CS 455: Computer Communications and Networking
HW-2: Application and transport layer

Grading, submission, and late policy:
- You are expected to complete this homework **on your own** (not with a partner)
- This lab accounts for **2%** of your final grade
- The standard late policy applies - Late penalty for this lab will be 15% for each day. Submissions that are late by 3 days or more will not be accepted
- You will submit your solution via Blackboard

1. [30 pt] Consider the network provided in Fig. 2.12 of the textbook. For simplicity, let's assume that the LAN delay is 0 and the Internet delay is 2 seconds. Assume that the average object size is 80Kb and there are 20 requests per second from the institution's browsers to the origin servers.
   a. Calculate the traffic intensity (also called link utilization) on the access link.
   b. Find the total response time. The total response time/delay is the sum of LAN delay, access delay and Internet delay. Here, the average access delay can be calculated as x/(1-y) where y is the traffic intensity you calculated above and x is the average time required to send one object over the access link.
   c. Now suppose a cache is installed in the institutional LAN with a hit rate of 0.5. Find the total response time.

2. [10 pt] What is the use of mail access protocols? Why can't we use SMTP to deliver the emails all the way to receiving user agent's computer?

3. [20 pt] Suppose Client A initiates an FTP session with Server S. At about the same time, Client B also initiates an FTP session with Server S. What are the possible source and destination port numbers for the following? (note that popular services such as FTP have preassigned port numbers
   https://en.wikipedia.org/wiki/List_of_TCP_and_UDP_port_numbers)
   a. The segments sent from A to S
   b. The segments sent from B to S
   c. The segments sent from S to A
   d. The segments sent from S to B
   e. If A and B are different hosts, is it possible that the source port number in the segments from A to S is the same as that from B to S?
   f. What if A and B are the same hosts, same question (e).

4. [20 pt] For the Internet checksum that we discussed in class (used in UDP and TCP), consider two bytes 01011100 and 01100101.
    a. Calculate the Internet checksum of the two bytes
    b. Show that the checksum captures all 1-bit errors (1 bit changed in either of the two bytes) using an example.
    c. Show that the checksum might not capture all 2-bit errors (1 bit changed in each of the two bytes) using an example.