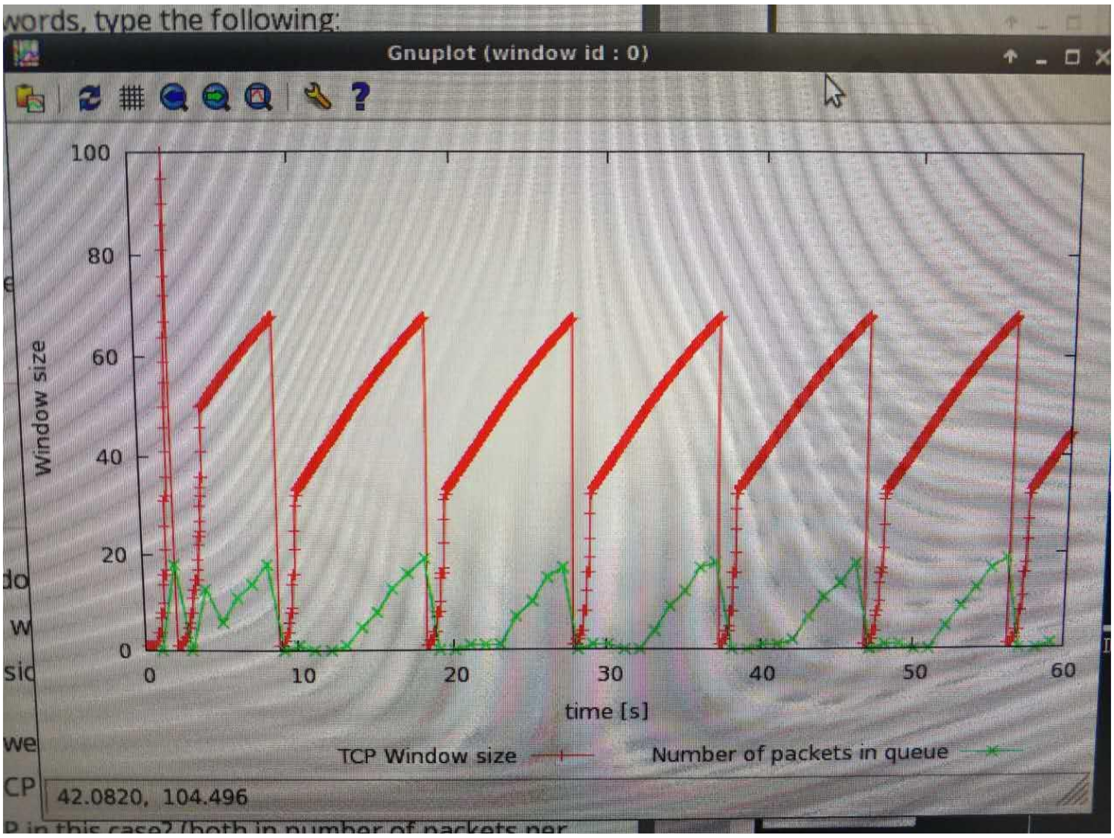
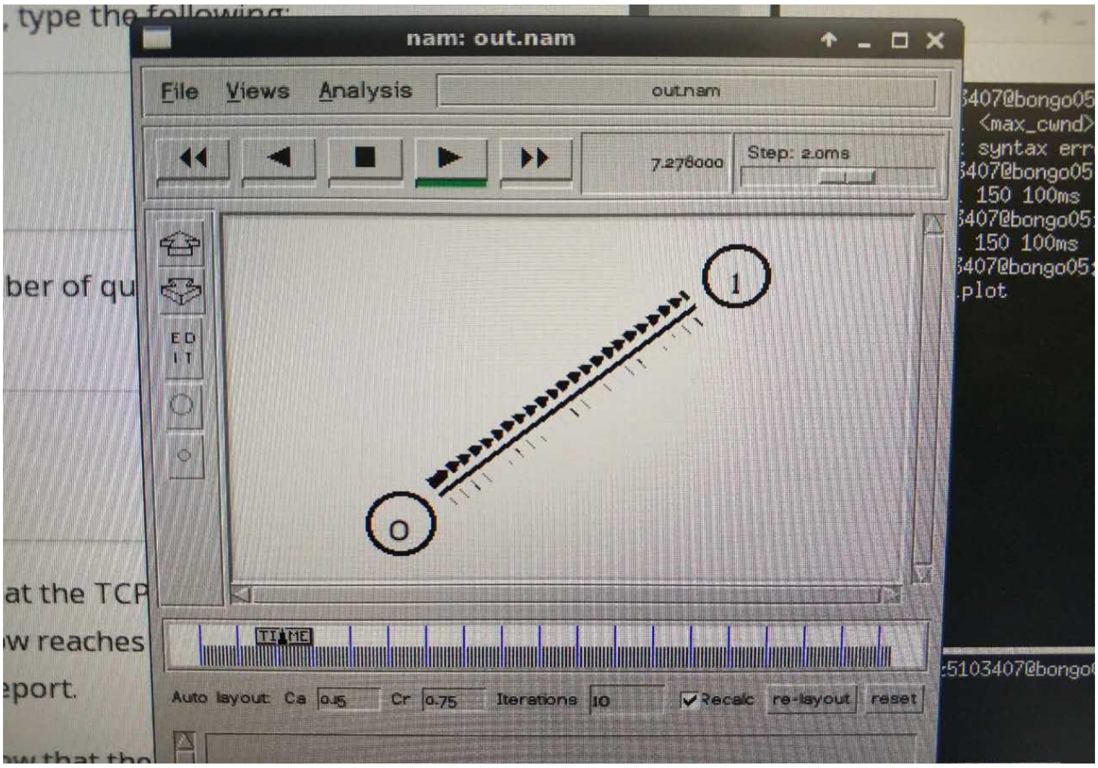
Exercise 1:

Question 1.:

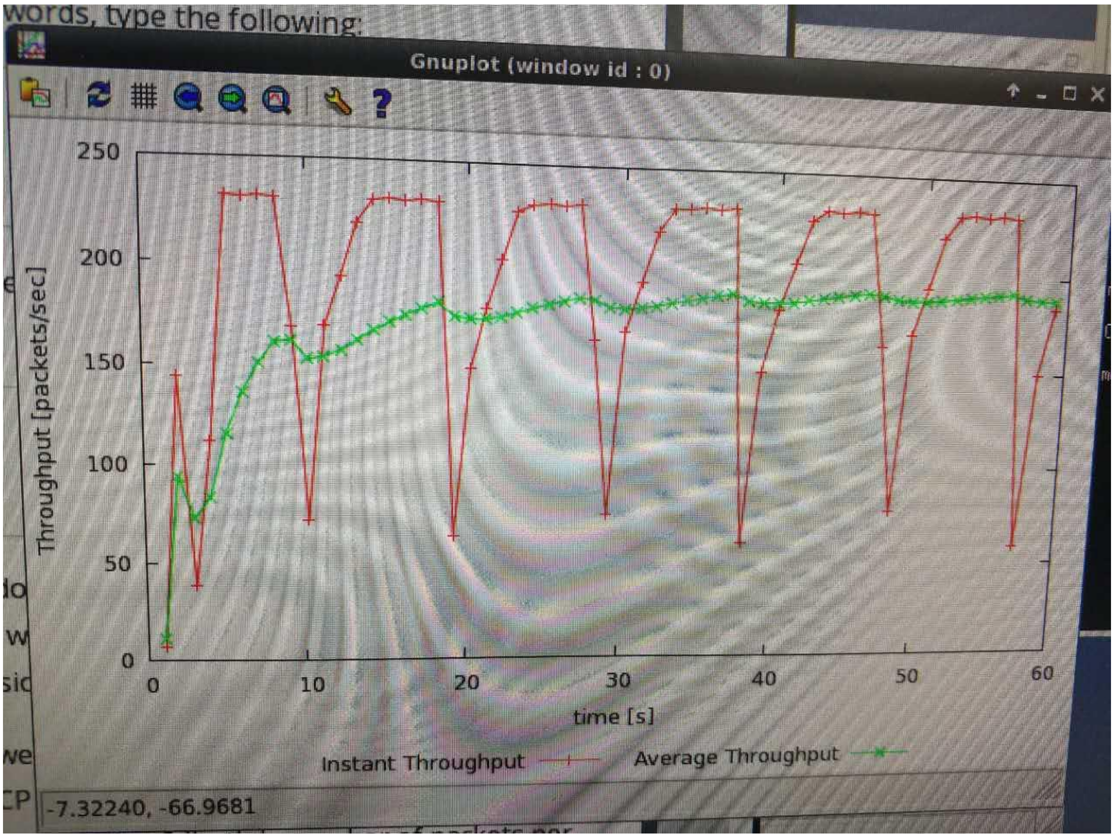




The threshold is 150 packets, however, from this graph, maximum size of congestion window is 100 packets during the slow start phase. Because the maximum size of queue is nearly 20 packets, so there are some packets are dropped. The retransmission timeout causes TCP to reduce the current congestion window to zero and set a new threshold (around 50 packets) during new slow start phase.

After that, it will swap in two phases, the slow start phase and a congestion avoidance phase. Every time when the queue drops the packets, it will enter the slow start phase. During other time, it will stay in the congestion avoidance phase.

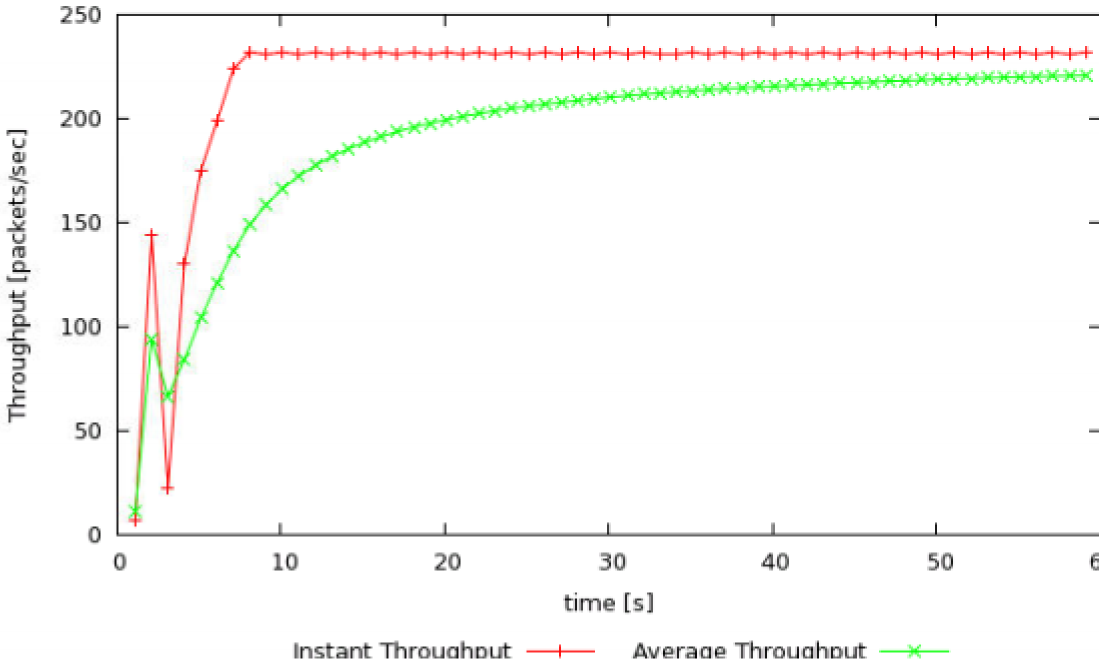
Question 2:

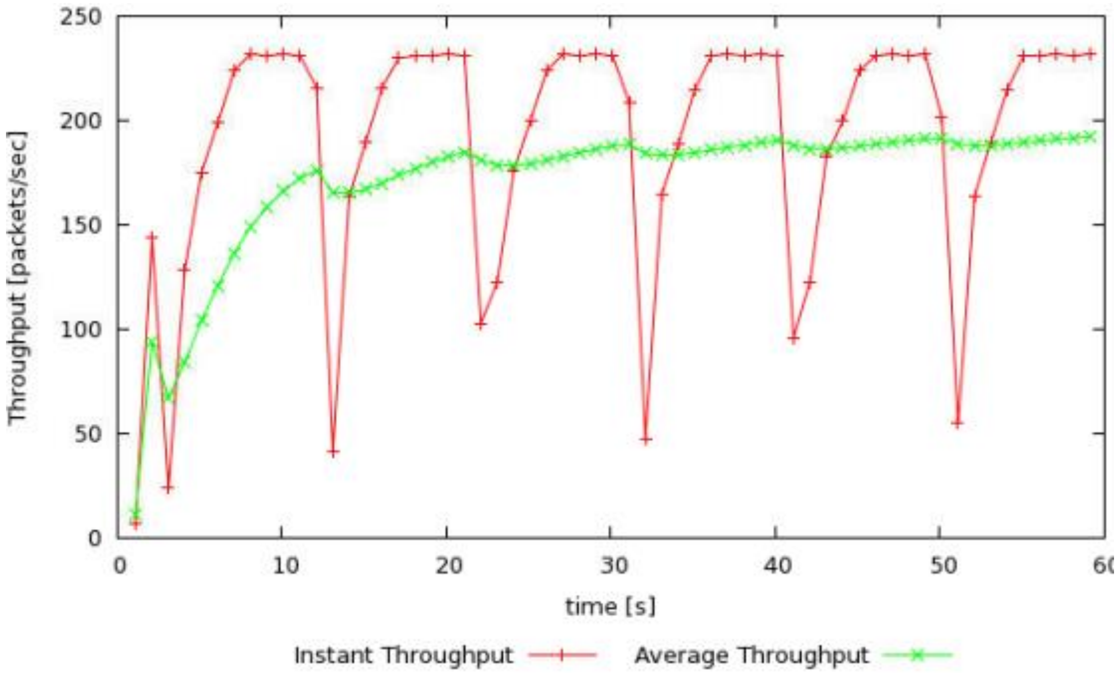


The average throughput of TCP in this case is around **190 packets per second** Because after 20 seconds, average throughput keeps stable.

Because the IP and TCP headers are both 20bytes, so the throughput is **820.8 Kbps (190 * (500 + 20+20) * 8).**

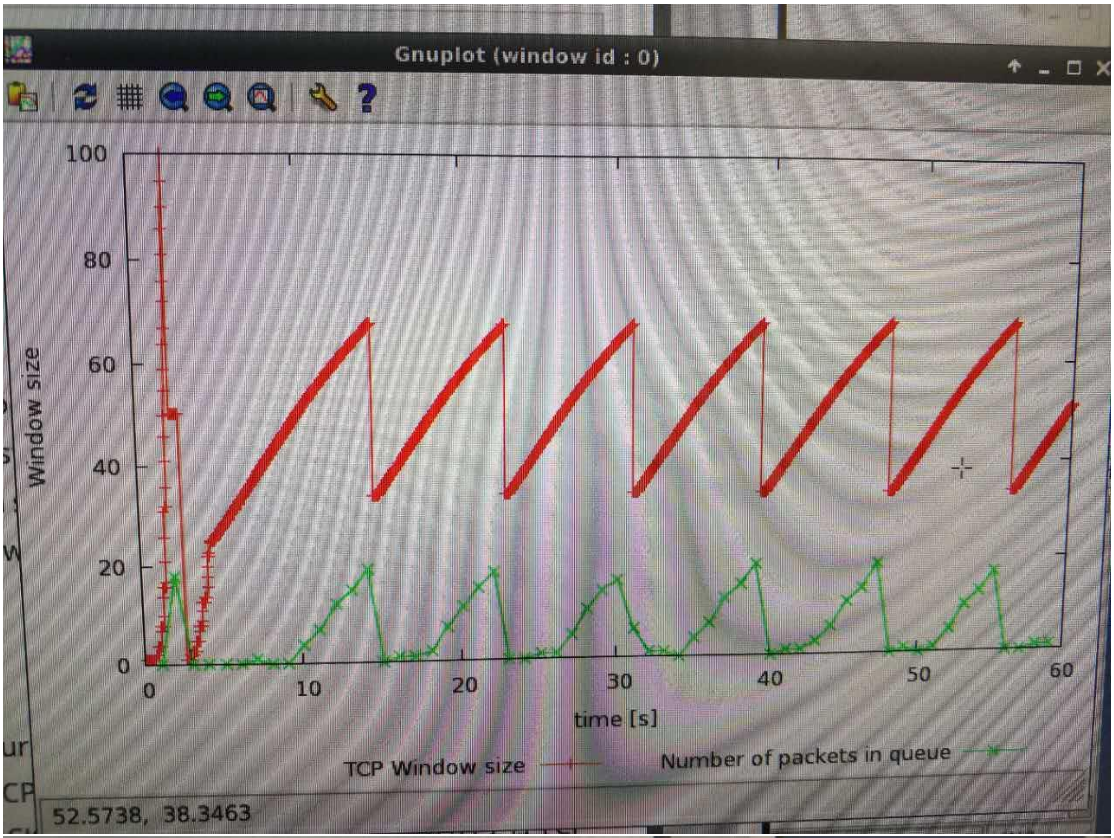
Question 3:

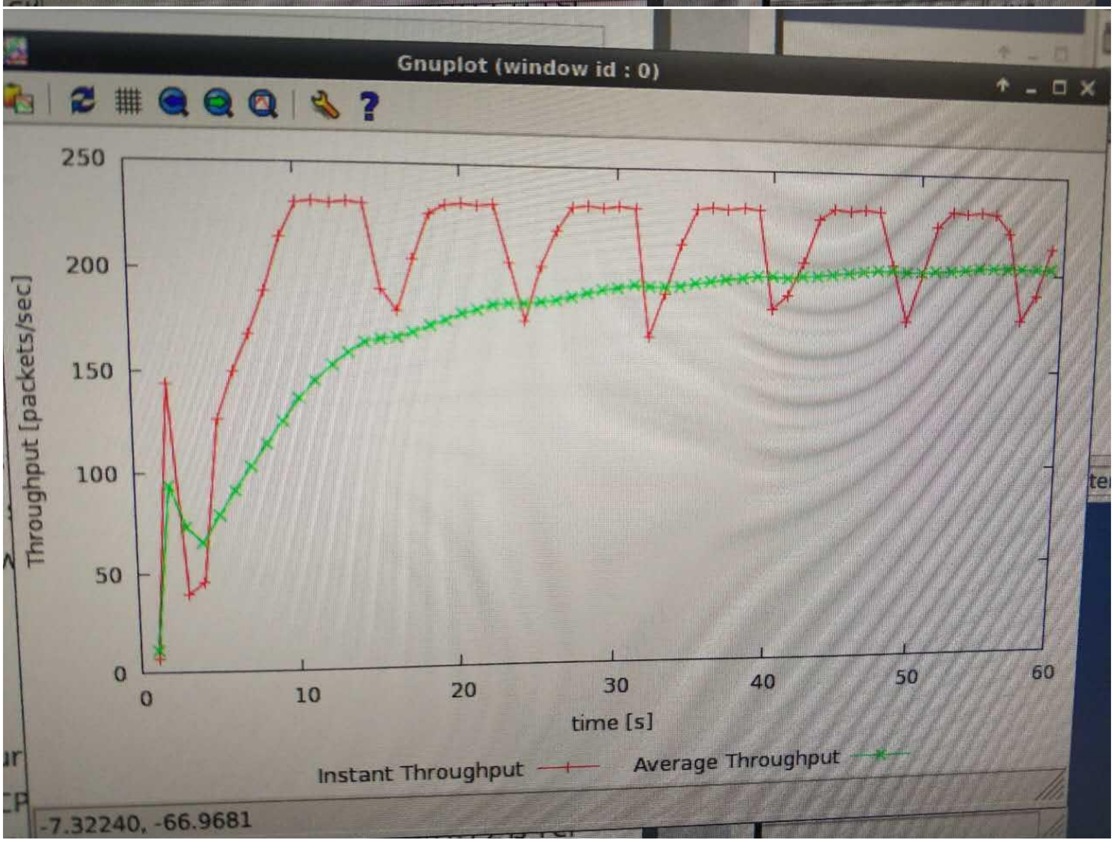




The average packet throughput is about 210 packets per second.
The average throughput **210*540*8=907.2 Kbps**, which is a little lower than the link capacity.

Question 4:

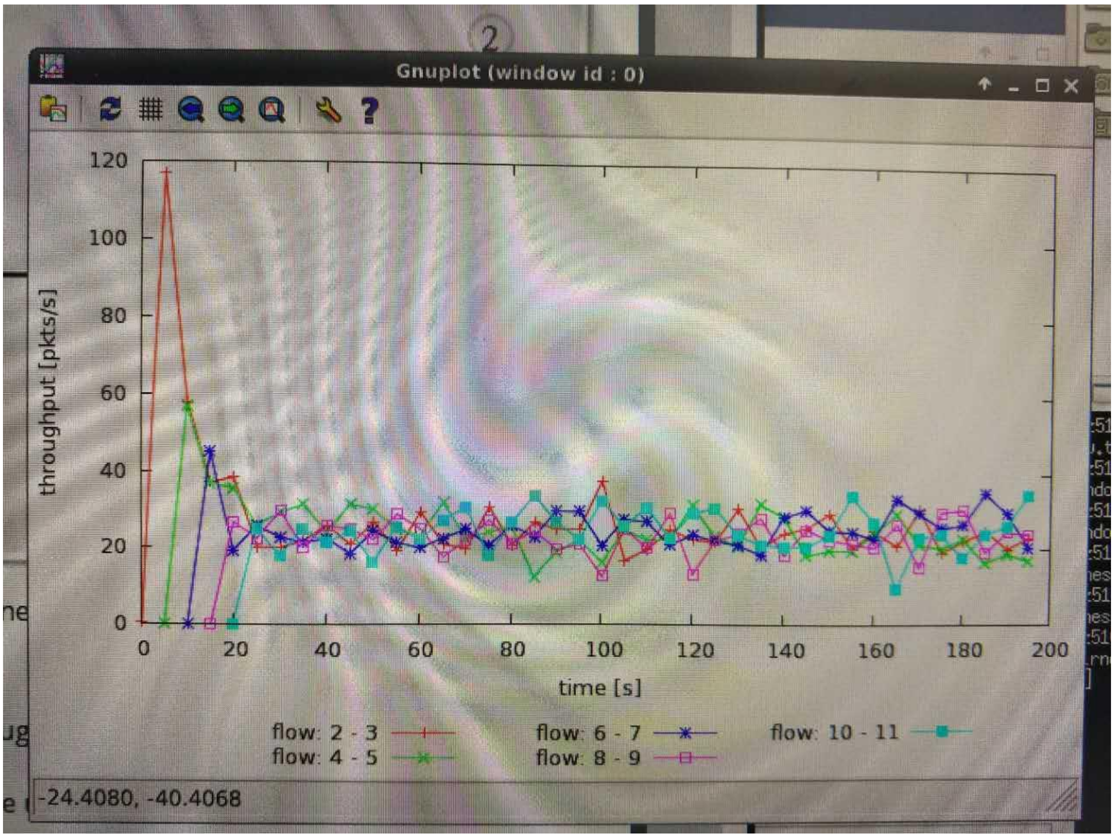




When TCP Reno receives a triple duplicate ACK (it means there a loss happens), it does not enter a slow start phase. Instead, it has the Fast Recover, which is to halves its current congestion window (from nearly 70 to 35) and increases it linearly, until losses start taking place again. Comparing to TCP Reno, TCP Tahoe has a slow-start phase when a loss appears

The throughput of TCP Tahoe is about **190** packets per second.
The throughput of TCP Reno is about **200** packets per second.

Exercise 2:



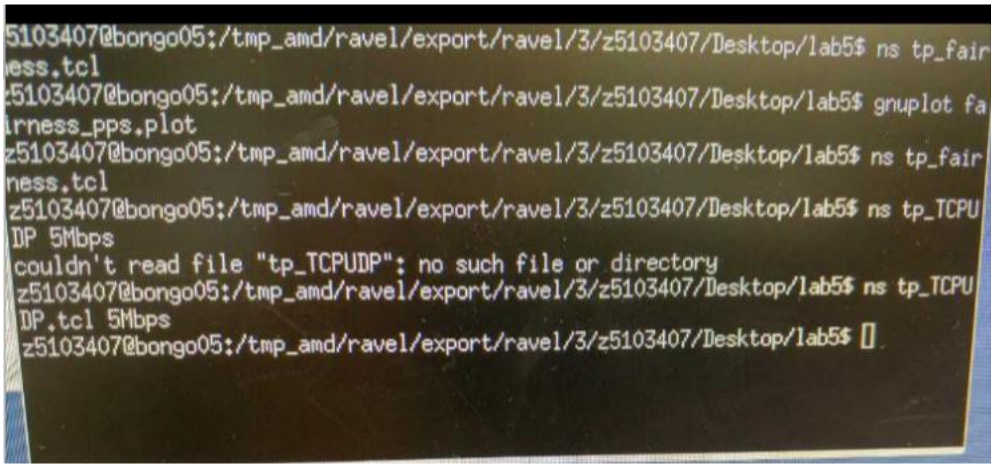
Question 1:
Every time when a new flow connects to common link, the throughput of each flow will decrease sharply. **It means each flow get an equal share of the capacity of common link.**

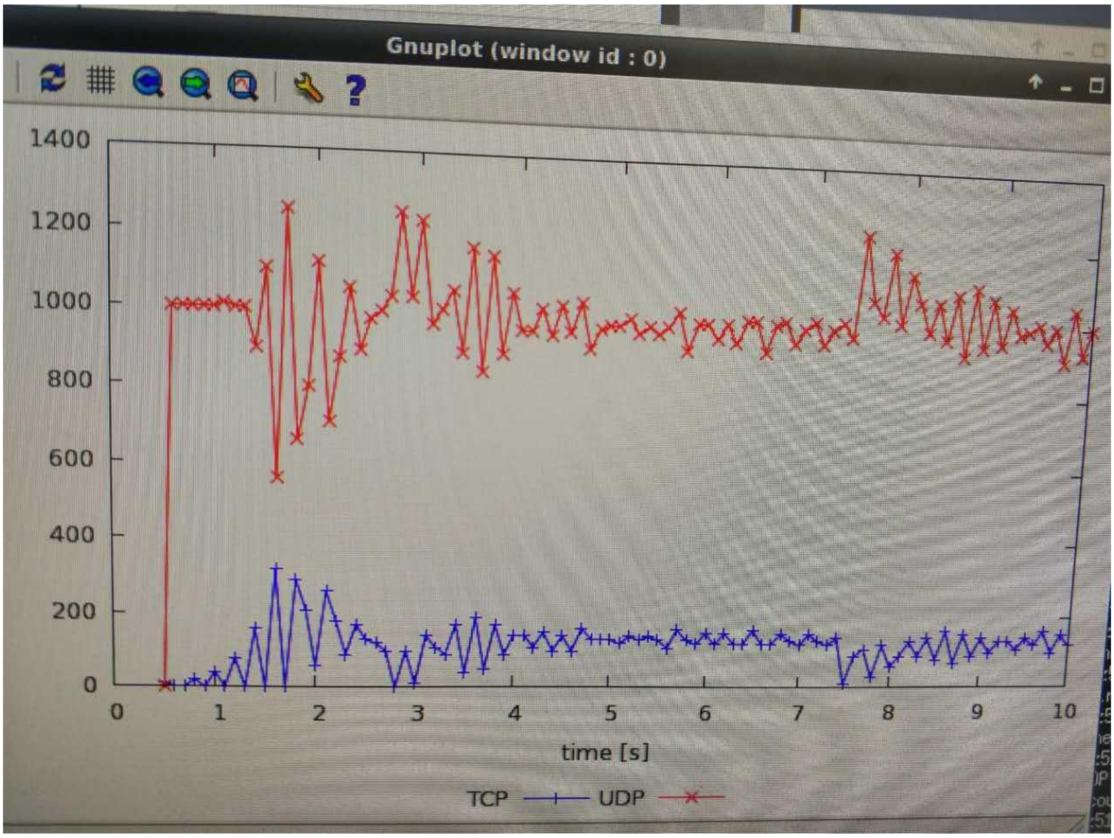
Question 2:
Every time when a new flow connects to common link, the throughput of each flow will decrease sharply. The slope of these line is the same during one period.
The mechanism of TCP which contribute to this behavior is congestion control. It means every flow will have the same condition, **so this behavior is fair.**

Exercise 3:

Question1:

There is a mistake in openlearning that is command **$ns tp_TCPUDP 5Mb cannot be run.** Instead of this, the right command is **$ns tp_TCPUDP.tcl 5Mb**





If the capacity of the link is 5 Mbps, the throughput of UDP will be higher than TCP.

Question 2:

Because the congestion control will not affect UDP. Although it is possible to drop some packets, UDP could transmit packets at a stable rate.

Question 3:

Advantages: UDP could regardless of the congestion in the network. During the same condition, TCP will reduce the transmission rate.

Disadvantages: it will increase the burden of network.

If everybody started using UDP instead of TCP for that same reason, it may cause the network paralysis.