B.Sc. in EEE, 5th Semester

09 December 2023
09:00 am – 12:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: EEE 4551
Course Title: Data Communication and Networking 1

Winter Semester, A. Y. 2022-2023
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. Consider a scenario where the Bangladesh government has hired you to design a robust network infrastructure for connecting all the public universities within the country. This network should facilitate the exchange of academic resources, research data, and administrative information among universities, allowing for seamless communication and collaboration. **40 (CO3, PO2)**

Taking into account the following requirements:

- Each university will have a dedicated network for its internal operations.
- The inter-university network should provide high-bandwidth connectivity for data-intensive applications, such as video conferencing and file transfers.
- The network should be scalable to accommodate future growth in the number of universities and users.
- The network should be secure and resilient to potential disruptions or cyberattacks.

Your task is to design a comprehensive network solution that addresses these requirements. In your design, clearly explain the following:

a. Network topology: Describe the overall structure of the network, including the arrangement of nodes and connections. Justify your choice of topology based on the given requirements.
b. Network devices: Identify the primary network devices (e.g., routers, switches, firewalls) required for the network and explain their respective roles in facilitating communication.
c. Network protocols: Specify the communication protocols (e.g., TCP/IP, UDP) that will be used for data transmission across the network. Explain the suitability of these protocols for the envisioned applications.
d. Network security measures: Propose security strategies to protect the network from unauthorized access, data breaches, and cyberattacks.
e. Network scalability: Explain how the designed network can be expanded to accommodate future growth in the number of universities and users.
f. Network management: Outline the network management tools and procedures that will be employed to monitor, maintain, and troubleshoot the network effectively.

Evaluation Criteria:

- Clarity and comprehensiveness of network design explanation.
- Appropriate selection and justification of network components.
- Effectiveness of diagrams, tables, and flowcharts in illustrating the network design.
- Consideration of future network expansion and security measures.
- Demonstration of network resilience and uptime considerations.

2. Assume your network designed in question-1 has been approved for implementation, and you are now assigned to implement the TCP/IP model and its application to your network. **40 (CO3, PO2)**

a. Explain why you chose the four layers of the TCP/IP model over the traditional OSI model for your network design.
b. Describe the primary responsibilities of each layer of the TCP/IP model in your network design.
c. Explain the concept of Protocol Data Units (PDUs), headers, and trailers in TCP/IP data encapsulation for both intra-network and inter-network data transmission.
d. Describe how the application-layer message, transport-layer segment, network-layer datagram, and link-layer frame are handled within their respective layers.
e. Identify the layers of the TCP/IP model responsible for routing in your network solution.
f. Explain why the Transport layer is considered the "heart" of the TCP/IP model in your network design.
g. In terms of connection-oriented and connectionless services, compare and contrast the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP).
h. Discuss the factors that determine IP address and subnet mask determination in your network solution.

Evaluation Criteria:

- Clarity and comprehensiveness of explanations.
- Accuracy and relevance of examples.
- Depth of understanding of TCP/IP model concepts.
- Demonstrate the practical application of TCP/IP model principles.
- Effectiveness of diagrams, illustrations, and tables.

3. Assume your network design has been implemented successfully, and now determine the optimal routing algorithms to ensure efficient and reliable data delivery across the network. This decision will significantly impact network performance and user experience. **35 (CO3, PO2)**

Evaluate and select the most suitable routing algorithms or a combination of algorithms from the following options:

- Shortest-Path,
- Flooding,
- Flow-based,
- Distance-Vector,
- Link-State,
- Hierarchical and
- Multicast.

Justify your choices considering the following factors:

- Network size and complexity,
- Traffic patterns and priorities,
- Real-time data transmission requirements,
- Network resilience and fault tolerance,
- Scalability and adaptability to future growth.

Evaluation Criteria:

- Comprehensive analysis of routing algorithm characteristics and suitability.
- Clear justifications for selecting specific algorithms or combinations.
- Effective use of diagrams, tables, and flowcharts for illustration.
- Demonstration of a deep understanding of routing algorithm principles.
- Practical application of routing algorithm concepts to the given network scenario.

4. Suppose you want to send 100 data from a source to a destination. Using appropriate illustrations, explain how data communicates through the following switching methods: **10 (CO1, PO1)**
   a. Circuit switching and
   b. Packet switching.

   Identify and explain which method is superior:
   c. in terms of guaranteed service and
   d. in terms of faster delivery time.

5. You are assigned to transfer a large dataset of 500 gigabytes from one server to another. Your available options are to transmit the data over a network link with a bandwidth of 1 Gbps (Gigabits per second) or to copy the data onto an external hard drive and physically transport it to the destination. **10 (CO2, PO2)**

   Calculate the time it would take to transfer the 500 GB dataset using the network link, and compare it with the time required to transport the data physically if you assume the transit speed of the courier service is 50 mph (miles per hour). Which method would be faster for transferring this dataset?

   Show your calculations for both methods and explain which method you would choose and why, considering factors like speed, time, and efficiency.

6. Imagine you're managing a data transmission process from your laptop to a server located across a series of interconnected networks. There are three different links involved, each with its own characteristics. Your task is to calculate the total end-to-end delay for a packet travelling from your laptop to the server, considering various factors along the way. **15 (CO2, PO2)**

   The given parameters are:
   - Packet length (L): 2,000 bytes,
   - Propagation speed on all links: 2.0×10^8 meters per second,
   - Transmission rate of all links: 5 megabits per second (Mbps),
   - Packet switch processing delay: 2 milliseconds (msec),
   - Length of the first link: 3,000 kilometers,
   - Length of the second link: 2,500 kilometers,
   - Length of the third link: 1,500 kilometers.

   Calculate the total end-to-end delay for the packet, considering the transmission rates, propagation speeds, link lengths, and packet switch processing delay along the entire route.