

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 – A**There 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)

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Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

**SECTION – A**There 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.
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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 –A**There 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)

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USE SEPARATE SCRIPTS FOR EACH SECTION

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### **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.

**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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### Contd ... Q. No. 2

- (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)**
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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Full Marks: 280

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

**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)

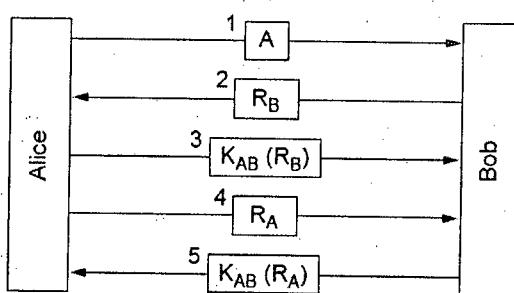


Figure 4.1: Two-way authentication using a challenge-response protocol

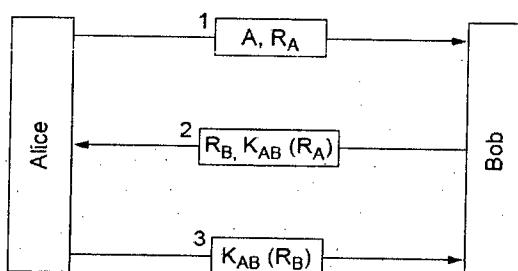


Figure 4.2: A shortened two-way authentication protocol

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 $\frac{2}{3}$ )

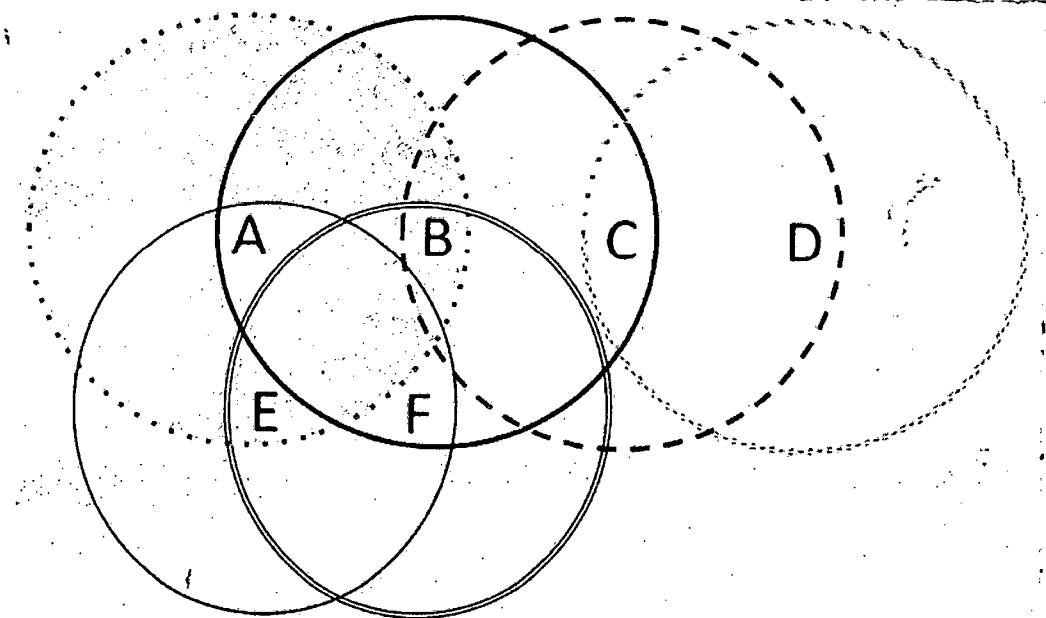
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### SECTION-B

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

**SECTION – A**

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

Symbols have their usual meanings.

1. (a) A routing protocol works with five consecutive steps as follows: i) Discover neighbor routers, ii) Measure cost to each neighbor, iii) Construct a packet incorporating costs to all neighbors, iv) Send the packet to all other routers, and v) Compute shortest path to all routers. The trickiest part among these steps is the fourth one, i.e., sending the packet (consisting costs to neighbors) to all other routers. To facilitate this part, a notion of *Sequence Number* is used. The sequence number helps in identifying fresh packets, and thus, helps to decide on whether or not to send a newly-arrived packet consisting costs to neighbors. (23)

Now, do you think the usage of only sequence number perfectly solves the problem of deciding whether to send a newly-arrived packet consisting costs to neighbors or not? If yes, elaborate how the problem gets solved. If not, then elaborate what are the remaining issues to be solved and describe how they can be solved?

- (b) Draw a high-level networking architecture of Internet and show where Path Vector Protocol (related to BGP) is generally used. (23  $\frac{2}{3}$ )

Besides, justify or refute the following statement with necessary elaboration – “Path Vector Protocol extends Link State Routing Protocol and deals with all routers on the way to find a shortest path”.

2. (a) Two typical approaches for broadcast routing could be to send distinct packets to each router or to flood the same packet over a network. Do you think these approaches possess any limitation? (23)

If, not then elaborate all the advantages of these approaches. If, yes then what are the limitations and what could be the possible way(s) to alleviate the limitations? You need to elaborate your answer with necessary figures(s) and description.

- (b) A network consists of four sub-networks namely A, B, C, and D. These are connected as follows: A-B-C-D. Here, the packet handling capabilities of the sub-networks are as follows: A and D can handle packets with a maximum size of 2KB, B can handle packets with a maximum size of 1KB, and C can handle packets with a maximum size of 512 B. Now, you are given a job to transmit packets of 2KB from A to D. (23  $\frac{2}{3}$ )

What will be the problem you are going to face to perform the transmission? Is there any way to solve the problem? If yes, then describe the ultimate consequence.

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3. (a) "In TCP, transmissions of three message are enough to establish a connection except the case of Call Collision." – Justify or refute with necessary figure(s) and elaboration. (23)
- (b) "In UDP, a slow sender may pose a threat of substantial overhead, which can be minimized by Nagle's solution. Similarly, in UDP, Clark's solution solves the problem exposed by a slow receiver." – Justify or refute with necessary figure(s) and elaboration. (23⅓)
4. (a) A network protocol designer is given the task of controlling network congestion with the primary target of ensuring stability. To do so, he enables the method of additive increase of congestion window in case of finding favorable situation (packets are being successfully transmitted) and additive decrease of congestion window in case of finding adverse situation (packets are being dropped). Do you think this choice will ensure stability over multiple transmitters? If so, then describe how it ensures stability over multiple transmitters. If not, then describe why not and elaborate a better alternative. (23)
- (b) Distinguish between TCP Tahoe and TCP Reno with necessary figure(s) and elaboration. (23⅓)

### SECTION-B

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

5. (a) When bit stuffing is used as framing method, is it possible for the loss, insertion or modification of single bit to cause an error not detected by the checksum? If not, why not? If so, how can it be ensured that the single bit error is detected? Does the checksum length play a role here? (12)
- (b) What are the odds that can arise when two hosts simultaneously send an initial packet in Protocol 4 (Stop and Wait Protocol)? Explain with appropriate figures. (14)
- (c) Both Go Back N and Selective Repeat Protocol supports the concept of multiple outstanding frames. If a 3 bit sequence number is used what is the range of distinct sequence number that can be used for frames outstanding at any instant for both the mentioned protocols? Also explain the reasons behind choosing such range for both Go Back N and Selective Repeat Protocol. (14)
- (d) A block of bits with  $n$  rows and  $k$  columns uses horizontal and vertical parity bits for error detection. Suppose that exactly 4 bits are inverted due to transmission errors. Will the mentioned scheme be able to detect this error? Will the scheme be sufficient to correct it? (6⅓)

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6. (a) Consider the delay of pure ALOHA versus slotted ALOHA at high load. Which one of the mentioned protocols is preferable in this case? Explain your answer. (8)
- (b) A LAN uses binary countdown method as Multiple Access Protocol. At a certain instant, the ten stations have the virtual station numbers 8, 2, 4, 5, 1, 7, 3, 6, 9 and 0. The next three stations to send are 4, 3 and 9, in the mentioned order. What are the new virtual station numbers after all three have finished their transmissions? (6 $\frac{2}{3}$ )
- (c) The wireless LANs use MACA instead of CSMA/CD protocol. What are the odds of using CSMA/CD protocol for wireless LANs? Under what conditions, if any, would it be possible to use CSMA/CD instead? (10)
- (d) What is hidden and exposed station problem? Describe the process how these problems are solved in 802.11 MAC sub layer protocol. (12)
- (e) To increase reliability, some sites use two or more bridges in parallel between pairs of LANs. This arrangement, however, introduces some problems because it creates loops in the topology. Explain the problems with an appropriate figure. How these problems can be overcome? (10)
7. (a) Show DNS operations for a site, say, www.buet.ac.bd with diagram when the local DNS server does not have this URL in its cache. (14)
- (b) DNS uses UDP instead of TCP. If a DNS packet is lost, there is no automatic recovery. Does this cause a problem? If so, how is it solved? (12)
- (c) From an ISP's point of view, POP3 and IMAP differ in an important way. POP3 users generally empty their mailboxes every day. IMAP users keep their mail on the server indefinitely. Imagine that you were called to advise an ISP on which protocol it should support. What considerations would you bring up? (6 $\frac{2}{3}$ )
- (d) Briefly describe how e-mail works for ISP customers using both SMTP and POP3 protocol. Use the intervention of DNS sever whenever you find it necessary. (14)
8. (a) The CEO of Cisco Inc. gets an idea of developing a mutating routing algorithm (an algorithm that can mutate depending on the network automatically) with collaboration of Google. The CEO asks his legal department to look into it, and they in turn ask engineering department for help. As a result, the chief engineer calls his counter-part at Google to discuss the technical aspects of the project. The engineers then report back to their respective legal departments, which then confer by telephone to arrange the legal aspects. Finally, the two CEOs discuss the financial side of the deal. Is this an example of a multi-layer protocol model? Write the advantages of using multi-layer protocol in terms of networking concept. (8)
- (b) Write a short note on HTTP protocol of World Wide Web. (10)
- (c) What is the principle difference between connection-oriented and connection-less communication? (6)
- (d) What is a Virtual LAN? Briefly describe the working procedure of a Virtual LAN. (16)
- (e) What is frequency hopping spread spectrum? (6 $\frac{2}{3}$ )

**SECTION – A**

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

1. (a) Two military troops want to exchange highly-sensitive information between them. Here, both the troops need to ensure secrecy of the exchanged information while the information is under communication, i.e., no intruder can interpret any information under communication. Alongside, both the troops need to ensure that the information can be received only from the other troop, i.e., only from the authenticated source. Finally, both the troops want to ensure that the mode of information exchange will retain the capability of non-repudiation, i.e., a sender cannot refute after sending its own information. To meet all these requirements, both the troops agree on using message digests. (23 $\frac{2}{3}$ )

Now, you need to assess whether the choice of message digests is sufficient enough to meet all the requirements. If you think that the choice of message digests is sufficient enough, then you need to elaborate how the choice meets all the requirements. If not, then you need to state why the choice does not meet the requirements and what other possible alternative(s) (with brief elaboration) could be used in place of message digests.

(b) Authentication between two parties can be done using a notion of two-way challenge-response protocol. The protocol may need five different information exchanges, which can be minimized to three information exchanges. However, irrespective of the number of information exchanges, a shared key needs to be established between the communicating parties. Diffie-Hellman key exchange mechanism can assist to establish a shared key between the communicating parties. (23)

One of the prominent vulnerabilities of the Diffie-Hellman key exchange mechanism is that it is prone to Bucket-Bridge or Man-In-The-Middle attack. In such an attack, an intruder can get into the two parties that want to establish a shared key. To alleviate this vulnerability (i.e., the Bucket-Bridge or Man-In-The-Middle attack), a researcher proposes to utilize a timestamp and a random number that will be used only once (or nonce in its general term). Do you think the usage of a timestamp and a nonce is justified to guard against the Bucket-Bridge or Man-In-The-Middle attack? If so, then you need to elaborate how the usage of a timestamp and a nonce can guard against the attack. If you think that the usage of a timestamp and a nonce is not justified to guard against the attack, then you need to elaborate why it is not justified.

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2. (a) The IEEE 802.11 protocol operates in two different modes - Distributed Co-ordination Function (DCF) and Point Co-ordination Function (PCF). In DCF, 802.11 uses CSMA/CA. Here, two types of channel sensing are generally used - Physical channel sensing and Virtual channel sensing. You need to elaborate the methodology of the Virtual channel sensing. Here, you also need to elaborate how it operates in case of having fragments of a frame. (23 $\frac{2}{3}$ )

(b) Bridges are used for switching in Data Link Layer to connect different LANs. To make Bridges plug-n-play, i.e., start operating from the time of connecting it without any more configurations being required, the notion of Transparent Bridge is widely used. In Transparent Bridges, paths to different LANs are learned through backward learning or tracing the reverse path of an incoming frame. Here, if the destination of a frame remains unknown, then the notion of flooding is used. Such mechanism can create a problem with experiencing infinitely looping frames in case of having two parallel transparent bridges between two different LANs or having a similar kind of topology. (23)

To alleviate the problem of experiencing infinitely looping frames, a potential countermeasure could be to operate over an overlay spanning tree. Here, the tree is formed from a graph that is constructed through taking each bridge as a node and each LAN as a link. Do you think that this countermeasure will be a workable solution? If so, then you need to elaborate how it gives a workable solution with an example. If you think that this countermeasure will not be a workable solution, then you need to elaborate reason(s) behind your thoughts and how the solution could be made workable.

3. (a) One of the good sides of CDMA is that it allows each station to transmit over the entire frequency spectrum all the time. This good side is completely missing in many similar other techniques such as AMPS, D-AMPS, and GSM. This happens as these techniques demand multiplexing over the contending stations in the time domain. Consequently, many a times CDMA is found to perform better than these techniques. (23 $\frac{2}{3}$ )

Now, let a new solution come up to overcome the barrier AMPS, D-AMPS, GSM, and similar techniques experience while multiplexing accesses of contending stations in the time domain. The solution attempts to enable each station to transmit over the entire frequency spectrum all the time through utilizing the concept of Hamming distance. It utilizes the condition that d-bit error can be corrected through ensuring a minimum of  $(2d+1)$  Hamming distance among the allowed codewords. It separately enables the same mechanism for both cases - while the medium experiences single-bit error and while the medium experiences burst errors.

Now, you need to judge the success scenario of the new solution. You need to answer whether the new solution can succeed or not. If yes, then elaborate why and how this succeeds. If not, then elaborate what is the reason behind its failure.

(b) A company has several branches all over the world. The branches communicate among themselves over a network containing network devices (such as switches, routers, etc.) that can fail individually at any time without offering any high level of reliability. Besides, the branches do not demand any fixed bandwidth for communicating among themselves. Alongside, the branches do not need in-order arrival of the packets under communication. (23)

Now, to meet these requirements, you need to choose the appropriate mode of communication between two conventional modes - packet switching and circuit switching. You need to justify your choice and elaborate the underlying communication mechanism of the choice.

4. (a) Adaptive Tree Walk protocol is one of the classical examples of limited-contention protocol. Here, each station is considered as a leaf of a binary tree. The protocol generally begins from the root of the tree and traverses the tree according to what happens while being at a node. The protocol gives changes to all stations under the currently-traversing node to initiate their communications. (23  $\frac{2}{3}$ )

Now, you are given a task to optimize the traversal mechanism through not starting from the root of the tree. You need to elaborate how you can do it with necessary example(s).

(b) "In one-bit sliding window protocol, there can be duplicated packets in communication" - validate or invalidate this statement with necessary example(s) and elaboration. (23)

### SECTION – B

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

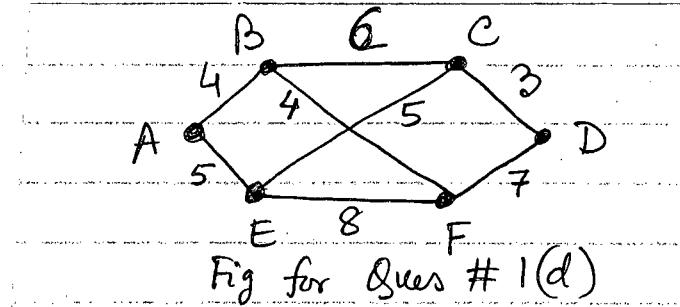
5. (a) Draw a block diagram to show the operation of SSL. Why is HTTPS not used for all web traffic? Discuss possible weaknesses in the implementation of HTTPS. (20)
- (b) Name four common types of DNS query. Show the DNS operation for a site, say, www.yahoo.com with diagram when the local DNS server does not have this URL in its cache. (16  $\frac{2}{3}$ )
- (c) Discuss DNS spoofing attack in brief. (10)
6. (a) Show DHCP operation. When is DHCP preferred and when is it not compared to static addressing? How does a Rough DHCP Server cause security threat? (16  $\frac{2}{3}$ )
- (b) What is TCP handoff? Discuss different uses and abuse of cookie mechanism. (20)
- (c) Compare H.323 with SIP. (10)

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7. (a) What is delayed duplicate problem in the context of connection establishment? How does three-way handshake solve it? (12)
- (b) Discuss dynamic buffer allocation at transport layer. Show a potential problem of this technique. What are the limitations of RPC? (18)
- (c) How is retransmission timeout calculated dynamically in TCP? What potential problem may occur in this scheme? (16 $\frac{2}{3}$ )
8. (a) What is persistence timer in TCP? What is the purpose of PSH and URG bits in TCP header? Why Nagle's algorithm used in TCP implementations? When can't this algorithm be used? (18)
- (b) Discuss count to infinity problem in brief in the context of distance vector routing. Discuss the use of source port field in NAT. (10)
- (c) Where should we place standard and extended ACLs and why? For a given network address 10.10.128.0/17, you need to create subnets such that at most 400 hosts can be accommodated in one subnet. Determine the range of usable host addresses and broadcast address in dot decimal notation for the last subnet. (18 $\frac{2}{3}$ )
-

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

1. (a) Compare circuit switching, virtual circuit and datagram with respect to signaling overhead, utilization and speed. (12)
- (b) Why is distance vector routing algorithm not suitable for large networks? Explain. (10)
- (c) Flooding is not practical for most applications but it does have uses in military applications. What may be the reasons for such applications? (10)
- (d) Consider the subnet as shown below where distance vector routing is used and following vectors have just come to router C: from B(5, 0, 8, 12, 6, 2); from D(16, 12, 6, 0, 9, 10); and from E(7, 6, 3, 9, 0, 4). The measured delays to B, D and E are 6, 3 and 5, respectively. What is C's new routing table? (14 2/3)



2. (a) What is the role of Sequence number in each packet while flooding link state packets (by routers)? What can happen if the sequence number gets corrupted? What can be a possible solution? (12)
- (b) Explain reverse path forwarding broadcast algorithm with necessary diagram. (12)
- (c) Give an argument why leaky bucket algorithm should allow just one packet per tick, independent of how large the packet is. (10 2/3)
- (d) Consider a flow having a maximum packet size of 1000 bytes, a token bucket rate of 10 million bytes/sec, a token bucket size of 1 million bytes and a maximum transmission rate of 50 million bytes/sec. How long can a burst at maximum speed last? (12)

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3. (a) Draw the state transition diagram for TCP connection establishment and release. You must show normal and abnormal scenarios. (14)
- (b) What are the issues related to a fixed RTT timer of TCP? How is it made dynamic? Which one is the main factor that influences the dynamism of RTT? Explain with equations. (12)
- (c) What is the main purpose of persistence timer in TCP? What problem does it try to solve? (7)
- (d) Explain silly window syndrome with an example case (when it occurs). Mention one solution to this problem. (7)
- (e) Draw the UDP header and explain its fields. Why is there no "ACK" or "Sequence number" field? (6 $\frac{2}{3}$ )
4. (a) How does RPC work? Explain with necessary block diagram. (10)
- (b) What are the factors considered by a TCP sender to control congestion in the network? What is the purpose of congestion window? Explain briefly. (10)
- (c) What does authoritative record mean in domain name system? Give example. (6 $\frac{2}{3}$ )
- (d) Explain different components involved in email communication using necessary topology diagram. (12)
- (e) Distinguish between IMAP and POP3. (8)

### SECTION – B

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

5. (a) A straightforward way to use DES for encrypting a long piece of plaintext is to break the plaintext into consecutive 8-byte (64-bit) blocks and encrypt them one after another with the same key. However, this straightforward method can easily come under the threat of simple copy-paste like attack by an intruder. To overcome this, each plaintext block can be XOR-ed with the previous ciphertext block before being encrypted. However, this method also exhibits the limitation of requiring an entire 64-bit block to arrive before decryption can begin. This requirement can be completely undesirable for interactive applications, where byte-by-byte encryption is required. (23 $\frac{2}{3}$ )

Now your first task is to present and elaborate with necessary figures how you can perform the byte-by-byte encryption.

Second, you need to figure out whether your solution would exhibit a limitation of messing up 64 bits even in case of having only 1-bit transmission error. If you do not find so, you need to elaborate how your solution can overcome this limitation. If you find so, you need to present another mechanism for overcoming the limitation.

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### **Contd... Q. No. 5**

(b) A firm is using public-key cryptography for ensuring protection of its data being transmitted over a network. The firm starts thinking of enabling a mechanism of authentication in addition to the already-existing secrecy of data. To do so, it starts analyzing all the possibilities. (23)

One of the security experts of the firm mentions that there is no other way but to use shared-key authentication for achieving the goal. He mentions several methods available in this regard such as Two-way authentication, authentication using HMACs, Needham-Schroeder authentication, Otway-Rees authentication, etc.

Do you agree with the expert that authentication will not be possible using a public key. If you agree, then explain the reasons behind it. If you disagree, then elaborate a mechanism by which you can enable authentication using public-key cryptography.

6. (a) In a WDMA protocol, each station is equipped with two transmitters and two receivers as follows: one fixed-wavelength receiver for listening to own control channel, one tunable receiver to select a data transmitted to listen to, one fixed-wavelength transmitter to output data frames, and one tunable transmitter to send one other stations' control channels. Now, you need to judge whether none, or anyone, or both of the following statements are true for the protocol— (23 $\frac{2}{3}$ )

- (i) Neither control nor data signal transmitted simultaneously by multiple transmitter stations to the same receiver station can be successfully transmitted.
- (ii) Both control and data signals transmitted simultaneously by multiple transmitter stations to the same receiver station can be successfully transmitted.

You need to make your judgment with proper reasoning and necessary figures.

(b) A Hawaiian company began with a network having only a couple of machines. It started the network operation with Slotted ALOHA. After a few years, the company grew over tens of computers. Then, it realized that it cannot go any more with Slotted ALOHA. It started thinking of throwing away Slotted ALOHA altogether and enabling a Collision-free protocol in place of the Slotted ALOHA. (23)

Do you think that throwing away Slotted ALOHA altogether was the best approach to be adopted? If you think so, then explain reasons behind it. If you do not think so, then mention what could be a better option and why.

7. (a) You are given a job of connecting several LANs. Which of the following device(s) you will use to do so - hub, switch, bridge, and router. Elaborate reason(s) behind your choice and the mechanism of using the chosen device. (23 $\frac{2}{3}$ )

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### Contd... Q. No. 7

(b) A network designer designs a system for mobile communication with 1 MHz band available for 100 stations each having 10 KHz. Keeping 1 bit per hertz, he comes up with a speed of 10 kbps in this case. After doing so, he concludes that a speed higher than 10 kbps is not achievable here with any of the contemporary mobile communication systems. (23)

Do you think that the conclusion drawn by the designer is a correct one considering only the contemporary systems? If you think so, you need to justify it. If you do not think so, you need to elaborate one existing system that can refute the conclusion through going beyond the speed of 10 kbps.

8. (a) LED offers long lifetime, less temperature sensitivity, and low-cost solution for light sources in fiber optic networks compared to that of laser. However, laser still gets preference over LED in some cases. You need to point out the cases where laser gets the preference and you need to mention reasons behind getting the preference.  $(13\frac{2}{3})$
- (b) Draw a passive star connection in a fiber optics network. (10)
- (c) Can we use Hamming code for error correction in a system where burst errors of  $k$  length may arrive? If yes, then how can we do that? If not, then which property of Hamming code inhibits the usage and how does the property inhibits the usage? (23)
-

**SECTION - A**

There are FOUR questions in this Section. Answer any THREE.

1. (a) What is the difference between 'Connectionless' and 'Connection Oriented' services?

Give examples of a protocol for each of these two types of services. (6 $\frac{2}{3}$ +2)

- (b) (i) A bit stream 101010101 is transmitted using standard CRC method where the generator polynomial is  $(x^3 + x + 1)$ . Show the actual bit string transmitted. (10+10)

- (ii) Explain how to choose the generator polynomial  $G(x)$  while calculating CRC to detect each of the following types of errors.

- Two isolated single-bit errors
- Burst error of length 'k'

- (c) For any code with 'm' message bits and 'r' check bits that allows all single bit errors to be corrected, it is required that  $(m + r + 1) \leq 2^r$ . Now, what would be the relation between 'm' and 'r' that allows correcting double bit errors? Explain how hamming codes generated to correct single bit errors can be used to correct burst error of length 'k'. (10+8)

2. (a) (i) The distance from earth to a distant planet is approximately  $9 \times 10^{16}$  m. What is the channel utilization if a stop-and-wait protocol is used for frame transmission on a 64 Mbps point-to-point link? Assume that the frame size is 32 KB and the speed of light is  $3 \times 10^8$  m/s.

- (ii) In the previous problem, suppose a sliding window protocol is used instead. For what send window size will the link utilization be 100%? You may ignore the protocol processing times at the sender and the receiver. (8+8)

- (b) How does a layer 2 switch work i.e., what algorithms does it (layer 2 switch) use to 'learn' and 'forward' incoming frames? Why layer 2 switches may need to run 'Spanning Tree Protocols'? Explain with an example scenario. (8+8)

- (c) Describe a scenario where it is preferable to use Virtual LAN (VLAN). Explain how VLAN can be implemented using VLAN aware switches. (10+4 $\frac{2}{3}$ )

3. (a) Explain why CSMA/CD cannot be used in Wireless LAN? (8 $\frac{2}{3}$ )

- (b) Answer the following questions in the context of IEEE 802.11 standard for wireless LAN. (4+10+8+10+6)

- (i) What is the difference between 'Infrastructure' and 'Ad-hoc' mode?

- (ii) Explain with a suitable scenario, how does CSMA/CA work?

**Contd ... Q. No. 3**

- (iii) What is 'Virtual Channel Sensing'? Explain with an example.
  - (iv) What is the function of 'InterFrame Spacing' intervals? Explain with an example.
  - (v) Explain APSD (Automatic Power Save Delivery).
4. (a) Consider the part of the DNS name space divided into zones (which are circled) shown in Figure for Question 4(a). Each zone has an associated name server for that zone. Any host in a zone is configured with the IP address of the local name server of its zone. Further, all the name servers are configured with the IP addresses of the root name servers. A name server of any zone is also configured with the IP address of the name server of its immediate child zone. Now answer the following:

**(16+8)**

- (i) A host 'eng.washington.edu' wants to find the IP address of 'flits.cs.vu.nl'. Illustrate how does the DNS resolution work.
- (ii) What is the difference between 'iterative query' and 'recursive query'? Explain using the example DNS resolution process you have just described above.

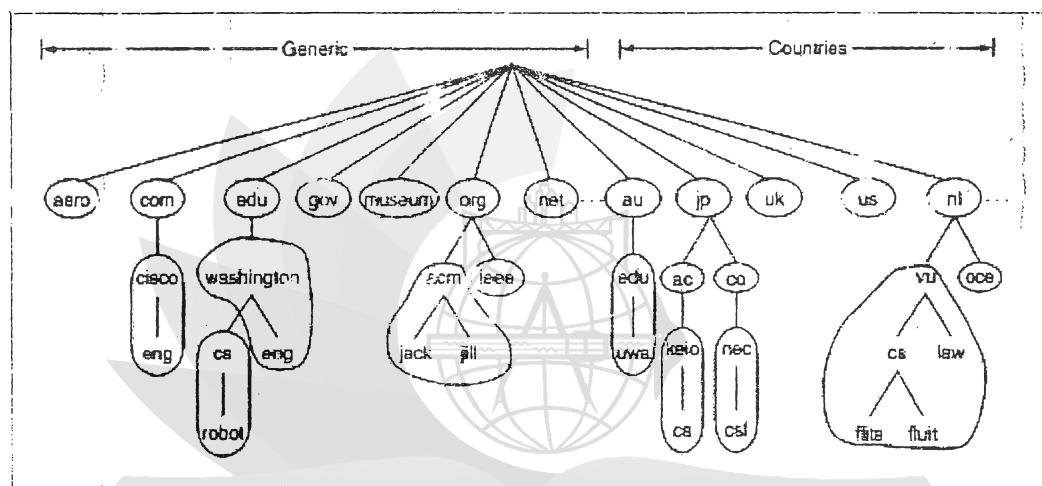


Figure for Question 4(a): Part of the DNS name space divided into zones (which are circled).

- (b) How does 'Content Delivery Network (CDN)' work? What is 'DNS redirection' in the context of CDN?

**(8+4½)**

- (c) Write down the services provided by each of the following protocols.

**(10)**

- (i) IMAP, (ii) RSTP, (iii) SIP and (iv) Chord

### **SECTION - B**

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

5. Secure data transmission was of the utmost importance even at the age of Julius Caesar (around 2K years ago). That time, security of transmitted data was attempted to be ensured through ciphering using substituting a character with another character (for example, 'a' was transmitted as 'd', 'b' was transmitted as 'e', and the rest in sequence).

Contd ..... P/3

However, this type of transmission was not too secure, as the transmitted data could be easily deciphered within a short period of time through trying 26 (assume the number of characters in the alphabet to be 26) different possibilities of substitution. After the invention of computing devices, the deciphering task becomes much easier limiting the task execution time within a fraction of second! Now, a successor of the Roman General Julius Caesar tried to make the substitution mechanism more secure. He used a simple trick - in place of in-sequence substitution, he exploited random substitution of the characters. This simple trick resulted in  $26!$  Different possibilities in place of initial 26 possibilities. The emperor felt a great protection for his information in transmission, and started using the trick.

$$(10+18+18\frac{2}{3}=46\frac{2}{3})$$

With no time, the new trick was also broken. Later, a different technique called transposition was started to be used. The transposition method used a key, which specified relative columnar positions of a row-wise written plaintext while performing the ciphering. The transposition method was further improved by Myszkowski through using duplicate letters in the key. Even then, this method neither guaranteed to provide full protection to the information in transmission.

Subsequently, an amazing method for protecting information in transmission was proposed. It uses a one-time pad, which is XOR-ed with the information before sending it for transmission. The receiving device again performs the same XORing task with the one-time pad to retrieve the original information. It looks really great from the perspective of protection level. However, again, a new problem arises—how can the sending and receiving devices set up the pad on the fly without letting other people know? Besides, even after setting the shared one-time pad, it was not sure how to ensure non-repudiation, i.e., the sender of a sent message cannot subsequently deny that he has not sent the message. Now you need to answer the following:

- (a) How was the new trick of random substitution broken?
  - (b) How can a sending device and a receiving device set up one-time pad on the fly without letting other people know?
  - (c) Why it is not possible to ensure non-repudiation using a shared key? Is there any other alternative(s)? If no, then what is(are) the reason(s) for not being able to perform non-repudiation by any means? If yes, then briefly describe one of the alternatives.
6. Tomorrow's wars are forecasted to be happened in space. Aircrafts, having high speed, will fight in the space. In such cases, communication among these flying soldier-like machines will be necessary.

## CSE 321

### Contd ... Q. No. 6

Suppose, our air-force has given an assignment to a foreign Professor to establish the communication among such flying machines owned by us.  $(23+23\frac{2}{3}=46\frac{2}{3})$

The Professor happily takes the assignment of establishing the communication. After all, it is a challenging problem! The professor establishes two different types of communications among the aircrafts-reliable and unreliable communications. In the case of establishing the reliable communication, the Professor utilizes a well-known technique called TCP Reno. In the technique, if three duplicate ACKs are received, the congestion window is set to half of its previous value instead of setting it to 1 MSS, which is followed in the basic TCP, i.e., TCP Tahoe. Besides, TCP Reno sets the slow start threshold equal to the new congestion window, performs a fast retransmit, and enters a phase called Fast Recovery. Additionally, if an ACK times out, TCP Reno uses slow start as it is in TCP Tahoe.

Next, the Professor thinks about controlling and executing programs in the aircrafts from ground stations. For this purpose, he utilizes the unreliable transmission along with the notion of Remote Procedure Call. Here, he exploits Marshalling in the ground station and Unmarshalling in the aircrafts. This way the Professor demonstrates our air-force officers that they can write and execute programs written in any language such as C from the ground stations.

The air-force officers believe in what the Professor says. However, soon after starting a war, the officers find difficulties both in reliable data transmission among the aircrafts and in executing C-like programs in the aircrafts from the ground stations. An officer somehow knew that you have already done a course on computer networking. Therefore, wasting no time, the officer sends you an SOS to save our Motherland and requests for identifying potential flaws in the design of the professor. Now, you need to do the following:

- (a) Briefly describe the action(s) that might go wrong while using TCP Reno for the communication between the aircrafts.
  - (b) What are the reasons for facing difficulties in executing C-like programs in the aircrafts from the ground stations?
7. In recent times, ambitious developers have revealed a project that aims to create a decentralized Internet, where all storing and routing will be carried out by nodes run by individual users. Even though the project is currently in its very early stage, the developers aim to provide a service similar to most ISPs by using individuals that are paid for performing the routing and storage and operations themselves.  $(23+23\frac{2}{3}=46\frac{2}{3})$

In near future, if the project would get matured enough, even an independent set of a small number of users will have a chance to deploy its own routing strategies. Suppose, in that near future, your employer company (which has such an independent set of users) faces a problem of deploying a routing strategy that achieves good QoS. To ensure such QoS, the company for allowing burst transmission from its own nodes, however, being confined within a certain prescribed limit even in case of the burst transmissions.

Along with the requirement of ensuring QoS, the company feels that it might need to fragment the incoming large-size packets. However, it has no idea about the capability or requirement of such fragmentation in other companies.

Now being an employee of the company, you need to solve the two problems. Here, you need to address the following issues:

- (a) How can the QoS requirement be met?
- (b) What mode(s) of fragmentation can be adopted? .

Briefly answer both of the above questions.

8. (a) Traditional networks follow the notion of layering, which generally consists of a number of layers. A brave researcher wanted to be maverick by sweeping the layering notion away and do all the networking tasks in only one layer. Subsequently, another researcher (not as brave as the previous one) wanted to do all the networking tasks in two layers - Physical Layer and Data Link Layer. Briefly describe what consequences the two researchers will face with their single-layer and two-layer designs respectively. **(15+15=30)**
- (b) Your employer asks you to devise a new networking protocol that will simultaneously optimize all operational metrics such as correctness, simplicity, stability, fairness, optimality, etc., i.e., you need to devise a new networking protocol that will outperform all existing protocols for each of the operational metrics. The employer mentions that failure to do so without proper justification will result in firing you from your job. Now, how can you answer to your employer such that you can retain your job? [Hint: Is there any "proper justification" for not being able to do so?] **(16 $\frac{2}{3}$ )**

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পৃথিবীতে যত গাছ আছে তা সবই যদি কলম হয়ে যায় এবং সমুদ্র (দোয়াত হয়ে যায়),  
তাকে আরো সাতটি সমুদ্র কালি সরবরাহ করে তবুও আল্লাহর কথা (লেখা) শেষ হবে না।  
অবশ্যই আল্লাহ মহাপরাক্রমশালী ও জ্ঞানী। (লুকমানঃ ২৭)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : CSE 321 (Computer Networks)

Full Marks: 280

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

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

1. (a) What are the benefits of Mobile IP over traditional IP system? Briefly describe the following terms in relation to Mobile IP: **(10 $\frac{2}{3}$ )**
- (i) Mobile Node (MN)
  - (ii) Home Address (HoA)
  - (iii) Care of Address (CoA)
  - (iv) Correspondent Node (CN)
  - (v) Home Agent (HA)
  - (vi) Foreign Agent (FA)
- (b) Describe the process of discovering and registering the CoA. Include necessary diagrams in your description. **(10+10=20)**
- (c) An MN is currently located in a foreign network of a Mobile IP network. A CN is communicating with the MN. Consider the following network conditions, on average. The round trip time (RTT) between a CN and HA is 20 ms; between HA and FA is 30 ms; between FA and CN is 26 ms; and between FA and MN is 4ms. Additionally, you can assume that the one way delay across any link is half the RTT across that link, on average. In this scenario, what will be the average RTT between the MN and CN? **(10)**
- (d) Explain Manchester and Differential Manchester encoding. Which one is more noise resilient? **(6)**
2. (a) Discuss the similarities and differences of OSI and TCP/IP reference models. **(13)**
- (b) Consider the following bit sequence that represents a frame: **(13)**
- 10101110101111011111111011110111111000010110101111011111111000
- What would be the transmitted bit stream, when frame boundaries are identified using
- (i) Flag bytes with byte stuffing.
  - (ii) Starting and ending flags, with bit stuffing.
- For byte stuffing, assume the Flag byte is: 10111101; the Escape byte is: 11111111. For bit stuffing, assume the flag is: 01111110.
- (c) What is Hamming distance of a coding system? Show that to correct  $d$  bit error, you need a distance  $2d+1$  coding system. **(2+8=10)**
- (d) Derive the inequality  $(m+r+1) \leq 2^r$ ; Where,
- $m$  is the number of data bits in a frame
- $r$  is the number of redundant/check bits added to a frame

## CSE 321

3. (a) Take a look at Figure 1. It shows the time line of data communication using RTS/CTS among several wireless devices. From this figure, infer the topology of the network. You can represent the topology as an undirected graph. There is no need to identify the transmission ranges of the nodes. Very briefly state the reasoning behind your inferences.

(20)

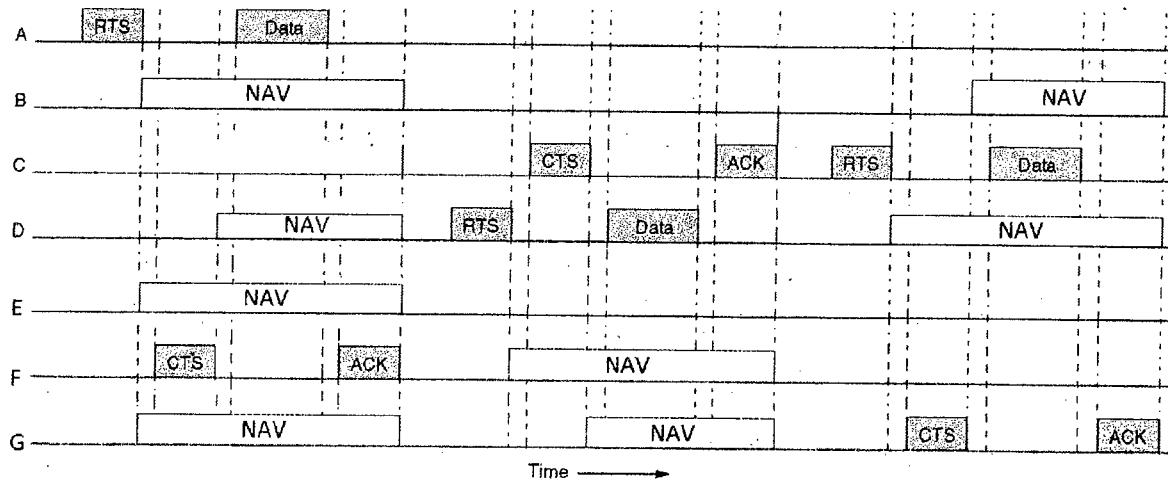


Figure 1: Figure for Question 3 (a)

- (b) You need to configure 20 computers into 3 different LANs. LAN #1 will contain 10 computers; LAN #2 and #3 will contain 5 computers each. Following are some additional constraints:

(18)

- \* You cannot use shared medium to connect all the computers of a LAN.
- \* You can only use Layer #2 networking devices. Within Layer #2, if there are many possible device types, you can use any of them as you need. However, note that, all the devices available in the market have exactly 8 ports; and the budget you have only permits you to buy 3 devices.
- \* You can obviously use necessary connectors to connect the computers to the ports of the device of your choice. You can also use connectors to connect any pair of ports of the same or different devices, if needed.

Can you build the network as asked? Briefly explain your configuration with a diagram.

- (c) Why does the frame format of Ethernet include a 'Pad' field? Why is the maximum padding size 46 bytes?

(8 2/3)

4. (a) "In some scenarios, 1-bit sliding window protocol may result in each data frame being transmitted twice" – Explain with an example.

(8)

- (b) Show with examples that the maximum number of outstanding frames in sliding window protocol using "Go back N" and "Selective Repeat" cannot be more than MAX\_SEQ and  $(MAX\_SEQ+1)/2$  respectively. (Here, MAX\_SEQ is the maximum possible sequence number of a frame).

(8+8=16)

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### Contd... Q. No. 4

- (c) Analyze the channel efficiency of Basic Bit-map Protocol at low and high load. How does Binary Countdown Protocol improve on it? (10)
- (d) In Adaptive Tree Walk Protocol, show that the optimal level to being searching the tree is  $\log_2(q)$ , where q is the number of ready stations. (6 $\frac{2}{3}$ )
- (e) Briefly describe how keyboard and mouse can communicate with a desktop computer through Bluetooth. (6)

### SECTION – B

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

5. Alice is owner of a software company. Trudy is an employee in the company. After each month, Alice pays Trudy through an on-line balance transfer request that is sent to Alice's banker Bob. [All names follow traditional cryptography] Now, before placing each transfer request Alice wants to authenticate Bob using a shared key. Alice has no idea how she can do it. Therefore, Alice hires Falsdy [this name does not follow traditional cryptography!]. Falsdy first comes up with a naive two-day authentication protocol, and then shortened it. (23 $\frac{2}{3}$ +23=46 $\frac{2}{3}$ )

After getting the two-say authentication protocols, Alice becomes very happy. She becomes happier thinking that she has two different versions of the same protocol. She starts using both the protocols with Bob.

After a couple of months, Alice wants to change her shared secret key with Bob. Now, she realizes that she needs to manually communicate with Bob each time she wants to change the key. However, she does not like to do so, as, after all, she lives in a digital era! Therefore, she again hires Falsdy for designing an algorithm for establishing a shared key. Falsdy, this time, goes to Diffie and Hellman (these names get back to traditional cryptography), and gets such an algorithm. The tragic end of this story is that Trudy, being an intruder in Alice's company, breaks the authentication protocols and intervenes in the key sharing algorithm.

Now, you need to do the following:

- (i) Depict the basic and shortened two-way authentication protocols using a shared key. In addition, show how Trudy breaks both of the protocols.
  - (ii) Depict the algorithm for establishing a shared key. In addition, show how Trudy intervenes in the operations of the algorithm.
6. In an unknown planet, its aliens somehow invent computing machines and get very excited. They want to establish reliable data communication among the machines. Two aliens, named Sallien and Rallien (fractious names), are given the job to establish the reliable communication. Sallien decides to work on the sender's side and Rallien decides to work in the receiver's side. Now, the first mechanism they agree upon is that Sallien transmits one chunk of data, Rallien receives it and sends an acknowledgement to Sallien, Sallien transmits the next chunk of data only after getting the acknowledgement and the whole process continues. The mechanism works for reliable communication and they become happy! (11+11+12 $\frac{2}{3}$ +12=46 $\frac{2}{3}$ )

## CSE 321

### Contd... Q. No. 6

All of a sudden, both of them discover that the communication speed exhibits poor performance with this mechanism. Therefore they decide that Sallien can transmit a fixed number of multiple chunks before getting an acknowledgement. This mechanism improves the speed, and they become happier!

After a few days, they discover a new problem. When either Sallien or Rallien remains slow, for example only a small volume of data is sent by Sallien in an interactive manner or a small volume of data is received at a time by Rallien's application, their mechanism performs poorly. They want to solve these problems, but, get screwed. Therefore, they come down to earth and contact to famous researchers named Nagle and Clark. These two researchers give solutions to the above-mentioned problems. After all, they are human!

This is not the end of story. When Sallien and Rallien happily decide to get back to their planet with the solutions, they fortunately meet another researcher named Tahoe. Tahoe tells them they will face another problem when they would try to pump data in their communication networks exceeding their network capacities. Both Sallien and Rallien can forecast the problem and look screwed again. Tahoe helps them with a solution to get rid from this problem. Another researcher, name Reno, smiles seeing the solution Tahoe gives to the aliens, as he knows a better solution than Tahoe.

Now, you need to briefly depict all the solutions Sallien and Rallien get from Nagle, Clark, and Tahoe. Also, you need to briefly depict the solution of Reno.

7. In a city, its citizens want to establish a network among computing devices. The citizens form a team for building the network. The team forms a subteam for deciding how data will be routed over the computing devices.  $(10+15+6+15\frac{2}{3}=46\frac{2}{3})$

The subteam comes up with a solution where each computing device exchanges its distance to all other devices with only its neighbor devices. The solution primarily works.

However, after a few days the subteam discover a problem called "count-to-infinity problem". They solve this problem using "split horizon" and "forced update" rules.

Subsequently, a researcher arrives in the city. He says that even with both the solutions, the problem may still persist. He gives them a solution combining OSPF and BGP. The city survives a long period of time with this solution.

Now, you need to do the following:

- (i) Draw an example scenario of happening "count-to-infinity" problem.
- (ii) Briefly present the two solutions for preventing the problem.
- (iii) State why the problem may still persist even with the solutions.
- (iv) State how OSPF and BGP may work in combination.

8. Write short notes on:  $(11+11+12+12\frac{2}{3}=46\frac{2}{3})$
- (i) Random Early Detection, (ii) Jacobson's RTT estimation mechanism,
  - (iii) Network Address Translation (NAT), (iv) Leaky bucket algorithm.

L-3/T-2/CSE

Date : 07/01/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : CSE 321 (Computer Networks)

Full Marks : 280

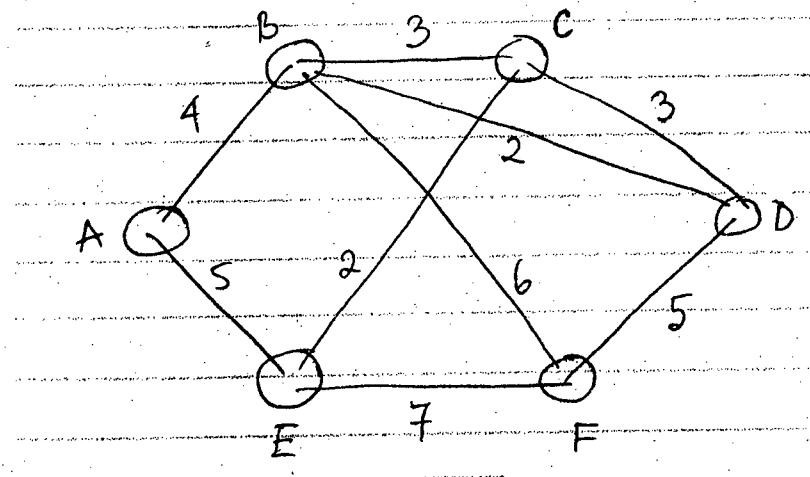
Time : 3 Hours

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) Describe functionality of different layers in OSI reference model. Discuss how the TCP-IP reference model is workable with less number of layers compared to OSI reference model. (20)  
 (b) What do you mean by public key cryptography? Describe with example. What are the advantages of public key cryptography over symmetric key cryptography? (13  $\frac{2}{3}$ )  
 (c) How can you distribute public and private keys through certification? (13)
  
2. (a) How is flooding as a means of routing packets? Explain the advantages and disadvantages. (15)  
 (b) Consider the subnet shown in Fig. 2(b). Distance vector routing (10)



is used and the following vectors have just come to router D.

B (6, 0, 11, 10, 5, 7)

C (5, 2, 0, 8, 3, 9)

F (8, 5, 4, 9, 7, 0)

The number shown on the links are the measured delays between two routers. Give the outgoing line to be used as well as the expected delay from router D.

(c) Show that the hierarchical routing saves the memory for routing tables and searching time in routing packets. (9  $\frac{2}{3}$ )

(d) Describe how pruning is done in multicast routing if distance vector routing is used as routing algorithm. (12)

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3. (a) Introduce leaky bucket and token bucket algorithm. How can you relate these algorithms with traffic shaping in IP networks? (15)
- (b) A computer on a 6 Mbps network is regulated by a token bucket. The token bucket is filled at a rate of 1 Mbps. It is initially filled to capacity with 8 megabits. How long can the computer transmit at the full 6 Mbps? (10)
- (c) What are the main reasons of fragmentation? How can handle fragmentation in IPv4? (11 2/3)
- (d) Consider a IP packet with length 1 GB. Show the value of fields related to the packet length for this transmission. (10)
4. (a) Write short note on "Virtual Private Network". (13)
- (b) Consider a machine with domain name mango.buet.ac.bd is accessing a web server www.uvic.ca. Show the DNS resolution steps used in recursive and iterative techniques. (13)
- (c) Describe SMTP and POP3 protocol for email system with necessary examples. (13)
- (d) Describe quote-printable encoding in email system. (7 2/3)

### SECTION - B

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

5. (a) For any code with 'm' message bits and 'r' check bits that allows all single bit errors to be corrected, it is required that  $(m+r+1) \leq 2^r$ . Show how this lower limit on the number of check bits 'r' is determined? Explain how hamming codes can be used to correct burst error of length 'k'? (10+8)
- (b) A bit stream 10101010101010 is transmitted using standard CRC method where the generator polynomial is  $(x^3 + x + 1)$ . Show the actual bit string transmitted. (12)
- (c) In the sliding window protocol using selective repeat, the maximum window size is  $(2^{n-1})$  where 'n' is the number of bits used for sequence numbers. Justify this restriction on the maximum window size with a suitable scenario. Explain how the Negative Acknowledgement (NAK) frame is used in the selective repeat protocol. (12+4 2/3)
6. (a) Explain why Ethernet which runs CSMA/CD at the MAC layer enforces a minimum frame length and describe how this minimum length has been determined for 10 Mbps Ethernet. (8+5)
- (b) Why layer 2 Ethernet switches may need to run 'Spanning Tree Protocols'? Explain with an example scenario. Describe a scenario where it is preferred to use Virtual LAN (VLAN). (8+8)

## CSE 321

### Contd ... Q. No. 6

- (c) Using a suitable scenario explain how 802.11 (Wi-Fi) MAC protocol attempts to avoid collisions in the presence of hidden terminals using RTS/CTS mechanism. (9)
- (d) Consider 802.11 data frame format in the Figure for Q. 6(d). Note that in the frame, there are four address fields. Now describe a scenario where all four address fields are used. (8 2/3)

Bytes	2	2	6	6	6	2	6	0-2312	4
	Frame control	Duration	Address 1	Address 2	Address 3	Seq.	Address 4	Data	Check-sum

Figure for Question 6(d)

7. (a) Why is the starting sequence number of a TCP connection not always zero (0)? Explain with a suitable scenario. (12)
- (b) Why is it not desirable to send small size segments? Describe Nagle's algorithm for limiting small size segments from sender. Give example of an application for which Nagle's algorithm should be disabled. (4+4+4)
- (c) Describe TCP's acknowledgement policy. (10)
- (d) What is "symmetric connection release"? How does TCP implement "symmetric connection release"? Why does TCP wait in 'TIME WAIT' state before closing a connection during active close? (4+5+3 2/3)
8. (a) Why is the timeout value of retransmission timer set dynamically in TCP? Describe Jacobson algorithm for calculating the timeout value (of retransmission timer) in TCP? What is the problem of updating RTT on retransmitted segments? (6+6+4)
- (b) Answer the following question in the context of TCP congestion control algorithm.
- (i) How 'congestion window' is updated during 'Slow Start' state and 'Congestion Avoidance' state? What is the intuition behind these two different update strategies? Explain. (3+5)
- (ii) What is the function of the variable 'Threshold'? (2)
- (iii) What are the two events that TCP uses to detect congestion? How do TCP's responses to these two events differ? What is the intuition behind such differences? (2+2+5)
- (c) It may be required to extend the size of the 'Sequence Number' field in TCP header with increasing network bandwidth. Explain. (5 2/3)
- (d) Why do some applications prefer UDP over TCP as underlying transport protocol? Explain with an example application. (6)

**SECTION - A**There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) A 12-bit Hamming code whose hexadecimal value is 0xE4F arrives at a receiver. What was the original value in hexadecimal? Assume that not more than 1 bit is in error. Show detailed calculation steps. **(18)**
- (b) Describe how CRC (Cycle Redundancy Check) is used to detect errors. Also explain how to choose the generator polynomial  $G(x)$  while calculating CRC to detect each of the following types of errors. **(8+7)**
- (i) Two isolated single-bit errors
  - (ii) An odd number of bits in error
- (c) Why bit stuffing is required when special flag bytes are used to recognize frame boundaries? A sender wants to transmit the bit string, 1000010000010000001 at the data link layer. The special bit pattern to be used as flag byte is: 10000001. What is the bit string actually transmitted after bit stuffing? Underline the stuffed bits in the resulting bit string. **(4+9 2/3)**
2. (a) Consider the topology in Figure 2(a). Here the switches S1, S2, S3 and S4 are running Spanning Tree Protocol (STP). Bridge ids used by switches for STP are given in the figure. Hubs H1, H2 and hosts A, B do not understand STP. Assume STP has converged and the network is stable. Now answer the followings. **(2+8+3+5)**
- (i) Which switch will be the root of the spanning tree? Why?
  - (ii) For each of the switches identify the status (root port/designated port/blocked port) of all of its ports.
  - (iii) Which path would a frame take while going from host A to host B? List the name of intermediate switches in the path.
  - (iv) If switch S3 goes down and STP converges again, would the path traversed by a frame from host A to host B change? Explain your answer.

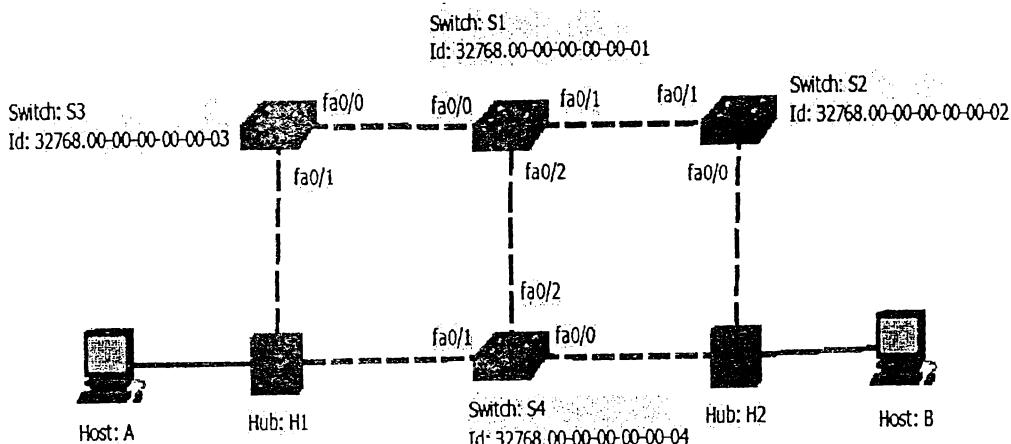


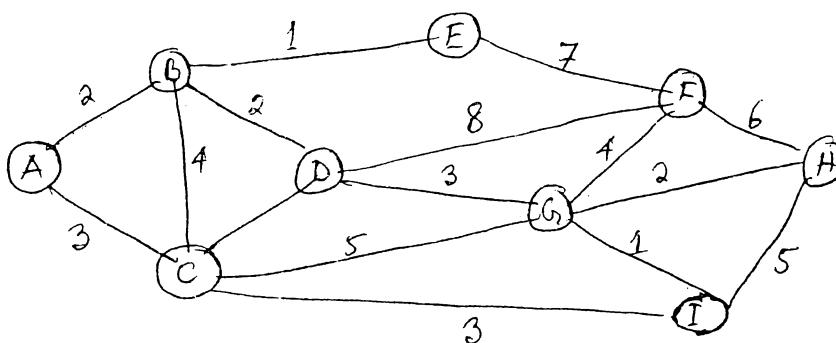
Figure 2(a)

- (b) Why Virtual LAN (VLAN) is such called? Explain with a suitable example how VLAN works. **(5+10)**
- (c) Explain how 10 Mbps Ethernet, 10Base-T was upgraded to Fast Ethernet, 100Base-T4 using the then existing Category 3 UTP cabling. **(13 2/3)**
3. (a) Describe 'TCP congestion control algorithm with a suitable example scenario. Your description must include answers to the followings. **(18)**
- (i) Usage of the variables 'Congestion Window' and 'Threshold'. What are the initial values of these variables? How subsequent values are calculated?
  - (ii) How does the sender calculate the size of sending window?
  - (iii) When does congestion window grow exponentially and when does it grow linearly? What is the motivation behind such approach?
  - (iv) How congestion window is increased on each successful transmission during exponential increase (slow start) and during additive increase.
  - (v) What is the difference in response to the events: timeout and three duplicate ACK? What is the reasoning behind such difference?
  - (vi) An example graphical plot of congestion window against transmission number illustrating the algorithm.
- (b) If the estimate of TCP round-trip time, RTT, is currently 30 msec and the following acknowledgements come in after 26, 32 and 24 msec respectively, what is the new timeout value determined using Jacobson Algorithm? Use  $\alpha = 0.9$  where  $\alpha$  denotes the smoothing factor for both RTT and mean deviation D. What is the problem of updating RTT on retransmitted segments? What was Karn's solution to this problem? **(8+4+3)**
- (c) Explain the problem of 'Silly Window Syndrome' in TCP. What was Clark's solution to this problem? What is the function of 'Persistence Timer' in TCP? **(6+4+3 2/3)**
4. (a) Of the two sliding windows protocols at Data Link Layer: 'Go Back N' and 'Selective Repeat', which one is more efficient with regard to bandwidth utilization? Explain. **(8)**
- (b) Illustrate 'Adaptive Tree Walk' medium access control protocol. Why this protocol is called Limited-Contention protocol? **(10)**
- (c) What is the problem of 'Delayed Duplicate' packet? List two reasons for which delayed duplicates may appear in the network. How does TCP attempt to solve this problem? **(3+5+10)**
- (d) An extension to the original TCP header is the addition of 'Window Scale' option that allows the receiver to advertise larger window size (up to  $2^{30}$  bytes). Explain why this extension is necessary. **(10 2/3)**

SECTION - B

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

5. (a) Write down the basic requirements of Advanced Encryption Standards (AES). Describe the implementation of encryption and decryption proposed by Rijndael following AES. (20)
- (b) Compare cipher block chaining with cipher feedback mode in terms of the number of encryption operations needed to transmit a large file. Which one is more efficient and how much? (13)
- (c) What do you mean by digital signature? Describe the techniques of symmetric and public key signature with examples of dispute resolutions. (13 $\frac{2}{3}$ )
6. (a) Describe how the problem of distributing keys are solved by the public key algorithms. Describe RSA with example as a means of key generation, encryption and decryption in a public key cryptography. (20)
- (b) Show how a resolver looks up a remote name in domain naming system. Present the meaning of the following DNS database for cs.vu.nl. (13)
- |                |       |    |    |                   |
|----------------|-------|----|----|-------------------|
| flits.cs.vu.nl | 86400 | IN | A  | 130.37.16.112     |
| flits.cs.vu.nl | 86400 | IN | MX | 2 zephyr.cs.vu.nl |
| rowboat        |       | IN | A  | 130.37.56.201     |
|                |       | IN | MX | 1 rowboat         |
|                |       | IN | MX | 2 zephyr          |
- (c) What are the functionalities of POP3 protocol? Explain the functions of fetching messages from mail server using POP3 with suitable example. (13 $\frac{2}{3}$ )
7. (a) What is the basic motivation behind hierarchical routing? For a three layer hierarchy of routers a solution with K clusters of K regions of K routers is considered close to optimal. Now for a network of 4800 routers show the routing table structure (specify size), naming convention of the routers and routing algorithms in the near optimal scenario. (20)
- (b) Show the OSI reference model of network protocol with brief description of each layer. Show protocol stack of a PC work station, router and network interface card. (13)
- (c) Consider the following network of routers where the numbers on the links indicate link cost. (13 $\frac{2}{3}$ )



Find out the shortest paths of all other routers from router A

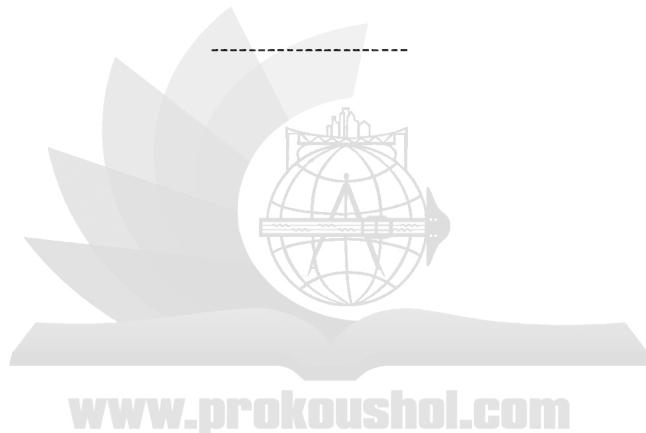
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8. (a) How can you monitor the system to detect when and where congestion occurs in a network? How does choke packet control congestion? To maintain QoS during congestion imagine a flow specification that has a maximum packet size of 1000 bytes, a token bucket rate of 10 million bytes/sec, a token bucket size of 1 million bytes and a maximum transmission rate of 50 million bytes/sec. How long can a burst at maximum speed last? (20)

(b) What are the advantages of differential services over integrated services. Describe the implementation of “expedited forwarding” and “assured forwarding” as a means of differential services. (13)

(c) Explain the following with respect to IPv6  $(13\frac{2}{3})$

- (i) fixed header length
- (ii) Provision of extension headers.
- (iii) Payload more than 64 KB
- (iv) Capability of addressing



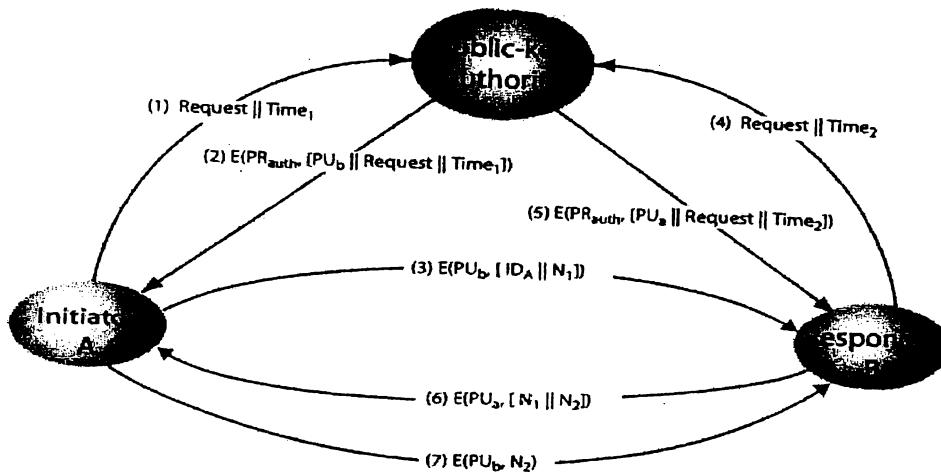
The figures in the margin indicate full marks.

**USE SEPARATE SCRIPTS FOR EACH SECTION**

**SECTION – A**

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

1. (a) For the data stream 01100110, draw the graphs for each of the following line coding schemes (14)
  - (i) **Differential Manchester.** Consider, Level before the start of the signal was positive
  - (ii) **Multiline Transmission, Three Level (MLT – 3).** Consider, the last non-zero level is – V and level before the start of the signal is 0.
(b) Encrypt the message 'TAKE PREPARATION' with the following ciphering techniques using the key 'ENEMY' (12+6=18)
  - (i) Playfair Cipher, (ii) Vigenere Cipher
  - (c) How does a stateless protocol like HTTP keeps user state? Briefly explain.  $(8 \frac{2}{3})$
  - (d) Explain MAC address with an example. (6)
  
2. (a) Explain 'Hidden Station' and 'Exposed Station' problems. Does MACA (Multiple Access with Collision Avoidance) protocol solve these problems? Explain briefly. (23)
  
(b) "As CSMA (Carrier Sense Multiple Access) protocol senses the medium before transmitting and sends whenever the medium is found idle, there should not be any collision" – do you think the statement is correct? Justify your answer with a scenario. (10)
  
(c) Referred to the Figure 2(c), answer the following questions (8)



**Figure 2(c)**

Contd ..... P/2

**Contd ... Q. No. 2(c)**

- (i) How does initiator A become sure that Public Key of B is learnt from the Public Key Authority rather than from some other masquerading nodes?
- (ii) How does responder B become sure about the identity of initiator A?
- (d) Differentiate between A and NS resource records of DNS.  $(5 \frac{2}{3})$
3. (a) Briefly describe the encryption and decryption techniques of Feistel Cipher.  $(22 \frac{2}{3})$
- (b) In 'Backoff' procedure of CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) protocol, each station needs to resume the countdown when the channel is found idle again. What will be the problem if the station restarts the countdown from the beginning rather than resuming? Explain with a scenario.  $(10)$
- (c) The 'Gigabit Ethernet' layer should be optimized for a text messaging application. Among Traditional, Carrier Extension and Frame Bursting, which one do you suggest the best for this purpose? Defend your claim.  $(7)$
- (d) What will be the problem if duration of Point-Coordination Inter Frame Space (PIFS) is chosen greater than that of Distributed Inter Frame Space (DIFS) in IEEE 802.11 protocol? Briefly explain.  $(7)$
4. (a) Design a Hamming Code with dataword length = 4, codeword length = 7 and  $d_{min} = 3$ .  
How is the position of a single bit error detected?  $(18 \frac{2}{3})$
- (b) Briefly explain Iterative and Recursive DNS lookup with example.  $(14)$
- (c) Briefly explain the address field of HDLC frame.  $(7)$
- (d) How do five stations share a common channel with 'Reservation Method'? Explain with a scenario.  $(7)$

**SECTION-B**

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

5. (a) What are the differences between Leaky Bucket algorithm and Token Bucket algorithm? Mention a potential problem of Token Bucket algorithm and provide a solution for the problem with a suitable example.  $(7+9)$

- (b) Imagine a flow specification that has a maximum packet size of 1000 bytes, a token bucket rate of 10 million bytes/sec, a token bucket size of 1 million bytes and a maximum transmission rate of 50 million bytes/sec. Assume that the bucket is full at the start of the interval. How long can a burst at maximum speed last?  $(7\frac{2}{3})$
- (c) What is the problem of isarithmic control? Suggest a possible solution to this problem. (7)
- (d) "Isarithmic, Token Bucket and Leaky Bucket manage traffic from the end host. We also need congestion management scheme at the router" — Why? Briefly explain two packet scheduling algorithms in this respect.  $(4+12)$
6. (a) Explain 'path vector routing' with a suitable example. Differentiate between path vector routing and distance vector routing.  $(13+6)$
- (b) Can distance vector routing algorithm handle the "three node instability" problem? Explain with an example.  $(8\frac{2}{3})$
- (c) Write the steps of "Link State" routing algorithm. Briefly describe the algorithm used in "Link State" routing to form the shortest path tree with a suitable example.  $(7+12)$
7. (a) Explain the congestion control mechanism implemented in TCP to control potential congestions. (16)
- (b) What is reassembly lockup? How can deadlocks be detected?  $(8\frac{2}{3})$
- (c) Point out a security problem in the connection establishment procedure (three-way hand shaking) in TCP. (7)
- (d) Briefly describe the operation of Dynamic Host configuration protocol (DHCP). (15)
8. (a) Compare Classless Internet Domain Routing (CIDR) with classful addressing scheme. Explain with a suitable example.  $(10)$
- (b) What are the layers proposed in Open Systems Interconnection (OSI) model? Briefly explain the functionalities of network layer, transport layer, session layer and presentation layer.  $(7+8)$
- (c) Why do we need to break up datagram packets into fragments? What is the purpose of fragmentation offset field of an IPV4 datagram?  $(3+6)$
- (d) What are the differences between TCP and UDP? List some possible uses of UDP.  $(5+5)$
- (e) What is the purpose of using the Address Resolution Protocol (ARP)?  $(2\frac{2}{3})$

**SECTION – A**

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

1. (a) What are the two reasons for using layered protocols? **(5+12)**

List the functions of each of the following layers: Application layer, Transport layer, Network layer, Data Link Layer, Medium Access Control sub-layer and physical layer.

(b) What is Domain Name System (DNS)? Explain briefly how DNS name servers are organized? Assume a workstation in the CSE department of BUET wants to resolve the IP address of the host- ‘www.cs.unit.edu’. Illustrate how this name resolution process works using the organization of name servers that you have described before. **(4+8+12)**

(c) Why is UTP cable so called? Between category 3 and Category 5 UTP cables, which one has higher bandwidth and why? **(2 2/3 +3)**

2. (a) For any code with ‘m’ message bits and ‘r’ check bits that allows all single bit errors to be corrected, it is required that  $(m+r+1) \leq 2^r$ . Show how this lower limit on the number of check bits ‘r’ is determined? What would be the lower limit of ‘r’ that allows correcting two bit errors? Explain how hamming codes which are used to correct single bit errors, can be used to correct burst error of length ‘k’. **(6+4+6)**

(b) A bit stream 10101010101010 is transmitted using standard CRC method where the generator polynomial is  $(x+1)$ . Show the actual bit string transmitted. Show how CRC can be used to detect the following two types of errors. **(6+4+4+4)**

- (i) Two isolated single bit errors.
- (ii) Where there are an odd number of bits in errors.

Is it possible to correct single bit errors using CRC? If so, explain how.

(c) In the sliding window protocol using selective repeat, the maximum window size is  $2^{n-1}$  where ‘n’ is the number of bits used for sequence numbers. Justify this restriction on the maximum window size with a suitable scenario. Explain how the Negative Acknowledgement (NAK) frame is used in the selective repeat protocol? **(8+4 2/3 )**

3. (a) Write down the algorithms for each of the following medium access protocols: Pure Aloha, Slotted Aloha, 1-persistent CSMA and Non-persistent CSMA. Compare the preceding protocols in terms of channel utilization at various loads and explain intuitively the differences in their performances. **(12+12)**

(b) Explain why CSMA/CD is not used in wireless LANs? (4  $\frac{2}{3}$ )

(c) Explain the reason behind having a minimum length for Ethernet frames. Illustrate how this length is determined for 10Mbps Ethernet. How is it possible to maintain the same minimum frame size in Fast (100 Mbps) Ethernet as in 10 Mbps Ethernet? (8+6+4)

4. (a) How does ‘Distance Vector Routing’ protocol differ from ‘Link State Routing’ protocol? (8)

(b) Demonstrate the ‘Count-to-Infinity’ problem in the distance vector routing protocol with a suitable example. Explain how split horizon with poison reverse attempts to solve this problem. (12+8)

(c) List the five steps in the ‘Link State Routing’ process. Describe each of the steps briefly. (3  $\frac{2}{3}$  +15)

### **SECTION – B**

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

5. (a) Give an example of mutual authentication using public-key cryptography. Show that it is protected from reflection attack. (13)

(b) Using RSA public-key cryptosystem encrypt “csebuet” with  $p = 7$ ,  $q = 11$ , and  $\{a = 97, b = 98, c = 99, \dots, z = 122\}$ . Show that the receiver can decrypt the message using the private-key. (20)

(c) A different 48-bit key is used in different DES iterations. How does DES compute 16 different 48-bit keys from a fixed 56-bit key input? What computation does DES do in each iteration to produce 64-bit output from 64-bit input? (13  $\frac{2}{3}$ )

6. (a) Can you establish a TCP connection using two-way hand shaking instead of three-way hand shaking? (8)

(b) What are the problems that a TCP implementation will face to share a buffer space to receive segments from multiple TCP connections? (10)

(c) Suppose, host A and B have 30KB and 40 KB data respectively to exchange with each other using a full-duplex TCP connection. The starting sequence number to transmit data at both hosts is 0. Maximum segment size is 2 KB. A receiver buffer of 20 KB is available at both hosts. Show the connection establishment phase, then all the segment transmissions with acknowledgement number, window size, congestion window, and slow-start-threshold values for the first 20 KB data transmission. What will happen if

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## Contd ... Q. No. 6(c)

the applications at both hosts do not fetch data from the receive buffer? Show all the segment transmissions with all the above mentioned values for the complete data transmission if the applications at both hosts fetch segments from the receive buffers as they arrive but every fifth segment gets lost in the network. Assume all the retransmitted segments are passed successfully.

(28  $\frac{2}{3}$ )

7. (a) Why is it necessary to employ congestion control mechanisms at both network and transport layers? How do network and transport layers detect congestion? (12  $\frac{2}{3}$ )
- (b) Give a solution for congestion notification combining warning bit and choke packets. What will be the potential benefits of such solution? (7)
- (c) Jitter control needs a router to determine whether a packet is ahead or behind the schedule. A packet is then forwarded quicker if it is behind the schedule, otherwise, it is held just long enough to get it back on schedule. Give a solution for the router to determine the packet's status with respect to its schedule. (Hints: An end-to-end delay bound can be distributed over multiple hops.) (20)
- (d) A computer on a 6-Mbps network is regulated by a token bucket. The token has the capacity of 1 MB and is filled at a rate of 1 Mbps. How long can the computer transmit at the full 6-Mbps? (7)
8. (a) If you are the administrator of 905-th subnet of 180.180.0.0/16 network, (13)  
(i) What is your subnet ID?  
(ii) What is the subnet mask?  
(iii) What is the broadcast IP address of your subnet?  
(iv) What is the IP address of the first host in your subnet?  
(v) What is the IP address of the last host in your subnet? How many hosts you can keep in your subnet?
- (b) You, your sister, mom, and dad are using Internet from a home network. The network address of your home network is 192.168.70.0/24. You can assume host ID 1, 2, 3, and 4 for you, your sister's, mom's and dad's computers respectively. You all share a real IP address 200.200.200.201 from an ISP using a home router having PAT support. Suppose, you, your mom and dad are browsing a web server having the IP address 70.70.70.71 and your sister is doing telnet to a compute having the IP address 90.90.90.91. Port numbers for the web service (http) and the telnet are 80 and 23 respectively. Show the address and port mappings at PAT for your family's communications. You can assume arbitrary port assignments at the computers and at the PAT. Show all the translations that at PAT on the packets back and forth. (13)

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### **Contd ... Q. No. 8**

(c) Write pseudo code for ARP. (Hints: Write two modules, one to broadcast an ARP request and the other to respond to a request. Use ARP cache to minimize the number of broadcasts). What is the use of proxy-ARP? (13)

(d) Can a DHCP relay auto configure itself with the help of an external DHCP server?

Explain your answer.

$(7 \frac{2}{3})$



BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations, 2006-2007

Sub : **CSE 321** (Communication Engineering)

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) Briefly describe the ATM service categories. (10)  
(b) Explain the ATM cell format with necessary diagrams. (15)  
(c) What are the characteristics of a virtual path connection of an ATM network? (10)
  
2. (a) A source emits one of four symbols  $s_0$ ,  $s_1$ ,  $s_2$  and  $s_3$  with probabilities  $\frac{1}{3}$ ,  $\frac{1}{6}$ ,  $\frac{1}{4}$  and  $\frac{1}{4}$  respectively. The successive symbols emitted by the source are statistically independent. Calculate the entropy of the source. (10)  
(b) Briefly discuss source encoding and Shannon's first theorem of source-encoding. (15)  
(c) What is mutual information of a discrete memory less channel? Write down its important properties. (10)
  
3. (a) Discuss the Frequency Division Multiple Access (FDMA) strategy of bandwidth allocation for satellite communication. (20)  
(b) List the different ways of categorizing communication satellites and satellite orbits. (10)  
(c) Diagrammatically show different satellite communication configurations with necessary description. (5)
  
4. (a) What are the different ways that may be used to increase the capacity of a cellular system? (10)  
(b) What are the key differences between first and second generation cellular systems? (10)  
(c) Briefly describe the GSM network architecture. (15)

**CSE 321****SECTION-B**

There are **NINE** questions in this section. Answer any **SEVEN**.

5. In a Cyclic Redundancy Check (CRC) error detecting scheme suppose message D = 11110000110010 and the predetermined division P = 1001001. Calculate the Frame Check Sequence (FCS) and validate it. **(10+5)**
  
6. Write short notes on the following:
  - (a) Asynchronous Transmission **(9)**
  - (b) Block Error Correcting Code **(6)**
  
7. (a) Why do you think a source may break up a large block of data into smaller blocks and transmit the data in many frames? **(6)**
  
 (b) Explain the Go-Back-N ARQ for controlling error in sliding window flow control. **(9)**
  
8. (a) What are the data transfer modes at HDLC? **(6)**
  
 (b) Describe the Control Field of an HDLC frame. **(6)**
  
 (c) Name the three phases of the operation of HDLC. **(3)**
  
9. (a) Briefly explain the functions of Transmitters and Receivers of a Frequency Division Multiplexing (FDM) system. **(10)**
  
 (b) Explain Wavelength Division Multiplexing. **(5)**
  
10. Find the number of the following devices that can be accommodated by a T1 type TDM line if 1% of the T1 line capacity is reserved for synchronization purposes. **(15)**
  - (a) 110-bps teleprinter terminals.
  - (b) 300-bps computer terminals.
  - (c) 1200-bps computer terminals.
  - (d) 9600-bps computer output ports
  - (e) 64-kbps PCM Voice Frequency Lines.

How would these numbers change if each of the sources were transmitting an average of 10% of the time and a statistical TDM was used? The data rate of T1 type line is 1.644 mbps.

11. (a) Why is synchronous TDM called synchronous? (3)
- (b) Describe the main features of ADSL. Why each cancellation is used here? (4+2)
- (c) Explain statistical Time Division Multiplexing. (6)
12. Suppose there are 4 hops between 2 given end systems. We want to transmit a message of 3200 bits in a line with a data rate of 9600 bps. If we use packet switching then fixed packet size is 1024 bits and overhead bits per packet is 24. If we use circuit or virtual circuit switching then call setup time is 0.5 seconds. Propagation delay per hop is 0.01 seconds. Ignore processing delay at the nodes. Compute end to end delay for circuit switching, virtual circuit packet switching and datagram packet switching. (5×3)
13. (a) What are the differences between datagram packet switching and virtual circuit packet switching? (6)
- (b) Mention the advantages of packet switching over circuit switching. (4)
- (c) Consider a simple telephone network consisting of 2 end offices and 1 intermediate switch with a 1 MHz full duplex trunk between each end office and the intermediate switch. Assume a 4 kHz channel for each voice call. The average telephone is used to make 2 calls per 10 hour work day, with a mean call duration of 2 minutes. 10 percent of the calls are long distance. What is the maximum number of telephones an end office can support? (5)