



北京邮电大学

# EBU5302 B

Complete the information below about yourself very carefully.

QM student number

BUPT student number

Class number


Joint Programme Examinations 2019/20

For examiners' use only

EBU5302 Telecommunications Systems

Paper B

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. Md Hasanuzzaman Sagor

# 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

- a) Explain the methods of circuit switching and packet switching, and identify the main advantage and the main disadvantage of each method.

**[4 marks]**

[illegible]

- b) A music signal  $x(t)$  has a bandwidth of 10 kHz. Signal  $x(t)$  is sampled at a rate 30% higher than the Nyquist rate to provide a guard band.  $x(t)$  is quantised by a uniform quantiser  $Q$ . Symbol A to H represent the amplitudes produced by the quantiser. The probability pm of each symbol is shown in the following table:

Table 1

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

- i) What is the minimum sampling rate for  $x(t)$ ? [2 marks]
- ii) Design a Huffman code for the information produced by  $Q$ . Please explain the principles of source coding with the designed code. [7 marks]
- iii) What is average number of bits to be transmitted of the designed Huffman code? [2 marks]
- iv) What is the information content of  $x(t)$ ? What is the source entropy of  $x(t)$ ? [4 marks]
- v) What is the maximum entropy of  $x(t)$ ? What is the source efficiency of  $x(t)$ ? [4 marks]
- vi) What is the code efficiency for  $x(t)$ ? [2 marks]

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[illegible]

[illegible]

[illegible]

**Question marking:**  $\frac{-}{4} + \frac{-}{21} = \frac{-}{25}$

## Question 2

- a) Consider an AWGN channel with bandwidth 50MHz, received signal power 10mW, and noise PSD (power spectral density)  $N_0/2$ , where  $N_0 = 2 \cdot 10^{-9}$  W/Hz. How much does capacity increase by doubling the received power? How much does capacity increase by doubling the channel bandwidth?

**[6 marks]**

[illegible]

[illegible]

b) Consider a (7,4) code with generator matrix:

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

- i) Find all the codewords of the code. **[8 marks]**
- ii) What is the minimum distance of the code? **[1 mark]**
- iii) Find the parity check matrix of the code. **[4 marks]**
- iv) Find the syndrome for the received vector  $\mathbf{y} = [1101011]$ . **[6 marks]**

[illegible]



[illegible]

[illegible]

**Question marking:**  $\frac{6}{6} + \frac{1}{19} = \frac{1}{25}$

- i) ideal filtering
- ii) filtering with ISI
- iii) noise plus ISI polar NRZ

[illegible]

[illegible]

- b) What important information eye patterns can provide about the characteristics of a signal? Briefly explain them.

**[4 marks]**

[illegible]

- c) Calculate the autocorrelation function  $R(k)$  of the polar NRZ signalling assuming bit to bit data independence and equally likely occurrence of two voltage levels.

**[7 marks]**

[illegible]

	<b>7 marks</b>

- d) A random binary data sequence 110100101... is transmitted by using a Manchester (split-phase) line code with the pulse  $p(t)$  shown below. Sketch the wave form  $y(t)$ .

$$p(t) = \text{rect}\left(\frac{t + T_b/4}{T_b/2}\right) - \text{rect}\left(\frac{t - T_b/4}{T_b/2}\right)$$

[5 marks]

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	<b>5 marks</b>

- e) List two methods to improve the inter-symbol interference (ISI).

[2 marks]

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**Question marking:**  $\frac{7}{7} + \frac{4}{4} + \frac{7}{7} + \frac{5}{5} + \frac{2}{2} = \frac{25}{25}$

a) What are FDMA, TDMA, CDMA and OFDMA? You may want to use diagrams to illustrate your answers. What are the key features and applications for each of them?

[illegible]

[illegible]

b) Draw a block diagram to show how an OFDM demodulator works.

**[9 marks]**

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[illegible]

[illegible]

- c) Determine the isotropic free space loss at 4GHz for the shortest path for a point-to-point system. The shortest path from the transmitter to the receiver is 35853 km.

**[4 marks]**

[illegible]

[illegible]

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

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Rough Working

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