北京郵電大學

Queen Mary University of London

For examiners' use only

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Total	

EBU5504 A

Joint Programme Examinations 2018/19

EBU5504 Networks and Protocols

Paper A

Time allowed 2 hours

Answer ALL questions

Complete the information below about yourself very carefully.

QM student number										
BUPT student number										
Class number										

INSTRUCTIONS

1. **You must NOT take answer books, used or unused, from the examination room.**
2. Write only with a 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 Zhijin Qin, Dr Adnan Kiani

Filename: 1819_EBU5504_A No answer book required

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) Draw all the layers of the OSI network stack and the TCP/IP reference model showing how they are related.

[5 marks]

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	5 marks

b) A small company has four departments namely Engineering, Business, Human Resources, and IT. All the departments have their own network topologies.

i. Engineering department has five computers connected in a ring topology.
ii. Business department has four computers connected in a mesh topology.
iii. HR department has five computers connected in a bus topology.
iv. IT department has four computers connected in a star topology.
v. Further, all the departments are connected with each other in a tree topology.

Construct a topology for the company's network showing links amongst computers in each department and how they are connected in a Hybrid Topology.

[5 marks]

	Do not write in this column
	5 marks

c)

i. Power conservation is an important factor in IoT Networks. List down two techniques that help to improve power management in IoT Networks. **(2 marks)**

ii. List down the three challenges for large scale deployment of IoT. **(3 marks)**

[5 marks]

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	5 marks

d)

i. In CSMA/CD protocol, a truncated exponential back-off mechanism is employed after collisions. Explain how this mechanism works. **(3 marks)**

ii. Consider a CSMA/CD protocol designed with one-way propagation delay of 2msec and a bit rate of 1Mbps. Explain why a minimum size frame condition must be imposed and calculate the size of this minimum frame. **(5 marks)**

iii. What is the main drawback of using TDMA for medium access. **(2 marks)**

[10 marks]

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Do not write in this column

10 marks

Question marking: $\frac{\quad}{5}+\frac{\quad}{5}+\frac{\quad}{5}+\frac{\quad}{10}=\frac{\quad}{25}$

Question 2

a)

i. Describe the role of preamble field in an Ethernet frame. **(2 marks)**

ii. Gigabit Ethernet supports frame bursting. Explain how frame bursting results in collision reduction. **(3 marks)**

[5 marks]

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	5 marks

b)

i. In IEEE 802.11 based networks, channel access is regulated through the use of SIFS and DIFS intervals. Explain the procedure. **(3 marks)**

ii. What is the hidden terminal problem and how is it overcome in CSMA/CA protocol. **(3 marks)**

iii. What does PIFS stand for in CSMA/CA mechanism**.** **(2 marks)**

[8 marks]

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	8 marks

c)

i. Overhearing and Idle listening are two important factors in Wireless Sensor Network (WSN) MAC layer. Explain what they are. **(2 marks)**

ii. In Sensor-MAC (S-MAC) protocol, nodes periodically sleep to conserve energy. What is the major drawback in this procedure and how does T-MAC overcome it. **(2 marks)**

[4 marks]

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d)

i. In 802.15.4 based networks, devices can be categorized into two classes. Name the classes and describe the features of devices belonging to each class. **[4 marks]**

ii. Name the two Network Topologies supported by 802.15.4. **[2 marks]**

iii. In 802.15.4 PAN optional super frame, what is the role of network beacon field. **[2 marks]**

[8 marks]

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	8 marks

Question marking: $\frac{-}{5} + \frac{-}{8} + \frac{-}{4} + \frac{-}{8} = \frac{--}{25}$

Question 3.

a) Explain briefly the source of transmission impairment after signals travel through the transmission medium.

[3 marks]

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	3 marks

b) Let $x(t)$ be a continuous-time signal of bandwidth W=1 kHz, amplitude $0 \leq x(t) \leq 1$. Signal $x(t)$ is digitised as follows. Firstly, $x(t)$ is sampled at a rate higher than the Nyquist rate to provide a guard band of 500 Hz. Then, the sampled signal is quantised by a 3-bit uniform quantiser, resulting in the digital sequence $x_Q[n]$. If each symbol is coded by a sequence of 3 bits, determine the bit rate resulting from digitizing x(t).

[5 marks]

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	5 marks

c) A signal $y(t)$ has a bandwidth of 30kHz. $y(t)$ is quantised by a uniform quantiser *Alpha*. Symbol A to D represent the amplitudes produced by the quantiser. The probability P(m) of each symbol is shown in the following table:

Table 1

Symbol	A	B	C	D
P(m)	0.18	0.49	0.24	0.09

i. Obtain the information content of $y(t)$ and entropy of the information source under the probabilities in Table I.

(6 marks)

ii. Design a Huffman code for the information produced by *Alpha* and calculate the average code length.

(7 marks)

iii. Calculate the maximum entropy of y(t) as well as the source efficiency of y(t).

(4 marks)
[17 marks]

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	17 marks

Question marking: $\frac{}{3} + \frac{}{5} + \frac{}{17} = \frac{}{25}$

Question 4

a) This question concerns baseband modulation. An 8-PAM communication system employs rectangular pulses of duration of $T_S = 1$ s and amplitudes -7A, -5A, -3A, -A, A, 3A, 5A and 7A to transmit the binary sequences 000, 001, 010 … 110 and 111, respectively.

a. Draw the PAM signal corresponding to the binary sequence S=110000111011. You can take as the start of the PAM signal the time instant t = 0 s. **(3 marks)**

b. Draw the signal constellation and calculate the distance between symbols. **(3 marks)**

[6 marks]

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	6 marks

b) A digital information source produces binary sequences at a rate of 1 kbps. The probability of producing the value 0 is the same as the probability of producing the value 1. In order to protect the information against errors caused during transmission, Hamming code is employed in this system. The following parity check matrix H has been obtained by using Hamming algorithm:

$$\mathbf{H} = \begin{pmatrix} 1 & 1 & 1 & 0 & h_0 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & h_1 & 0 & 1 & 1 & 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & h_2 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & h_3 & 1 & 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{pmatrix}$$

and corresponds to a (n, k) Hamming code.

i. Determine the entropy of the digital information source and the channel capacity. **(6 marks)**

ii. Determine n and k, the code rate R_C, the missing column in **H** and the generator matrix **G**.

(7 marks)

iii. Hamming codes belong to the family of linear block codes. Explain the property of linearity and check that code words 111111111111111 and 111110000001100 satisfy such property.

(6 marks)

[19 marks]

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

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