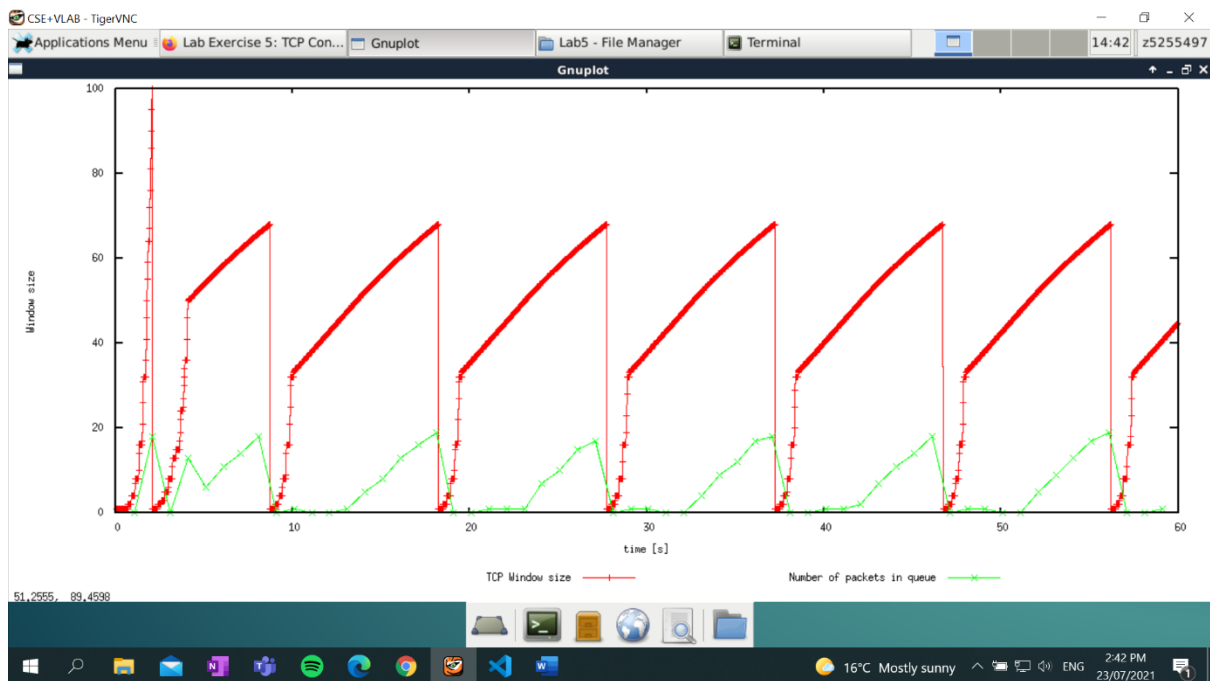


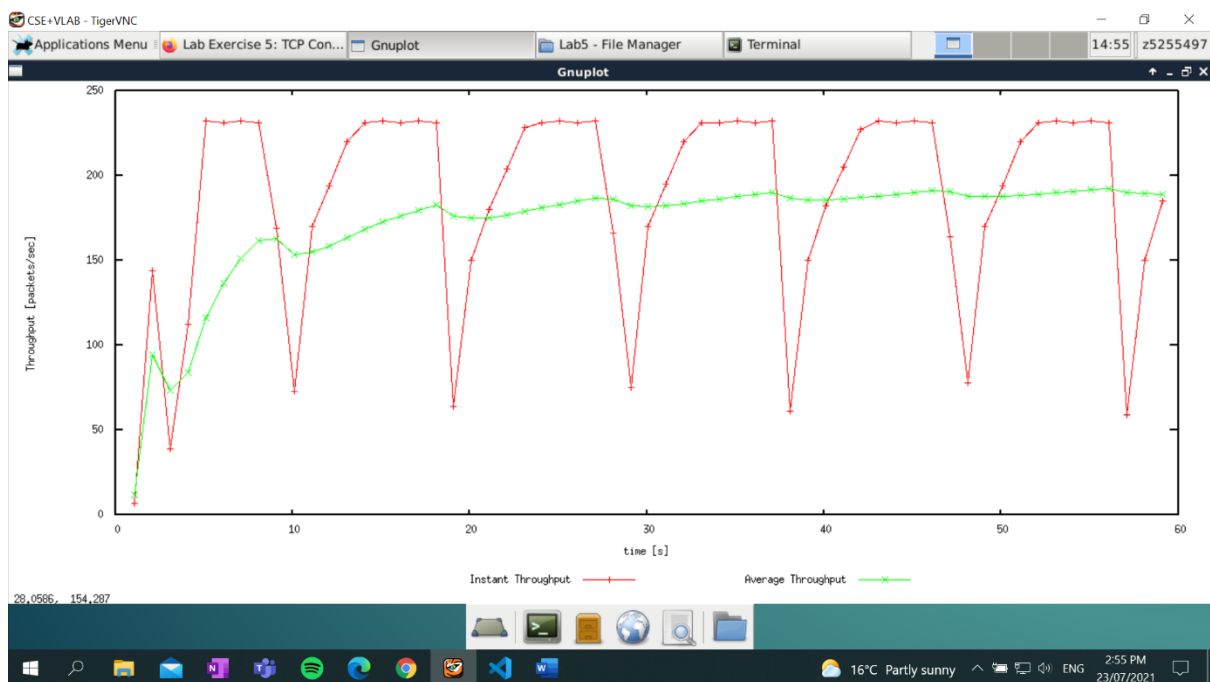
### Question 1.1



The maximum size of the congestion window is 100.

The loss happens and the windows size is reduced to 1.

### Question 1.2

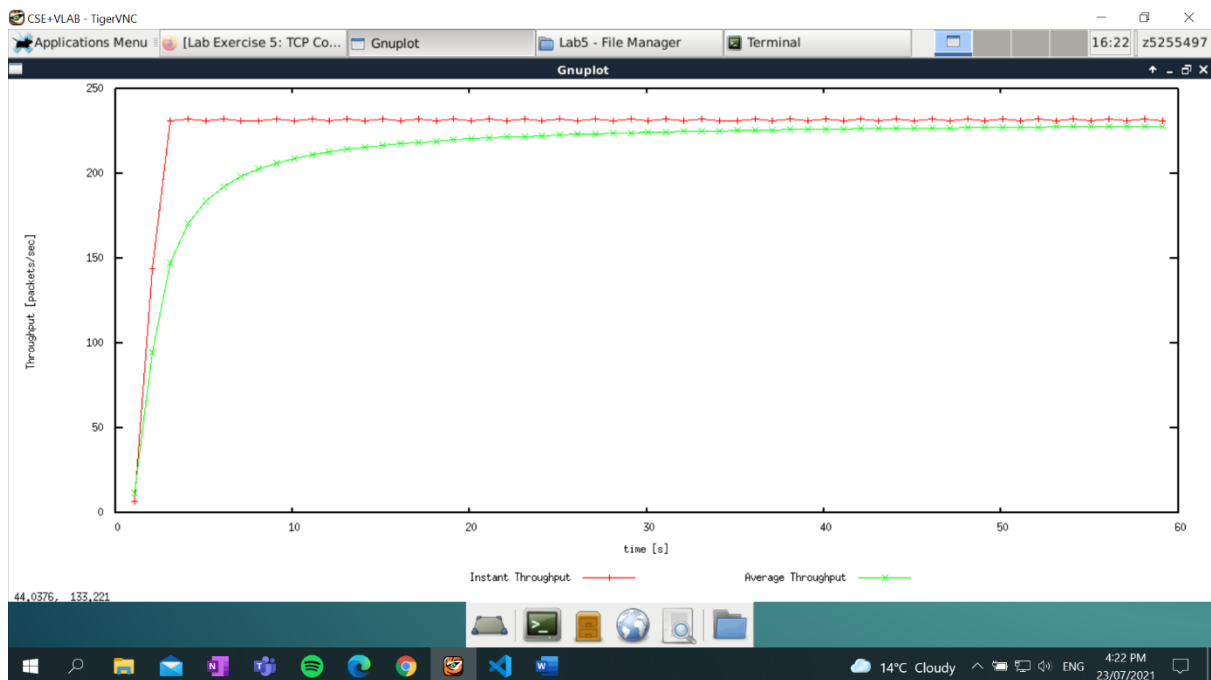
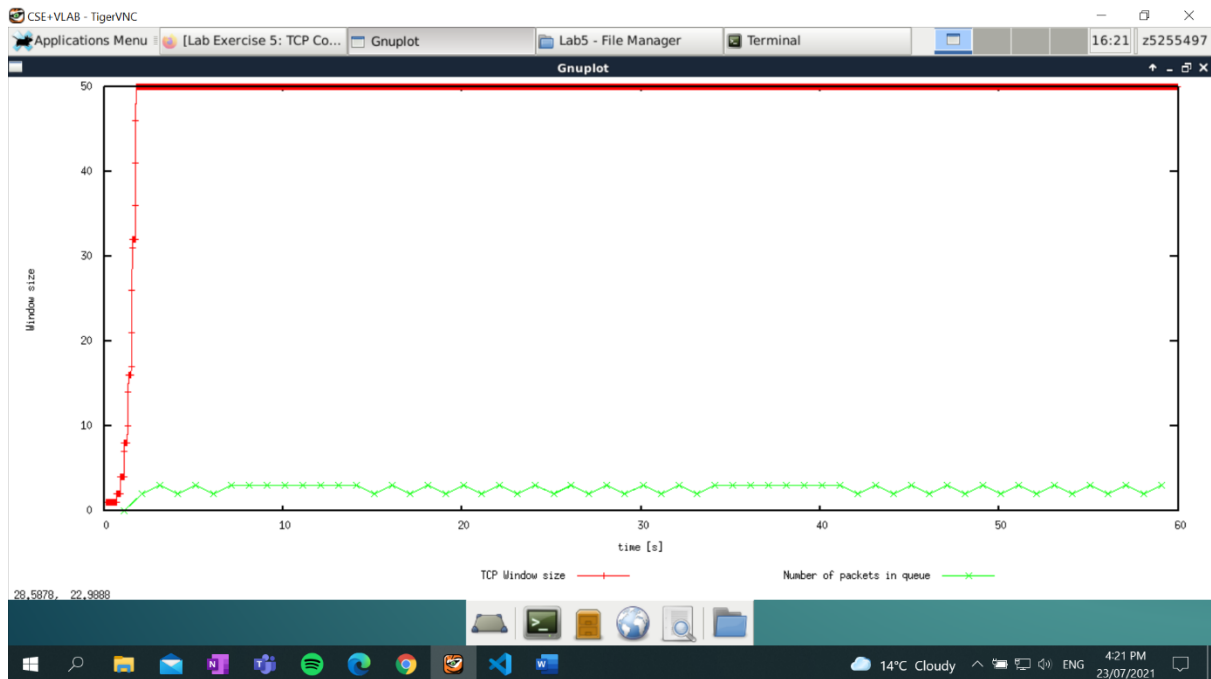


The average throughput is about 188 packets/second.

Without headers: each packet has 500 bytes of data. The average throughput is  $188 * 500 = 9400$  bytes/second.

With headers: each packet has  $500 + 2 \times 20 = 540$  bytes of data. The average throughput is  $188 \times 540 = 101520$  bytes/second.

### Question 1.3



The screenshot shows a Windows desktop environment. At the top, there is a taskbar with several open applications: 'Applications Menu', 'Lab Exercise 5: TCP Con...', 'WindowMon.tr (/tmp\_a...', 'Lab5 - File Manager', and 'Terminal'. The main window is a gedit editor titled 'WindowMon.tr (/tmp\_and/kamen/export/kamen/2/z5255497/cs3331/Lab5) - gedit'. It contains a list of IP addresses and ports, such as '35 35.100000000000001 0 0.0 231.0 3 225.11560693641619'. The bottom of the screen shows a Windows taskbar with icons for various applications like File Explorer, Mail, Photos, and a system tray showing the date and time as 4:22 PM on 23/07/2021.

I noticed when the maximum window size is 50, the TCP did not oscillate and reached a stable behaviour.

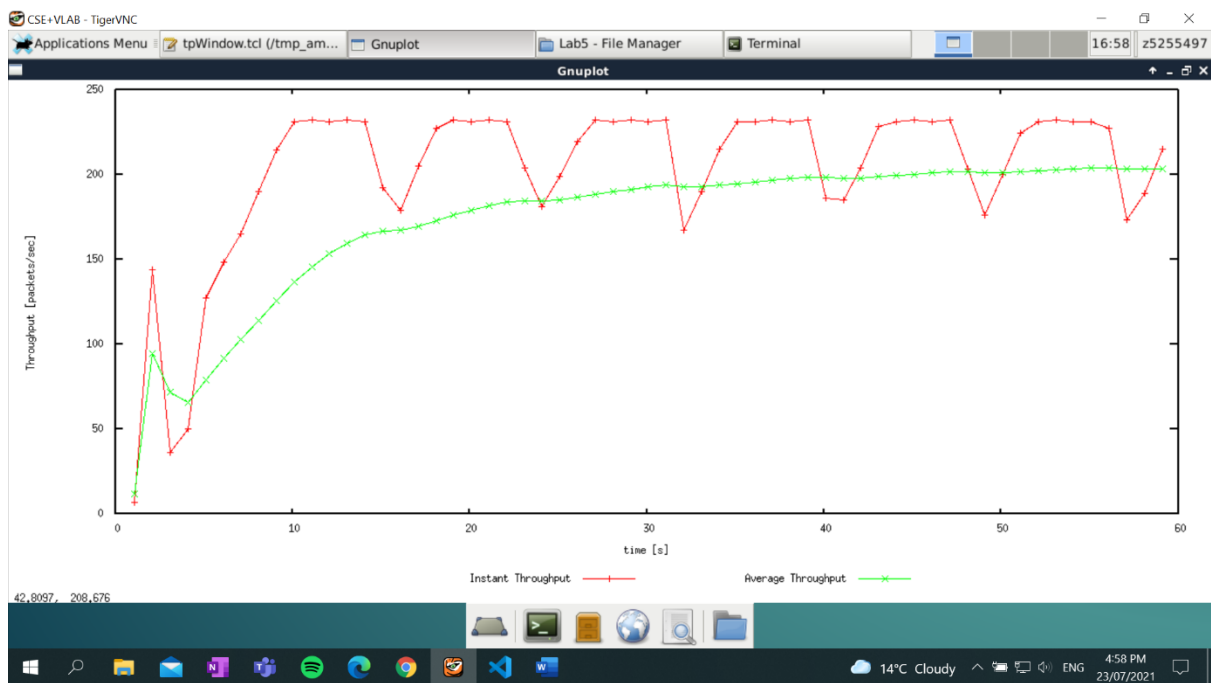
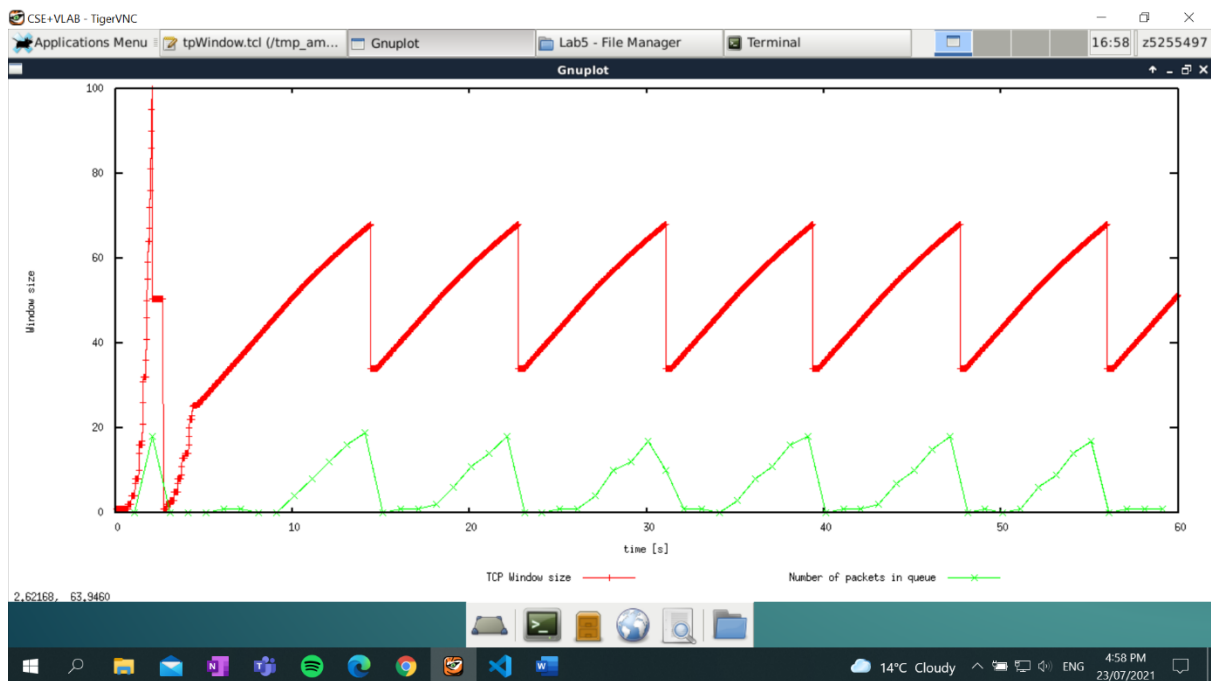
When the maximum windows size is 50, the average throughput size is about 227 packets/second.

Without headers: each packet has 500 bytes of data. The average throughput is  $227 * 500 = 113500$  bytes/second.

With headers: each packet has  $500 + 2 * 20 = 540$  bytes of data. The average throughput is  $227 * 540 = 122580$  bytes/second.

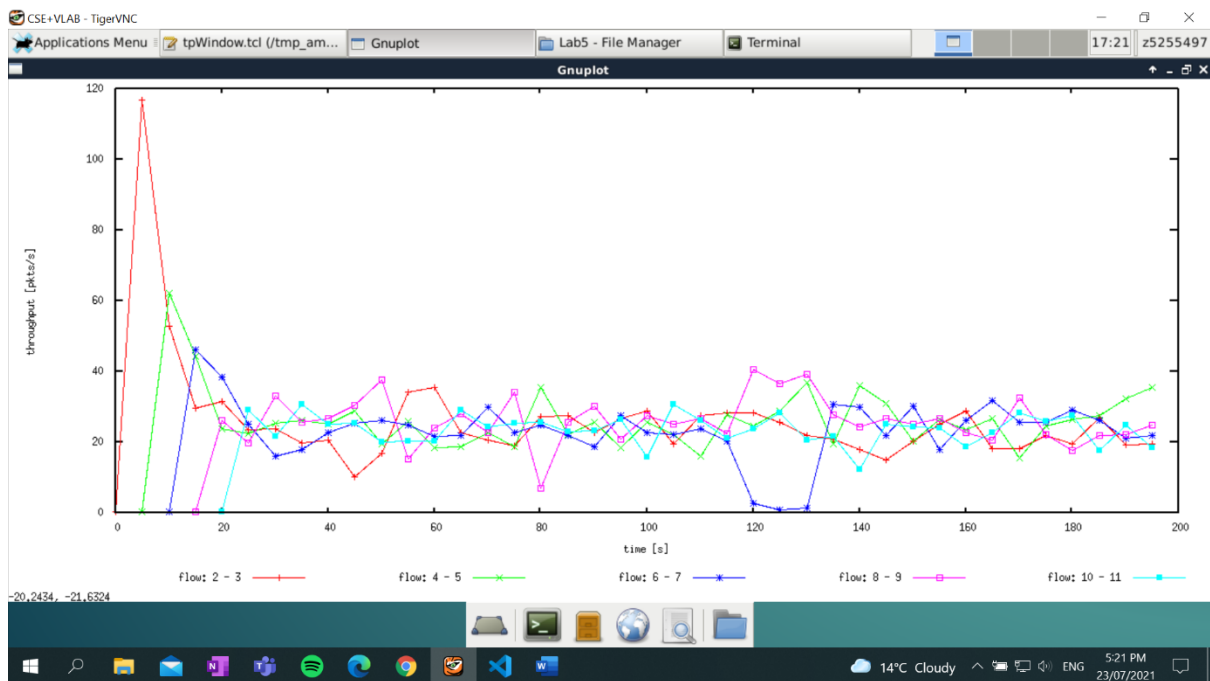
Compare to the actual capacity 1 Mbps, its capacity rate is  $122580/125000 = 98\%$ .

## Question 1.4



The congestion window size only back to zero once because TCP Reno only reduce it to zero when its timeout. The average throughput is around 200 for TCP Reno and is around 188 for TCP Tahoe.

## Question 2.1

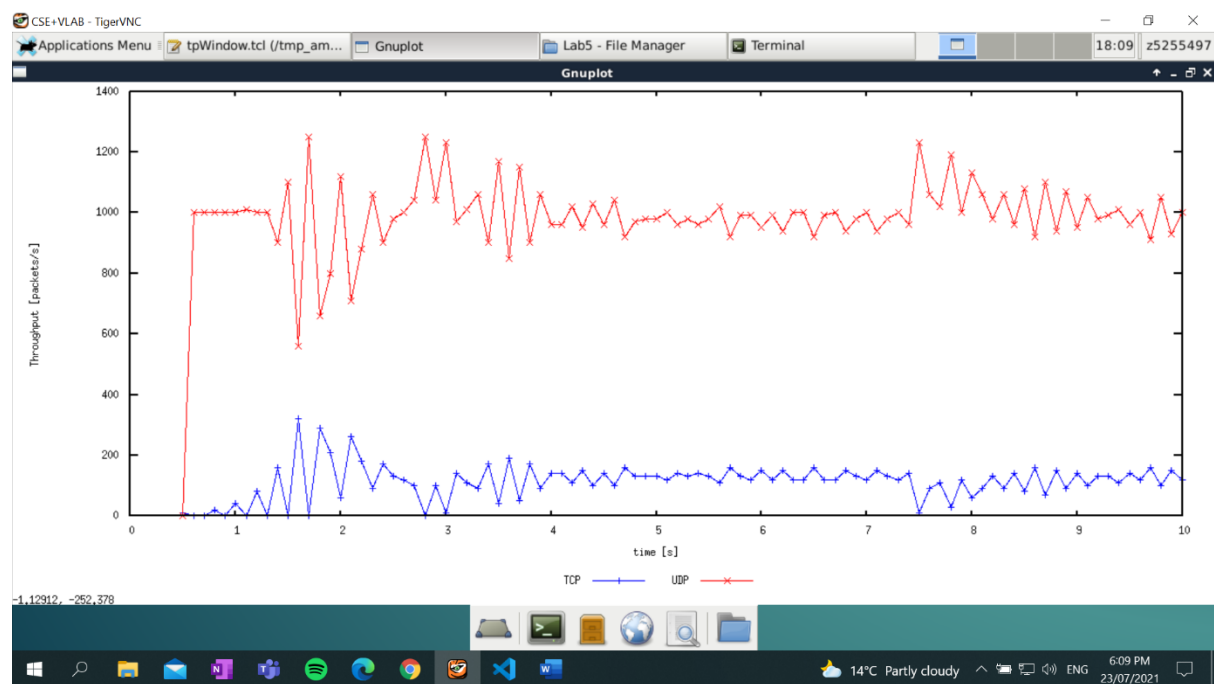


Yes, it does. Each flow starts at different time but as time passes, the throughput for each flow covers to around 20-40 packets/second.

## Question 2.2

After a new flow is created, the throughput of all existing flow will decrease. The mechanism is timeout and it is fair because the earlier flow should adjust its flow when other flow join the network.

### Question 3.1



TCP has congestion control but UDP does not have congestion control. UDP will maintain a higher throughput rate than TCP.

### Question 3.2

UDP does not have congestion control. It takes most of the link for itself and does not care about the package loss. TCP has congestion control. It will try to maintain a stable connection and not overload the link by adjusting the window size.

### Question 3.3

Advantage of UDP: Higher throughput, faster transmission speed, .

Disadvantage of UDP: No congestion control, packet loss and corruptions, no retransmission of lost packets.

If everyone starts using UDP, there will be a network congestion because UDP has no congestion control. There will also be a lot of packet loss, and difficult to detect corrupted packages.