UNIVERSITI
TEKNOLOGI
PETRONAS

# FINAL EXAMINATION
# JANUARY 2025 SEMESTER

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|---|---|---|
| **COURSE** | **:** | **EDB3023/EEB4063/EFB3043 - DATA AND COMPUTER NETWORK** |
| **DATE** | **:** | **10 APRIL 2025 (THURSDAY)** |
| **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. A decimal number, 875, is to be transmitted from station **A** to station **B** in a network as a binary number. The pre-determined polynomial divisor accepted by both **A** and **B** is $X^5 + X^3 + X^2 + 1$. Cyclic Redundancy Check (CRC) algorithm is used to detect whether this message has been transmitted with an error.

   i. Write the message and the divisor in binary format.

   [2 marks]

   ii. Determine the Frame Check Sequence (FCS) and the message that should be transmitted from **A** to **B**.

   [6 marks]

   iii. Suppose that the third leftmost bit of the message is inverted due to noise on the transmission link, determine the result of the CRC calculation at the receiver.

   [6 marks]

   b. Two neighboring nodes (**A** and **B**) use a sliding-window protocol with a 3-bit sequence number. Go-Back-N ARQ error control is used with a window size of 4. Assuming **A** is transmitting, and **B** is receiving, show the window positions at both **A** and **B** for the following succession of events

   i. before **A** sends any frame, and

   [2 marks]

   ii. after **A** sends frames 0, 1, 2, 3, and receives acknowledgement from **B** indicating frames 0, 1, and 2 have been successfully received.

   [5 marks]

c. Suppose a protocol architecture has defined four layers for communication, say, Base layer, Net layer, Transport layer and Max layer. The header length of the Base layer and of the Net layer is 2 Bytes; the Transport layer, 3 Bytes; the Max layer, 4 Bytes. Besides this, each layer has a 4-bit end marker. If a 70-byte packet is received, determine the size of actual message.

[4 marks]

2. a. Compare the white noise density levels in closed rooms in London and Sydney in January, with the average temperatures of 5° C and 24° C, respectively.

[4 marks]

b. A channel can transmit signals in the frequency range of 2500 kHz to 4000 kHz. Assuming the signal-to-noise ratio is 40 dB, determine the theoretical maximum capacity of the channel.

[5 marks]

c. In **FIGURE Q2**, frames are generated at node **A** and sent to node **C** through node **B**. Determine the minimum data rate required between nodes **B** and **C** so that the buffers of node **B** are not flooded. Use the following information:

- The data rate between **A** and **B** is 100 kbps
- The propagation delay is 5 μs/km for both lines
- There are full-duplex lines between the nodes
- All data frames are 1000 bits long; ACK frames are separate frames with length of 150 bits
- Between **A** and **B**, a sliding-window protocol with a window size of 3 is used
- Between **B** and **C**, stop-and-wait flow control is used
- There are no transmission errors

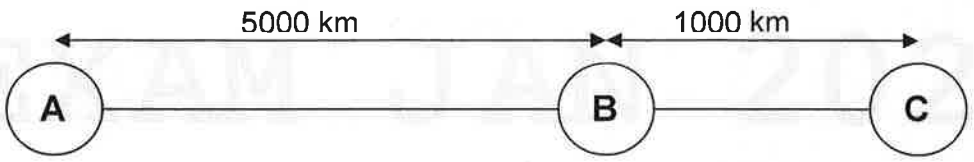


**FIGURE Q2**

[8 marks]

d. A packet-switching network is using a virtual circuit to transmit data from a source node to a destination node. A message of size 60 Bytes is to be transmitted from node **X** to node **Y**. The virtual circuit designed has 3 intermediate nodes, **a**, **b**, and **c**. Each packet in the network has a 5-byte header that contains the control information.

i. Determine the transmission time of the message sent from **X** to **Y** if the original message is broken up into 4, 6 and 12 packets, respectively.

[6 marks]

ii. Discuss the impact of breaking down the message into smaller packets on the transmission time.

[2 marks]

3. a. For a CSMA/CD, the frame transmission time must be at least twice the maximum propagation time. Suppose that a network using CSMA/CD has a data rate of 20 Mbps. The maximum propagation time of this network has been found to be 20 μs. Determine the frame transmission time and the minimum size of the frame.

[4 marks]

b. The following parameters are defined for a switching network:

$N$ = number of hops between two end systems
$L$ = message length in bits
$B$ = data rate, in bits per second (bps), on all links
$P$ = fixed packet size, in bits
$H$ = overhead (header) bits per packet
$S$ = call setup time (circuit switching or virtual circuit) in seconds
$D$ = propagation delay per hop in seconds

Assume that there are no acknowledgments and ignore processing delay at nodes. For $N = 4$, $L = 5000$, $B = 9600$, $P = 1024$, $H = 16$, $S = 0.2$, and $D = 0.001$, compute the end-to-end delay for the following switching techniques:

i. Datagram packet switching

[7 marks]

ii. Virtual Circuit packet switching

[3 marks]

c. Derive general expressions of the end-to-end delay for the Circuit Switching and Datagram packet switching techniques and show the conditions under which the delays are equal.

[4 marks]

d. For the Internet Protocol (IP) address/Subnet Mask: 17.16.193.8/19 determine the following:

- subnet address (netid),
- broadcast address,
- class,
- first usable address, and
- last usable address.

[7 marks]

4. a. The Classless Inter-Domain Routing (CIDR) is an approach in IP that allows more flexible allocation of IP addresses than the previous classful network design in IP. Perform CIDR aggregation and determine the resulting longest prefix match on the IP addresses in **TABLE Q4**.

**TABLE Q4**

| | | | |
|---|---|---|---|
| **191.97.93.0/21** | **191.97.95.0/21** | **191.97.87.0/21** | **191.97.89.0/21** |

[6 marks]

b. An Internet Service Provider (ISP) has been granted a block of IP addresses starting from **180.140.0.0/17**. The ISP needs to distribute these addresses in three groups as follows:

- The first group has 64 subnets; each subnet needs 256 addresses.
- The second group has 64 subnets; each subnet needs 128 addresses.
- The third group has 128 subnets; each subnet needs 32 addresses.

i. Determine the total number of addresses granted to the ISP and the total allocated addresses.

[5 marks]

ii. Determine the blocks of addresses allocated to each group.

[9 marks]

iii. Determine the number of unused addresses.

[2 marks]

c. A network has been allocated a block of 1024 addresses from **195.37.0.0** to **195.35.3.255**. Using CIDR addressing scheme, derive the subnet mask address in dotted decimal form.

[3 marks]

- END OF PAPER -