1. TCP and UDP are two types of transport layer protocols that are used to transmit data across a network. TCP establishes a reliable connection before sending any data and uses error-checking and retransmission mechanisms to ensure accurate delivery. On the other hand, UDP does not establish a connection before sending data and does not have error-checking mechanisms, making it faster but less reliable.

2. A hub is a device that connects multiple devices on a network and acts as a central point for data transmission. A switch is an advanced version of a hub, which uses MAC addresses to forward data to specific devices, instead of broadcasting data to all connected devices. A router is a device that connects multiple networks together and directs traffic between them.

3. A layer 3 switch is a switch that can perform routing functions in addition to its switching capabilities. It uses IP addresses to forward data instead of just MAC addresses.

4. IPv4 and IPv6 are two versions of the Internet Protocol. IPv4 is the most widely used version, while IPv6 is being adopted to address the shortage of IP addresses in IPv4. IPv6 addresses are 128 bits long and represented in hexadecimal, while IPv4 addresses are 32 bits long and represented in decimal.

5. In IPv4, a subnet mask is used to separate the network and host portions of an IP address. It is a 32-bit number that, when combined with an IP address, can be used to divide a network into smaller subnetworks.

6. In IPv4 addressing, a prefix is the number of bits in the subnet mask that are set to 1. For example, a prefix of /24 represents a subnet mask of 255.255.255.0, which is often used for small networks. A prefix of /16 represents a subnet mask of 255.255.0.0, which is often used for larger networks.

7. The default gateway is the IP address of a device on a network that serves as an entry point to other networks. DNS translates domain names to IP addresses, while DHCP is used to automatically assign IP addresses to devices on a network.

8. A MAC address is a unique identifier assigned to a network device and is used to identify the device at the data link layer of a network. A port address is a unique identifier assigned to a specific process or service running on a device and is used to identify the process or service at the transport layer of a network.

9. LANs are networks that connect devices in a small geographical area, such as a home or office. WANs are networks that connect devices in a larger geographical area, such as a city or country.

10. Some typical LAN topologies are bus, star, ring, and mesh.

11. A loopback address is a special IP address (127.0.0.1) that refers to the local host. It is used for testing network connectivity and communication between the host and its own network stack.

12. ICMP is used to send error messages and operational information indicating success or failure when communicating over an IP network. ARP is a network protocol used to map a network address, such as an IP address, to a physical (MAC) address on a local network. ARP is used to determine the MAC address of a device on the same network segment as the device sending the ARP request, this allows a device to communicate with other devices on the network using their MAC address instead of their IP address. It is mainly used for resolving network addresses to physical addresses on a local network segment.

```
Last login: Sun Jan 29 00:09:18 on ttys000
❯ pwd
/Users/surajmandal
❯ ls
Applications     Documents        Dropbox          MEGAsync         Music            Pictures         google-cloud-sdk
Desktop          Downloads        Library          Movies           OneDrive         Public
❯ cd Desktop/humber/5002-sdn/lab1
❯ mkdir test
❯ cd test
❯ netstat -r
Routing tables

Internet:
Destination        Gateway            Flags          Netif Expire
default            mynetwork          UGScg            en0
127                localhost          UCS              lo0
localhost          localhost          UH               lo0
169.254            link#12            UCS              en0      !
192.168.2          link#12            UCS              en0      !
192.168.2.1/32     link#12            UCS              en0      !
mynetwork          98:1e:19:fd:fe:fa  UHLWIir          en0   1198
192.168.2.16       a:f9:da:bc:fd:87   UHLWIi           en0   1027
192.168.2.32/32    link#12            UCS              en0      !
192.168.2.255      ff:ff:ff:ff:ff:ff  UHLWbI           en0      !
224.0.0/4          link#12            UmCS             en0      !
224.0.0.251        1:0:5e:0:0:fb      UHmLWI           en0
239.255.255.250    1:0:5e:7f:ff:fa    UHmLWI           en0
255.255.255.255/32 link#12            UCS              en0      !
broadcasthost      ff:ff:ff:ff:ff:ff  UHLWbI           en0      !

Internet6:
Destination        Gateway            Flags          Netif Expire
ifconfig
default            fe80::%utun0       UGcIg          utun0
default            fe80::%utun1       UGcIg          utun1
default            fe80::%utun2       UGcIg          utun2
default            fe80::%utun3       UGcIg          utun3
default            fe80::%utun4       UGcIg          utun4
localhost          localhost          UHL              lo0
fe80::%lo0         suraj-m1.local     UcI              lo0
suraj-m1.local     link#1             UHLI             lo0
fe80::%anpi0       link#4             UCI            anpi0
suraj-m1.local     ba:22:96:9:db:f2   UHLI             lo0
fe80::%anpi1       link#5             UCI            anpi1
suraj-m1.local     ba:22:96:9:db:f3   UHLI             lo0
fe80::%ap1         link#11            UCI              ap1
suraj-m1.local     3e:a6:f6:7:c9:3b   UHLI             lo0
fe80::%en0         link#12            UCI              en0
surajs-iphone.loca a:f9:da:bc:fd:87   UHLWIi           en0
suraj-m1.local     96:68:2e:64:6d:e7  UHLI             lo0
fe80::8421:1ff:fe9 86:21:1:91:74:e9   UHLI             lo0
fe80::8421:1ff:fe9 86:21:1:91:74:e9   UHLI             lo0
fe80::%utun0       suraj-m1.local     UcI            utun0
suraj-m1.local     link#15            UHLI             lo0
fe80::%utun1       suraj-m1.local     UcI            utun1
suraj-m1.local     link#16            UHLI             lo0
fe80::%utun2       suraj-m1.local     UcI            utun2
suraj-m1.local     link#17            UHLI             lo0
fe80::%utun3       suraj-m1.local     UcI            utun3
suraj-m1.local     link#18            UHLI             lo0
fe80::%utun4       suraj-m1.local     UcI            utun4
suraj-m1.local     link#19            UHLI             lo0
ff00::             localhost          UmCI             lo0
ff00::             link#4             UmCI           anpi0
ff00::             link#5             UmCI           anpi1
ff00::             link#11            UmCI             ap1
ff00::             link#12            UmCI             en0
ff00::             link#13            UmCI           awdl0
ff00::             link#14            UmCI            llw0
ff00::             suraj-m1.local     UmCI           utun0
ff00::             suraj-m1.local     UmCI           utun1
ff00::             suraj-m1.local     UmCI           utun2
ff00::             suraj-m1.local     UmCI           utun3
ff00::             suraj-m1.local     UmCI           utun4
ff01::%lo0         localhost          UmCI             lo0
ff01::%anpi0       link#4             UmCI           anpi0
ff01::%anpi1       link#5             UmCI           anpi1
ff01::%ap1         link#11            UmCI             ap1
ff01::%en0         link#12            UmCI             en0
ff01::%utun0       suraj-m1.local     UmCI           utun0
ff01::%utun1       suraj-m1.local     UmCI           utun1
ff01::%utun2       suraj-m1.local     UmCI           utun2
ff01::%utun3       suraj-m1.local     UmCI           utun3
ff01::%utun4       suraj-m1.local     UmCI           utun4
ff02::%lo0         localhost          UmCI             lo0
ff02::%anpi0       link#4             UmCI           anpi0
ff02::%anpi1       link#5             UmCI           anpi1
ff02::%ap1         link#11            UmCI             ap1
ff02::%en0         link#12            UmCI             en0
ff02::%utun0       suraj-m1.local     UmCI           utun0
```

```
ff02::%utun1       suraj-m1.local     UmCI           utun1
ff02::%utun2       suraj-m1.local     UmCI           utun2
ff02::%utun3       suraj-m1.local     UmCI           utun3
ff02::%utun4       suraj-m1.local     UmCI           utun4
❯ ifconfig
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
    options=1203<RXCSUM,TXCSUM,TXSTATUS,SW_TIMESTAMP>
    inet 127.0.0.1 netmask 0xff000000
    inet6 ::1 prefixlen 128
    inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
    nd6 options=201<PERFORMNUD,DAD>
gif0: flags=8010<POINTOPOINT,MULTICAST> mtu 1280
stf0: flags=0<> mtu 1280
anpi0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether ba:22:96:09:db:f2
    inet6 fe80::b822:96ff:fe09:dbf2%anpi0 prefixlen 64 scopeid 0x4
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
anpi1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether ba:22:96:09:db:f3
    inet6 fe80::b822:96ff:fe09:dbf3%anpi1 prefixlen 64 scopeid 0x5
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
en3: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether ba:22:96:09:db:d2
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
en4: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether ba:22:96:09:db:d3
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
en1: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=460<TSO4,TSO6,CHANNEL_IO>
    ether 36:d4:27:ee:78:c0
    media: autoselect <full-duplex>
    status: inactive
en2: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=460<TSO4,TSO6,CHANNEL_IO>
    ether 36:d4:27:ee:78:c4
    media: autoselect <full-duplex>
    status: inactive
bridge0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=63<RXCSUM,TXCSUM,TSO4,TSO6>
    ether 36:d4:27:ee:78:c0
    Configuration:
        id 0:0:0:0:0:0 priority 0 hellotime 0 fwddelay 0
        maxage 0 holdcnt 0 proto stp maxaddr 100 timeout 1200
        root id 0:0:0:0:0:0 priority 0 ifcost 0 port 0
        ipfilter disabled flags 0x0
    member: en1 flags=3<LEARNING,DISCOVER>
            ifmaxaddr 0 port 8 priority 0 path cost 0
    member: en2 flags=3<LEARNING,DISCOVER>
            ifmaxaddr 0 port 9 priority 0 path cost 0
    nd6 options=201<PERFORMNUD,DAD>
    media: <unknown type>
    status: inactive
ap1: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 3e:a6:f6:07:c9:3b
    inet6 fe80::3ca6:f6ff:fe07:c93b%ap1 prefixlen 64 scopeid 0xb
    nd6 options=201<PERFORMNUD,DAD>
    media: autoselect (<unknown type>)
    status: inactive
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 96:68:2e:64:6d:e7
    inet6 fe80::1093:3f:b867:4508%en0 prefixlen 64 secured scopeid 0xc
    inet 192.168.2.32 netmask 0xffffff00 broadcast 192.168.2.255
    nd6 options=201<PERFORMNUD,DAD>
    media: autoselect
    status: active
awdl0: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 86:21:01:91:74:e9
    inet6 fe80::8421:1ff:fe91:74e9%awdl0 prefixlen 64 scopeid 0xd
    nd6 options=201<PERFORMNUD,DAD>
    media: autoselect
    status: active
llw0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 86:21:01:91:74:e9
    inet6 fe80::8421:1ff:fe91:74e9%llw0 prefixlen 64 scopeid 0xe
```

```
    nd6 options=201<PERFORMNUD,DAD>
    media: autoselect
    status: active
ROUTE(8)                                    System Manager's Manual                                    ROUTE(8)

NAME
     route – manually manipulate the routing tables

SYNOPSIS
     route [-dnqtv] command [[modifiers] args]

DESCRIPTION
     Route is a utility used to manually manipulate the network routing tables.  It normally is not needed, as a system
     routing table management daemon such as routed(8), should tend to this task.

     The route utility supports a limited number of general options, but a rich command language, enabling the user to specify
     any arbitrary request that could be delivered via the programmatic interface discussed in route(4).

     The following options are available:

     -d      Run in debug-only mode, i.e., do not actually modify the routing table.

     -n      Bypass attempts to print host and network names symbolically when reporting actions.  (The process of translating
             between symbolic names and numerical equivalents can be quite time consuming, and may require correct operation
             of the network; thus it may be expedient to forget this, especially when attempting to repair networking
             operations).

     -t      Run in test-only mode.  /dev/null is used instead of a socket.

     -v      (verbose) Print additional details.

     -q      Suppress all output.

     The route utility provides six commands:
utun0: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 2000
    inet6 fe80::e1c2:de38:c654:3681%utun0 prefixlen 64 scopeid 0xf
    nd6 options=201<PERFORMNUD,DAD>
utun1: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1000
    inet6 fe80::ce81:b1c:bd2c:69e%utun1 prefixlen 64 scopeid 0x10
    nd6 options=201<PERFORMNUD,DAD>
utun2: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
    inet6 fe80::c7a4:f5dd:b4eb:adca%utun2 prefixlen 64 scopeid 0x11
    nd6 options=201<PERFORMNUD,DAD>
utun3: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
    inet6 fe80::30c3:7cea:e837:f457%utun3 prefixlen 64 scopeid 0x12
    nd6 options=201<PERFORMNUD,DAD>
utun4: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
    inet6 fe80::9ee2:ef24:e2b4:10ce%utun4 prefixlen 64 scopeid 0x13
    nd6 options=201<PERFORMNUD,DAD>
❯ route
usage: route [-dnqtv] command [[modifiers] args]
❯  route --help
route: illegal option -- -
usage: route [-dnqtv] command [[modifiers] args]
❯  route -h
route: illegal option -- h
usage: route [-dnqtv] command [[modifiers] args]
❯  route help
route: bad keyword: help
usage: route [-dnqtv] command [[modifiers] args]
❯ man route
❯ hostname
suraj-m1.local
❯ ping 127.0.0.1
PING 127.0.0.1 (127.0.0.1): 56 data bytes
64 bytes from 127.0.0.1: icmp_seq=0 ttl=64 time=0.106 ms
64 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=0.131 ms
64 bytes from 127.0.0.1: icmp_seq=2 ttl=64 time=0.143 ms
64 bytes from 127.0.0.1: icmp_seq=3 ttl=64 time=0.128 ms
64 bytes from 127.0.0.1: icmp_seq=4 ttl=64 time=0.254 ms
^C
--- 127.0.0.1 ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 0.106/0.152/0.254/0.052 ms
surajmandal@suraj-m1 ~/Desktop/humber/5002-sdn/lab1/test master*                                    4.97s
❯
```