**BEng Course B38CN: Introduction to Communications and Networks**

**<u>Coursework Exercises</u>**

**Semester 2020/2021**

# Instructions:

1. You need to answer all the four questions. These will contribute to 55% of the final coursework marking.

2. It is preferable that your solutions are **typed** and printed in A4 papers.

3. Plagiarism issues should be avoided! Please refer to the Disciplinary

Procedures of the University: http://www.hw.ac.uk/registry/Discipline.php.

# Questions:

1. (a) Describe three advantages of digital transmission over analog transmission?

(3)

(b) Is Nyquist theorem true for optical fiber or only for a copper wire?

(3)

(c) How many frequencies does a full-duplex QAM-64 modem use?

(2)

(d) Describe the main differences between circuit switching, message switching, and packet switching.

(6)

(e) Explain the difference between unacknowledged connectionless service and acknowledged connectionless service in the data link layer. How do the protocols that provide these services differ?

(4)

(f) Briefly describe the virtual circuits and datagrams.

(3)

(g) Explain the principles of 1-persistent Carrier Sense Multiple Access (CSMA) and *p*-persistent CSMA protocols.

(4)

2. (a) The 66 low-earth orbit satellites in the Iridium project are divided into six north-south necklaces around the earth. At the altitude they are using, the period is 90 minutes. What is the average interval for handoffs for a stationary transmitter on the ground?

(4)

(b) An audio digitizing utility in a PC is used to sample an input audio signal at the Nyquist sampling rate of 24000 samples/s.
(i) What is the bandwidth of the input audio signal?

有问题（不应该是最大带宽？）

(2)

(ii) If 64 quantization levels are used to approximate audio signal samples, calculate the bit rate of the digitized signal.

(2)

(iii) What is the required file size to record 20 seconds of the digitized signal?

(2)

(c) Suppose that the maximum pulse rate at which pulses can be transmitted through a baseband transmission channel with no intersymbol interference is 8000 pulses/s.
(i) Calculate the bandwidth of the baseband channel.

(2)

(ii) Suppose each pulse is represented by 2 bits. Calculate the resulting bit rate of the system.

(2)

(iii) Suppose the maximum reliable transmission rate over the above baseband channel is 16 kbps. What is the required signal-to-noise ratio (SNR) to achieve this rate? Represent the SNR in dB.

(4)

(d) Sometimes when a mobile user crosses the boundary from one cell to another, the current call is abruptly terminated, even though all transmitters and receivers are functioning perfectly, why?

(2)

(e) Compare the delay in sending an x-bit message over a $k$-hop path in a circuit-switched network and in a (lightly loaded) packet-switched network. The circuit setup time is $s$ sec, the propagation delay is $d$ sec per hop, the packet size is $p$ bits, and the data rate is $b$ bps. Under what conditions does the packet network have a lower delay?

(5)

3. (a) Suppose the standard Cyclic Redundancy Check (CRC) method is used to transmit a frame 10011101. The generator polynomial is $G(x) = x^3+1$.

(i) Show the checksummed frame to be transmitted.

(6)

(ii) Suppose the bit string 10111101100 is received after transmission. Is there any transmission error? If so, show how the errors are detected at the receiver's end.

(4)

(b) The following table shows how parity bits $b_1$, $b_2$, $b_4$, and $b_8$ are used in an even-parity (11, 7) Hamming code.

| | $b_1$ | $b_2$ | $b_3$ | $b_4$ | $b_5$ | $b_6$ | $b_7$ | $b_8$ | $b_9$ | $b_{10}$ | $b_{11}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | x | | x | | x | | x | | x | | x |
| 2 | | x | x | | | x | x | | | x | x |
| 4 | | | | x | X | x | x | | | | |
| 8 | | | | | | | | x | x | x | x |

(i) Suppose a binary bit string "1110101" is to be encoded using this Hamming code. What is the bit string after encoding?

(2)

(ii) Suppose the bit string "00111111000" is received at the receiver. Is there any transmission error? If so, what is the most likely encoded bit string at the transmitter? What is the original bit string before the encoding?

(8)

(c) Explain the difference between connection-oriented acknowledged service and

connectionless acknowledged service. How do the protocols that provide these services differ?

(5)

4. (a) Consider the delay of pure ALOHA versus slotted ALOHA at low load. Which one is less? Explain your answer.

(2)

(b) Assume that there are exactly $N$ stations in a LAN using a bit-map protocol. The frame size of all the stations is $d$ bits. How long (in bit times) does a station, $s$, have to wait in the worst case before it can start transmitting its frames?

(4)

(c) Sixteen stations, numbered 1 through 16, are contending for the use of a shared channel by using the adaptive tree walk protocol. If stations 2, 4, 5, 8, 12, and 13 suddenly become ready at once, how many bit slots are needed to resolve the contention?

(7)

(d) Evaluate the delay and channel efficiency properties of both contention protocols and collision-free protocols in the Medium Access Control (MAC) sublayer.

(4)

(e) Why does UDP exist? Would it not have been enough to just let user processes send raw IP packets?

(4)

(f) What is the minimum TCP segment size? What are the common uses of TCP segments of the minimum size?

(2)

(g) What is the major difference between a reliable byte stream and a reliable message stream?

(2)