UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION
SEPTEMBER 2023 SEMESTER

COURSE : EDB3023/EEB4063 - DATA & COMPUTER NETWORK

DATE : 1 DECEMBER 2023 (FRIDAY)

TIME : 9.00 AM - 12.00 NOON (3 HOURS)

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
5. **DO NOT** open this Question Booklet until instructed.

Note :

i. There are **TEN (10)** pages in this Question Booklet including the cover page .

ii. **DOUBLE-SIDED** Question Booklet.

1. a. You are a logistics manager overseeing operations at a busy seaport responsible for handling both passenger ferries and cargo ships. Your goal is to optimize the processes involved in passenger embarkation/disembarkation, cargo loading/unloading, and vessel departure/arrival to improve efficiency and customer satisfaction. By using the concept of layered protocol, design and sketch a protocol layering for the logistics and handling processes. The layers must be in order, to include source/destination and other processes such as embarkation/disembarkation, cargo loading/unloading, and vessel departure/arrival.

[4 marks]

b. Based on the basic properties of Transmission Control protocol (TCP) and User Datagram Protocol (UDP), determine the suitable protocol that should be used for the following applications. Briefly justify your reasons.

i. Periodic transmission of sensor data (e.g. temperature).

[3 marks]

ii. Real-time audio transmission.

[3 marks]

c. In a complex industrial environment with numerous sources of potential interferences, such as electrical motors and wireless devices, you are tasked with making a critical decision regarding the choice of twisted pair cable for data transmission. Shielded Twisted Pair (STP) and Unshielded Twisted Pair (UTP) are two available options.

i. Justify the suitable type of twisted pair that will give a better performance.

[3 marks]

ii. Discuss the challenges and any other trade-offs considerations that should be included in your decision.

[3 marks]

d. Signal-to-Noise Ratio (SNR) is a strength measurement of a desired signal relative to the background noise. Suppose that a digitized TV picture is to be transmitted from a source that uses a matrix of 900 x 1200 picture elements (pixels), where each pixel can take one of 32 intensity values. Assume that 30 pictures are sent per second.

i. Determine the source rate.

[3 marks]

ii. Assume that the TV picture is now to be transmitted over a channel with 3.5 MHz bandwidth and a 45 dB SNR. Determine the capacity of the channel.

[3 marks]

e. For a parabolic reflective antenna, the gain is found to be 45.46 dB. Determine the diameter of the parabolic reflective antenna if the operating frequency of the antenna is 12 GHz. Assume that the effective area, A_e, is 0.56 of the antenna area.

[3 marks]

2. a. Decode and sketch the timing diagrams for the following binary data "101000011000011" to signals using the following methods.

i. Differential Manchester (Note: Most recent preceding bit 1 has a high to low voltage).

[3 marks]

ii. High-Density Bipolar 3-zeros (HDB3) (Note: Most recent preceding bit 1 has negative voltage and odd number of 1s since last substitution).

[3 marks]

b. By using illustration, describe the Pulse Code Modulation (PCM) process and justify why PCM is the preferred modulation choice compared to Delta Modulation (DM).

[4 marks]

c. Parity checking is a simple method of detecting errors. The Two Dimension parity scheme is much more robust than the single even parity checking scheme. By designing a new two-dimension odd parity checking scheme with 5 x 6 matrix array size, with parity bits included, describe how a single bit-error can be correctable.

[5 marks]

d. Error control refers to a mechanism for detecting and correcting errors that occur in data transmission. Cyclic Redundancy Check (CRC) scheme is one of the most powerful error-detecting mechanisms. A decimal number, 653, is to be transmitted from station A to B in a network as a binary number. The pre-determined divisor accepted by both stations is $X^5+X^4+X^2+1$.

i. By using CRC Polynomial Long Division method, generate the Frame Check Sequences (FCS) and the message that should be transmitted from A to B.

[5 marks]

ii. Suppose the fifth bit from the left is inverted during transmission. By using Modulo Two CRC method, evaluate if there is any error detected at receiver's end. Justify your answer.

[5 marks]

3. a. Flow control is one of the important functions of a data link layer. Assume a 3-bit sequence is used in a sliding window flow control protocol (maximum window size is 6). The current state of a source node is, Last frame ACK_{ed} = 2 and the Last frame transmitted = 5.

i. Determine the initial value of the current window size.

[2 marks]

ii. The node transmits 3 DATA frame and then receives an ACK (Receive Ready) frame with number 6. After these frames have been transmitted and received, determine the new value of the current window size.

[3 marks]

b. In **FIGURE Q3**, a multiplexer combines four 100-kbps channels using with a frame size of three character. Estimate the output from the four arbitrary inputs. (Assume the input is following the channel order).

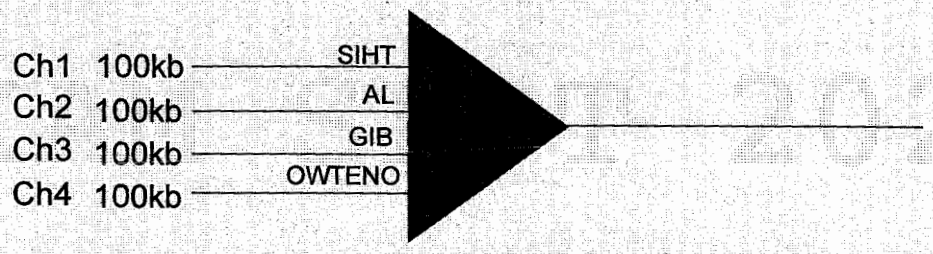

FIGURE Q3

[3 marks]

c. Circuit switching and packet switching are the two different methods of Wide Area Network (WAN) switching that are used to connect multiple communicating devices with one another. Construct and evaluate the event timing for both circuit switching and packet switching. Assume three packets flow from source to destination and there are two intermediate nodes.

[5 marks]

d. Space-division is one of the common switching technologies used in WAN.

i. Design and determine the total cross-points for a single-stage switch with 20 input lines and 20 output lines.

[2 marks]

ii. Design and determine the total cross-points for a three-stage switch with 20 input lines and 20 output lines. You may consider the following specifications:

- Each switch in the first stage and last stage has 5 x 2 crosspoints.
- The middle stage has 4 crossbars each with 2 x 2 crosspoints.

[5 marks]

e. As a network engineer, you are required to design and illustrate the proposed Local Area Network (LAN) for a new office building with the following requirement:

- LAN A has 4 stations and is connected using BUS topology. LAN A is also connected to the internet.
- LAN B has 3 stations and is connected using BUS topology. LAN B is also connected to LAN A.
- LAN C has 5 stations and is connected using STAR topology. LAN C is also connected to LAN B.
- LAN D has 4 stations connected with using RING topology. LAN D is also connected to LAN C.

[5 marks]

4. a. A bus topology local network for two stations with a distance of 1 km apart, a data rate of 10 Mbps, and a frame size of P = 256 with 80 bits of overhead per frame. Each frame is acknowledged with an 88-bit frame before the next is sent. The propagation speed on the bus is 200 m/μs. Consider the transfer of a file containing one million 8-bit characters from one station to another. Determine the total elapsed time and effective throughput of the network system.

[4 marks]

b. Describe the **THREE (3)** advantages of using Virtual Local Area Network (VLAN).

[3 marks]

c. Carrier Sense Multiple Access (CSMA) is a contention-based access method commonly used in computer networks. With the aid of a diagram, describe how P-Persistent CSMA can be implemented in a computer network. Discuss the advantages and potential drawbacks of using this approach.

[5 marks]

d. IP stands for "Internet Protocol," which is the set of rules governing the format of data sent via the internet or local network. In IPv4 addressing, the first three classes are divided into a fixed number of blocks.

i. Derive the number of blocks and the block size of Class A.

[3 marks]

ii. Discuss how a Classless Inter-Domain Routing (CIDR) is able to provide a short-term solution in IPv4 addressing shortages.

[3 marks]

iii. Design an efficient and well-organized subnetting scheme for the IP address 192.168.100.154/27. Determine the subnet address, broadcast address, first usable address, and last usable address for your proposed subnet design.

[7 marks]

- END OF PAPER-