McGill

Department of Electrical & Computer Engineering
McConnell Engineering Building
3480 University, Montréal, Québec, H3A 0E9

FALL 2022

ECSE308: INTRODUCTION TO COMMUNICATION SYSTEMS AND NETWORKS
Assignment 2 (D,E,F)

Notes:

- Submit your homework by **5PM, Tuesday, November 15/2022**.
- You **must** include your name and ID number on the 1st page of your homework and provide solutions for *all* 8 problems in blue in your submitted homework. Otherwise, your homework **will not be marked**.
- You are *encouraged* to try all the questions. The TA's will discuss and solve all the problems in black in the corresponding tutorial sessions as examples. However, no solution will be posted. Therefore, please attend your tutorial sessions to discuss and obtain helps for doing your homework.

D1. Why multiplexing and multiple-access are needed for communications? What are the basic differences between these two techniques?

D2. Briefly compare FDMA, TDMA, and CDMA in terms of bandwidth for each user, cost, and guard band/time.

D3. What is the main difference between ALOHA and CSMA?

D4. What is the main difference between 1-persistent, non-persistent and p-persistent in CSMA?

D5. Consider a FDM system having a frequency band of 120 kHz, which is equally divided into 6 channels.

a. Calculate the bit rate of each channel in the case of no guard band. Assume that all channels achieve the same SNR level of 5 *dB*.

b. Suppose this FDM system additionally requires the guard band of 10% of the bandwidth of each channel. Calculate the bit rate of each channel.

D6. Consider an AWGN channel for 64 kbps data transmission. What is the theoretical minimum required signal-to-noise ratio (SNR) to achieve a spectral efficiency of 1 bps/Hz? Find the channel bandwidth needed to for 64 kbps data transmission with SNR=0.1 and 0.01. Discuss the results.

D7. In a pure ALOHA system, it is observed that that a frame can be transmitted without collision with a probability of 0.2.

a. What is the average number of transmissions required to successfully transmit a frame through this system?

b. What is the throughput of this system?

c. If we want to improve the throughput of the system, should we increase or decrease the load? If each frame is 1000 bits long and a time slot is 0.1s, calculate the maximum achievable throughput of this system in terms of bps.

d. If a slotted ALOHA is used instead, should we increase or decrease the load to improve the throughput of the system? Calculate the maximum achievable throughput of this slotted ALOHA with the same assumptions as in c.

D8. Why is CSMA/CD impractical for WiFi but suitable for Ethernet?

E1. Why do we need internetworking? Briefly discuss the internetworking issues

E2. Briefly define connection-oriented and connectionless services. What is Virtual-Circuit? Why connectionless service can be referred to as best-effort service?

E3. Provide the role of Switching Fabric in the Router. Among different Switching Fabric structures described in this module, which one is most suitable for a very large number of inputs? Justify your answer.

E4. In comparison to the IPv6 header, which fields are removed from the IPv4 header? Why it is possible to remove these fields?

E5. In an 8×8 Banyan switching fabric, demonstrate the path that a packet with the routing header of "111" takes when it is the 5th input. If another packet is on the 3rd input at the same time, what would its routing address be (apart from "111") to cause a collision?

E6. Suppose that a captured IPv4 header is represented in hexadecimal as the following:

Ox45 00 01 63 00 03 00 00 31 06 7D A5 0A 8F 1A F2 C0 1E 1F 04

What is the length of the data portion of this packet? What is the source IP address of this packet.

E7. Given the following CIDR block as in the following table, find their subnet IP addresses and broadcast addresses.

CIDR block	Subnet IP address	Broadcast address
10.0.3.76/8		
123.128.16.221/16		
123.5.0.0/16		
192.129.255.0/24		

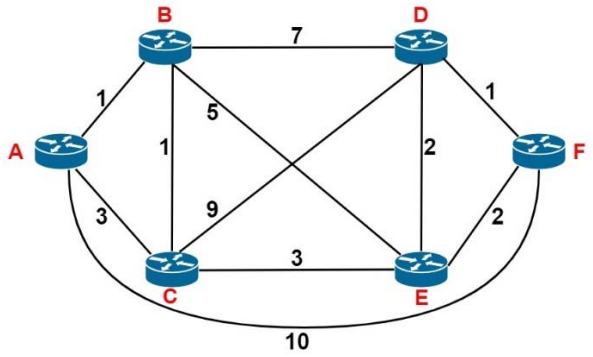
E8. Consider three queues A, B, and C, each has two packets. The packet arrival and serving times are as follows.

Queue	Packet	Arrival time	Serving time
A	A_1	0	5
	A_2	1	3
B	B_1	0	4
	B_2	3	7
C	C_1	2	8
	C_2	5	7

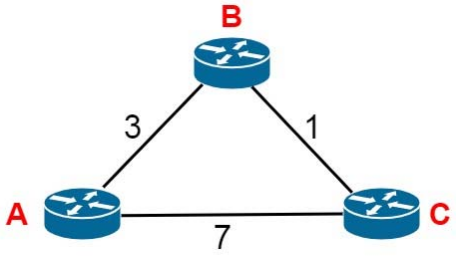
a. Using Fair Queuing, calculate the serving order of each packet.

b. Assume that queues A, B, and C are assigned with the weights $w_A = 1, w_B = 2,$ and $w_C = 3$, respectively. Using the Weight Fair Queuing, calculate the serving order of each packet.

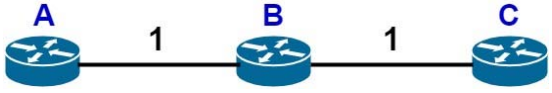
E9. Given the following network diagram, use the Dijkstra's algorithm to find the shortest path from node A to other nodes. Provide the shortest path from A to F.



E10. Using the Bellman Ford algorithm to calculate the shortest path in the following network. Show the routing update including path costs of each nodes in each iteration.



E11. Suppose that in the following network, the link from node B to node C is failed, show that applying the Bellman Ford algorithm to this network would result the count-to-infinity issue.



F1. IP can transfer packets between any two hosts in the Internet, why IP is not adequate for delivering data between the two application processes?

F2. What is the difference between port and socket?

F3. Briefly explain all steps for three-way handshake mechanism in TCP for connection setup.

F4. Briefly describe fast retransmit mechanism. Explain its effect for reliable data transfer.

F5. What are the names of two commonly used mechanisms for traffic management? Briefly explain them.

F6. Explain the leaky bucket model in the transport control to manage the traffic flow.

F7. For a given window size of 64kB, the link round-trip time between two hosts is estimated as 250ms.

a. Calculate the maximum throughput for this scenario in bps.
b. If the minimum required throughput is 4Mbps, how can it be achieved?

F8. In a TCP session, the average round-trip time between two hosts is estimated as 60ms.

a. Briefly express TCP round-trip time.
b. For α=0.8, as the weight of the running average, calculate the estimated round-trip time for the following instantaneous round-trip time values as 50ms, 130ms, 20ms.
c. For α=0.2, recalculate the estimated round-trip time for the given values in question b.
d. In general, what is the range of α? How does α affect the estimation of round-trip time?

F9. The leaky bucket mechanism is employed as a traffic management technique. Assume that maximum outgoing traffic is 2 packets/second. The bucket is empty at t=0. At the time instances t=1,2,4,8,12,17, the bucket receives 4 packets.

a. Considering the infinite bucket size, plot the number of packets inside the bucket versus time from t=1 to t=20.
b. How long does it take to send all the packets inside the bucket?
c. For the current transmission scenario, what is the minimum required bucket size? Why? Please briefly explain it.

F10. A bucket is initially full for the token bucket algorithm. The input traffic between t=1 and t=5 is given in the table below, where the number of packets sent at the corresponding time instances is indicated. When the periodic token regeneration rate is r packets/second, find the necessary bucket size B as a function of r. Please note that r can be only positive integer values.

Time (Seconds)	1	2	3	4	5
Number of packets received	3	4	6	0	2