UNIVERSITI TEKNOLOGI PETRONAS

FINAL EXAMINATION
MAY 2023 SEMESTER

COURSE : **EDB3023/EEB4063 - DATA & COMPUTER NETWORK**

DATE : **7 AUGUST 2023 (MONDAY)**

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 **NINE (9)** pages in this Question Booklet including the cover page .

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

1. a. You are at home watching a live football telecast. Based on the scenario, design a simplified data communication model in terms of block diagram. The diagram must be in order and you are also required to suggest suitable hardware/device for each of the elements.

[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. Voice over Internet Protocol (VoIP).

[3 marks]

ii. File Transfer.

[3 marks]

c. As a network engineer in a telecommunications company, you are asked to develop a proposal to set up a digital private branch exchange (PBX) for a new office building with 50 users. The management has also insisted on minimal costs with sufficient network performance.

i. Justify the suitable transmission medium and data rate to be utilized.

[4 marks]

ii. Discuss the challenges and any other design considerations that should be included in your proposal.

[4 marks]

d. Signal-to-Noise Ratio (SNR) is a strength measurement of a desired signal relative to the background noise. In a communication system, a "CAT-5" twisted-pair cable has a bandwidth of about 100 MHz. The system is required to transmit information at a bit rate of 500 Mbps.

i. Determine if a SNR of 3dB is sufficient to transmit reliably that much information. By using calculation, please explain and justify your answer.

[4 marks]

ii. Another important parameter in communication systems is Bit Error Rate (BER). Discuss the relationships between the SNR and BER parameters in determining the performance of a digital communication systems.

[3 marks]

2. a. Decode and sketch the timing diagrams for the following binary data "0101001100001100001" 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]

iii. Quadrature Phase Shift Keying (QPSK). Sketch the waveform and the constellation diagram.

[4 marks]

b. 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 hexadecimal number, 28D, 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. Construct the digital logic shift register circuit implementation for the CRC scheme.

[3 marks]

ii. By using CRC Modulo-Two arithmetic method, generate the Frame Check Sequences (FCS) and the message that should be transmitted from A to B.

[4 marks]

iii. Validate the FCS in part **Q2b(ii)** by using Polynomial Long Division method.

[4 marks]

iv. Assume the fourth and the fifth Least Significant Bits (LSBs) are inverted during transmission due to noise in the transmission link. Evaluate if there is any error detected at the receiver. Justify your answer.

[4 marks]

3. a. Flow control is a technique for assuring that a transmitting entity does not overwhelm a receiving entity with data. Design a frame transmission model for Stop-and-Wait Automatic Repeat Request (ARQ) protocol where the transmissions of the first data frame and its ACK are error-free, but the second data frame has bit errors and is dropped by the sender. All subsequent transmissions (data and ACK) are assumed to be error-free. Construct the flow of data frame until the receiver's Next Frame Expected (NFE) = 3.

[5 marks]

b. The Frequency Division Multiplexing (FDM) technique is used to transmit five voice signals simultaneously over a microwave communication system. The bandwidth of a voice signal is 4 kHz, and it is demodulated with a frequency carrier between 50 kHz to 80 kHz. Design the FDM system architecture for the receiver.

[4 marks]

c. In a switched communication network, data from a station is routed to the destination by being switched from node to node. Space-division is one of the common switching technologies used in Wide Area Switched Network.

i. Design and determine the total cross-points for a three-stage switch with 8 input lines and 8 output lines. You may consider the following specifications:

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

[5 marks]

ii. If you are to upgrade the network for voice and internet services, propose the selection of your switching network. Justify your answer.

[3 marks]

d. A campus network is a building or group of buildings all connected to one enterprise network that consists of many local-area networks (LANs). As a network engineer, you are required to design a new campus area network consisting of two buildings. Each person will have their own PCs and each department is connected to their own LAN with the following requirement:

- The registry department will be located on the first floor of building A and have 4 full-time staff. Administration department will be located on the second floor with five staff members. Both LAN networks are connected, and each department will be able to connect to internet.
- The finance department will be located on the ground floor of building B with 2 full-time staff and 1 part-time staff. The IT department will be located on the second floor where it will be connected to the Wide Area Network (WAN). The LAN in building B is also connected to the Registry department.
- Each department will require a network printer.

Design a LAN System using **BUS topology** and illustrate the proposed LAN design.

[8 marks]

4. a. Five equal-size datagrams belonging to the same message leave for the destination one after another. However, they travel along different paths as shown in **TABLE Q4** below.

TABLE Q4

Datagram	Path Length	Visited Switches
1	3,200 km	1,3,5
2	11,700 km	1,2,5
3	12,200 km	1,2,3,5
4	10,200 km	1,4,5
5	10,700km	1,4,3,5

Assume that the delay for each switch (including waiting and processing) are 3 ms, 10 ms, 20 ms, 7 ms, and 20 ms respectively. The propagation speed is given as 2×10^8 m /s. Determine the time and evaluate the order for each datagram to arrive at the destination. Ignore any other delays.

[4 marks]

b. Describe the **THREE (3)** disadvantages of a hub device compared to a switch.

[3 marks]

c. Carrier Sense Multiple Access (CSMA) is a network protocol that listens to or senses network signals on the carrier/medium before transmitting any data.

i. With the aid of a diagram, describe the principle of a CSMA operation to permit two or more pairs of nodes to communicate over a common medium simultaneously.

[4 marks]

ii. Propose a suitable CSMA approach with collision detection for ethernet IEEE 802.3. Explain the operation with the help of a diagram.

[4 marks]

d. Subnetting is the strategy used to partition a single physical network into more than one smaller logical sub-networks (subnets).

i. Discuss the **THREE (3)** benefits of Internet Protocol (IP) subnetting.

[3 marks]

ii. Determine the subnet address, broadcast address, class, first usable address and last usable address for the following IP/Subnet Mask: 182.44.182.16/26.

[7 marks]

- END OF PAPER