



Study Programme	: Bachelor of Science in Engineering / Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: EEX5434 Data Communications & Networking
Academic Year	: 2022/23
Duration	: 3 hours
Date & Time	: 21 st February 2024, 9:30 a.m. – 12:30 p.m.

General Instructions

1. Read all instructions carefully before answering the questions.
 2. This question paper consists of **Five (5)** questions in **Four (4)** pages.
 3. Answer **all Five (5)** questions. All questions carry equal marks.
 4. Answer for each question should commence from a new page.
 5. This is a **Closed Book Test (CBT)**.
 6. Answers should be in clear handwriting.
 7. Do not use Red colour pen.
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Q1.(a) Consider a university which has two administrative buildings (A1 and A2) and 4 academic buildings (B,C & D). Building A1 has the primary data center of the university and A2 has a back up (secondary) data center. In case, primary data center is not available, services are provided by the secondary data center. For this purpose, it is necessary to synchronize the primary and backup very often to make sure that they contain the same content.

All academic buildings heavily rely on the services provided by the servers located in the data centers. You have been asked to design the network connecting the above buildings. The university requires efficient communication among all departments and divisions in these buildings and centralized access to shared resources located in the data centers. Based on this scenario, answer the following questions.

- (i) Propose two different network topologies that could be suitable for this scenario, explaining the advantages and disadvantages of each. [04]
- (ii) Select the most suitable topology out of the topologies you proposed in (i), and justify your choice based on the University's needs and constraints. [02]
- (iii) Mention at least two networking technologies or protocols that could be employed within the proposed network topology to ensure reliable communication and data transfer. [02]
- (iv) To cater to the increasing need for accessing through mobile devices, how would you integrate wireless connectivity into your proposed network design? (Illustrate the answer using a suitable diagram) [02]

(b) An ideal power limited communication channel with additive Gaussian noise with 1MHz bandwidth and S/N ratio of 15 transmits the information at the theoretical maximum rate. If the S/N ration is reduced to 7, how much bandwidth is required to maintain the same rate. [04]

(c) Illustrate the Manchester and Differential Manchester encoding processes using a binary sequence 10101100 and discuss how these encoding schemes ensure synchronization between the transmitter and receiver. [06]

Q2.(a) Email is one of the most popular and essential application on Internet today. Mail delivery is done via Simple Mail Transfer Protocol (SMTP). Consider the following scenario:
A student at the Open University, having an email address, s123@ou.ac.lk, sends an email to a friend in University of Tokyo, whose email address is jane@u-tokyo.ac.jp . Considering "ns.ou.ac.lk" and "ns.u-tokyo.ac.jp" are the DNS servers of OUSL and University of Tokyo respectively, show all the DNS transactions that will take place for the purpose of this email delivery using a suitable diagram. State your assumptions clearly, if any. [07]

(b) How do SMTP and MIME complement each other in the process of email communication? [02]

- (c) (i) Explain the key characteristics of UDP and how they differ from TCP in terms of connection establishment, reliability, and flow control. [03]
- (ii) Select which protocol from TCP or UDP best suits for the following applications providing proper justification for your selection. (Your answer should explain how the selected protocol fulfills the requirement in the given application.)
- Imagine you are designing a real-time online gaming application where players compete in a multiplayer environment.
 - A Company needs to securely transfer large files between its headquarters and multiple remote offices located in different countries.
 - Imagine you are designing a real-time sensor data monitoring system for an industrial plant. The system needs to collect data from various sensors distributed throughout the plant and provide real-time insights to operators for monitoring and decision-making purposes [06]
- (iii) Briefly describe the main difference between RTP and RTCP protocols. [02]

Q3. (a) "A system called Network Address Translation (NAT), allows the addresses to be rewritten when packets traverse network borders to allow them to continue on to their correct destination."

- Justify the above statement describing the main function of a NAT device. [02]
- Describe how NAT helps conserve IPv4 address space and facilitates the transition to IPv6. [03]

(b) (i) Discuss how subnetting and supernetting optimize address space utilization in IP networks. [03]

(ii) An Internet Service Provider (ISP) has 2 networks N1 and N2 and they are assigned IP addresses as given below:

Network N1 – 192.168.0.0 / 24

Network N2 – 192.168.2.0 / 22

The following table gives the details of clients assigned for each network.

Network	Client name	Required host addresses
N1	A	75
	B	20
	C	40
N2	D	200
	E	350

Provide the subnet plan for the above clients specifying the network address (in CIDR format), the broadcast address, the subnet mask and the possible range of host addresses of each client. You must clearly show each step you use to work out this plan.

[12]

Q4. (a) Discuss how advantageous of using sliding window flow control over stop and wait flow control in terms of Latency, bandwidth utilization and channel throughput. [03]

(b) Consider a communication system between 2 stations A & B. Station A wants to send 10 frames of information to station B, using 3-bit sequence numbers.

(i) If frame 7 gets corrupted on the way, show how the protocol will recover from error condition and complete frame transmission for the following 2 cases with a window size of 5. Draw a diagram clearly showing the important parameters to illustrate the correct operation of each protocol.

- a. Go-Back-N ARQ
- b. Selective repeat ARQ [08]

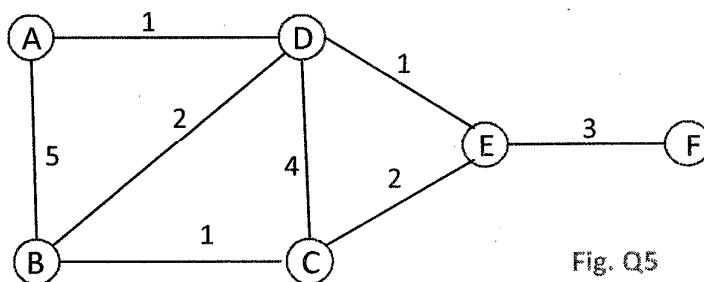
(ii) Based on their operations, how each of the above protocols reacts for the frames received with out-of-order sequence numbers? [02]

(c) Discuss how the adoption of Software-Defined Networking (SDN) with Network Functions Virtualization (NFV) in campus network architectures improves the scalability, flexibility, and operational efficiency compared to traditional legacy networks. [07]

Q5. (a) Differentiate Interior (Intra domain) routing protocols & Exterior (Interdomain) routing protocols providing example for each. [04]

(b) Fig. Q5 shows a network in which routers use Distance Vector Routing protocol. It has six nodes and the cost for each interface is marked at a particular instance.

(i) Show the forwarding table of Node A to determine the shortest path from A to all other nodes of the network. You need to show the entries from the initialization until the state of the table converges. (Assume that all routers initialize at the same time, and that, at each round of the algorithm, each router receives distance vectors from all its neighbors simultaneously.) [12]



(ii) After convergence, what happens if the link between E and F is broken? What problems may arise when updating the forwarding table in this new situation? [03]

(iii) Briefly explain a method to avoid the above problem mentioned in (ii) above [01]