1. Give the network id and host id of the following IPv4 address: a) 56.89.34.25 b) 165.25.242.8 c)212.115.65.24 d) 227.54.68.26 e) 249.84.69.54

   Ans. a) 56.89.34.25 Network id 56, Host id: 89.34.25 (CLASS A)

   b) 165.25.242.8 Network id 165.25, Host id: 242.8 (CLASS B)

   c)212.115.65.24 Network id 212.115.65, Host id: 24 (CLASS C)

   d) 227.54.68.26 In Class D, an IP address is reserved for multicast addresses. It does not possess subnetting. Class D IP addresses are not allocated to hosts and are used for multicasting. Multicasting allows a single host to send a single stream of data to thousands of hosts across the Internet at the same time. It is often used for audio and video streaming, such as IP-based cable TV networks. Another example is the delivery of real-time stock market data from one source to many brokerage companies.

   e) 249.84.69.54 This class is reserved for research and Development Purposes. (CLASS E)

2. If a class B network on the Internet has a subnet mask of 255.255.240.0, what is the maximum number of hosts per subnet.

   Ans. The 'subnet mask 255.255.240.0' has binary representation as, '11111111 11111111 11110000 00000000'. Here in this '20 bits' set in the subnet. So (32-20) = 12 bits are taken for host ids.

   Hence, the 'Total possible values of host ids' are '2^{12} = '4096'. Out of these '4096' values, two 'addresses' are reserved. The 'address' with all 'bits as 1' is reserved as 'broadcast address' and 'address' with all 'host' id bits as '0' is used as the subnet network address.

   The number of 'addresses' usable for 'addressing' specific 'hosts in each network' is always '$2^N - 2$' where N is the 'number of bits for host id'.

   In our 'case for subnet mask 255.255.240.0', number of hosts is '$2^N - 2$' = '$2^{12} - 2$' = '4096 - 2 = 4094'.

3. Given an IP address 211.25.38.26. Find the network ID, 5th host ID, last host ID and broadcast ID of the given network.

   Ans. 211.25.38.26, It is belonging to class C and its n value is 24.

   The binary representation of the given address is.

         11010011   00011001   00100110   00011010

   The first address in the block can be found by setting the rightmost 32 – n bits to 0s.

   If we set 32–24 rightmost bits to 0, we get,

         11010011   00011001   00100110   00000000 or 211.25.38.0

   The last address (broadcast ID) in the block can be found by setting the rightmost 32 – n bits to 1s.

   If we set 32–24 rightmost bits to 1, we get,

         11010011   00011001   00100110   11111111 or 211.25.38.255

   5th host ID, 211.25.38.5

   last host ID, 211.25.38.254

   network ID, 211.25.38.0

   broadcast ID, 211.25.38.255

4. Using fixed length subnetting divide the given network 196.220.84.32 into two parts. Give the first host ID, Last host ID, Subnet mask and the number of hosts connected.

   Ans. Clearly, the given network belongs to class C.

   We have a big single network having IP Address 196.220.84.32

   Network mask is 255.255.255.0

   Binary representation is 11000100 11011100 01010100 00100000

   For creating two subnets and to represent their subnet IDs, we require 1 bit. So, we borrow one bit from the Host ID part. After borrowing one bit, Host ID part remains with only 7 bits.

11000100.11011100.01010100.**0/1 (host id)**
If borrowed bit = 0, then it represents the first subnet.
If borrowed bit = 1, then it represents the second subnet.
IP Address of the two subnets are-

196.220.84.00000000 = 196.220.84.0
196.220.84.10000000 = 196.220.84.128
For 1st Subnet-
 First subnet n1=25
IP Address of the subnet1 = 196.220.84.0/25
Total number of IP Addresses = 2^7 = 128
Total number of hosts that can be configured = 128 – 2 = 126
Range of IP Addresses = [196.220.84.00000000, 196.220.84.01111111] = [196.220.84.0, 196.220.84.127]
Direct Broadcast Address = 196.220.84.01111111 = 196.220.84.127
Subnet1 mask = 255.255.255.128
first host ID: 196.220.84.1
Last host ID: 196.220.84.126
For 2nd Subnet-
First subnet n2=25
IP Address of the subnet2 = 196.220.84.128/25
Total number of IP Addresses = 2^7 = 128
Total number of hosts that can be configured = 128 – 2 = 126
Range of IP Addresses = [196.220.84.10000000, 196.220.84.11111111] = [196.220.84.128, 196.220.84.125]
Direct Broadcast Address = 196.220.84.11111111 = 196.220.84.255
Subnet2 mask = 255.255.255.128
first host ID: 196.220.84.129
Last host ID: 196.220.84.254

5. Find the network address, first host address, last host address, default mask for the following ip address 1)110.56.28.55 2) 142.120.48.23 3) 206.156.36.84
   Ans. 1)110.56.28.55 it is coming under CLASS A, DEFAULT MASK 255.0.0.0, first host address is 110.0.0.1, last host address 110.255.255.254, network address 110.0.0.0
   2) 142.120.48.23 it is coming under CLASS B, DEFAULT MASK 255.255.0.0, first host address is 142.120.0.1, last host address 142.120.255.254, network address 142.120.0.0
   3) 206.156.36.84 it is coming under CLASS C, DEFAULT MASK 255.255.255.0, first host address is 206.156.36.1, last host address 206.156.36.254, network address 206.156.36.0
6. Divide the network using variable length subnetting (2 subnets) for the network 192.10.25.130/26 give the first host ID, last host ID, Subnet mask and network address.
   Ans. We have a big single network having IP Address 192.10.25.130
   Net mask is 255.255.255.192
   Binary representation is 11000000 00001010 00011001 10000010
   For creating two subnets and to represent their subnet IDs, we require 1 bit.
   So, we borrow one bit from the Host ID part.
   After borrowing one bit, Host ID part remains with only 5 bits.
   11000000 00001010 00011001 10 **0/1 (host id)**
   If borrowed bit = 0, then it represents the first subnet.
   If borrowed bit = 1, then it represents the second subnet.

Network (IP) Address of the two subnets is-

192.10.25.10000000 = 192.10.25.128
192.10.25.10100000 = 192.10.25.160

For 1st Subnet-
First subnet n1=27
IP Address of the subnet = 192.10.25.128/27
Total number of IP Addresses = 2^5 = 32
Total number of hosts that can be configured = 32 − 2 = 30
Range of IP Addresses = [192.10.25.10000000, 192.10.25.10011111] = [192.10.25.128, 192.10.25.159]
Direct Broadcast Address = 192.10.25.10011111= 192.10.25.159
Subnet1 mask= 255.255.255.224
first host ID: 192.10.25.129
Last host ID: 192.10.25.158
For 2nd Subnet-
Second subnet n2=27
IP Address of the subnet = 192.10.25.160/27
Total number of IP Addresses = 2^5 = 32
Total number of hosts that can be configured = 32 − 2 = 30
Range of IP Addresses = [192.10.25.10100000, 192.10.25.10111111] = [192.10.25.160, 192.10.25.191]
Direct Broadcast Address = 192.10.25.10111111= 192.10.25.191
Subnet2 mask=255.255.255.224
first host ID: 192.10.25.161
Last host ID: 192.10.25.190

7. The subnet mask of a particular network is 255.255.31.0 which of the following pairs of the IP address could belong to this network a) 172.57.88.62 and 172.56.87.233 b) 10.35.28.2 and 10.25.29.2 c) 191.203.31.87 and 191.234.31.88 d) 128.8 129.43 and 128.8.161.55. Justify your answer.

Ans. The set bits of a subnet mask indicate the network bits and the unset bits indicate the host bits for an IP address in that network.

Here the subnet mask = 11111111 11111111 00011111 00000000.

The first two octet and the last 5 bits of the 3rd octet give us the network bits of any IP address in that network. For two IP addresses belonging to the same network these specific bits should match. So, in the options the first 2 octet and the last 5 bits of the 3rd octet of both the IP addresses should match.

In options A. and C., the addresses clearly have different 2nd octet.

In option B., the first IP address has an even 3rd octet, and the second IP address has an odd 3rd octet, so they differ in the last bit of the 3rd octet. Hence, they are from different networks.

In option D., the first two octet match. 129= $(1000\ 0001)_2$ and 161= $(1010\ 0001)_2$, so the last 5 bits of their 3rd octet also match. Hence, they belong to the same network.

∴ D. is the answer.

Or (Another method)

Suppose we have a host A with IP Address IP_A and Subnet mask of the subnet of which A is a part is M_s. Now when A wants to send packet to a host B with an IP address say IP_B, then A will first AND the subnet-Mask M_s with IP_A to find out the subnet-id IDN of the subnet to identify whether IP_B belongs to the same network. Now if B also belongs to the same network, then IP_B BITWISE-AND M_s must be equal to IDN which A has calculated. If IP_A and IP_B belongs to same network, we must have IP_A BITWISE-AND M_s == IP_B BITWISE-AND M_s

Out of the 4 options, only option D matches.

128.8.129.43 BITWISE-AND 255.255.31.0 = 128.8.1.0

128.8.161.55 BITWISE-AND 255.255.31.0 = 128.8.1.0

∴ D. is the answer.

8. Given an IP address 192.168.12.56 Give the following. 1. Network address 2. Default mask 3.1st host ID 4. Last host ID 5. Broadcast address.

Ans. Given IP Address is 192. 168.12.56

Binary representation is 11000000 10101000 00001100 00111000

Total number of IP Addresses possible are 2^8 = 256

Total number of hosts that can be configured = 256– 2 = 254

Network address: 192.168.12.0

Default mask: 255.255.255.0

1st host ID: 192.168.12.0

Last host ID: 192.168.12.254

Broadcast address: 192.168.12.255

9. An Internet Service Provider (ISP) has the following chunk of CIDR-based IP addresses available with it:245.248.128.0/20. The ISP wants to give half of this chunk of addresses to Organization A, and a quarter to Organization B, while retaining the remaining with itself. Which of the following is a valid allocation of addresses to A and B? a) 245.248.136.0/21 & 245.248.128.0/22 b) 245.248.128.0/21 & 245.248.128.0/22 c)245.248.132.0/22 & 245.248.132.0/21 d) 245.248.136.0/22 & 245.248.132.0/21 justify your answer?

Ans. IP addresses available with it:245.248.128.0/20, Net id 20 bits and host id 12 bits

Binary representation is 11110101 11111000 10000000 00000000

Total number of IP Addresses = 2^{12} = 4096

Out of these 2^{12} addresses, half (or 2^{11}) addresses must be given to organization A and quarter (2^{10}) addresses must be given to organization B. So, routing prefix for organization A will be 21. For B, it will be 22.

ORGANIZATION A:

If we fix the 21st bit as 0.

11110101. 11111000. 10000000 . 00000000

NID   HID

245.248.128.0/ 21

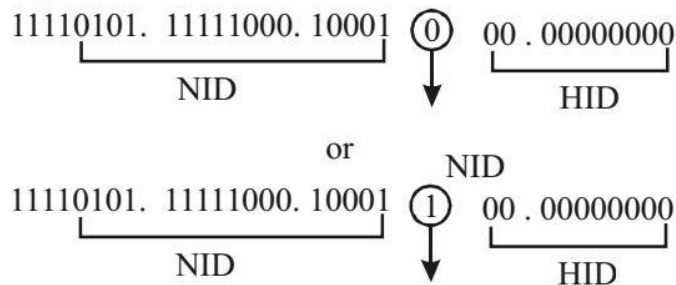11110101. 11111000. 10001000 . 0000000

NID   HID

For organization A in bit 21st, now take 1

⇒ 245.248.136.0/ 21

Organization B:

NID = 11110101 11111000 10000000 00000000. So, for B network ID will be.

CASE A: If we fix for organization A, 21st bit as 1

11110101. 11111000. 10001 ⓪ 00 . 00000000

NID   HID

or   NID

11110101. 11111000. 10001 ① 00 . 00000000

NID   HID

So, bit number 22 could be 0 or 1.

⇒ 245.248.136.0/ 22 or ⇒ 245.248.140.0/ 22.

CASE B: If we fix for organization A, 21st bit as 0.

So, bit number 22 could be 0 or 1.

⇒ 245.248.128.0/ 22 or ⇒ 245.248.132.0/ 22.

Conclusion: Since half of 4096 host addresses must be given to organization A, we can set 21st bit to 1 and include that bit into network part of organization A, so the valid allocation of addresses to A is 245 .248.136.0/21.

Now for organization B, 21st bit is set to '0 ' but since we need only half of 2048 addresses, 22nd bit can be set to '0 ' and include that bit into network part of organization B so the valid allocation of addresses to B is 245 .248.128 .0/22.

So, answer is B, 245.248.136.0/21 and 245.248.128.0/22.