

L-3/T-2/CSE

Date : 12/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2021-2022

Sub : **CSE 321** (Computer Networks)

Full Marks : 210

Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Design a network with necessary agents to support mobile hosts. Describe how we can apply the network over different types of networks covering LANs, WANs, etc. **(23)**
(b) Classful IP addressing needs to be done for a company with different distant branches each having a number of computers. Analyze whether the notion of subnetting will be required here. Explain with necessary example(s) **(12)**

2. (a) In datagram subnets, DVR is applied with the notions of Forced Update and Split Horizon Rule. You need to design an example network, where such applications cannot remove the inefficiency of count-to-infinity problem. Analyze your example with necessary diagram(s). **(23)**
(b) Describe the types of networks where we need BGP to operate. Discuss peering options over such networks with necessary diagram(s). **(12)**

3. (a) Construct a network where we can experience congestion collapse. Analyze how AIMD can lessen the extent of such congestion, with necessary figure(s). **(23)**
(b) Explain how a remote application can be called from a networked machine at distance. Discuss the process with necessary figure(s). **(12)**

4. (a) In the networking word, there exist different types of computing machines. Some of the machines are fast, whereas some other machines are slow. Thus, in the case of networked data transmission, we can have slow receivers as well as slow senders. Now, from the perspective of the Transport layer, you need to distinguish between solutions for the slow receivers as well as slow senders. Explain your answer with necessary figure(s). **(23)**
(b) Develop a methodology for RTO estimation in a network, where packet drops are common. Explain your methodology with necessary figure(s). **(12)**

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SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Suppose four active nodes -- nodes A, B, C, and D-- are competing for access to a channel using slotted ALOHA. Assume each node has an infinite number of packets to send. Each node attempts to transmit in each slot with probability p. The first slot is numbered slot 1, the second slot is numbered slot 2, and so on. (8+7=15)
- (i) Find the probability that the first success occurs in slot 4.
 - (ii) Calculate the efficiency of this four-node system.
- (b) Draw the Ethernet frame format. You need to write the lengths of each field. (*Hint 1: There are seven fields. Hint 2: The payload field is of variable length ranging from 46-1500 bytes*). Illustrate the reason(s) behind keeping the last two bits of Preamble field different than the rest. (10)
- (c) Suppose, you (Hostname: *ckruet.edu*) are querying the IP-address for *cse.buet.edu*. However, BUET maintains an authoritative DNS server *dns.buet.edu* for the hostnames ending with *buet.edu*. List all the DNS record(s) stored in 1).edu TLD DNS server and 2) *dns.buet.edu* DNS server that facilitate(s) your query. You need to mention the record(s) in this format (Name, Value, Type). Feel free to use any IP address(es) of your choice, if need arises. (10)
6. (a) Consider three LANs interconnected by two routers, as shown in Figure below. Answer the following questions. (5+5+5+5=20)

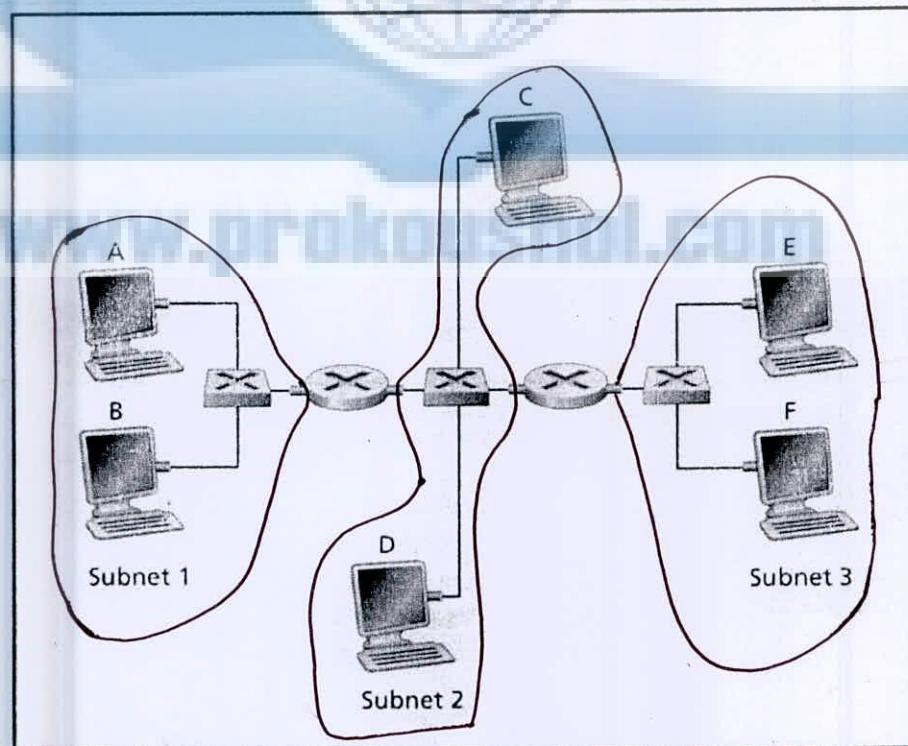


Figure for Question 6(a)

- (i) Assign IP addresses to all of the interfaces. For Subnet 1 use addresses of the form **172.16.1.XXX**; for Subnet 2 use addresses of the form **172.16.2.XXX**; and for Subnet 3 use addresses of the form **172.16.3.XXX**

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Contd...Q.No. 6(a)

- (ii) Assign MAC addresses to all of the adapters.
- (iii) Consider sending an IP datagram from Host E to Host B. Suppose all of the ARP tables are up to date. Enumerate all the steps.
- (iv) Repeat (iii), now assuming that the ARP table in the sending host is empty (and the other tables are up to date)

(b) We need to send data at a 5-Mbps rate. There are two encoding options: (8)

- (i) A combination of 4B/5B and NRZ-I, or
- (ii) Manchester coding

Argue which option should be followed to minimize the required bandwidth.

(c) Why switches are considered **self-learning**? Briefly explain. (7)

7. (a) Very briefly answer the following questions: (10)

What is the main improvement CSMA brought over ALOHA variants (Plain ALOHA, Slotted ALOHA)? Could CSMA solve the problem entirely? What is the need for CSMA/CD?

(b) Assume the generator G (= 1001) is used in CRC. Now, answer the following questions. (5+5=10)

- (i) Illustrate how this generator can detect any single bit error in data D.
- (ii) Determine whether the above G detects any odd number of bit errors. State the reason(s) clearly.

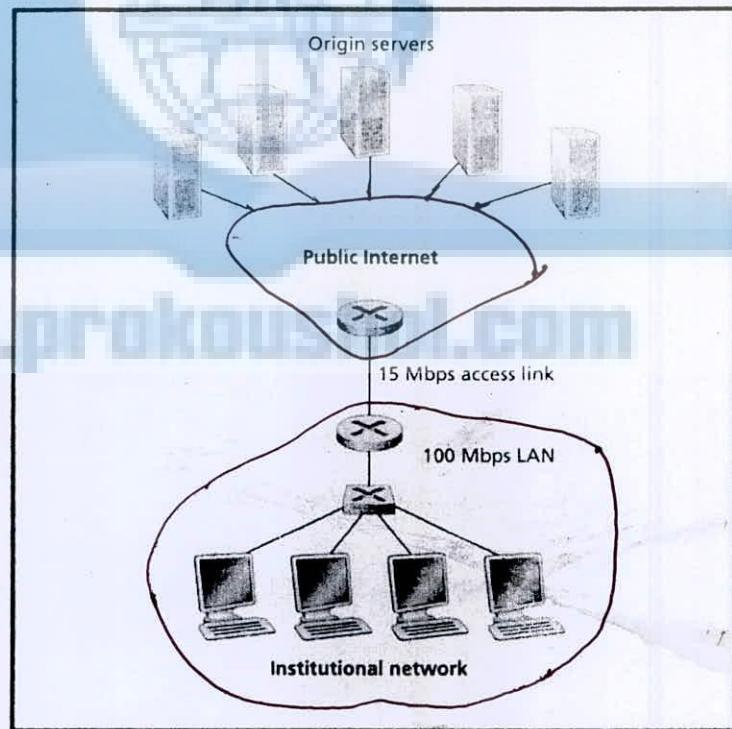


Figure for Question 7(c)

(c) Consider the figure above, for which there is an institutional network connected to the Internet. Suppose that the average object size is 850,000 bits and that the average request rate from the institution's browsers to the origin servers is 20 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is three seconds on average.

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Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) and the average Internet delay. For the

average access delay, use $\frac{x}{1-xy}$ where x is the average time required to send an object over the access link and y is the arrival rate of objects to the access link.

(8+7=15)

(i) Determine the total average response time.

(ii) Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.4. Find the total average response time in this case.

8. (a) Suppose you walk into a room, connect to Ethernet, and want to download a Web page. Identify all the protocol steps that take place, starting from powering on your PC to getting the Web page. Assume there is nothing in our DNS or browser caches when you power on your PC. Explicitly indicate in your steps how you obtain the IP and MAC addresses of a gateway router.

(20)

(b) Consider sending over HTTP/2 a Web page that consists of one video clip, and five images. Suppose that the video clip is transported as 2000 frames, and each image has three frames.

(5+5=10)

(i) If all the video frames are sent first *without interleaving*, calculate the number of frames to be transported until all five images are sent.

(ii) If frames are *interleaved*, calculate the number of frame(s) needed until all five images are sent.

(c) How self-synchronization property helps the data transmission? Explain briefly.

(5)

L-3/T-II/CSE

Date : 06/05/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **CSE 321** (Computer Networks)

Full Marks : 210

Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this section. Answer any **THREE**.

1. (a) When to use static NAT? Explain with an example. Write down the benefits and limitations of PAT. (8)
- (b) Suppose a company uses a 172.16.20.0/23 network which the network admin wants to divide equally among the four divisions. What will be the network address, subnet mask, and the IP ranges of each division? Show necessary calculations. (9)
- (c) How to get IPv6 address dynamically? Explain all three options. (9)
- (d) “Mobile IP tries to optimize network bandwidth usage” Do you agree with this statement. Justify your answer with necessary diagram(s). (9)
2. (a) What can be inferred about an IPv4 packet whose M-bit is 0 and offset bits are non-zero? Again, what if M=0, Offset = 0? Explain briefly. (8)
- (b) Distinguish between Internal router, ABR and ASBR in multi-area OSPF. Use necessary diagram to explain. (9)
- (c) If the source and destination PCs are in two separate networks, how can the source PC acquires the destination MAC address? Explain with a simple topology diagram. (9)
- (d) Distinguish between milk and wine policy while discarding packets? Give example applications for which these policies are applicable. Justify your answer. (9)
3. (a) What is the purpose of RST and URG flag in TCP header? Is there any possible attack that can be launched using this flag? (8)
- (b) What are the challenges in TCP if it uses selective repeat policy instead of Go-back-N policy? Give an example to explain. (8)
- (c) Compare TCP Reno and TCP Tahoe congestion control algorithm with necessary figure. (12)
- (d) What is the purpose of floating static route in a routing protocol? How is it configured? (7)
4. (a) Consider that an organization has 10 internal LANs and wants to use DHCP server for their client machines. How many DHCP servers should they deploy? Do they need any other component? Use a necessary topology diagram to explain. (9)

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Contd...Q.No. 4

- (b) Compare iterative and recursive DNS resolutions. Which one is better in your opinion? Why? (9)
- (c) Using necessary diagram(s), explain the operations of SMTP and IMAP protocols in email communication. (9)
- (d) What are the possible applications of web proxy server? Explain in brief. (8)

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) “Between Limited-Contention Protocols and CSMA with Collision Detection Protocol, CSMA with Collision Detection Protocol is better as CSMA with Collision Detection Protocol completely eliminates collision, whereas, Limited-Contention Protocols allow collisions to a great extent.” – based on this statement, you need to answer the following. (20)
- (i) Do you agree with the statement?
 - (ii) If you agree, you need to justify why and how the scenario mentioned in the statement can happen in reality. If you disagree, then you need to explain reason(s) behind your disagreement. Show all necessary derivations and figures, as required.
- (b) A network engineer is experienced with Switched Ethernet, Fast Ethernet, and Gigabit Ethernet. He can enable data transmission over such Ethernets. (15)
- When the engineer starts working with wireless medium, he understands the shared nature of the wireless medium. To overcome the interference problem over the shared medium, he adopts physical carrier sensing and enables transmission only when a channel is found to be clear.
- Now, your task is to go one step ahead and enable virtual carrier sensing instead of physical carrier sensing. How can you do that mimicking 802.11? Explain with necessary figure(s) and elaboration.
6. (a) “In the Data Link Layer, if a timer is maintained in software for each outstanding packet within the window of a Sliding Window Protocol, then the Sliding Window Protocol can have the maximum value of its window size ($2^n - 1$) while having n-bit sequence number in each packet.” – based on this statement, you need to answer the following. (20)
- (i) Do you agree with the statement?
 - (ii) If you agree, you need to justify reasons behind the statement. If you disagree, then you need to explain reason(s) behind your disagreement. Show all necessary derivations and figures, as required.

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Contd...Q.No. 6

- (b) If we employ r-bit redundant information for error correction over m-bit data using Hamming distance, then the lower limit of r can be determined using the following formula.

(15)

$$(m + r + 1) \leq (2^r)$$

Does this hold even if we utilize bit stuffing and de-stuffing for the purpose of frame generation?

If so, you need to justify why the above formula will hold even in the case of utilizing bit stuffing and de-stuffing. If not, then you need to elaborate the reasons for which the above formula will not hold.

7. (a) A network designer needs to design a network that enables communication with a classical GEO satellite. To do so, in his designed network, he plans to utilize the frequency assignment, time division multiplexing, and framing format used for GSM. You need to elaborate how the network designer can do it. Or, if you think that the intended communication with a classical GEO satellite cannot be enabled in such a way, then you need to elaborate this with all underlying reasons. Show necessary figures in your elaboration.

(20)

- (b) If an application demands that network congestion gets handled at the very beginning of its transmission and the congestion will not occur afterwards, then which of the following methods will be the best choice to be implemented - circuit switching, message switching, or packet switching?

Justify your answer with necessary elaborations. Besides, you need to present relevant figures to support your elaborations.

(15)

8. (a) You are given a task of enhancing fault tolerance of a network containing multiple LANs through having redundant active connectivity between the LANs. To do so, can you use the concept of spanning tree bridges, where each of the bridges is a transparent bridge? Justify your answer with necessary elaborations and figures.

(20)

- (b) Distinguish among Wide Area Networks, Metropolitan Area Networks, and Local Area Networks with necessary figures.

(15)

L-3/T-2/CSE

Date: 10/04/2022

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2019-2020

Sub: **CSE 321** (Computer Networks)

Full Marks: 210

Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION - AThere are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) How many different Class B networks are possible? Show necessary calculations.
How many hosts are possible per network? (8)
(b) Distinguish between NAT and PAT. Which one is preferred? Why? (10)
(c) Compare circuit switching and datagram with respect to speed, overhead and utilization factors. (7)
(d) What is the main difference between distance vector and link state routing protocols? Which one is preferred for large networks? Why? (10)
2. (a) How can you prevent count-to-infinity problem in distance vector routing algorithm? (5)
(b) Explain the purposes of Area Border Router (ABR) and Autonomous System Boundary Router (ASBR) in multi-area OSPF with necessary topology diagram. (10)
(c) What is the main objective of Mobile IP? How is packet forwarded when the mobile device is in a foreign network? Explain with necessary topology diagram. (10)
(d) Compare MANET, VANET and FANET. Write down few applications of each one. (10)
3. (a) What is the main objective of TCP 3-way connection establishment phase? Is it possible to exploit this to launch attacks? How? (10)
(b) What is the purpose of using DHCP relay agent? Where should you place this agent in a network? Show necessary diagram. (12)
(c) Consider a scenario where the TCP receiver's buffer size is 4KB. The receiver now sends a packet with ACK = 1, sequence number = 4096 and window size = 2048. What does it mean to the sender? What will happen next? (13)
4. (a) Compare POP3 and IMAP protocols. (10)
(b) Consider that a user from cse.buet.ac.bd domain wants to resolve cs.mit.edu. Show necessary diagram if such DNS resolution is done through iterative approach. Assume that there is no DNS caching anywhere in the path. (12)
(c) Show (with necessary diagram) where the HTTP Proxy server is placed in a network. What can the network admin monitor through this server? Explain. (13)

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SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) “Basic Bit-map Collision-free MAC protocol is always better than ALOHA, CSMA, or even Adaptive Tree Walk Protocol.” – do you agree with it?

If you agree, you need to justify why this should happen. If you disagree, you need to explain reason(s) behind the disagreement. Show necessary derivations, as required.

(20)

- (b) A company has several departments and it needs to establish different LANs for different departments. The company expects to make sure that a machine (even while being in Promiscuous mode) in one department cannot capture packets generated from a machine in another department.

To do so, the company connects machines in the same department together in a single LAN and has machines in different departments under different LANs. Then, the company connects the different LANs using hubs. Alongside, the company makes sure that there exists single spanning tree architecture of the whole network so that there arises no loop in operation even after having parallel hubs.

Now, you need to determine whether the above design and deployment will work as expected. If so, then you need to elaborate how the above design and deployment will work as expected. If you think otherwise, then you need to explain why the above design and deployment will not work as expected.

(15)

6. (a) A network engineer is given a task of designing a DLL protocol for data communication of a reliable application. In this regard, he is explicitly asked to perform the task of error detection and robust framing in his developed custom DLL protocol.

To do so, he has come up with the following DLL protocol –

- 1) Putting character count at the beginning of a frame for the purpose of framing,
- 2) Introducing r parity bits for m data bits maintaining the condition that $(m + r + 1) \leq 2^r$ along with arranging x consecutive codewords in a matrix (one codeword in a row) and transmitting one column at a time to handle a maximum burst error of $3x$ bits, and
- 3) Sliding window protocol using selective repeat.

Now, you need to pinpoint whether the above protocol will operate correctly only from the perspective of performing the task of error detection and robust framing.

Justify your answer.

(20)

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Contd... Q. No. 6

(b) In a fiber optic network, a network engineer enables the notion of different inter-frame spacing such as SIFS, EIFS, PIFS, and DIFS to lessen the extent of interference. Do you think that such a mechanism can result in lessening the extent of interference? If so, then elaborate how this can result in lessening the extent of interference with all necessary details and designs.

If you do not think so, then you need to elaborate why this cannot result in lessening the extent of interference. Besides, in such a case, you need to present an alternate design that can result in lessening the extent of interference. (15)

7. (a) GSM adopts Time Division Multiplexing in addition to having the notion of multiframe." – validate or refute this statement with necessary explanations and figures. (20)

(b) OSI and TCP/IP reference models are two widely known reference models in the domain of computer networking. These models have different numbers of layers each with different operations.

In our real-life computer networks, which reference model we generally use? Elaborate the generally-used reference model and its layers. (15)

8. (a) Distinguish the following with necessary elaborations and figures. (20)

- i) QPSK versus QAM, and
- ii) GEO satellite versus LEO satellite

(b) How can an Ethernet network experience the following? Explain their underlying mechanisms with necessary diagram(s). (15)

- i) Binary exponential backoff, and
- ii) Exposed station problem.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations (January 2020 Semester)

CSE 321 (Computer Networks)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION -AThere are **FOUR** questions in this section. Answer any **THREE**.

- 1 a) Consider a host (X) in a LAN wants to communicate another host (Y) in a remote LAN. Explain the ARP operation in such as a scenario with the necessary diagram. (10)
- b) Consider you are given the address space **172.16.10.0/23**. Now you are to subnet the address according to the host requirements for different departments that are given in the following table. Then fill up the empty columns with values resulting from your calculation. Use the smallest subnet sizes that will accommodate the relevant number of hosts and do not leave any gap (at the start of given address space or between the subnets). (20)

Department	No. of hosts required	Network address	Broadcast Address	Subnet Mask
Sales	100			
Service	90			
Accounts	30			
Sales	12			
HR	10			

2a) “Sending hop-by-hop choke packets performs better than sending the choke packet to the sender”- Do you agree with the statement? Justify your opinion with necessary figure(s). (10)

b) What are the different tables required for OSPF routing? How can a router build those tables during the OSPF operation? Which table contributes to provide full network structure to each OSPF router? (10)

c) What can be a possible solution to Count-to-infinity problem? Explain briefly. (10)

3a) What is the purpose of DHCP relay agent? Show its operation using a topology diagram. (10)

b) Compare TCP Tahoe with TCP Reno congestion control algorithm with necessary figure(s). (10)

c) In a TCP session, the receiver sends ACK=1 with a sequence number 8192 and Window Size 0. What does it imply to the sender? (10)

4a) What is non-authoritative DNS resolution? When can it happen? Do you trust such resolution? (10)

b) What is the purpose of cookies in HTTP communication? What are its benefits and drawbacks? (10)

c) Explain the roles of SMTP and IMAP protocols in email communication using necessary figure. (10)

Life may be very improbable, but it did happen and it happened in accordance with physical laws, and physical laws are laws that God made. – Charles Townes

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations (January 2020 Semester)

Sub: **CSE 321** (Computer Networks)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. a) A Bangladesh-based IT firm has opened its new branch in USA. To expedite the firm's activities, to balance its network traffic load, to enhance reliability of its communication, and to ensure security in its data transmission, the firm has decided to create a VLAN over its main office in Bangladesh and its new branch in USA. Note that, there exist traditional network equipment and devices connecting the two countries – Bangladesh and USA. [15]

You are given the problem of developing the VLAN between the two parts of the firm – one in Bangladesh and another in USA. The first question you need to answer here is whether you can develop the VLAN or not.

If you can develop the VLAN, explain in detail how you can do it with a design of the VLAN. If you cannot do it, then you need to explain reason(s) behind not being able to do it. You need to present your explanation with necessary figure(s).

- b) Wavelength Division Multiple Access (WDMA) is a concept that is related to Frequency Division Multiple Access (FDMA). In WDMA, wavelength is used in fiber communication systems to partition channels. In FDMA, one channel or bandwidth is divided into multiple individual bands, each for use by a single user. Each individual band or channel is wide enough to accommodate the signal spectra of the transmissions to be propagated. Here, the data to be transmitted is modulated onto each subcarrier, and all of them are linearly mixed together. [15]

A network specialist analyzes the notion of WDMA in detail, and come up with a conclusion that Hidden Station problem and Exposed Station problem can occur in case of WDMA. Now, you need to explain whether the conclusion on possibility of occurring Hidden Station problem and Exposed Station problem can occur in case of WDMA is correct or not. If you think that the conclusion is correct, then you need to explain how the problems can occur. If you think that the conclusion is wrong, then you need to explain reason(s) why the conclusion is wrong. Present all necessary figures in support to your explanation.

6. a) "There could be two different variations of Sliding Window protocol – Go Back N and Selective Repeat. Between these two different alternatives, timer is required for each frame only for Go Back N, as such timer is not required for Selective Repeat." - You need to validate or invalidate this statement or conclusion. You need to explain your answer with necessary figure(s) and/or pseudocode(s). [15]

- b) In case of a baud rate of 2400, determine data rates in cases of QPSK, QAM-16, QAM-64, V.32, and V.32 bis. Explain your process of determination through presenting corresponding

Constellation Diagrams.

7. a) "In CDMA, Time Division Multiplexing is used to increase data rate" – validate or refute [15] this statement with necessary explanations and examples.

b) You are given a task of designing a DLL protocol for data communication of a very reliable application. In this regard, you are explicitly asked to perform the task of error detection and correction in your developed DLL protocol. [15]

To do so, you are given with the following DLL protocol –

- 1) Bit stuffing for framing,
- 2) r parity bits for m data bits maintaining the condition that $(m+r+1) \leq 2^r$ along with arranging k consecutive codewords in a matrix (one codeword in a row) and transmitting one column at a time to handle a maximum burst error of k bits, and
- 3) Sliding window protocol using Go Back N.

Now, you need to pinpoint whether the above protocol will operate correctly only from the perspective of performing the task of error detection and correction. Justify your answer.

8. a) Considering different performance measures at low network traffic load and high network traffic load, different types of MAC protocols (such as non collision free protocols, collision free protocols, etc.) can be in operation in the same network. You need to present and elaborate how this can be done. Moreover, you need to present how we can realize benefit through enabling different types of MAC protocols in the same network. You need to show necessary derivation(s) and graph(s) in this regard. [15]

b) A network researcher wants to redefine the protocol stack through merging pairs of different classical layers (Application Layer, Network Layer, Transport Layer, and Data Link Layer) together. For this purpose, Application Layer and Network Layer are planned to be merged together as Layer 1. Besides, Transport Layer and Data Link Layer are planned to be merged together as Layer 2. The two layers after merging, i.e., Layer 1 and Layer 2, are planned to be kept in isolation. [15]

Now, you need to elaborate how the merging could be done from the perspectives of protocols and interfaces of Layer 1 and Layer 2. In case you think that the merging is not possible, you need to elaborate reason(s) behind this thought.

It is He who sent His Messenger with guidance and the religion of truth to manifest it over all religion. And sufficient is Allah as Witness. [Al Quran 48:28]

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) A network engineer is, first, given two options to send routing decision making related information over a packet switching datagram subnet under his control. The first option is to send distances of neighbors to all other routers (classical LSR), and the second option is to send distances of all other routers to neighbors (classical DVR). The engineer chooses the second option, i.e., to send distances of all other routers to neighbors, in a classical manner. This gives him to have two advantages – (i) simplicity, and (ii) fully distributed routing algorithm. However, here, he faces two key limitations – (i) slow convergence even after incorporating "Split Horizon" and "Forced Update", and (ii) no provision of incorporating multiple paths. (20)
Now, considering the limitations, the network engineer changes his strategy from "sending distances of all other routers to only the neighbors" to "sending distances of all other routers to all other routers" (thus, it is now neither classical LSR nor classical DVR). After adopting this approach, the engineer performs necessary processing over all available information in a router. Accordingly, he claims that both the limitations get solved keeping the two advantages and incurring no more added limitation.
Considering the changes made by the engineer, i.e., "sending distances of all other routers to all other routers", you need to pinpoint which of the above-mentioned limitations (if any) can actually be solved and what additional problems (if any) can get created. Elaborate your answer with necessary figures and elaborations.
(b) "Border Gateway Protocol (BGP) adopts Path Vector Protocol to allow policy making, to avoid loops, and to permit transits between customer-provider or even between two peers" – validate or invalidate this statement with necessary figures and elaborations. (15)

2. (a) Both IPv4 and IPv6 define ranges of IP addresses as private IP addresses to enable using behind a NAT. A network engineer is given a task of configuring his network hosts' IP address behind a NAT, where sometimes he needs to enable fragmentation for some of his applications. Either of the two possible solutions for fragmentation, namely transparent fragmentation and non-transparent fragmentation will be made available to him in case he needs to do fragmentation. (20)
Considering the above-mentioned aspects, you need to identify which one (or even none, or both) between IPv4 and IPv6 the network engineer can adopt. You need to make your judgment with proper reasoning and necessary elaborations.

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- (b) "Reverse Path Forwarding is basically intended for the purpose of broadcast routing, however, its concept can be equally applicable in Multicast routing" – validate or invalidate this statement with necessary figures and elaborations. (15)
3. (a) Nagel's solution and Clark's solution in flow control solve the problem with slow sender and slow receiver, respectively. You are given a task to integrate these two solutions to deal with two hosts communication using Real-time Transport Protocol (RTP), which refers to a protocol implemented in the Application layer to deal with multiplexing and de-multiplexing of several real-time streams. (20)
- You, first, need to answer whether you can perform the integration task. If you think you can perform the task, then you need to elaborate how you can do it. If you think it cannot be done, then you need to justify your thought with necessary elaborations.
- (b) "A fixed value of Retransmission Timeout Timer (RTO) is better to be always in operation than to compute it after transmission of each packet due to having no computational overhead in the first case and huge computational overhead in the second case" – validate or invalidate this statement with necessary figures and elaborations. (15)
4. (a) Can you get a saw-tooth behavior in TCP Tahoe congestion control algorithm? If so, then elaborate why and how you can get it. (20)
- If you think it is not possible to get it in TCP Tahoe, then is there any alternative to get it? If so, then elaborate why and how you can get it in an alternative.
- Your elaboration needs to have necessary figures.
- (b) "Congestion collapse can only occur in case of TCP, and it is impossible in case of UDP" – validate or invalidate this statement with necessary figures and elaborations. (15)

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

All the symbols have their usual meanings unless explicitly mentioned.

5. (a) What is protocol layering? Give two arguments for and two counter arguments against protocol layering? (3+4)
- (b) Describe briefly the delay components in the end-to-end delay (i.e., the time it takes for a packet to reach from the source to its destination) in a packet switched network. (6)
- (c) What is the advantage of using persistent HTTP over non-persistent HTTP? Illustrate with an example. (8)
- (d) Suppose Alice, using a desktop based e-mail client (such as outlook) sends a message to Bob, who accesses his mail using a web-based e-mail account (such as Gmail). Describe how the message gets from Alice's host to Bob's host. Particularly, list the series of application-layer protocols that are used to move the message between two hosts. (5)

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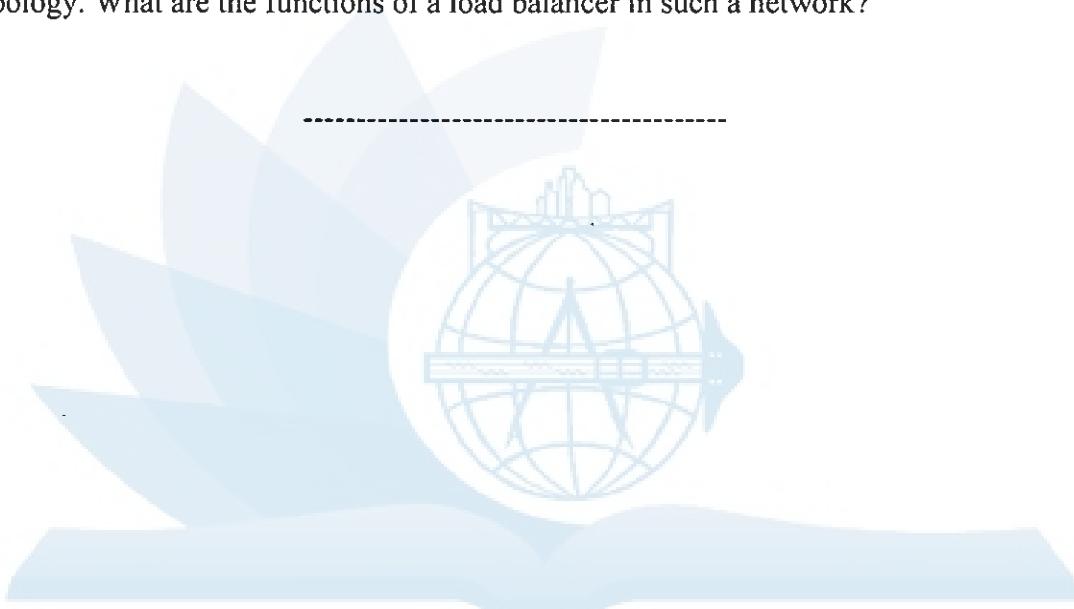
Contd ... Q. No. 5

- (e) Suppose you have just created a new e-commerce startup company called 'Tori Ghori' to sell watches and clocks online. You have registered the domain name *torighori.com* at a registrar. You have also procured a range of public IP addresses: 210.210.210.1-210.210.210.4 from some ISP. You plan to run your own web server and DNS server. But for e-mail, you plan to use Google's Gmail service keeping your domain name, i.e., any mail sent to an address of the form *username@torighori.com*, will eventually land in some Gmail inbox. Now, describe in details how and what record would you insert into the DNS database such that people can browse your website at *www.torighori.com* and you can also use the Gmail inbox for your incoming mails. Fill up other details as required. To verify your configuration, list the sequence of actions that will occur after your setup and configuration, when – (i) someone wants to visit the Web page *www.torighori.com* and (ii) sends you a mail at *yourname@torighori.com*. (6+3)
6. (a) Consider a generator polynomial $G = 11011$ that has been selected for some CRC calculation. Now answer the following: (4+5)
- Why can G be used to detect any single bit error?
 - Can the above G be used to detect any odd number of bit errors? Justify your answer.
- (b) What are the four desirable properties of a multiple access protocol (MAC) for a broadcast channel of rate R bits per second? What are the three broad classes of MAC protocols? (4+3)
- (c) How does CSMA/CD work? Why does Ethernet, which runs CSMA/CD at the MAC layer, enforce a minimum frame length (e.g., 64 bytes for 10 Mbps Ethernet)? (6+4)
- (d) Describe the 'binary exponential backoff' algorithm that is used in Ethernet. Why this algorithm is such called? What is the intuition behind the algorithm? (9)
7. (a) Why do layer 2 Ethernet switches need to run 'Spanning Tree Protocol (STP)'? Explain with an example scenario. (6)

- (b) Describe a scenario where it is preferable to use Virtual LAN (VLAN). Why VLAN is such called? What is the function of 802.1Q protocol in a VLAN implementation? (5+2+3)
- (c) Why does 802.11 MAC protocol not implement collision detection? Describe the operation of 802.11 CSMA/CA protocol. In which step of its operation does CSMA/CA attempt to avoid collision (in comparison to CSMA/CD)? Explain. What are the functions of 'InterFrame Spacing (IFS)' intervals: DIFS and SIFS in the operation of CSMA/CA you have just described? (4+6+5+4)

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8. (a) Write down the events and actions of a Selective Repeat (SR) sender and an SR receiver. What consideration should be taken into account while determining the timeout value at the SR sender? **(10+3)**
- (b) Suppose you walk into a room with your laptop, connect to a Wi-Fi access point (which is in turn connected to a gateway router through wired media), and want to download a page. What are all the protocol steps that take place, starting from powering on your laptop to getting the Web page? Assume there is nothing in your DNS or browser caches when you power on your laptop. Explicitly indicate in your steps how you obtain the IP and MAC addresses of the gateway router. **(10)**
- (c) Describe, with a suitable diagram, data center network architecture with a hierarchical topology. What are the functions of a load balancer in such a network? **(8+4)**



SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) A network protocol designer wants to design a new congestion control protocol for TCP. The congestion control protocol increases congestion window (cwnd) as follows: (30)
 - (i) It makes cwnd triple (THREE times) after each RTT, i.e., successful transmission of a cwnd, up to a certain threshold on cwnd, and
 - (ii) It increases cwnd by 1 MSS after each 2 (TWO) consecutive RTTs, i.e., successful transmission of two cwnds, after the threshold on cwnd.

In case of a timeout, the cwnd is set to 1 MSS and the threshold on cwnd is set to half of the last cwnd that was in operation just before the timeout occurring. Now, you need to answer the following:

 - (i) What is the increase in cwnd for each ACK in case of a successful transmission? Show necessary derivations for your answer(s).
 - (ii) Show the change in cwnd in a figure having successive transmission attempts in the X axis (which is generally done in traditional figures) for different types of events covering successful transmission attempts *up to* the event of cwnd attaining the threshold on cwnd, successful transmission attempts *after* the event of cwnd attaining the threshold on cwnd, and retransmission timeouts.
 - (iii) Compare operation of this congestion control mechanism with that of TCP Tahoe and TCP Reno with necessary figures.

(b) You are given the task of detecting congestion over wireless medium. Possible options for doing it are to explore increase in RTTs, to detect expirations of RTO, to detect packet drops due to filling up router queues, and to get router hints. (16 $\frac{2}{3}$)

Do you think you can use all these options for your designed task? If so, explain why and how you can do it. If not, then explain only the reason for not being able to do it.

2. (a) An application is generating data at a rate of 25 MBps for 40 ms. There are three different techniques for achieving QoS in the Network layer for the application as follows: (10+10+10=30)
 - (i) Usage of a leaky bucket having a packet outgoing rate of 10 MBps,
 - (ii) Usage of a token bucket having a capacity of 500 KB and token generation rate of 2 MBps, and
 - (iii) Usage of a token bucket (having specification as mentioned above) feeding the leaky bucket (having specification as mentioned above).

Show outcome of each of the techniques with necessary figures and derivations.

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Contd... Q. No. (2)

- (b) "ARP is not required if a network enables DHCP" – validate or invalidate this statement with necessary figure(s) and elaboration. (16 $\frac{2}{3}$)
3. (a) In OSPF, how can you experience the Count to Identify problem? Can you use the "Split Horizon Rule" here? Is "Forced Update" required here to completely overcome the Count to Infinity problem?
Answer with all necessary figures and/or pseudocodes. (10+10+10=30)
- (b) "Applications enabling Remote Procedure Call always use UDP after marshalling and before un-marshaling" – validate or invalidate this statement with necessary figure(s) and elaboration. (16 $\frac{2}{3}$)
4. (a) Consider the following two different ways of shared secret key based two-way authentication using a challenge-response protocol. Here, each symbol and name corresponds to their traditional meanings. (10+10+10=30)

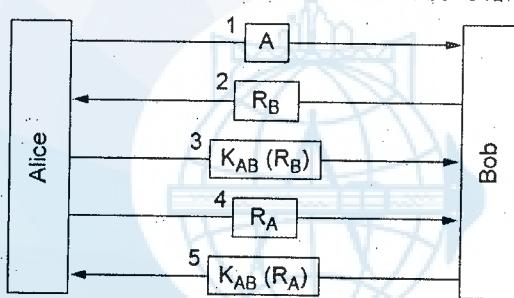


Figure 4.1: Two-way authentication using a challenge-response protocol

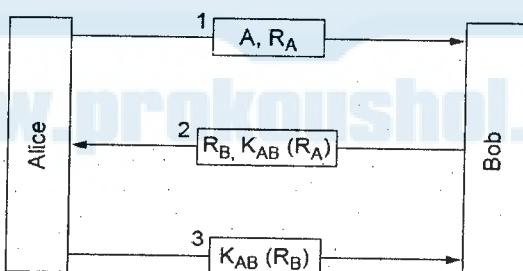


Figure 4.2: A shortened two-way authentication protocol

Now, you need to answer the following:

- (i) Is the approach presented in Figure 4.1 prone to the Reflection attack? If so, show and explain how it can happen with necessary figure.
- (ii) Is the approach presented in Figure 4.2 prone to the Reflection attack? If so, show and explain how it can happen with necessary figure.
- (iii) How can you improve the two-way authentication protocol (shown in the above figures) to escalate its level of security? Show and explain with necessary figure.
- (b) How can you establish a shared secret key in two different entities (for example Alice and Bob) in a secured way? Explain with necessary figure. (16 $\frac{2}{3}$)

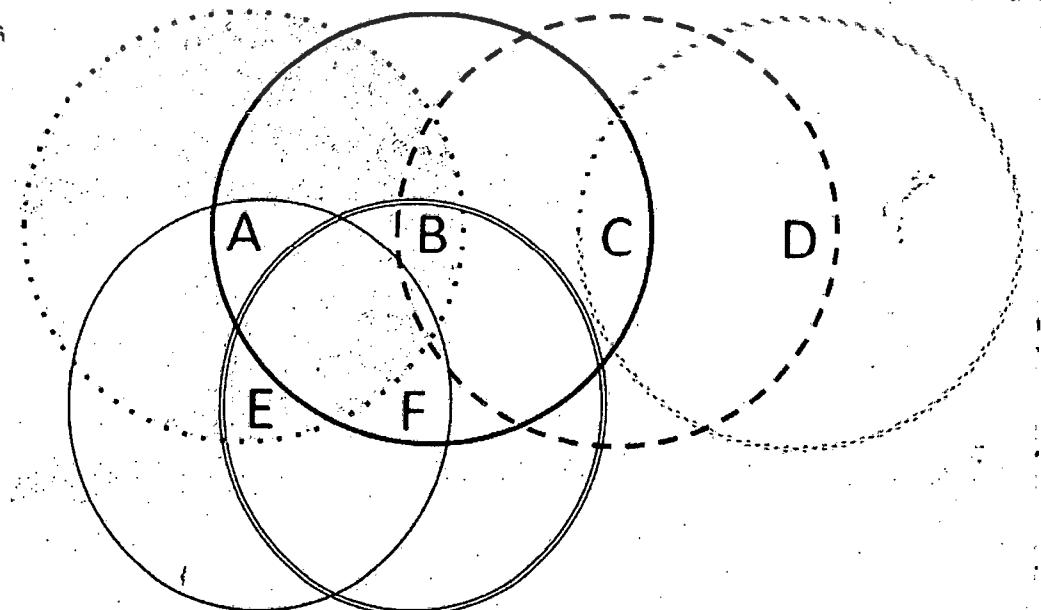
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SECTION-B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) What is the principle difference between connectionless and connection-oriented communication? (6 $\frac{2}{3}$)
- (b) Give three examples of distinct applications for which unreliable communication is appropriate. (6)
- (c) Characterize the spread, bandwidth, latency, error rate, scalability and administrability of the WAN. (9)
- (d) A bit stream 10011101 is transmitted using the standard CRC method described in the text. The generator polynomial is x^3+1 . Show the actual bit string transmitted. Suppose the third bit from the left (payload) is inverted during transmission. Show that this error is detected at the receiver's end. (15)
- (e) Define piggybacking and pipelining. (6)
- (f) In Data Link Control, briefly explain the procedure known as byte stuffing. (4)
6. (a) Describe the assumptions of dynamic channel allocation in LANs and MANs. (15)
- (b) A channel has a bit rate of 4 kbps and a propagation delay of 20 msec. For what range of frame sizes, does stop and wait give an efficiency of at least 50 percent? (8)
- (c) In a slotted aloha system, suppose there are 5 nodes where each transmits with probability p. What is the likelihood, in a given slot time, that one of the nodes successfully transmits a packet? Why does CSMA outperform Aloha? (12)
- (d) Suppose your friend is telling about a new combined bit/byte-level framing protocol he has invented on his own, which he calls "HybridFraming". Here's how it works: The bit-pattern "01010101" is used as a sentinel to identify frame boundaries (i.e., the sentinel is inserted at the beginning and end of each frame, with the payload data sandwiched between). If the sentinel pattern occurs in the payload data, then a "1" is stuffed right after the sequence "010101" (i.e., so 01010101 would produce 010101101). He says that since you only stuff 1 bit, this protocol is more efficient than traditional approaches. Provide a concrete example demonstrating why this protocol is unlikely to work how he thinks. (11 $\frac{2}{3}$)

7. (a)



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Contd... Q. No. 7(a)

Consider the wireless topology above, comprised of 6 nodes. Circles around each node illustrate their transmission range, e.g. A's range is shown by the dotted, shaded circle. Assume that if the transmissions of two nodes' will interfere at a location if and only if they transmit at the same time and their transmission areas overlap. In these problems, assume that losses only occur due to collisions.

(8)

(i) When node A transmits to node B, list the potential hidden terminals from A (in either direction, i.e., those who might clobber A's transmission or those who might be clobbered by A's transmission and exposed terminals).

(ii) What about the Hidden terminals and Exposed terminals when node B transmits to node C?

(b) Briefly describe the Adaptive Tree Walk Protocol. A collection of 2^n stations uses the Adaptive Tree Walk Protocol to arbitrate shared cable. At a certain instant, two of them become ready. What are the minimum, maximum, and mean number of slots to walk the tree if $2^n \gg 1$?

(12)

(c) "All algorithms must be public, only the keys are secret" – Do you agree with the statement with respect to Cryptology? Briefly explain.

(6 2/3)

(d) In RSA algorithm, let's say, $p = 5, q = 13$.

(10+5+5=20)

(i) Choose appropriate values for e and d.

Using these values,

(ii) Encrypt 'F' to a number x.

(iii) Now decrypt x and show that after decryption, we get back the original plaintext 'F'.

[All the symbols p, q, e, d preserve their usual meaning]

8. (a) What is the key difference of message digests from traditional digital signatures like symmetric-key signatures and public-key signatures?

(6 2/3)

(b) What is cookie with respect to World Wide Web? Mention three practical applications of cookies.

(3+5=8)

(c) Caching is the concept of saving pages for subsequent use. However, if a proxy (a process taking care of caching) throws out pages quickly, the hit rate becomes very low failing the purpose of caching. Again, if it keeps pages for too long, we may end up with stale pages.

(17)

However, using Last-Modified and If-Modified-Since headers, we can develop a heuristic on how long a page should be cached. Explain your idea of such a heuristic.

(d) Write short notes on any two of the following three topics:

(15)

(i) MIME (ii) URL (iii) Steganography