

- Please submit manually (hardcopy printed on paper) by the end of the class.
- You have to type your answers over computer and then take a printout. No handwritten submissions please. And please do not ask if you can submit handwritten homework since if I could say "yes" to that question, I would not write all of these stuff.
- No late submissions
- Everyone must submit his/her own work! Plagiarized homework will be graded as minus 100 and will be reported to the Dean's office for disciplinary actions according to university regulations.
- If you find solution manual or key or an online tool for any of these questions from somewhere, you are not allowed to use them. Using such material will be considered as plagiarism.
- BE AWARE OF ALL TYPE OF UNIT CONVERSIONS. BE CAREFUL ABOUT THE ARITHMETIC. NO PARTIAL GRADES!!!!!!

1) (40 points) Consider a packet switched network for the communication of two end points A and B . There are two switching nodes, X and Y , between A and B . The capacity of the link between A and X is 10 Mbps (10,000,000 bps). The capacity of the link between X and Y is 5 Mbps (5,000,000 bps). The capacity of the link between Y and B is 2 Mbps (2,000,000 bps).

A wants to send a file of 50 Kbytes (50,000 bytes) to B using this packet switching network. One packet has 5000 bytes of data and 100 bytes of header. After receiving the entire file, B sends an acknowledgment back to A through the same network. The recipient B imposes 0.001 sec processing delay before sending the acknowledgment after receiving the last packet (no other processing delays in the network). Assume there is no transmission time for the acknowledgment.

The network is not used for another communication until acknowledgment is received.

The distance between A and X is 60 km: The distance between X and Y is 60 km. Finally, the distance between Y and B is 30 km. The speed of signal is 300,000 km/s.

a) What is the round-trip time for sending the file and receiving its acknowledgment in the abovementioned scenario? Show your work.

Hint: draw the packets as we did in class to understand the scenario.

b) What is the throughput of this system? Show your work.

Notice: be aware of bit and byte conversion.

2) (30 points) In a production line, three robots work with the following job descriptions and performance figures. *RobotA* carries the items to *RobotB* for inspection. After *RobotB* finishes the inspection, it puts the item on a conveyor band. At the end of the band, *RobotC* gets the item and pack it. The rate of *RobotA* to carry the items is 3 items/min. *RobotB* spends 15 seconds for the inspection of an item and another 10 seconds to put the item on the band. The travel time for an item on the conveyor band is 150 seconds. Finally, *RobotC* packs one item in 15 seconds. Assume there is enough storage area for all of the robots if the items need to wait.

What is the total production time for 10 items? Explain your answer.

3) (30 points) Consider a direct link with capacity 25 Kbps (25000 bits per second) between two end points A and B . The link layer protocol between A and B is that A sends two packets consecutively. Then A waits for an acknowledgment from B in order to send the next two packets. There is no processing delay at B to send an acknowledgement after receiving the second packet. The length of one packet is 4750 bits of data and 250 bits of header. The length of the acknowledgment packet is 50 bits with no extra header. The length of this link is 10 km and the speed of signal is 200,000 km/s.

What is the utilization of this link at the steady state?

Show your work.