



北京邮电大学

EBU5302 A

Complete the information below about yourself very carefully.

QM student number

BUPT student number

Class number

Joint Programme Examinations 2018/19

For examiners' use only

EBU5302 Telecommunications Systems

Paper A

Answer ALL questions

1	
2	
3	
4	
Total	

Only regular scientific calculator allowed. No SMART PHONE calculator is ALLOWED.

Make and type of any electronic calculator you are using _____

INSTRUCTIONS

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. Do all rough work in the answer book – do not tear out any pages.
4. If you use Supplementary Answer Books, tie them to the end of this book.
5. Write clearly and legibly.
6. Read the instructions on the inside cover.

Examiners

Dr Yuanwei Liu, Dr Yan Sun

Instructions

Before the start of the examination

- 1) Place your BUPT and QM student cards on the corner of your desk so that your picture is visible.
- 2) Put all bags, coats and other belongings at the back/front of the room. All small items in your pockets, including wallets, mobile phones and other electronic devices must be **placed in your bag in advance. Possession of mobile phones, electronic devices and unauthorised materials is an offence.**
- 3) Please ensure your mobile phone is switched off and that no alarm will sound during the exam. **A mobile phone causing a disruption is also an assessment offence.**
- 4) Do not turn over your question paper or begin writing until told to do.

During the examination

- 1) You must not communicate with or copy from another student.
- 2) If you require any assistance or wish to leave the examination room for any reason, please raise your hand to attract the attention of the invigilator.
- 3) If you finish the examination early you may leave, but not in the first 30 minutes or the last 10 minutes.
- 4) For 2 hour examinations you may **not** leave temporarily.
- 5) For examinations longer than 2 hours you **may** leave temporarily but not in the first 2 hours or the last 30 minutes.

At the end of the examination

- 1) You must stop writing immediately – **if you continue writing after being told to stop, that is an assessment offence.**
- 2) Remain in your seat until you are told you may leave.

Question 1

Let $x(t)$ be a band-limited signal with bandwidth $W = 30\text{kHz}$. Signal $x(t)$ is sampled at a rate 50% higher than the Nyquist rate to provide a guard band. $x(t)$ is quantised by a uniform quantiser $Beta$. Symbol A to H represent the amplitudes produced by the quantiser. The probability $P(m)$ of each symbol is shown in the following table. Here $P(m)$ is defined as the probability of each symbol m .

Table 1

Symbol	A	B	C	D	E	F	G	H
$P(m)$	0.1	0.3	0.08	0.25	0.03	0.05	0.18	0.01

- a) What is the minimum sampling rate that avoids aliasing for $x(t)$?

[2 marks]

	Do not write in this column
	2 marks

- b) Design a Huffman code for the information produced by *Beta*. Please explain the principles of source coding with the designed code.

[8 marks]

[illegible]

[illegible]

c) What is the average number of bits to be transmitted of the designed Huffman code?

[2 marks]

[illegible]

- d) What is the information content of the symbols produced by *Beta*? What is the source entropy of the sequence of symbols?

[4 marks]

[illegible]

- e) What is the maximum entropy of the discrete source that produces 8 symbols? What is the source efficiency of the sequence produced by *Beta*? What is the code efficiency for the designed Huffman coding scheme?

[3 marks]

[illegible]

- f) Explain the Sampling Theorem with appropriate diagrams (Please explain both from time domain and frequency domain). Based on the frequency domain diagram, please use diagrams to explain why it is easier to design a simple filter with the aid of applying oversampling.

[6 marks]

[illegible]

[illegible]

Question marking: $\frac{-}{2} + \frac{-}{8} + \frac{-}{2} + \frac{-}{4} + \frac{-}{3} + \frac{-}{6} = \frac{-}{25}$

Question 2

- a) Two binary random variables X and Y are distributed according to the joint PMF (Probability Mass Function) given by

$$\begin{aligned} P(X=0, Y=1) &= \frac{1}{4}; \\ P(X=1, Y=1) &= \frac{1}{2}; \\ P(X=0, Y=0) &= \frac{1}{4}. \end{aligned}$$

Determine $H(X, Y)$, $H(X)$, $H(Y)$, $H(X/Y)$, $H(Y/X)$ and $I(X;Y)$.

[11 marks]

[illegible]

[illegible]

b) Given (5,2) code defined as below, what can you tell when a sequence $r=10101$ received?

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 1 \end{bmatrix}$$

[14 marks]

[illegible]

[illegible]

[illegible]

Question marking: $\frac{1}{11} + \frac{1}{14} = \frac{1}{25}$

[illegible]

[illegible]

- b) Sketch roughly the PSDs and find their bandwidths. For each case, compare the bandwidth to the case where $p(t)$ is a half-width rectangular pulse.

[8 marks]

[illegible]

[illegible]

Question marking: $\frac{\quad}{17} + \frac{\quad}{8} = \frac{\quad}{25}$

- a) A multilevel digital communication system is to operate at a data rate of 15 kbits/s. If 4-bit words are encoded into each level for transmission over the channel, what is the minimum required bandwidth for the channel?

[4 marks]

[illegible]

- b) What are FDMA, TDMA and CDMA? You may want to use diagrams to illustrate your answers. What are the corresponding application scenarios for FDMA, TDMA, and CDMA (which generations of communications systems)? What are the key features for each of them?

[12 marks]

[illegible]

[illegible]

- 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 a 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.

[9 marks]

[illegible]

[illegible]

Question marking: $\frac{-}{4} + \frac{-}{12} + \frac{-}{9} = \frac{-}{25}$

Use this section for rough work

Do not
write in
this
column

2018-19-1

Rough Working

Page 26 of 29

Use this section for rough work

Do not
write in
this
column

2018-19-1

Rough Working

Page 27 of 29

Use this section for rough work

Do not
write in
this
column

2018-19-1

Rough Working

Page 28 of 29

Use this section for rough work

	Do not write in this column

2018-19-1

Rough Working

Page 29 of 29