北京郵電大學

Queen Mary University of London

Joint Programme examinations 2011/12

For examiner's use only

1	
2	
3	
4	
Total	

EBU5302 Telecoms Systems

Paper A

Time allowed 2hours 30 minutes

Answer ALL FOUR questions.

Complete the information below about yourself very carefully.

QM student number	
BUPT student number	
Class number	

Make and type of any electronic calculator you are using	

INSTRUCTIONS TO CANDIDATES

1. **You must not take answer books, used or unused, from the examination room.**
2. Write only in black or blue pen **and in English.**
3. **Write your answers in the space provided**
4. Do all rough work in the "Rough Working Section" – do not tear out any pages.
5. Write clearly so that it can be easily read.

Examiners

Prof Laurie Cuthbert
Dr Michael Chai
Dr Frank Gao

Filename: 1112_EBU5302_A No answerbook required

Question 1

a) A quantiser with maximum range ± 8V is built with an 8-bit A-D converter. The converter is coded so that there is a quantiser level at ± 8V and also at 0V. Assume the converter output is coded *P*xxxxxxx where *P*=1 for positive values and 0 for negative.

i) Calculate the quantisation interval *q* in mV.

ii) If a signal with power 100 mW is fed into the quantiser calculate the signal/distortion ratio (in dB) that would be obtained.

[8 marks]

b) Figure 1 shows the input blocks for the quantisation in a telephone Local Exchange.

i) State the name of Block A and Block B.

ii) Briefly explain the purpose of Block A and why it is essential.

iii) State the value of the main parameters for Block A and Block B.

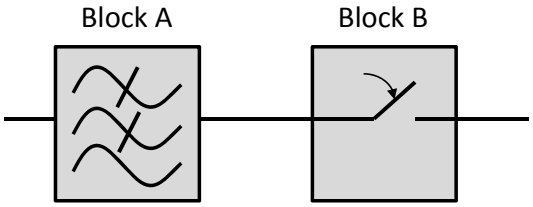


Figure 1

[8 marks]

c) Figure 2 shows a very simplified diagram of an ADSL connection.

i) Explain why the data is separated from the telephony signal and is not put through the A-law converter.

ii) Calculate (approximately) the maximum data rate that could be obtained if the data signal was passed through the A-law converter.

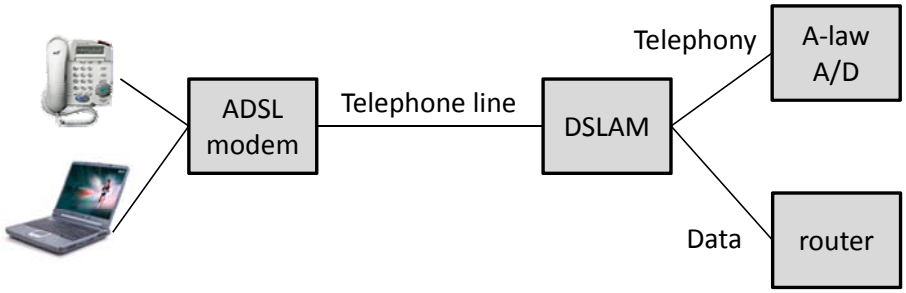


Figure 2

[6 marks]

d) If the maximum rate for a delta modulator is given by $\frac{\Delta}{T_s} \geq \max\left|\frac{dv(t)}{dt}\right|$ where Δ is the step size, T_s the sampling period, calculate the value of delta if $T_s = 10\mu s$ and $v(t) = 2 \sin (2\pi\ 10^3\ t)$

[3 marks]

Write your answers on the next 3 pages

Answers to Question 1

	Do not write in this column
a)	
	8 marks
b)	
i) Name of Block A:	**1 mk**
Name of Block B:	**1 mk**
ii) Purpose of Block A	

	Do not write in this column
	4 marks
iii) Value of main parameter for Block A	**1 mk**
Value of main parameter for Block B	**1 mk**
c)	

	Do not write in this column
	6 marks
d) If the maximum rate for a delta modulator is given by $\frac{\Delta}{T_s} \geq \max\left\|\frac{dv(t)}{dt}\right\|$ where Δ is the step size, T_s the sampling period, calculate the value of delta if $T_s = 10\mu s$ and $v(t) = 2 \sin (2\pi\ 10^3\ t)$	
	3 marks

Question 2

a) A packet of 1024 bits is to be transmitted over a link between London and Beijing that has a bit error probability p of 10^{-6}. Calculate the probability of the packet being in error for:

i) No error correction

ii) 1-bit error correction

iii) 2-bit error correction

[6 marks]

b) The packet in (a) is to be protected by single-bit error correction. Calculate the number of check bits that need to be added to the 1024 data word in order to give this correction capability.

[4 marks]

c) ARQ error correction is to be used on this link and there is no FEC so the packet size is 1024. Assume the one-way propagation time is 25ms, the bit rate on the link is 1Mbit/s and the length of an ACK packet can be neglected.

i) Calculate the effective information transfer bit rate if stop and wait transmission is used.

ii) Calculate the minimum window size in number of packets for a sliding window protocol to be used.

[5 marks]

d) The sliding window is set up so there is no timeout of the window (with the minimum size) and the only retransmissions are caused by errors in the packets. Assume that retransmissions can be modelled by a 1st order approximation. Calculate:

i) The effective bit rate when there is no error protection within the packet.

ii) The effective bit rate when there is single-bit FEC within the packet.

[8 marks]

e) Recalculate the effective bit rate of (d)(i) if the retransmissions are modelled as a second order approximation – i.e. some of the retransmissions have to be retransmitted.

[2 marks]

Write your answers on the next 3 pages

Answers to Question 2

	Do not write in this column
a)	
	6 marks
b)	

	Do not write in this column
	4 marks
c)	
	5 marks

	Do not write in this column
d)	
	8 marks
e)	
	2 marks

Question 3

a) Explain why equaliser is needed at the receiver and how a three-tap zero forcing equaliser works.

[7 marks]

b) Figure 3 shows an eye diagram of a transmission signal.

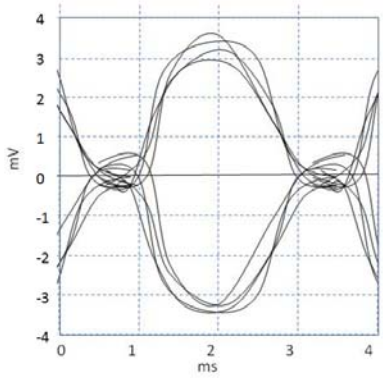


Figure 3

i. With reference to Figure 3 explain how the signal quality can be identified from the eye diagram.

ii. Calculate the peak signal to ISI ratio of this signal (in dB).

iii. Suggest, with justifications, an initial sampling time, T_0 for this signal.

[8 marks]

c) A synchronous transmission system using cable with 28 dB attenuation per km and regenerative repeaters every 10 km is affected by additive Gaussian noise. A binary bipolar line-code is used with equally spaced detection thresholds at the sampling points.

i) How much voltage gain (in dB) is required by the repeater to produce an error probability of 10^{-7} ?

ii) If the repeater gains cannot be increased because of the interference to other lines, explain and calculate how can the error probability be reduced from its current value of 10^{-5} to 10^{-7} ?

(Use the graph of Q(z) against z which located at the end of the exam paper).

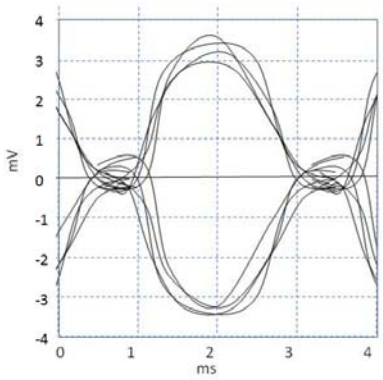
[10 marks]

Write your answers on the next 3 pages

Answers to Question 3

	Do not write in this column
a)	
	7 marks
b)	

Do not write in this column



Copy of Figure 3

8 marks

c)

i)

	Do not write in this column
ii)	
	10 marks

Question 4

a) A sine wave is to be used for two different signalling schemes:

i) PSK;

ii) QPSK.

The duration of a signal element is 10^5 s. If the received signal is of the following form,

$$s(t) = 0.005\sin(2\pi 10^6 t + \theta) \quad \text{volts}$$

and if the measured noise power at the receiver is 2.5×10^{-8} watts, determine E_b/N_0 in dB for each case.

[8 marks]

b) The following table illustrates the operation of an HFSS system for one complete period of the PN sequence.

Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Input data	0	1	1	1	1	1	1	0	0	0	1	0	0	1	1	1	1	0	1	0
Frequency	f_1		f_3		f_{27}		f_{26}		f_8		f_{10}		f_1		f_3		f_2		f_2	
PN Sequence	001				110				011				001				001			

To determine:

i) What is the period of the PN sequence?

ii) The system makes use of a form of FSK. What form of FSK is it?

iii) What is the number of bits per symbol?

iv) What is the number of FSK frequencies?

v) What is the length of a PN sequence per hop?

vi) Is this a slow or fast FH system?

vii) What is the total number of possible hops?

viii) Show the variation of the dehopped frequency with time.

[9 marks]

c) Frequency reuse improves the SNR from co-channel interference but reduces the capacity in each cell; diversity also improves SNR by up to about 6dB. Using a **mathematical approach**, explain how adding diversity to 3-cell cluster can give the same overall SNR from co-channel interference as a 7-cell cluster, but gives more capacity in each cell.

[8 marks]

Write your answers on the next 3 pages

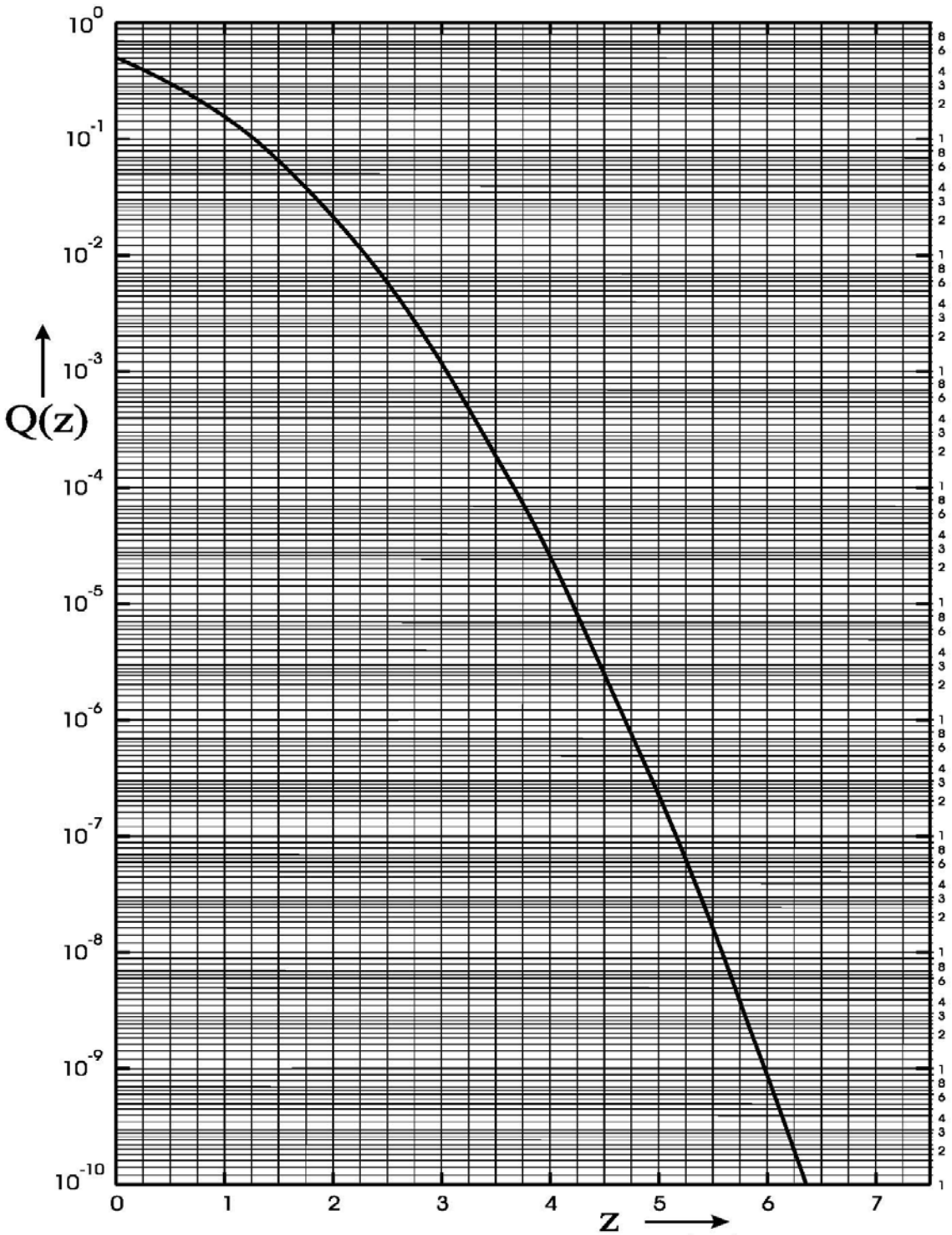
Answers to Question 4

	Do not write in this column
a)	**8 marks**

	Do not write in this column
b)	**9 marks**

	Do not write in this column
c)	**8 marks**

Question marking: $\frac{}{8} + \frac{}{9} + \frac{}{8} = \frac{}{25}$



Graph of Complementary Error function, $Q(z) = \int_{z}^{\infty} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{t^2}{2}\right) dt$

Rough Working Only

Rough Working Only

Rough Working Only

Rough Working Only