COMSATS University Islamabad, Lahore Campus

Terminal Examination – Semester Spring 2021

Course Title:	Data Communications and Computer Networks			Course Code:	CSC339	Credit Hours:	3(2,1)
Course Instructor/s:	Mr. Imran Raza, Dr. Tariq, Dr. M. Hasanain Ch., Dr. Atif Saeed Zahoor			Program Name:	BS Computer Science, BS Software Engineering		
Semester:	5th & 6th	Batch:		Section:	All sections	Date:	
Time Allowed:	**3 Hours**			**Maximum Marks:**	**50**		

Important Instructions / Guidelines:

- All questions are compulsory

1. Answer the following short questions: **[10]**

a. Discuss the problems with IP fragmentation and reassembly in detail. What alternatives will you consider?

b. Suppose that Ali shares a link with four other users. Ali uses parallel instances of non-persistent HTTP, and the other four users use non-persistent HTTP without parallel downloads.

- Do Ali's parallel connections help him get Web pages more quickly? Why or why not?
- If all five users open five parallel instances of non-persistent HTTP, then would Ali's parallel connections still be beneficial? Why or why not?

c. How the routing loop in Distance Vector Routing (DVR) causes Count to Infinity Problem? Also, discuss the solution of the Count to Infinity problem? Justify your answer with the support of a diagram.

d. A host A is required to open a web page at a URL, say google.com. Initially, the IP address of the HTTP server is not known. The host is willing to retrieve a JPEG image object at the specified URL that is saved on the same server. List the required application layer and transport layer protocols besides HTTP to successfully retrieve the image object from the server?

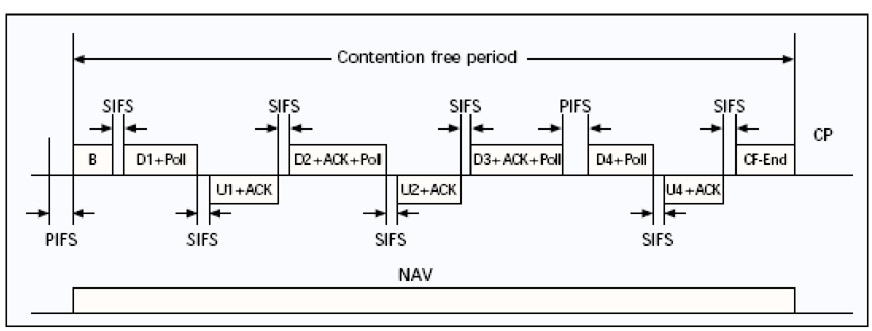
e. Suppose you are interested in detecting the number of hosts behind a NAT. You observe that the IP layer stamps an identification number sequentially on each IP packet. The identification number of the first IP packet generated by a host is random, and the identification numbers of the subsequent IP packets are sequentially assigned. Assume all IP packets generated by hosts behind the NAT are sent to the outside world.

- Based on this observation, and assuming you can sniff all packets sent by the NAT to the outside, can you outline a simple technique that detects the number of unique hosts behind a NAT? Justify your answer.
- If the identification numbers are not sequentially assigned but randomly assigned, would your technique work? Justify your answer.

2. Consider the WLAN scenario given below: **[5]**

a. Explain the coexistence of Point Coordination Function (PCF) and Distributed Coordination Function (DCF). How is it ensured that PCF is always a contention-free period?

b. In the PCF period, how an Access Point (AP) responds if it does not receive an ACK for a transmitted data frame?



3. **Suppose there are two ISPs providing WiFi access in C-block at CUI, with each ISP operating its own AP and having its IP address block.** **[5]**
   a. Further suppose that by accident, each ISP has configured its AP to operate over channel 11. Will the 802.11 protocol completely break down in this situation? Discuss what happens when two stations, each associated with a different ISP, attempt to transmit at the same time.
   b. Now suppose that one AP operates over channel 1 and the other over channel 11. How do your answers change?
4. **A TCP flow has a 2-Gb/s link with a latency of 2 seconds that transfers a 20 MB file. The receiver advertises a window of 2 MB, and the sender has an unlimited congestion window.** **[5]**
   a. How many RTTs does it take until slow-start opens the send window to 2MB?
   b. How many RTTs does it take to send the file?
   c. What is the effective throughput of the transfer? If the time to send the file is given by the number of required RTTs multiplied by the link latency.
   d. What percentage of the link bandwidth is utilized?
5. **An arbitrary measure of "power" is used to characterized network performance. The usual definition of power, *P*, is given by:** $\boldsymbol{d = \frac{load}{average\ delay}}$ **[5]**
   a. Why this definition of power is commonly used, and in what sense it is "arbitrary"?
   b. A commonly used approximation to the relationship between normalized load (which can vary between 0 and 1 only) and the average delay is $\boldsymbol{d = \frac{1}{1-\lambda}}$; where y is the normalized load offered to the network and d is the average delay of packets passing through the network. Find and sketch the value of, $\boldsymbol{P}$, as a function of the offered load for this network. Show the minimum and maximum values of power and load, as well as the value of offered load that maximizes the power.
   c. Now modify the definition of the power to emphasize throughput than delay, i.e., let us have $\boldsymbol{p = \lambda^2/d}$. Draw the new power function against the offered load, being careful to show the maximum and minimum values of both load and power, as well as the value of load that leads to maximum power. Why the value of load that maximizes the power is larger than in the previous part of the question?
6. **Suppose a new TCP congestion protocol TCPN is developed. It is similar to the congestion protocol we have discussed in the class but only has 2 phases: The Slow-Start phase and the Congestion-Avoidance phase. TCPN starts in the Slow-Start phase with CWND initially set to 1 (i.e., at RTT 0, CWND = 1), and ssthresh (slow-start threshold) set to 37. Its actions upon receiving each acknowledgment (Ack) in each of its phases are defined as follows.** **[5]**

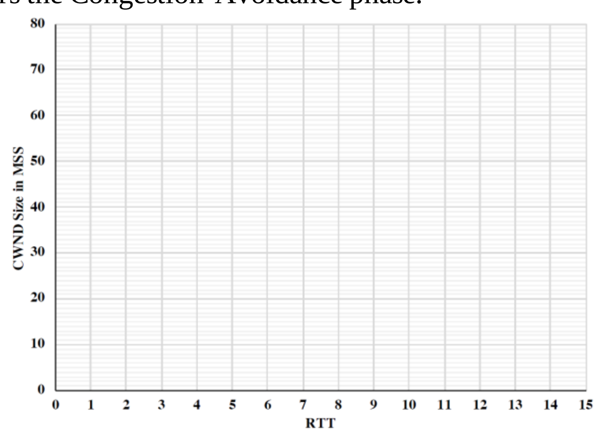
- Slow-start phase: for each Ack, CWND +=2
- Congestion-Avoidance Phase: for each Ack, CWND = CWND +2 / CWND

  When CWND $\geq$ ssthresh, TCPN exits Slow-Start and enters the Congestion-Avoidance phase.

  On a packet loss, TCPN always goes back to the Slow-Start phase and adjusts as follows.
- ssthresh = CWND / 4
- CWND = 1

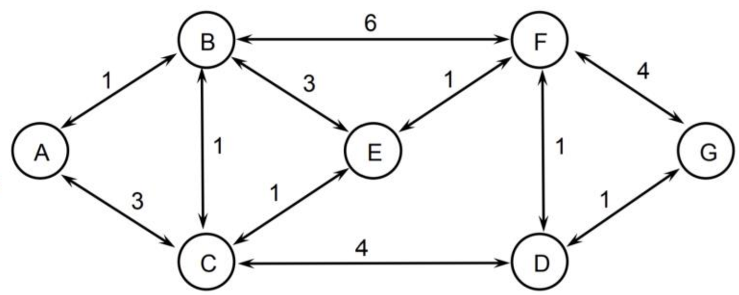
  Finally, when dividing, TCPN rounds numbers up to the nearest integer (e.g., 5/4 = 2, 9/2 = 5).

  Based on the protocol described above, answer the following questions:



   a. Using TCPN, draw a CWND-size vs. RTT graph for the first 14 RTTs. Assume a packet loss is detected right after the 7th RTT has passed. Clearly label the CWND size value for each RTT.
   b. Does TCPN ensure equal bandwidth sharing among multiple flows? Briefly explain why or why not.
   c. Assume no loss happens and header size is negligible. Assume the MSS of your transport protocol to be 1500 bytes and RTT is fixed at 200 ms. Calculate the average throughput (in Mbps) using TCPN for the first 5 RTTs. Assume 1 Mbps = 10^6 bps.

7. **Consider the network given below: [5]**
   a. Show the operation of Bellman Ford's (Distance Vector) algorithm for computing the least cost path from ***E*** to all destinations. Only compute the table of ***E.***
   b. Explain briefly how the Spanning Tree protocol works? Build a Minimum Spanning Tree (MST) using Reverse Path Forwarding (RPF) at node ***E*** to all nodes in the given network.



8. **Explain average queue length computation in Random Early Detection (RED). How RED ensures a roughly even distribution of drop over time? Explain with the help of an example. [5]**

9. **Develop a subnetting scheme for the network requirements given below. [5]**
   a. Would you prefer using VLSM or FLSM for the given scenario?
   b. Identify the total number of required subnets? What is the subnet mask of each subnet?
   c. List down the subnet ids and host address range of all the subnets.

IP address 214.112.5.0/24	
Segment	**Hosts**
Computer & Electrical Eng.	112
Design & Architecture	62
Humanities	32
WAN Link 1	2
WAN Link 2	2
WAN Link 3	3