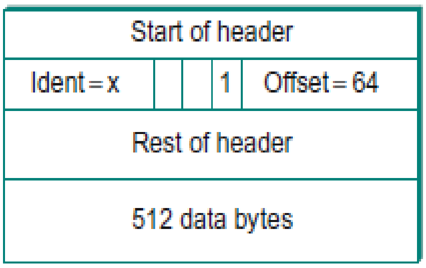
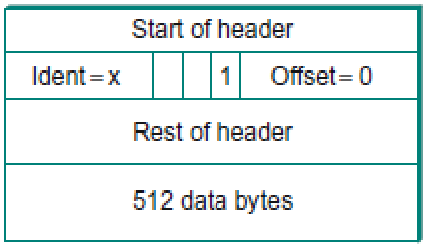
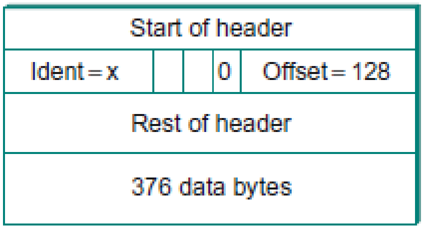
Fragmentation:

Q1: Suppose the fragments of the given Scenario, all pass through another router onto a link with an MTU of 380 bytes, not counting the link header. Show the fragments produced. If the packet(1400bytes+20-byte) were originally fragmented for this MTU, how many fragments would be produced?
Scenario: The packet with 1400 bytes of data and a 20-byte IP header, arrives at router which has an MTU of 532 bytes, hence the packet will be fragmented, into three fragments.
[Indicate the flags, offset, total bytes in each fragment etc., for given question and the scenario discussed]

Ans: For the given scenario, the resulting fragments are,-







-3marks

These fragments further will be fragmented as below:

M	offset	bytes data	source
1	0	360	1st original fragment
1	360	152	1st original fragment
1	512	360	2nd original fragment
1	872	152	2nd original fragment
1	1024	360	3rd original fragment
0	1384	16	3rd original fragment

-5marks

If fragmentation had been done originally for this MTU, there would be four fragments. The first three would have 360 bytes each; the last would have 320 bytes. -2marks

Q2: Consider sending a 5000 byte datagram(including the IP header) into a link that has an MTU of 300 bytes. How many fragments are generated assuming that no optional fields of the IP header are in use? What are their characteristics (i.e. Indicate the flags and offset values for each fragment, Consider the ID of the original packet is 'x').

Ans:

- Assume that the DF flag was not set
- Assume that no optional fields of the IP header are in use (i.e. IP header is 20 bytes)
- The original datagram was 5000 bytes, subtracting 20 bytes for header, that leaves 4980 bytes of data.

- Assume the ID of the original packet is 'x'
- With an MTU of 300 bytes, 300 - 20 = 280 bytes of data may be transmitted in each packet
- Therefore, (4980 / 280) = 18 packets are needed to carry the data. **– 2marks**
- The packets will have the following characteristics
  Packet 1: ID=x, Total_len=300, MF=1, Frag_offset=0
  Packet 2: ID=x, Total_len=300, MF=1, Frag_offset= 35
  Packet 3: ID=x, Total_len=300, MF=1, Frag_offset=70
  Packet 4: ID=x, Total_len=300, MF=1, Frag_offset=105
  Packet 5: ID=x, Total_len=300, MF=1, Frag_offset=140
  Packet 6: ID=x, Total_len=300, MF=1, Frag_offset=175
  Packet 7: ID=x, Total_len=300, MF=0, Frag_offset=210
  Packet 8: ID=x, Total_len=300, MF=0, Frag_offset=245
  Packet 9: ID=x, Total_len=300, MF=0, Frag_offset=280
  Packet 10: ID=x, Total_len=300, MF=0, Frag_offset=315
  Packet 11: ID=x, Total_len=300, MF=0, Frag_offset=350
  Packet 12: ID=x, Total_len=300, MF=0, Frag_offset=385
  Packet 13: ID=x, Total_len=300, MF=0, Frag_offset=420
  Packet 14: ID=x, Total_len=300, MF=0, Frag_offset=455
  Packet 15: ID=x, Total_len=300, MF=0, Frag_offset=490
  Packet 16: ID=x, Total_len=300, MF=0, Frag_offset=525
  Packet 17: ID=x, Total_len=300, MF=0, Frag_offset=560

  Packet 18: ID=x, Total_len=240, MF=0, Frag_offset=595 **-3 marks**

Delay and Bandwidth:

Q3: Suppose a 1-Gbps point-to-point link is being set up between the Earth and a new lunar colony. The distance from the moon to the Earth is approximately 385,000 km, and data travels over the link at the speed of light—3×10^8 m/s.
(a) Calculate the minimum RTT for the link.
(b) Using the RTT as the delay, calculate the delay × bandwidth product for the link.
(c) What is the significance of the delay × bandwidth product computed in (b)?
Ans: (a) The minimum RTT is 2 × 385, 000, 000m / 3×10^8m/s = 2.57 seconds.
(b) The delay×bandwidth product is 2.57s×1Gbps = 2.57Gb = 321 MB.
(c) This represents the amount of data the sender can send before it would be possible to receive a response.

Q4: How wide is each bit on a 2-Mbps link?
Ans: 1/bandwidth i.e., 1/2Mbps=0.5µs.

IPv6 Addressing:

Q5: Write the shortest form of the IPv6 addresses given in (i) and (ii), and determine whether the address notations in (iii)-(v) are correct :

(i)	2340:1ABC:119A:A000:0000:0000:0000:0000
(ii)	0000:00AA:0000:0000:0000:0000:119A:A231
(iii)	::4BA8:95CC::DB97:4EAB
(iv)	::00FF:128.112.92.116
(v)	74DC::02BA

Ans:

(i)	2340:1ABC:119A:A000::
(ii)	0000:00AA::119A:A231
(iii)	Incorrect
(iv)	Correct
(v)	Correct

Addressing:

Q6: Convert the IP address whose hexadecimal representation is C0290614 to dotted decimal notation.
Ans: 192.41.6.20

Q7: Give the broadcast address for a Class B network with ID172.16.0.0 using the default subnet mask?
Ans: 172.16.255.255

Q8: If a class C network address 211.1.1.0 is allocated to a network that uses the default subnet mask for this class. What is the default subnet mask and how many hosts can the network have?
Ans: *Default subnet maskis 255.255.255.0* ***- 1 Mark***
Class C address has 8 bit for host which will give 28-2=254 hosts. ***- 1 Mark***

Subnetting/Supernetting:

Q9: An ISP is granted a block of addresses starting with 190.100.0.0/16. If the ISP needs to distribute these addresses to 64 customers each require 256 addresses, design the sub blocks indicating the range and the prefix length and the total addresses assigned.

Ans: Starting address at 190.100.0.0/16, each require 256 addresses.
8 bits to represent 256, therefore 32-8 = 24 is the prefix.-1mark
Customer1 - 190.100.0.0/24 to 190.100.0.255/24
Customer2 - 190.100.1.0/24 to 190.100.1.255/24
Customer3 - 190.100.2.0/24 to 190.100.2.255/24
.
.
.
Customer64 - 190.100.63.0/24 to 190.100.63.255/24

-4marks

Hence 64 customers with 256 addresses each, 64*256 = 16384 addresses are assigned. -1mark

Q10: Provide CIDR notation for the IP address 222.1.1.20 with mask 255.255.255.192.
Ans: *CIDR notation – 222.1.1.20/26*

Q11: Assuming that a block of addresses granted to an organization is 205.16.37.39/28, determine the first and last address in this block. Determine the total number of addresses in this block.
Ans: First address – set 32-28 rightmost bits to zero – 205.16.37.32 ***- 1 Mark***
Last address – set 32-28 rightmost bits to all ones – 205.16.37.47 ***- 1 Mark***
Total number of addresses in this block – 2^32-n i.e., 2^32-28 = 2^4 = 16

- 2 Marks

The subnet mask 28 means that the first 28 bits of the IP address represent the network portion, and the remaining 4 bits are available for host addresses.

Converting the subnet mask 28 to binary results in 32 bits with the first 28 bits set to 1 and the last 4 bits set to 0:

11111111.11111111.11111111.11110000

To calculate the first address, we perform a logical AND operation between the given address (205.16.37.39) and the subnet mask:

Address: 11001101.00010000.00100101.00100111

Subnet Mask: 11111111.11111111.11111111.11110000

AND Operation: 11001101.00010000.00100101.00100000

The result of the AND operation gives us the network address, which is 205.16.37.32. Therefore, the first address in the block is 205.16.37.32.

To calculate the last address, we need to find the highest possible host address within the block. Since we have 4 bits available for host addresses (2^4 = 16), the highest host address is obtained by setting all 4 bits to 1:

Address: 11001101.00010000.00100101.00100111

Subnet Mask: 11111111.11111111.11111111.11110000

OR Operation: 11001101.00010000.00100101.00101111

The result of the OR operation gives us the broadcast address, which is 205.16.37.47. However, the last address in the block is always reserved as the broadcast address, so the actual last usable address is the one before the broadcast address. Therefore, the last address in the block is 205.16.37.46.

The total number of addresses in the block can be calculated by taking the number of available host addresses, which is 2^4 = 16, and subtracting 2 (one for the network address and one for the broadcast address). Therefore, the total number of addresses in the block is 16 - 2 = 14.

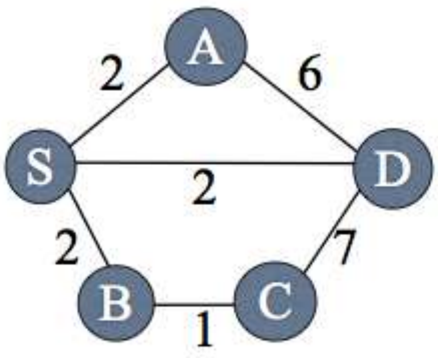
Q12: Suppose a router has built up the routing table shown in Table below. The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4. Describe what the router does with a packet addressed to each of the following destinations:
(i)128.96.40.151
(ii) 192.4.153.17
(iii) 192.4.153.90

SubnetNumber	SubnetMask	NextHop
128.96.39.0	255.255.255.128	Interface 0
128.96.39.128	255.255.255.128	Interface 1
128.96.40.0	255.255.255.128	R2
192.4.153.0	255.255.255.192	R3
(default)		R4

<u>Ans:</u> Perform logical AND operation of given destination with SubnetMask – obtained resultant to be compared with subnetNumber and hence the respective nextHop.
(i)128.96.40.151 – Default (R4)
(ii) 192.4.153.17 – R3
(iii) 192.4.153.90 – Default (R4)

<u>Forwarding / Routing:</u>

Q13: For the network shown in Figure below, give global distance–vector tables when
(i) Each node knows only the distances to its immediate neighbors.
(ii) Each node has reported the information it had in the preceding step to its immediate neighbors.
(iii) Step (ii) happens a second time.



Ans: (i)

Information stored at node	Distance to Reach Node				
	S	A	B	C	D
S	0	2	2	∞	2

A	2	0	∞	∞	6
B	2	∞	0	1	∞
C	∞	∞	1	0	7
D	2	6	∞	7	0

(ii)

Information stored at node	**Distance to Reach Node**				
	S	A	B	C	D
S	0	2	2	3	2
A	2	0	4	5	4
B	2	4	0	1	4
C	3	5	1	0	5
D	2	4	4	5	0

(iii)

Information stored at node	**Distance to Reach Node**				
	S	A	B	C	2
S	0	2	2	3	4
A	2	0	4	5	4
B	2	4	0	1	5
C	3	5	1	0	0
D	2	4	4	5	2