Course – Section	Computer Networks (CS3001 - Fall 2023) – (*BDS-7A, BSE-7A*, *BSR-5A*)
Assignment Num.	01 (CLO: 1)
Total Marks	50
Start Date	07-September-2023
Due Date/Time	**12-Sep-2023** (*BDS-7A, BSE-7A*) // **13-Sep-2023** (*BSR-5A*)
Submission	Submit hard copy at the start of the class
Author	Muhammad Hashim Bilal Qureshi (l201219@lhr.nu.edu.pk)
Approved By	Dr. Syed M. Irteza (m.irteza@nu.edu.pk)
Submission Guidelines	- *Assignments must be received before the deadline. Submissions after the deadline will face a 5% grade penalty (within 1 day), or a 25% grade penalty (within 2 days), or a 50% grade penalty (within 3 days).* - *Please do the work by yourself, this is an individual assignment.* - *Plagiarism cases will be dealt with strictly.*

Question 01 **(5 marks)**

Some content providers have created their own networks. Describe Google's network. What motivates content providers to create these networks?

Question 02 **(5 marks)**

Visit the Computing End-End Delay (Transmission And Propagation Delay) interactive exercise at the companion Web site (Kurose, 8ed). Among the rates, propagation delay, and packet sizes available, find a combination for which the sender finishes transmitting before the first bit of the packet reaches the receiver. Find another combination for which the first bit of the packet reaches the receiver before the sender finishes transmitting.

Question 03 **(5 marks)**

Suppose end system A wants to send a large file to end system B. At a very high level, describe how end system A creates packets from the file. When one of these packets arrives to a router, what information in the packet does the router use to determine the link onto which the packet is forwarded? Why is packet switching on the Internet analogous to driving from one city to another and asking directions along the way?

Question 04 **(5 marks)**

Visit the Queuing Delay interactive exercise at the companion Web site (Kurose, 8ed). What is the maximum emission rate and the minimum transmission rate? With those rates, what is the traffic intensity? Run the interactive animation with these rates and determine how long it takes for packet loss to occur. Then repeat the experiment a second time and determine again how long it takes for packet loss to occur. Are the values different? Why or why not?

Question 05 **(5 marks)**

Suppose you would like to urgently deliver 50 terabytes data from Boston to Los Angeles. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain.

Question 06 **(5 marks)**

Suppose two hosts, A and B, are separated by 20,000 kilometers, and are connected by a direct link of R = 5 Mbps. Suppose the propagation speed over the link is $2.5 * 10^8$ meters/sec.

a. Calculate the bandwidth-delay product, $R * d_{prop}$.

b. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?

c. Provide an interpretation of the bandwidth-delay product.

d. What is the width (in meters) of a bit in the link? Is it longer than a football field?

e. Derive a general expression for the width of a bit in terms of the propagation speed s, the transmission rate R, and the length of the link m.

Question 07 **(5 marks)**

Referring to question 5, suppose we can modify R. For what value of R is the width of a bit as long as the length of the link?

Question 08 **(5 marks)**

Consider question 5 but now with a link of R = 500 Mbps.

a. Calculate the bandwidth-delay product, $R * d_{prop}$.

b. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one big message. What is the maximum number of bits that will be in the link at any given time?

c. What is the width (in meters) of a bit in the link?

Question 09 **(5 marks)**

Refer again to question 5.

a. How long does it take to send the file, assuming it is sent continuously?

b. Suppose now the file is broken up into 20 packets with each packet containing 40,000 bits. Suppose that each packet is acknowledged by the receiver and the transmission time of an acknowledgment packet is negligible. Finally, assume that the sender cannot send a packet until the preceding one is acknowledged. How long does it take to send the file?

c. Compare the results from (a) and (b)

Question 10 **(5 marks)**

Explain the OSI model and Internet Protocol stack separately with the help of a real-world analogy.

(Good Luck)