Ques1.

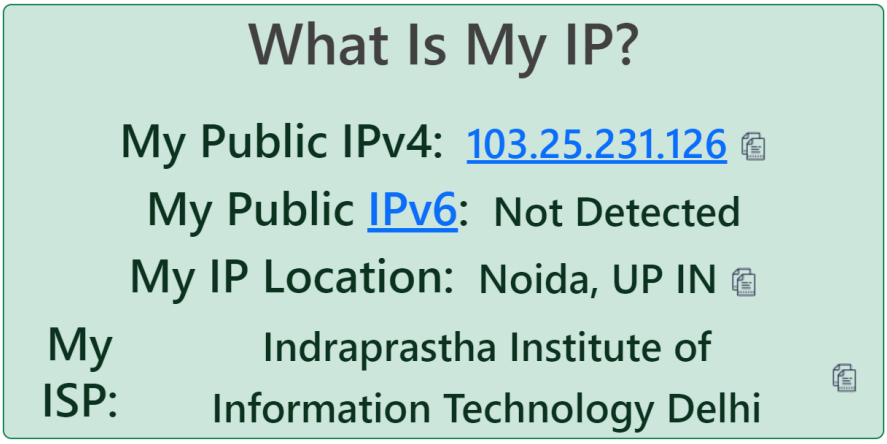
a)

```
vimansh_mahajan@Vimansh-PC:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.28.173.238  netmask 255.255.240.0  broadcast 172.28.175.255
        inet6 fe80::215:5dff:fe6a:3f5d  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:6a:3f:5d  txqueuelen 1000  (Ethernet)
        RX packets 578  bytes 525911 (525.9 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 311  bytes 47412 (47.4 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 62  bytes 5889 (5.8 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 62  bytes 5889 (5.8 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

vimansh_mahajan@Vimansh-PC:~$
```

The IP address of ‘eth0’ (network interface) is 172.28.173.238 (indicated in front of ‘inet’ in the screenshot).

b)

Using the website “https://www.whatismyip.com” I get the following result:



The IP addresses given by my machine and website are **DIFFERENT.**

Reason:

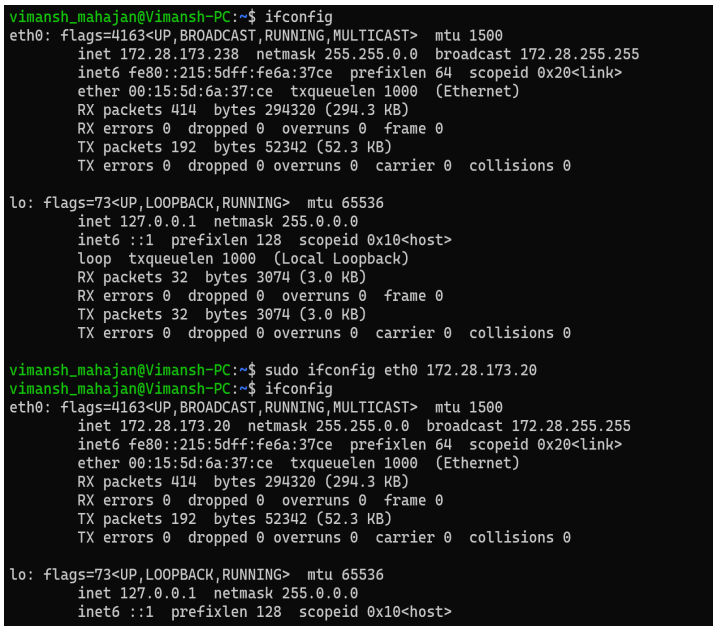
- The ‘**ifconfig**’ command of the system gives the Private IP Address.
    - The router or network within the local area network (LAN) assigns this IP address to the device.
    - It's used for communication between devices on the same network.

- **‘whatismyip.com’** gives the Public IP Address, which is the IP address assigned to the network by our Internet Service Provider (ISP) and is used for communication over the Internet.

- Used for identifying your network on the internet

Ques 2.

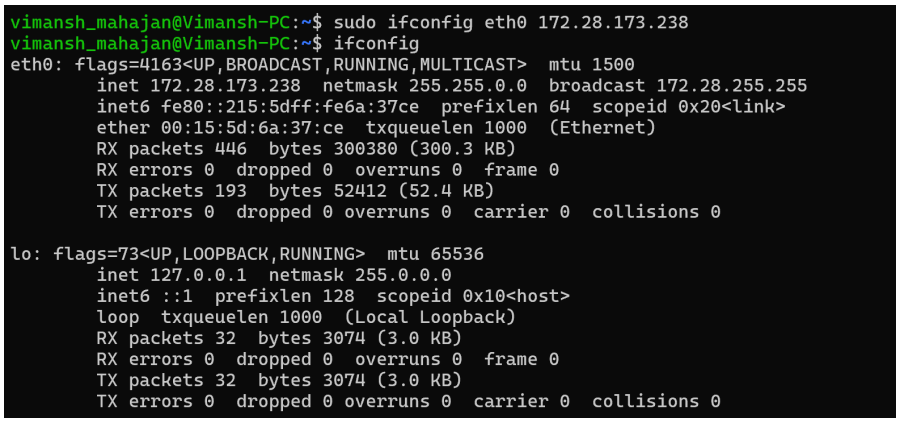
a)



In the screenshot above, first, the original IP address is shown using the command '**ifconfig**', Then it is changed to a new IP address using the command **ifconfig <if-name> <new-ip-addr>**

Original IP address: 172.28.173.238
Changed IP address: 172.28.173.20

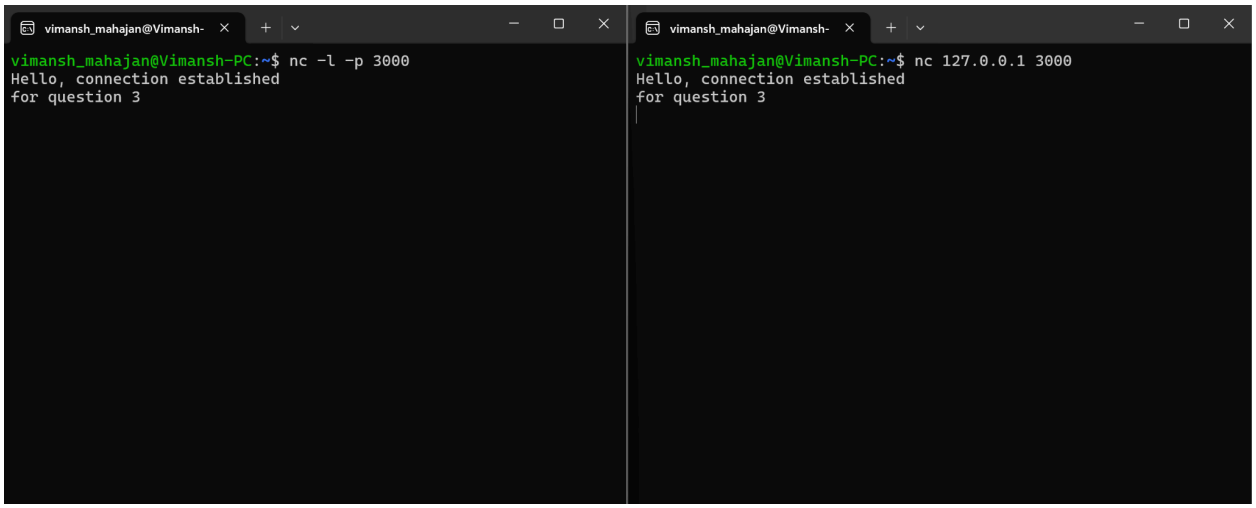
Revert to the original address using the command **ifconfig <if-name> <prev-ip-addr>**



Ques 3.

a)

The command used: nc -l -p 3000; -l= flag for listen mode; -p: flag for the port number followed by the port number



Connection established for LocalHost

b)

```
vimansh_mahajan@Vimansh-PC:~$ netstat -t
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 localhost:51148         localhost:3000          ESTABLISHED
tcp        0      0 localhost:3000          localhost:51148         ESTABLISHED
vimansh_mahajan@Vimansh-PC:~$
```

Local Address: localhost :51148

Foreign Address: localhost :3000

This represents the connection from the client (port 51148) to the server (port 3000)

Local Address: localhost :3000

Foreign Address: localhost :51148

This represents the connection from the server (port 3000) to the client (port 51148).

Ques 4.

a) An authoritative server for a zone is the name server that stores the IP addresses for the zone and holds the information about the zone's domains.

A **start of authority (SOA)** is a DNS record with information about a zone.
We first need to access the corresponding SOA record to find the authoritative name-server for a domain name.
If we want to find the SOA for google.in, we use the -type=soa with the nslookup command:

nslookup -type=soa google.in

An **authoritative answer** is a response we get directly from the primary DNS server holding the master copy of the zone file.

```
vimansh@Vimansh-PC:~$ nslookup -type=soa google.in
Server:         10.255.255.254
Address:        10.255.255.254#53

Non-authoritative answer:
google.in
        origin = ns1.google.com
        mail addr = dns-admin.google.com
        serial = 667519583
        refresh = 900
        retry = 900
        expire = 1800
        minimum = 60

Authoritative answers can be found from:
ns1.google.com  internet address = 216.239.32.10
ns1.google.com  has AAAA address 2001:4860:4802:32::a

vimansh@Vimansh-PC:~$ nslookup google.in ns1.google.com
Server:         ns1.google.com
Address:        216.239.32.10#53

Name:   google.in
Address: 142.250.194.228
Name:   google.in
Address: 2404:6800:4002:825::2004

vimansh@Vimansh-PC:~$
```

Summary of steps: First, we get the name of the primary name server using the command **nslookup -type=soa google.in**
Afterward, we use the primary server's name to get the authoritative answer containing the authoritative name server's IP address.

b)

```
vimansh@Vimansh-PC:~$ dig google.in

; <<>> DiG 9.18.24-0ubuntu5-Ubuntu <<>> google.in
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 10342
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4000
;; QUESTION SECTION:
;google.in.                     IN      A

;; ANSWER SECTION:
google.in.              294     IN      A       142.250.193.4

;; Query time: 0 msec
;; SERVER: 10.255.255.254#53(10.255.255.254) (UDP)
;; WHEN: Wed Aug 28 15:41:55 UTC 2024
;; MSG SIZE  rcvd: 54

vimansh@Vimansh-PC:~$
```

The Time To Live(TTL) for google.in is given in the screenshot above, i.e. **294 seconds** (check under **'ANSWER SECTION:'**)
After **294 seconds,** this entry would expire from the local DNS server.

Ques 5.
a)

```
vimansh@Vimansh-PC:~$ traceroute google.in
traceroute to google.in (142.250.192.228), 30 hops max, 60 byte packets
 1  Vimansh-PC.mshome.net (172.28.160.1)  0.912 ms  0.873 ms  0.863 ms
 2  192.168.32.254 (192.168.32.254)  6.728 ms  6.039 ms  6.030 ms
 3  vpn.iiitd.edu.in (192.168.1.99)  4.714 ms  3.896 ms  4.011 ms
 4  103.25.231.1 (103.25.231.1)  6.114 ms  4.475 ms  5.068 ms
 5  * * *
 6  10.119.234.162 (10.119.234.162)  6.817 ms  5.182 ms  5.162 ms
 7  72.14.194.160 (72.14.194.160)  8.271 ms  8.529 ms  8.226 ms
 8  142.251.54.111 (142.251.54.111)  48.640 ms 192.178.80.159 (192.178.80.159)  29.778 ms  29.306 ms
 9  142.251.54.65 (142.251.54.65)  26.851 ms 142.251.54.63 (142.251.54.63)  27.295 ms 142.251.54.65 (142.251.54.65)  26.823
ms
10  del11s13-in-f4.1e100.net (142.250.192.228)  29.693 ms  26.765 ms  26.745 ms
vimansh@Vimansh-PC:~$
```

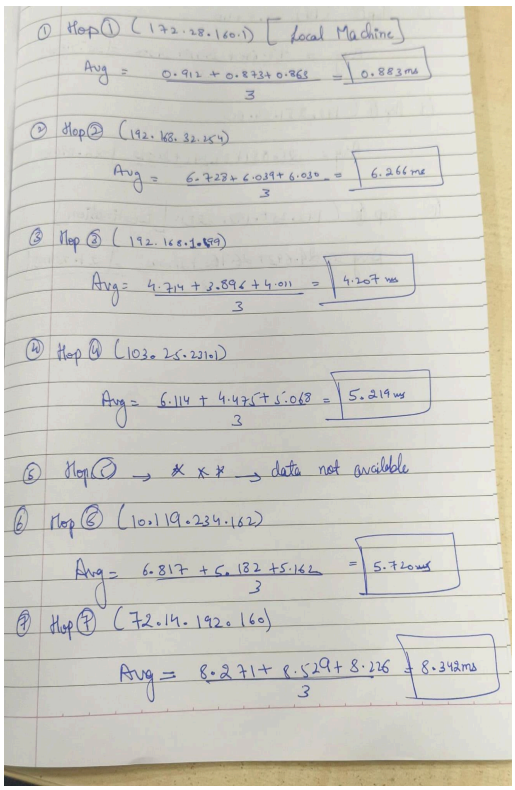
1 Vimansh-PC.mshome.net (172.28.160.1)
2 192.168.32.254 (192.168.32.254)
3 vpn.iiitd.edu.in (192.168.1.99)
4 103.25.231.1 (103.25.231.1)

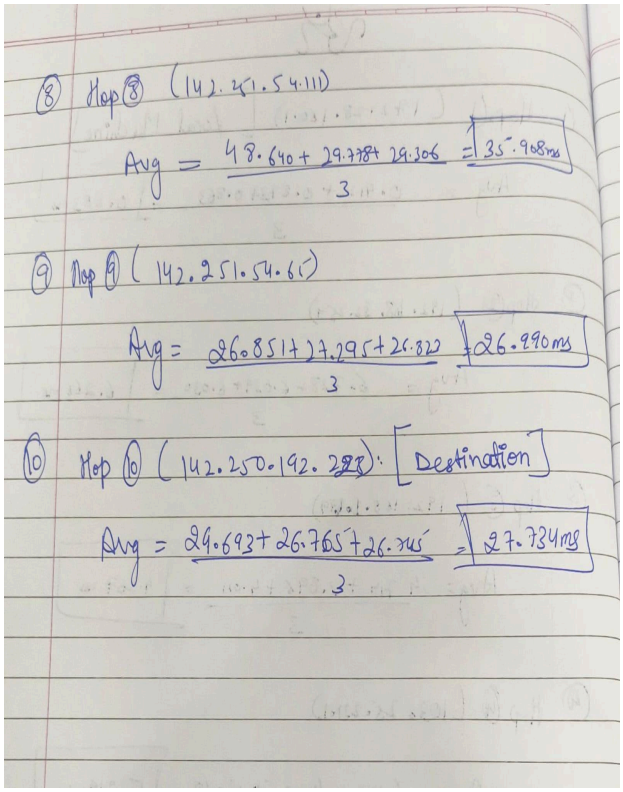
5 * * *
6 10.119.234.162 (10.119.234.162)
7 72.14.194.160 (72.14.194.160)
8 142.251.54.111 (142.251.54.111)
9 142.251.54.65 (142.251.54.65)
10 del11s13-in-f4.1e100.net (142.250.192.228) (final destination)
Intermediate hosts should be counted by excluding local machine and final destination
Therefore the total number of intermediate hosts are: **EIGHT (8)**

IP addresses

- ➔ 172.28.160.1 (Local host)
- ➔ 192.168.32.254
- ➔ 192.168.1.99
- ➔ 103.25.231.1
- ➔ xxx
- ➔ 10.119.234.162
- ➔ 72.14.194.160
- ➔ 142.251.54.111
- ➔ 142.251.54.65
- ➔ 142.250.192.228 (final destination)

Average Latency Calculations





Summary of Average Latencies:

1. **Hop 1:** 0.883 ms [Local Machine]
2. **Hop 2:** 6.266 ms **[Intermediate host]**
3. **Hop 3:** 4.207 ms **[Intermediate host]**
4. **Hop 4:** 5.219 ms **[Intermediate host]**
5. **Hop 5:** No data **[Intermediate host]**
6. **Hop 6:** 5.720 ms **[Intermediate host]**
7. **Hop 7:** 8.342 ms **[Intermediate host]**
8. **Hop 8:** 35.908 ms **[Intermediate host]**
9. **Hop 9:** 26.990 ms **[Intermediate host]**
10. **Hop 10:** 27.734 ms [Final Destination]

b)

```
vimansh@Vimansh-PC:~$ ping -c 50 google.in
PING google.in (142.250.192.228) 56(84) bytes of data.
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=1 ttl=55 time=28.5 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=2 ttl=55 time=28.0 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=3 ttl=55 time=28.9 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=4 ttl=55 time=28.1 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=5 ttl=55 time=28.6 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=6 ttl=55 time=28.8 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=7 ttl=55 time=28.2 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=8 ttl=55 time=27.6 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=9 ttl=55 time=27.9 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=10 ttl=55 time=33.2 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=11 ttl=55 time=28.8 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=12 ttl=55 time=27.8 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=13 ttl=55 time=28.7 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=14 ttl=55 time=30.6 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=15 ttl=55 time=28.5 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=16 ttl=55 time=29.4 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=17 ttl=55 time=28.9 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=18 ttl=55 time=29.0 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=19 ttl=55 time=29.1 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=20 ttl=55 time=29.8 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=21 ttl=55 time=28.4 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=22 ttl=55 time=29.5 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=23 ttl=55 time=28.6 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=24 ttl=55 time=28.4 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=25 ttl=55 time=28.0 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=26 ttl=55 time=28.1 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=27 ttl=55 time=28.6 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=28 ttl=55 time=28.6 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=29 ttl=55 time=28.1 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=30 ttl=55 time=29.0 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=31 ttl=55 time=29.2 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=32 ttl=55 time=28.3 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=33 ttl=55 time=28.1 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=34 ttl=55 time=28.5 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=35 ttl=55 time=28.2 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=36 ttl=55 time=29.1 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=37 ttl=55 time=28.4 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=38 ttl=55 time=27.9 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=39 ttl=55 time=28.4 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=40 ttl=55 time=28.6 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=41 ttl=55 time=33.0 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=42 ttl=55 time=28.2 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=43 ttl=55 time=30.5 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=44 ttl=55 time=28.5 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=45 ttl=55 time=27.9 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=46 ttl=55 time=29.4 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=47 ttl=55 time=28.9 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=48 ttl=55 time=29.2 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=49 ttl=55 time=29.5 ms
64 bytes from del11s13-in-f4.1e100.net (142.250.192.228): icmp_seq=50 ttl=55 time=28.5 ms

--- google.in ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 48986ms
rtt min/avg/max/mdev = 27.590/28.843/33.218/1.067 ms
```

The average latency is indicated in **Google.in ping statistics = 28.843ms**

c)

Adding up the ping latency of all the intermediate hosts obtained in (a) **(excluding ***)**:
Total Latency= 6.266+4.207+5.219+5.720+8.342+35.908+26.990+27.734 =
120.386ms

From the ping test to google.in, the average latency was:

Ping Average Latency = **28.843 ms**

Therefore, both values are **not equal**

Reason:

The sum of the average latencies of intermediate hosts from traceroute is greater than the average latency from the ping command because the traceroute command measures the **round-trip-time for each hop** along the path, while ping measures the total round-trip-time for the entire journey from source to destination and back in one go. Therefore, these latency values are **not equal**.

d)

The maximum latency for the intermediate host in (a) = **35.908ms;** it reflects the latency for one specific hop, for which it took the longest time.

The average latency in part(b) = **28.843ms;** represents the average round-trip time for packets travelling to the final destination and back. This average includes the latencies of all hops in the route.

Therefore we can say:

- The maximum latency in traceroute may be higher due to occasional delays at intermediate hops which maybe due to higher traffic or congestion at routers and other variable reasons.
- The average latency in ping reflects the overall performance to the destination and includes multiple measurements.

Hence, the values **do not match.**

e)

Taking an example of one of the hops:

103.25.231.1 (103.25.231.1) 13.384 ms 13.374 ms 13.366 ms

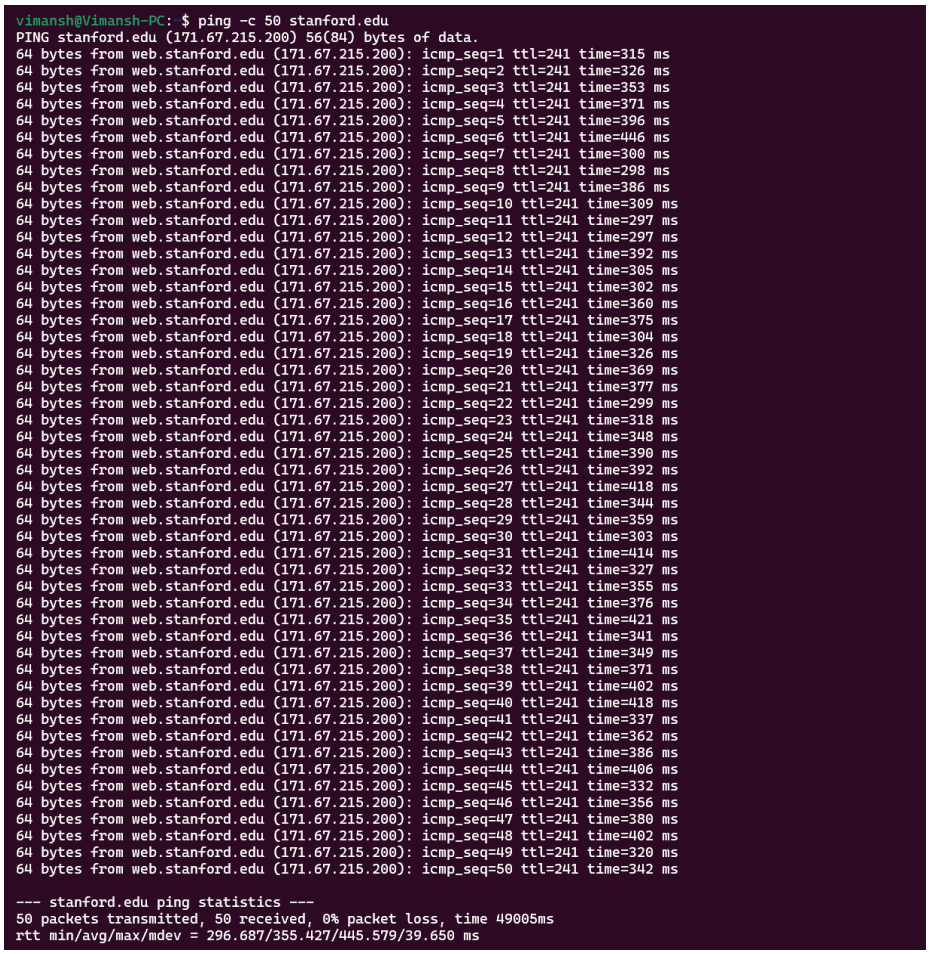
In this case, we see three different times mentioned in front of the IP address, which shows that 'traceroute' sends multiple packets (3 in this case) to measure latency, and it reports the time it took for each packet to reach that hop.

The first value (In this case: 103.25.231.1) is the hostname **(if resolved)** or IP address of the router or server.
The second value (In this case: 103.25.231.1) is the IP address of the router or network device at that particular hop.
AND, in an example like the below one:
192.178.80.159 (192.178.80.159) 36.069 ms 142.251.54.111 (142.251.54.111) 52.656 ms
192.178.80.159 (192.178.80.159) 36.548 ms

We see different IP address for a particular packet and another different IP address for the other one because each packet might take a **different route** to reach the router, and the time in

milliseconds mentioned refers to the latency of that packet to reach that router (just like the above example).

f)



```
vimansh@Vimansh-PC: ~$ ping -c 50 stanford.edu
PING stanford.edu (171.67.215.200) 56(84) bytes of data.
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=1 ttl=241 time=315 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=2 ttl=241 time=326 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=3 ttl=241 time=353 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=4 ttl=241 time=371 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=5 ttl=241 time=396 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=6 ttl=241 time=446 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=7 ttl=241 time=300 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=8 ttl=241 time=298 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=9 ttl=241 time=386 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=10 ttl=241 time=309 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=11 ttl=241 time=297 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=12 ttl=241 time=297 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=13 ttl=241 time=392 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=14 ttl=241 time=305 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=15 ttl=241 time=302 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=16 ttl=241 time=360 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=17 ttl=241 time=375 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=18 ttl=241 time=304 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=19 ttl=241 time=326 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=20 ttl=241 time=369 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=21 ttl=241 time=377 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=22 ttl=241 time=299 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=23 ttl=241 time=318 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=24 ttl=241 time=348 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=25 ttl=241 time=390 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=26 ttl=241 time=392 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=27 ttl=241 time=418 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=28 ttl=241 time=344 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=29 ttl=241 time=359 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=30 ttl=241 time=303 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=31 ttl=241 time=414 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=32 ttl=241 time=327 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=33 ttl=241 time=355 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=34 ttl=241 time=376 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=35 ttl=241 time=421 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=36 ttl=241 time=341 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=37 ttl=241 time=349 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=38 ttl=241 time=371 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=39 ttl=241 time=402 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=40 ttl=241 time=418 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=41 ttl=241 time=337 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=42 ttl=241 time=362 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=43 ttl=241 time=386 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=44 ttl=241 time=406 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=45 ttl=241 time=332 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=46 ttl=241 time=356 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=47 ttl=241 time=380 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=48 ttl=241 time=402 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=49 ttl=241 time=320 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=50 ttl=241 time=342 ms

--- stanford.edu ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49005ms
rtt min/avg/max/mdev = 296.687/355.427/445.579/39.650 ms
```

Average Latency: **355.427ms**

g)
Using **traceroute stanford.edu** and **traceroute google.in** respectively

```
vimansh@Vimansh-PC: $ traceroute stanford.edu
traceroute to stanford.edu (171.67.215.200), 30 hops max, 60 byte packets
 1  Vimansh-PC.mshome.net (172.28.160.1)  0.906 ms  1.292 ms  1.280 ms
 2  192.168.32.254 (192.168.32.254)  107.013 ms  107.000 ms  106.991 ms
 3  auth.iiitd.edu.in (192.168.1.99)  14.331 ms  14.522 ms  14.383 ms
 4  103.25.231.1 (103.25.231.1)  14.049 ms  14.449 ms  14.030 ms
 5  10.1.209.201 (10.1.209.201)  40.422 ms  38.199 ms  39.248 ms
 6  10.1.200.137 (10.1.200.137)  38.933 ms  34.683 ms  35.057 ms
 7  10.255.238.254 (10.255.238.254)  55.874 ms  57.115 ms  57.056 ms
 8  180.149.48.18 (180.149.48.18)  32.123 ms  32.089 ms  32.077 ms
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * campus-ial-nets-b-vl1104.SUNet (171.66.255.200)  296.303 ms *
25  * * campus-nw-rtr-vl1104.SUNet (171.66.255.200)  377.594 ms
26  * * web.stanford.edu (171.67.215.200)  377.374 ms
vimansh@Vimansh-PC: $ traceroute google.in
traceroute to google.in (142.250.192.228), 30 hops max, 60 byte packets
 1  * Vimansh-PC.mshome.net (172.28.160.1)  1.316 ms  1.306 ms
 2  * * *
 3  * * *
 4  * * *
 5  * * *
 6  * * 10.119.234.162 (10.119.234.162)  6.972 ms
 7  72.14.194.160 (72.14.194.160)  9.188 ms 72.14.195.56 (72.14.195.56)  13.051 ms 72.14.194.160 (72.14.194.160)  11.095 ms
 8  142.251.54.111 (142.251.54.111)  50.764 ms 192.178.80.159 (192.178.80.159)  34.192 ms  33.637 ms
 9  142.251.54.65 (142.251.54.65)  29.191 ms 142.251.54.63 (142.251.54.63)  34.608 ms  33.592 ms
10  del11s13-in-f4.1e100.net (142.250.192.228)  36.683 ms  37.262 ms  36.663 ms
vimansh@Vimansh-PC: $
```

We can notice the difference between the number of hops for stanford.edu **(26 hops)** and Google.in **(10 hops).** The first IP address in each traceroute refers to the local machine or the first router on our network, and the last IP address refers to the final destination server.

Therefore, we can see that it takes **16 more hops** to reach stanford.edu than to reach Google.in, indicating that the route to stanford.edu passes through more intermediate networks or devices.

h)

the average latency for:
stanford.edu = **355.427ms**
google.in = **28.843ms**

Reasons:

- Google has a vast global network of data centres and servers. When we ping google.com, the request is likely **routed to a nearby server/data center (**most likely in India**),** significantly reducing latency.

- When pinging stanford.edu (based in Stanford, California), the data packets have to **travel a greater distance**, resulting in more hops through intermediate servers, which increases the latency.

Ques 6.

```
vimansh@Vimansh-PC:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.28.173.238  netmask 255.255.240.0  broadcast 172.28.175.255
        inet6 fe80::215:5dff:fe7d:bacc  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:7d:ba:cc  txqueuelen 1000  (Ethernet)
        RX packets 209  bytes 220302 (220.3 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 164  bytes 11190 (11.1 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 20  bytes 2165 (2.1 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 20  bytes 2165 (2.1 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

vimansh@Vimansh-PC:~$ sudo ifconfig lo down
vimansh@Vimansh-PC:~$ ping 127.0.0.1
PING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.
^C
--- 127.0.0.1 ping statistics ---
7 packets transmitted, 0 received, 100% packet loss, time 6155ms

vimansh@Vimansh-PC:~$
```

To achieve 100% packet loss while pinging **127.0.0.1:**

1) Use **‘sudo ifconfig lo down’** command to disable the loopback interface (lo), which is responsible for handling the loopback address **127.0.0.1**
2) Used **‘ping 127.0.0.1’** command to send packets to this address.
3) Since 127.0.0.1 was down, a reply was not received, and 100% packet loss was achieved.