CS353 Spring 2016
Homework 2
Due: April 29th at 10am

Name: ______________________

USC-ID: ______________________

Grade Table (for staff use only)

Question	Points	Score
1	13	
2	9	
3	20	
4	20	
5	12	
6	16	
Total:	90	

Instructions

- Submit this homework on BlackBoard in pdf format
- To submit, you can print out this document, write your answers on it, scan it and upload it. Or you can also use a pdf markup program to insert your answers into this document in the provided spaces, Or create a separate solution pdf (without the questions), each answer neatly labeled, and upload only solutions.
- If you need more space for work attach sheets at the end of the homework when you submit
- If you have questions, please ask on Piazza
- Some potentially useful information:
  1 Byte = 8 bits, 1 Mbps = $10^6 \frac{\text{bits}}{\text{sec}}$, 1 Gbps = $10^9 \frac{\text{bits}}{\text{sec}}$, 1 millisecond (or msec) = 10^{-3} sec, 1 microsecond (or μsec) = 10^{-6} sec, 1 nanosecond (or nsec) = 10^{-9}. Assume speed of light is 2.0 x 10^8 m/s (speed in optical fibre)
- **READ THIS:** In this homework there are several questions that go beyond what we covered in class. When you start reading the question and it doesnot sound familiar, just work through the problem step-by-step and the answers should come out. Some of the problems involve some basic algebra and probability. They are mainly intuitive, but if you are having trouble with these concepts please attend office hours.

1. **Short Questions**

   (a) (2 points) DHCP allows a computer to acquire a new IP address whenever it moves to a new subnet. Why is this not always enough to address the communications needs of mobile hosts

   (b) (2 points) what is the main downside of requiring traffic destined to a mobile node to be sent first to its home agent?

   (c) (3 points) Suppose a client C repeatedly connects via TCP to a given port on a server S, and that each time it is C that initiates the close.How many TCP connections a second can C make here before it ties up all its available ports in TIME WAIT state? Assume client ephemeral ports are in the range of 1024 to 5119, and that TIME WAIT lasts 60 seconds.

   (d) (3 points) Explain the fundamental conflict between tolerating burstiness and controlling network congestion

   (e) (3 points) When TCP sends a (SYN, SequenceNum = x) or (FIN, SequenceNum = x) , the consequent ACK has Acknowledgment = x + 1; that is, SYNs and FINs each take up one unit in sequence number space. Is this necessary? If so, give an example of an ambiguity that would arise if the corresponding Acknowledgment were x instead of x + 1; if not, explain why.

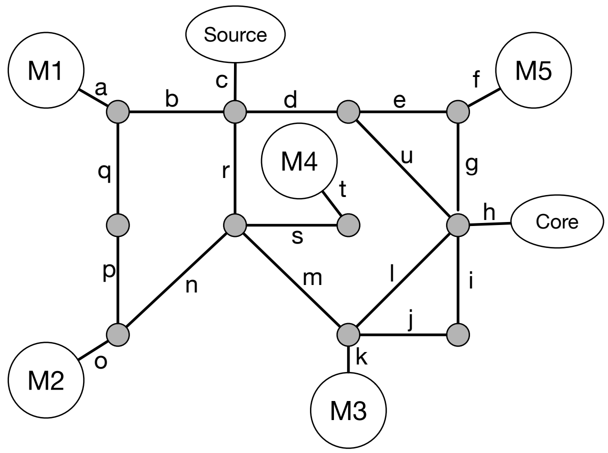
2. An organization has been assigned the prefix 212.1.1/24 (class C) and wants to form subnets for four departments, with hosts as follows: A 75 hosts
   B 35 hosts
   C 20 hosts
   D 18 hosts
   There are 148 hosts in all.

   (a) (4 points) Give a possible arrangement of subnet masks to make this possible.

   (b) (5 points) Suggest what the organization might do if department D grows to 32 hosts.

3. Multicast

Consider the following network, where a source S is sending a packet to group G, which has members m_1, m_2, m_3, m_4, m_5. Unicast routing is shortest-path, with all links having a cost of one. Multicast routing delivers a single sent packet to multiple destinations; below you will be asked to write the path a packet takes from the source to a particular destination (written as a series of links, such as k-j-i-h).



(a) Assume that the network uses DVMRP for multicast.

i. (2 points) Path traveled by packet from S to m_1
ii. (2 points) Path traveled by packet from S to m_2
iii. (2 points) Path traveled by packet from S to m_3
iv. (2 points) Path traveled by packet from S to m_4
v. (2 points) Path traveled by packet from S to m_5

(b) Assume that the network uses CBT for multicast.

i. (2 points) Path traveled by packet from S to m_1
ii. (2 points) Path traveled by packet from S to m_2
iii. (2 points) Path traveled by packet from S to m_3
iv. (2 points) Path traveled by packet from S to m_4
v. (2 points) Path traveled by packet from S to m_5

4. (20 points) Consider a flaky link where the initial transmission of a data packet is dropped if its number is prime (in other words, the initial transmissions of D2, D3, D5, D7, D11, D13 are dropped, but subsequent transmissions are ok). Note that the ACKs are cumulative and numbered according to the next expected packet (hence, A4 indicates the receipt of D1, D2, and D3). Hosts x and y are using a transport protocol with sliding window flow control with a constant window size of 5 packets and selective repeat. Three duplicate ACKs trigger a retransmission (hint: consider how many total ACKs makes for three duplicates?). Assume that the latency of the link is significantly longer than the transmission time of 5 packets and that the retransmit timeout is much longer than the RTT.

   Below, fill in the first 20 packets sent from host x (you donot need to indicate what ACKs are generated, though it may be helpful and we have entered the first few entries below). Mark which packets are retransmits due to timeouts and which are retransmits due to duplicate acknowledgements.

1.	D1	A2
2.	D2(dropped)	-
3.	D3 (dropped)	-
4.	D4	A2
5.	D5 (dropped)	-
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		

5. Assume that TCP implements an extension that allows window sizes much larger than 64 KB. Suppose that you are using this extended TCP over a 1-Gbps link with a latency of 50 ms to transfer a 10-MB file, and the TCP receive window is 1 MB. If TCP sends 1-KB packets (assuming no congestion and no lost packets):

   (a) (4 points) How many RTTs does it take until slow start opens the send window to 1 MB?

   (b) (4 points) How many RTTs does it take to send the file?

   (c) (4 points) If the time to send the file is given by the number of required RTTs multiplied by the link latency, what is the effective throughput for the transfer? What percentage of the link bandwidth is utilized?

6. Fair Queueing

   (a) Consider four flows traversing a single link with bandwidth 1Gbps. The four flows pass through a router implementing Fair Queueing before they reach the link. At their sources, the four flows are sending at the following rates:

   - Flow A: 100Mbps
   - Flow B: 200Mbps
   - Flow C: 400Mbps
   - Flow D: 500Mbps

   Assuming there are no other flows in the network, how much bandwidth does each flow get (in Mbps) after passing through the FQ router?

      i. (2 points) Flow A:

      ii. (2 points) Flow B:

      iii. (2 points) Flow C:

      iv. (2 points) Flow D:

   (b) Now assume that the router doesn't use fair queueing, but instead drops each flow at a specific rate to ensure that the resulting rates of undropped packets achieve the fair share rates above. What are the dropping rates (expressed as a fraction of dropped packets)? More specifically, for a given flow, what probability of dropping p will restrict that flow's throughput to its fair share?

      i. (2 points) Flow A:

      ii. (2 points) Flow B:

      iii. (2 points) Flow C:

      iv. (2 points) Flow D: