# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

**ORGANISATION OF ISLAMIC COOPERATION (OIC)**

**Department of Computer Science and Engineering (CSE)**

**SEMESTER FINAL EXAMINATION** **SUMMER SEMESTER, 2023-2024**

**DURATION: 3 HOURS** **FULL MARKS: 150**

## CSE 4411: Data Communication and Networking

**Programmable calculators are not allowed. Do not write anything on the question paper.**

Answer **all 6 (six)** questions. Figures in the right margin indicate full marks of questions with corresponding COs and POs in parentheses.

---

1. A web page consists of one base HTML file and 8 embedded objects (images/scripts/etc.). Assume the round-trip time (RTT) between the client and the server is 100 ms. Ignore DNS lookup time and assume request/response transmission times are negligible compared to RTT. — 6 + 6 + 4 (CO2) (PO2)

   a) Draw timeline diagrams (time on the x-axis) showing message exchanges for:
      1. Non-persistent HTTP
      2. Persistent HTTP

   b) Using the assumptions above, compute the total time from the moment the client starts until all objects are downloaded in three scenarios. Show steps and numerical results (in milliseconds) for the following scenarios:
      1. Non-persistent HTTP (no parallel connections)
      2. Persistent HTTP witn no pipelining (requests for embedded objects are made sequentially after the base HTML is received).
      3. Persistent HTTP with pipelining (after receiving the base HTML, the client immediately sends requests for all 8 embedded objects back-to-back; server responds to these requests).

   c) Explain two practical reasons why modern HTTP implementations no longer rely on non-persistent connections.

2. a) Answer the following questions from the perspective of the transport layer. — 6 + 10 + 4 (CO2) (PO1)
      i. Explain multiplexing and demultiplexing with an example in a diagram.
      ii. Draw diagrams of the following:
         1. An example of Connectionless Demultiplexing
         2. An example of Connection-oriented Demultiplexing
      iii. In connection-oriented demultiplexing, why do we need 4-tuple instead of 2-tuple similar to connectionless demultiplexing

   b) Explain TCP fast retransmission with a diagram. — 3 + 3 (CO2) (PO1)

3. a) Consider the topology in figure 1, at time = $t$, the cost of the link between A and B was 4, some time later at $t'$, the link cost changed to 60. The other link costs remain as shown. — 1 + 3 + 4 (CO3) (PO2)

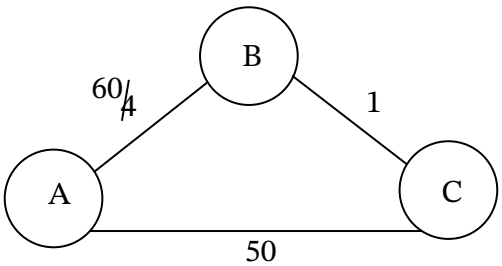


**Figure 1:** Topology for question 3.a

i. At time $t$, compute the routing tables at nodes B and C using RIP
ii. At time $t'$, compute the routing table at node B and node C using RIP & OSPF
iii. Is there any difference with the routing tables at time $t'$ produced by the RIP and OSPF? If yes, explain why the difference occurs

b) Explain the working mechanism of hierarchical OSPF, providing a diagram that includes the different specialized router types. 8 (CO3) (PO1)

c) A client wants to join a network whose network address is 192.168.10.0/24. The network runs a DHCP server that dynamically assigns IPv4 addresses to arriving clients. 7 + 3 + 4 (CO3) (PO2)

i. Draw a single labelled sequence diagram (or packet flow diagram) showing the DHCP message exchange between the client. Your diagram must show message names and layer-3 addressing
ii. Under what circumstances are the first two messages exchanged between the server and the client are optional or not required?
iii. Explain how DHCP enables reuse of addresses in a network.

4. a) You capture an Ethernet frame carrying a 10-bit payload 1101011011 ($D$) and the network uses generator 10011 ($G$). The capture shows the frame was accepted by the NIC. 6 + 4 (CO3) (PO2)

i. Compute the CRC remainder $R$ the sender computed and write the transmitted $< D, R >$ bit sequence.
ii. Explain briefly why CRCs of degree $n$ detect all burst errors of length $\leq n$.

b) Two employees on the same legacy Ethernet begin large file uploads simultaneously and collisions occur. The network uses CSMA/CD with binary exponential backoff. 4 + 5 + 3 (CO3) (PO2)

i. Briefly list the CSMA/CD steps from sensing to retransmission.
ii. After the 3rd collision ($m = 3$) compute the expected backoff in 512-bit time units
iii. Explain how exponential backoff reduces repeated collisions.

c) Discuss the difference between calculation-based forwarding and learning-based forwarding. 6 (CO3) (PO1)

5. a) A lecturer demonstrates two ways to share a smartphones mobile data connection at a small workshop: 4 + 6 (CO4) (PO2)

1. Case A: The smartphone enables Bluetooth tethering. A laptop and a tablet pair with the phone and access the internet through it.
2. Case B: The same smartphone creates a Wi-Fi hotspot, and the same laptop and tablet connect to it to use the phones mobile-data connection.

i. Define two primary connection modes of wireless networks.
ii. Which primary connection modes case A & case B fall into, and why?

b) CSMA/CA is used in IEEE 802.11 as the legacy MAC protocol. 4 + 4 + 4 (CO4) (PO2)

i. Why CSMA/CA is used? Why not other MAC protocols?
ii. What is the role of DIFS in CSMA/CA?
iii. How does RTS-CTS exchange ensure collision avoidance?

c) Explain the hidden terminal problem in a wireless network with a diagram. 5 (CO4) (PO1)

6. a) For each of the following modulation scenarios, draw the constellation diagram. $3 \times 2$ (CO4) (PO3)

   1. A modulation that sends 2 bits per symbol by varying phase only (constant amplitude).
   2. A modulation that sends 3 bits per symbol using two amplitude levels and four phase values.
   3. A modulation that sends 3 bits per symbol using four amplitude levels and two phase values.

   b) Sending information from one node to another in a wired medium requires converting the digital data into a digital signal. Suppose you transmitted 12 zeros in a wired medium. $5 + 4 + 3$ (CO4) (PO2)

   i. Explain self-synchronization and DC component problem of digital signal.
   ii. Why do NRZ-L and NRZ-I both have an average signal rate of N/2 Bd?
   iii. What happens at the receiver after sending the above bits, using NRZ-L and Manchester?

   c) According to the Nyquist theorem, the sampling rate must be at least 2 times the highest frequency contained in the signal. Explain why this is necessary 5 (CO4) (PO2)