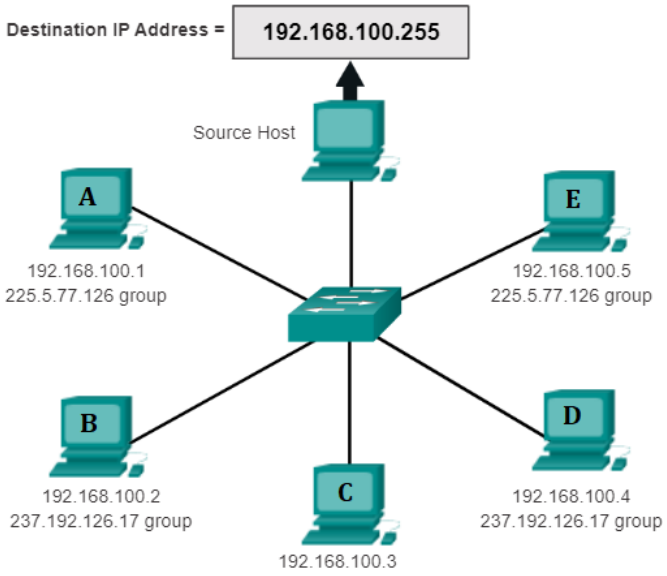
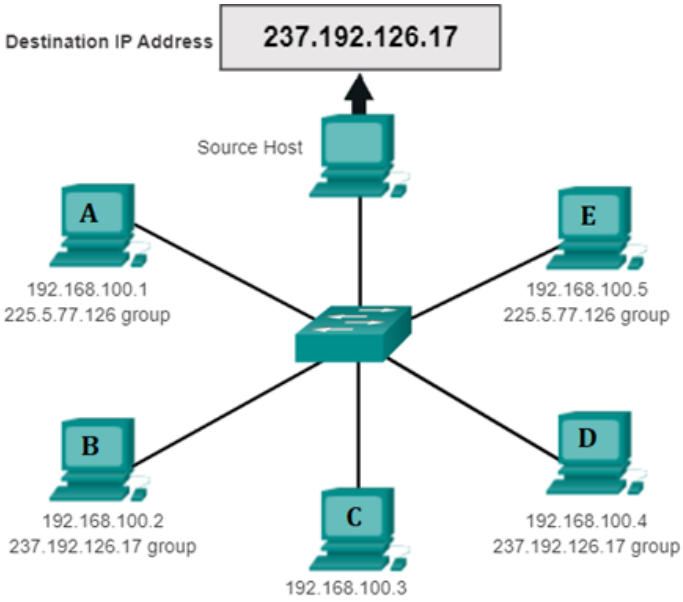
Tutorial 1: IPv4 Addressing and Subnetting

Q1. Which host(s) will receive a packet based on the address type (unicast/multicast/broadcast) given in the destination IP address?



(a) Broadcast; all



(b) Multicast; B,D

Q2. a) Identify IPv4 Addresses:

Analyze the table below and list the range of host and broadcast addresses given a network/prefix mask pair.

The first row shows an example of how the table should be completed.

IP Address/Prefix	First Host Address	Last Host Address	Broadcast Address
192.168.10.10/24	192.168.10.1	192.168.10.254	192.168.10.255
10.101.99.17/23	10.101.98.1	10.101.99.254	10.101.99.255
209.165.200.227/27	209.165.200.225	209.165.200.254	209.165.200.255
172.31.45.252/24	172.31.45.1	172.31.45.254	172.31.45.255
10.1.8.200/26	10.1.8.193	10.1.8.254	10.1.8.255
172.16.117.77/20	172.16.112.1	172.16.127.254	172.16.127.255
10.1.1.101/25	10.1.1.1	10.1.1.126	10.1.1.127
209.165.202.140/27	209.165.202.129	209.165.202.158	209.165.202.159
192.168.28.45/28	192.168.28.33	192.168.28.46	192.168.28.47

Solution: Find out the network address first by ANDing IP address and subnet mask. Then finding the first address is easy. Then find out the broadcast address and find the last host address.

IP Address in decimal	10	101	99	17/23
IP Address in binary	00001010	01100101	01100011	00010001
Subnet Mask in decimal	255	255	254	0
Subnet Mask in binary	11111111	11111111	11111110	0
Network Address (by ANDing) in binary	00001010	01100101	01100010	00000000
Network Address in decimal	10	101	98	0
First Host Address	10	101	98	1
Broadcast address	00001010	01100101	01100011	11111111
Broadcast address in decimal	10	101	99	255
Last Host Address	10	101	99	254

11111110 = 254
11111100 = 252
11111000 = 248
11110000 = 240
11100000 = 224
11000000 = 192
10000000 = 128

b) Classify IPv4 Addresses

Step 1: Analyze the table shown below and identify the type of address (network, host, multicast, or broadcast address).

The first row shows an example of how the table should be completed.

IP Address	Subnet Mask	Address Type
10.1.1.1	255.255.255.252	host
192.168.33.63 192.168.33. 00111111	255.255.255.192 255.255.255.11000000	broadcast
239.192.1.100	255.252.0.0	multicast
172.25.12.52	255.255.255.0	host
10.255.0.0	255.0.0.0	host
172.16.128.48 172.16.128.110000	255.255.255.240 255.255.255.11110000	Network
209.165.202.159 209.165.202. 10011111	255.255.255.224 255.255.255.11100000	broadcast
172.16.0.255	255.255.0.0	host
224.10.1.11	255.255.255.0	multicast

Step 2: Analyze the table shown below and identify the address as public or private.

IP Address/Prefix	Public or Private
209.165.201.30/27	Public
192.168.255.253/24	Private
10.100.11.103/16	Private
172.30.1.100/28	Private
192.31.7.11/24	Public
172.20.18.150/22	Private
128.107.10.1/16	Public
192.135.250.10/24	Public
64.104.0.11/16	Public

Private:

- **10.0.0.0 to 10.255.255.255 (10.0.0.0/8)**
- **172.16.0.0 to 172.31.255.255 (172.16.0.0/12)**
- **192.168.0.0 to 192.168.255.255 (192.168.0.0/16)**

Step 3: Analyze the table shown below and identify whether the address/prefix pair is a valid host address.

IP Address/Prefix	Valid Host Address?	Reason
127.1.0.10/24	**No**	**Loopback**
172.16.255.0/16	Yes	Host address
241.19.10.100/24	**No**	**Reserved**
192.168.0.254/24	Yes	Host address
192.31.7.255/24	No	Broadcast
64.102.255.255/14 64. 01100110.255.255	Yes	Host address
224.0.0.5/16	**No**	**Multicast**
10.0.255.255/8	Yes	Host address
198.133.219.8/24	Yes	Host address

- **Network and Broadcast addresses – within each network the first and last addresses cannot be assigned to hosts**
- **Loopback address – 127.0.0.1 a special address that hosts use to direct traffic to themselves (addresses 127.0.0.0 to 127.255.255.255 are reserved)**
- **Link-Local address – 169.254.0.0 to 169.254.255.255 (169.254.0.0/16) addresses can be automatically assigned to the local host**
- **TEST-NET addresses – 192.0.2.0 to 192.0.2.255 (192.0.2.0/24) set aside for teaching and learning purposes, used in documentation and network examples**
- **Experimental addresses – 240.0.0.0 to 255.255.255.254 are listed as reserved for future use. Currently using for research and experimental use.**
- **Reserved for addressing multicast groups – 224.0.0.0 to 239.255.255.255.**

Q3. How many possible networks are possible using Class B addresses? How many valid hosts are possible in each network?

Networks, 2^{14} = 16,384
Valid hosts per network, 2^{16} - 2 = 65,534

IP Address Classes

Address Class	1st octet range (decimal)	1st octet bits (green bits do not change)	Network(N) and Host(H) parts of address	Default subnet mask (decimal and binary)	Number of possible networks and hosts per network
A	1-127**	00000000-01111111	N.H.H.H	255.0.0.0	128 nets (2^7) 16,777,214 hosts per net (2^24-2)
B	128-191	10000000-10111111	N.N.H.H	255.255.0.0	16,384 nets (2^14) 65,534 hosts per net (2^16-2)
C	192-223	11000000-11011111	N.N.N.H	255.255.255.0	2,097,150 nets (2^21) 254 hosts per net (2^8-2)
D	224-239	11100000-11101111	NA (multicast)		
E	240-255	11110000-11111111	NA (experimental)		

Q4. Rewrite the IPv6 addresses with no leading zeros and compressed version.

Preferred	FE80:0000:0000:0000:0123:4567:89AB:DFEE
No leading zeros	**FE80:0:0:0:123:4567:89AB:DFEE**
Compressed	**FE80::123:4567:89AB:DFEE**
Preferred	FF02:0000:0000:0000:0000:0001:FF00:0200
No leading zeros	**FF02:0:0:0:0:1::FF00:200**
Compressed	**FF02::1:FF00:200**
Preferred	0000:0000:0000:0000:0000:0000:0000:0001
No leading zeros	**0:0:0:0:0:0:0:1**
Compressed	**::1**

Q5. Fill up the following table:

Hosts Needed	Subnet Mask (Binary)	Subnet Mask (Decimal)	Prefix Notation (/x)
250	11111111.11111111.11111111.00000000	255.255.255.0	/24
25	**11111111.11111111.11111111.11100000**	**255.255.255.224**	**/27**
1000	**11111111.11111111.11111100.00000000**	**255.255.252.0**	**/22**
75	**11111111.11111111.11111111.10000000**	**255.255.255.128**	**/25**
10	**11111111.11111111.11111111.11110000**	**255.255.255.240**	**/28**
500	**11111111.11111111.11111110.00000000**	**255.255.254.0**	**/23**

250 = 2^8 – 2 = 254

25 = 2^5 -2 = 30

1000 = 2^{10}-2 = 1024-2 = 1022

2^1 = 2
2^2 = 4
2^3 = 8
2^4 = 16
2^5 = 32
2^6 = 64
2^7 = 128
2^8 = 256
2^9 = 512
2^{10} = 1024

11111110 = 254
11111100 = 252
11111000 = 248
11110000 = 240
11100000 = 224
11000000 = 192
10000000 = 128

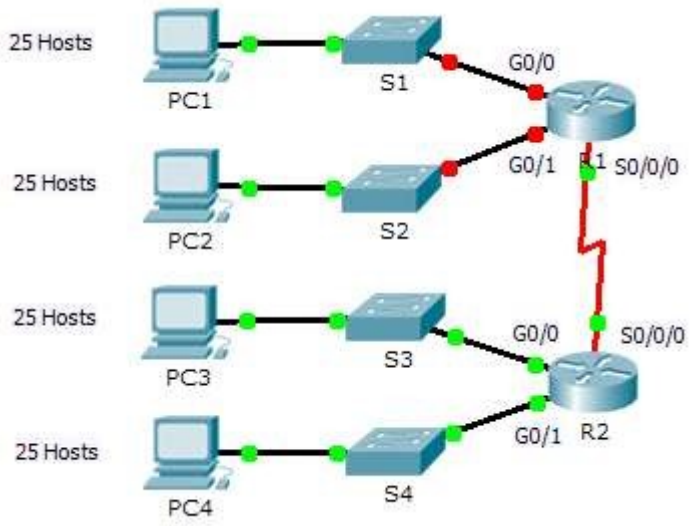
Q6. Fill up the following table:

Network Address	192	168	26	98
Subnet Mask	255	255	255	128
Network Address in Binary	11000000	10101000	00011010	01100010
Subnet Mask in Binary	11111111	11111111	11111111	10000000
Number of valid Hosts	**2^n - 2 = 2^7 – 2 = 128-2 = 126**			

Q7. Fill up the following table:

Network Address	192	168	13	64
Subnet Mask in decimal	255	255	255	224
Network Address in Binary	11000000	10101000	00001101	01000000
Subnet Mask in Binary	11111111	11111111	11111111	11100000
First usable Host IP address in decimal	192	168	13	65
Last usable Host IP address in decimal	192	168	13	01011110=94
Broadcast address in decimal	192	168	13	01011111=95
Next Network address in decimal	192	168	13	01111111=96

Q8. Design an IP Addressing Scheme for the following topology (using traditional Subnetting scheme).



Step 1: Subnet the 192.168.100.0/24 network into the appropriate number of subnets.

a. Based on the topology, how many subnets are needed? **5**

b. How many bits must be borrowed to support the number of subnets in the topology table? **3 bits**

c. How many subnets does this create? **2^3 = 8 Subnets**

d. How many usable hosts does this create per subnet? **2^5 -2 = 30 hosts**

e. Calculate the binary value for the first five subnets. The first subnet is already shown.

Net 0: 192. 168. 100. 0. 0. 0. 0. 0. 0. 0

Net 1: 192. 168. 100. **0. 0. 1. 0. 0. 0. 0. 0**

Net 2: 192. 168. 100. **0. 1. 0. 0. 0. 0. 0. 0**

Net 3: 192. 168. 100. **0. 1. 1. 0. 0. 0. 0. 0**

Net 4: 192. 168. 100. **1. 0. 0. 0. 0. 0. 0. 0**

f. Calculate the binary and decimal value of the new subnet mask.

11111111.11111111.11111111. **11100000**

255. 255. 255. **224**

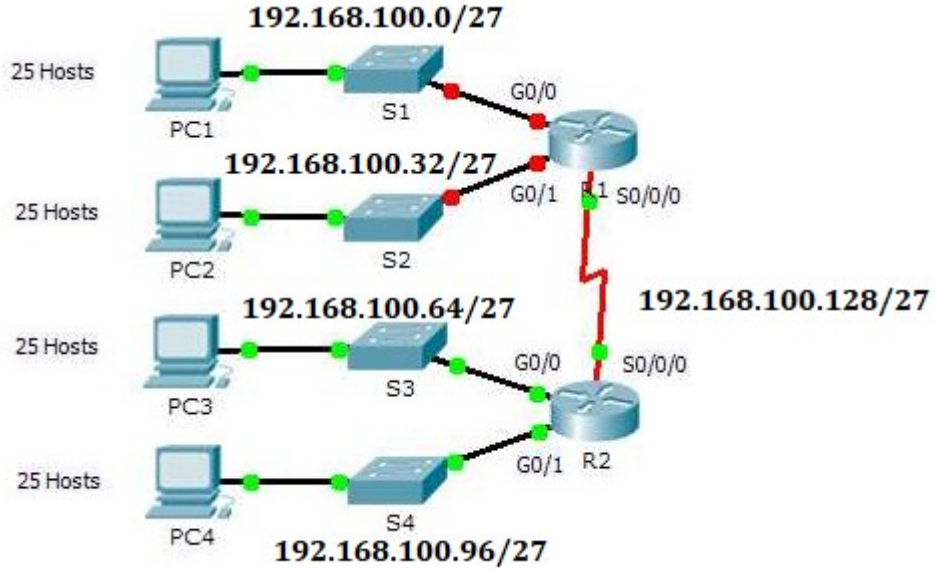
g. Fill in the **Subnet Table**, listing the decimal value of all available subnets, the first and last usable host address, and the broadcast address. Repeat until all addresses are listed.

Subnet Table

Subnet Number	Subnet Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
0	**192.168.100.0**	**192.168.100.1**	**192.168.100.30**	**192.168.100.31**
1	**192.168.100.32**	**192.168.100.33**	**192.168.100.62**	**192.168.100.63**
2	**192.168.100.64**	**192.168.100.65**	**192.168.100.94**	**192.168.100.95**
3	**192.168.100.96**	**192.168.100.97**	**192.168.100.126**	**192.168.100.127**
4	**192.168.100.128**	**192.168.100.129**	**192.168.100.158**	**192.168.100.159**
5	**192.168.100.160**	**192.168.100.161**	**192.168.100.190**	**192.168.100.191**
6	**192.168.100.192**	**192.168.100.193**	**192.168.100.222**	**192.168.100.223**
7	**192.168.100.224**	**192.168.100.225**	**192.168.100.254**	**192.168.100.255**
8				
9				
10				

Step 2: Assign the subnets to the network shown in the topology.

a. Assign Subnet 0 to the LAN connected to the GigabitEthernet 0/0 interface of R1:
192.168.100.0 /27
b. Assign Subnet 1 to the LAN connected to the GigabitEthernet 0/1 interface of R1:
192.168.100.32 /27
c. Assign Subnet 2 to the LAN connected to the GigabitEthernet 0/0 interface of R2:
192.168.100.64 /27
d. Assign Subnet 3 to the LAN connected to the GigabitEthernet 0/1 interface of R2:
192.168.100.96 /27
e. Assign Subnet 4 to the WAN link between R1 to R2: 192.168.100.128 /27



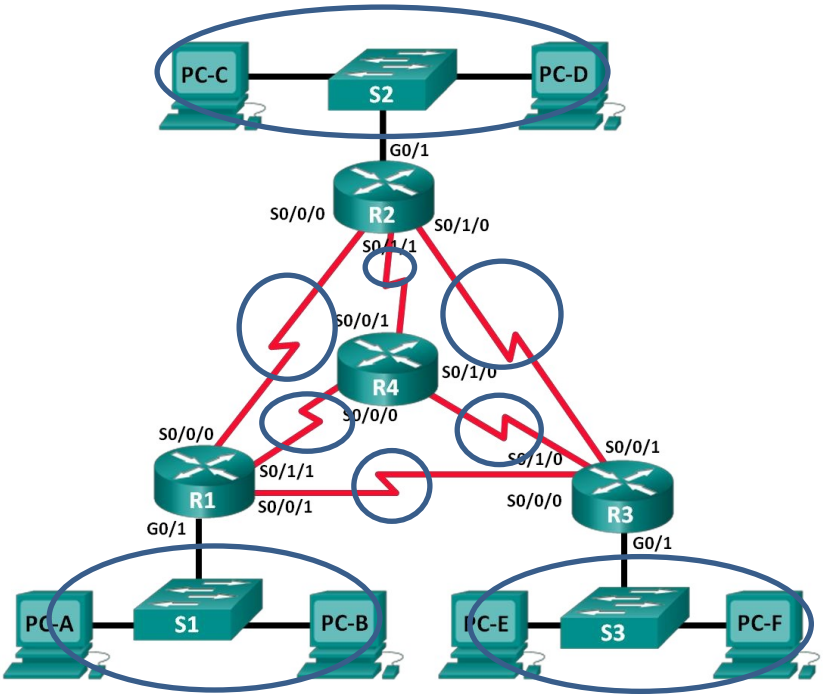
Step 3: Document the addressing scheme.

Fill in the **Addressing Table** using the following guidelines:
a. Assign the first usable IP addresses to R1 for the two LAN links and the WAN link.
b. Assign the first usable IP addresses to R2 for the LANs links. Assign the last usable IP address for the WAN link.
c. Assign the second usable IP addresses to the switches.
d. Assign the last usable IP addresses to the hosts.

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0	192.168.100.1	255.255.255.224	N/A
	G0/1	192.168.100.33	255.255.255.224	N/A
	S0/0/0	192.168.100.129	255.255.255.224	N/A
R2	G0/0	192.168.100.65	255.255.255.224	N/A
	G0/1	192.168.100.97	255.255.255.224	N/A
	S0/0/0	192.168.100.130/ 192.168.100.158	255.255.255.224	N/A
S1	VLAN 1	192.168.100.2	255.255.255.224	192.168.100.1
S2	VLAN 1	192.168.100.34	255.255.255.224	192.168.100.33
S3	VLAN 1	192.168.100.66	255.255.255.224	192.168.100.65
S4	VLAN 1	192.168.100.98	255.255.255.224	192.168.100.97
PC1	NIC	192.168.100.30	255.255.255.224	192.168.100.1
PC2	NIC	192.168.100.62	255.255.255.224	192.168.100.33
PC3	NIC	192.168.100.94	255.255.255.224	192.168.100.65
PC4	NIC	192.168.100.126	255.255.255.224	192.168.100.97

Q9. You have been given the 192.168.10.0/24 network address to subnet, with the following topology. Determine the number of networks needed and then design an appropriate addressing scheme.



Determine the number of subnets in the above Network Topology.

a. How many subnets are there? **9**

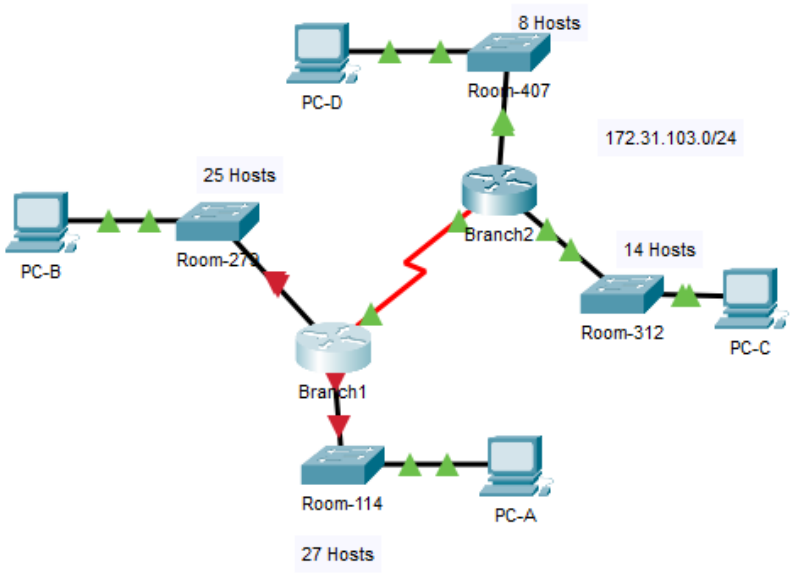
b. How many bits should you borrow to create the required number of subnets? **4**

c. How many usable host addresses per subnet are in this addressing scheme? **14**

d. What is the new subnet mask in dotted decimal format? **255.255.255.240 (255.255.255.11110000)**

e. How many subnets are available for future use? **7**

Q10. Design a VLSM Addressing Scheme for the following topology.



Step 1: Determine the number of subnets needed.

You will subnet the network address 172.31.103.0/24. The network has the following requirements:
a. PC-A LAN will require __27___host IP addresses:
b. PC-B LAN will require __25___host IP addresses:
c. PC-C LAN will require __14___host IP addresses:
d. PC-D LAN will require ___8___host IP addresses:
e. How many subnets are needed in the network topology? 5

Step 2: Fill up the following Subnet Table:

Subnet Description	Number of Hosts Needed	Network Address/CIDR	First Usable Host Address	Last Usable Host Address	Broadcast Address
PC-A LAN	27	172.31.103.0/27	172.31.103.1	172.31.103.30	172.31.103.31
PC-B LAN	25	172.31.103.32/27	172.31.103.33	172.31.103.62	172.31.103.63
PC-C LAN	14	172.31.103.64/28	172.31.103.65	172.31.103.78	172.31.103.79
PC-D LAN	8	172.31.103.80/28	172.31.103.81	172.31.103.94	172.31.103.95
WAN Link	2	172.31.103.96/30	172.31.103.97	172.31.103.98	172.31.103.99

Step 3: Fill up the following Address Table:

Device	Interface	Address	Subnet Mask	Default Gateway
Branch1	G0/0	172.31.103.1	255.255.255.224	N/A
	G0/1	172.31.103.33	255.255.255.224	N/A
	S0/0/0	172.31.103.97	255.255.255.252	N/A
Branch2	G0/0	172.31.103.65	255.255.255.240	N/A
	G0/1	172.31.103.81	255.255.255.240	N/A
	S0/0/0	172.31.103.98	255.255.255.252	N/A
Room-114	VLAN 1	172.31.103.2	255.255.255.224	172.31.103.1
Room-279	VLAN 1	172.31.103.34	255.255.255.224	172.31.103.33
Room-312	VLAN 1	172.31.103.66	255.255.255.240	172.31.103.65
Room-407	VLAN 1	172.31.103.82	255.255.255.240	172.31.103.81
PC-A	NIC	172.31.103.30	255.255.255.224	172.31.103.1
PC-B	NIC	172.31.103.62	255.255.255.224	172.31.103.33
PC-C	NIC	172.31.103.78	255.255.255.240	172.31.103.65
PC-D	NIC	172.31.103.94	255.255.255.240	172.31.103.81