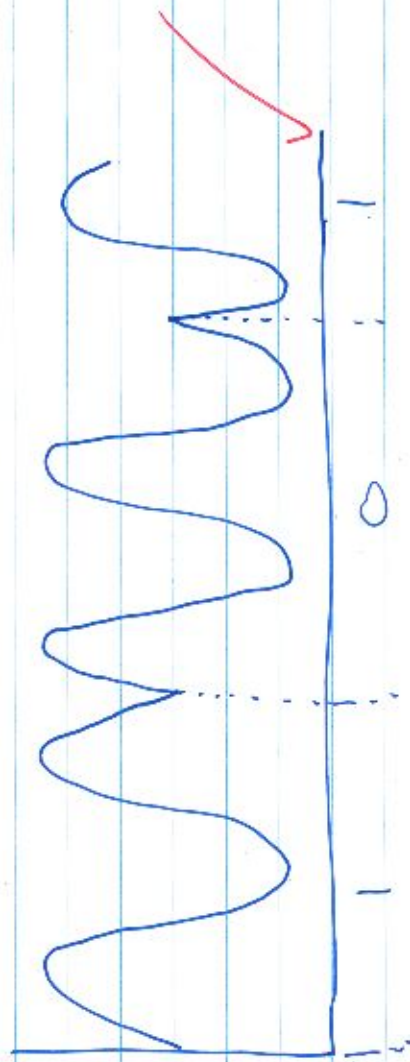
ASK
Amplitude shift keying uses a change in amplitude of signal to signify ones & zeros.

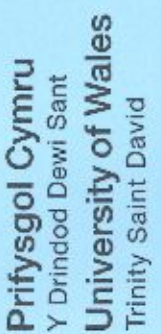


Fsk
Frequency shift keying uses a change in frequency to signify ones & zeros.



PSK
Phase shift keying uses a change in the phase of a wave to signify a change between ones & zeros.





**Complete, fold and seal
(see note 2 below)**

SURNAME: Kowe

FORENAME(S): Philip

12 Pages

Examination Answer Books

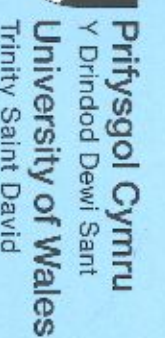
Instructions to Candidates

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.

[illegible]

1	Student Number	1602827
2	Title of Examination Paper	
3	Module Code	SGEE5005
4	Date and Time of Examination	9/5/19 9:30
5	Examination Venue	G43
6	Seat Number	
7	Number of Answer Books handed in	

(Gweler yr ochr arall am y fersiwn Cymraeg)



Llyfr Atebion Arholiadau

12 Tudalen

Cyfarwyddiadau i Ymgeiswyr

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwch eich enw yn y lle a ddarparwyd ar y dde, plygwch ef at selio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.
3. Rhaid i'r atebion fod mewn llawysgrifen ddatlenadwy. Gall yr Arholwyr naill ai anwybyddu sgrif arnatlenadwy, neu drefnu iddi gael ei threipio a chael yr ymgaisydd i dalu.
4. Ysgrifennwch eich atebion mewn inc.
5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw tras nodiadau yn y llyfr atebion a rhymu llinell drwyddynt.
6. Ni ddylid rhwgo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.
7. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwybwr/gwybywyr.
8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

Llenwch, plygwch a seliwch
(aweler nodyn 2 isod)

CYFENNYDD:

ENW(AU)CYNTAF:

1	Rhif Myfyriwr	
2	Teitl y Papur Arholiad	
3	Cod y Modwl	
4	Dyddiad ac Amser yr Arholiad	
5	Lleoliad yr Arholiad	
6	Rhif Seed	
7	Nifer y Llyfrau Atebion a gyflwynwyd	

[illegible]

(See the other side for English version)

B1

C

$$\text{frequency deviation} = f_{\text{max}} - f_c = 230 - 200 = 30 \text{ kHz}$$

$$\text{modulation index} = \beta = \frac{30}{10} = 3 \sqrt{15}$$

$$J_0 = 0.26 \times 30 = 7.8$$

$$J_1 = 0.34 \times 30 = 10.2$$

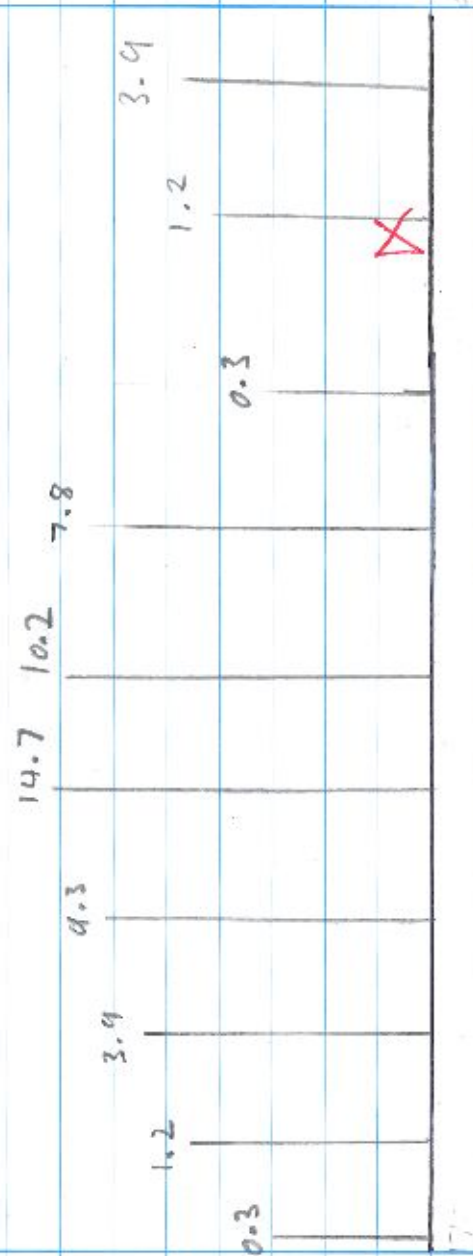
$$J_2 = 0.44 \times 30 = 14.7$$

$$J_3 = 0.31 \times 30 = 9.3$$

$$J_4 = 0.13 \times 30 = 3.9$$

$$J_5 = 0.04 \times 30 = 1.2$$

$$J_6 = 0.01 \times 30 = 0.3$$

~~| | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|
| 200 | 205 | 210 | 215 | 220 | 225 | 230 |
|-----|-----|-----|-----|-----|-----|-----|~~


①

$$20 = \frac{138}{\sqrt{k}} \log \frac{D}{d}$$

$$75 = \frac{138}{\sqrt{2.1}} \log \frac{D}{0.2}$$

$$75 = 95.23 \log \frac{D}{0.2}$$

$$\text{Anti-log} \frac{75}{95.23} = \frac{D}{0.2}$$

$$6.132 = \frac{D}{0.2}$$

$$D = \frac{6.132}{0.2} = 30.66$$

③①

$$M = \frac{v_{\max} - v_{\min}}{v_{\max} + v_{\min}} = \frac{22 - 6}{22 + 6} = 0.57$$

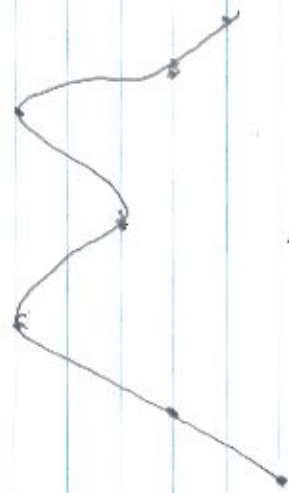
②

③

③②

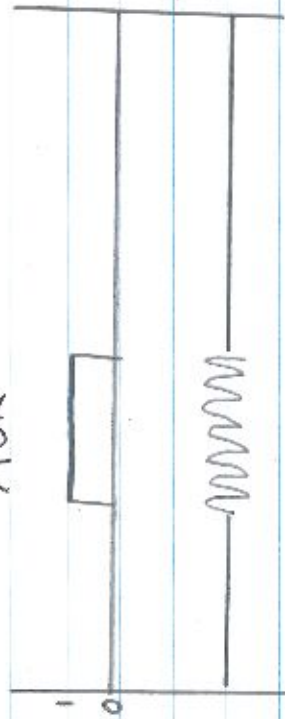
④

110
101
000
011
010
001
000



the term resolution means how many bits are used in order to make up the wave for example two resolution will mean less bits so the wave will not be smooth and will be of poor quality.

ASK



as ASK is where the amplitude is increased when a 1 is sent.



FSK is where the frequency is increased when a 1 is sent.

④

$$DR = 20 \log_{10}(N) \quad N = 2^8 = 256$$

$$20 \log_{10} 256 = 68.16 \text{ dB}$$

$$a = 32 / 256 = 0.8$$

$$V_{AN} = 0.8 / \sqrt{12} = 0.231$$

$$SQNR = 4.7 / 0.231 = 20.35 \text{ dB}$$

Ques 2

(A) 2th $m = \frac{V_m}{V_c} = \frac{40}{2} = 20$ ✓

(F) Subst $P_{\text{sub}} = \frac{1}{2} m^2$
 $= \frac{1}{2} 500^2 = 125000$ ✓

(A8) Quantisation is the ~~low~~ amount of points the wave has in it, this determines the smoothness of the wave. The quantisation error is the distance between these points.