COMPUTER SCIENCE & INFORMATION TECHNOLOGY

Computer Networks

Text Book: Theory with worked out Examples and Practice Questions
## 1. Concept of Layering

01. Ans: (b)  
**Sol:** Data link layer has error, flow, access control, framing as functionalities. Bit synchronization is part of physical layer.

02. Ans: (c)  
**Sol:** Given: At each layer, n bits of information is added/appended.  
\[ \text{Total message} = \text{original message} + \text{overhead} = m + nh \]  
\[ \% \text{ of overhead} = \frac{nh}{m + nh} \times 100\% \]

03. Ans: (b)  
**Sol:** packet \( \Rightarrow 3 \Rightarrow \text{NPDU} \Rightarrow H_1 \)  
Frame \( \Rightarrow 2 \Rightarrow \text{DPDU} \Rightarrow H_2 H_3 \) \( \Rightarrow T_3 \)

04. Ans: (a)

05. Ans: (c)  
**Sol:** Network Layer – 4 times  
Data Link Layer – 6 times

06. Ans: (a)  
**Sol:** Data link layer ensures reliable transport of data over a Physical point to point link.  
Network layer routes data from one network node to next.  
Transport layer allows end to end communication between two processes.

07. Ans: (c)  
**Sol:**  
**Fragment:** Network layer (fragmentation)  
**Segment:** Transport layer (segmentation)  
There is a restriction on the message length in the subnet, so breaking the lengthy message starts at transport layer.
2. LAN Technologies

01. Ans: (d)
Sol: Given:
B = 10^6 bps
Distance = 10000 km
T_p = 2 x 10^8 m/s
L = 50000 B

\[ p = T_x = \frac{L}{B} = \frac{50000 \times 8}{100 \times 10^4} \]

\[ = \frac{4 \times 10^3}{10} \times \frac{10^3}{10} \]

\[ = 4000 \]

\[ = \frac{10}{10} \]

\[ = 400 \text{ msec} \]

L = 50000 bits

02. Ans (a)
Sol: In Manchester encoding, we use two signal changes to represent a bit. Therefore always baud rate is twice the bit rate. Hence bit rate is half the baud rate.

03. Ans: (a)
Sol: Ethernet uses Manchester encoding in which bit has two signal segments, so 10Mbps = 10 x B def 2 signal segments per second = 20 mega baud.

04. Ans: 10000
Sol: B = 1 Gbps
d = 1 km
v = 200000 km/sec; \ L = ?

\[ L = \frac{2 \times d}{v} \]

\[ L = 2 \times \frac{1}{200000} \times 10^9 \]

\[ = 10000 \text{ bits or 1250 bytes} \]

05. Ans: (d)
Sol: Condition for minimum frame size is transmission delay = 2 x propagation delay.

\[ L/B = 2 \times \frac{d}{v} \]

L = 1250 x 8 bits,

B = 10^8 bits, d = 1 KM.

If we substitute values you get

v = 20,000 km/sec

06. Ans: 200
Sol: L = ?

B = 20 Mbps

T_p = 40 micro sec

T_x = L/B

= 100 ms

T_x = 2T_p

\[ \frac{L}{B} = 2 \times T_p \]

\[ L_{\text{min}} = 2T_p \times B \]

\[ = 2 \times 40 \times 10^{-6} \times 20 \times 10^6 \]

\[ = 2(40) \times (20) \text{ bits} = 1600 \text{ bits} \]

\[ = 200 \text{ Bytes} \]
07. Ans: (b)  
Sol: Collision number for A is 1, and for B it is 2.
Possible numbers for ‘A’ from backoff algorithm is (0,1), for B they are (0, 1, 2, 3)
Going by the Combinations, A will have 5 chances and B has 1 chance out of 8.
Rest of the two is Undecided.
n = 1, A = (0,1) , B = (0, 1)

<table>
<thead>
<tr>
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<th>B</th>
<th>Remark</th>
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<tr>
<td>0</td>
<td>0</td>
<td>Collision</td>
</tr>
<tr>
<td>0</td>
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<tr>
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<td>0</td>
<td>B = 1/4</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Collision</td>
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</table>

n = 2, A = (0,1) , B = (0,1,2,3)

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<th>Remark</th>
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<td>A</td>
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<tr>
<td>1</td>
<td>3</td>
<td>A</td>
</tr>
</tbody>
</table>

\[ A = \frac{5}{8} = 0.625, \quad B = \frac{1}{8} = 0.125 \]

Hence Probability for ‘A’ in 5/8 = 0.625.

08. (a) Ans: 137.5 (b) Ans: 125
Sol: Frame Transmission time = 1000/10 \times 10^6 = 100\mu s
At time t = 0 both A & B transmit
At time t = 12.5\mu s a detects collision
At time t = 25 \mu s
Last bit of B’s aborted transmission arise at A.
At t = 37.5\mu s first bit of A’s retransmissions arrives at B.
At 37.5\mu s A’s packet is completely arrives B.
100 + 37.5 = 137.5

09. Ans: 0.4404
Sol: All k-stations
For a stations P(1 – P)^k
For some stations among k-station
\[ = k . P (1–P)^{k–1} \]
\[ S_1 \quad S_2 \quad S_3 \quad S_4 \]
\[ P \quad 1 – P \quad 1 – P \quad 1 – P \]
For S_1 (0.1) (0.8) (0.7) (0.6) = 0.0336
For S_2 (0.9) (0.2) (0.7) (0.6) = 0.0756
For S_3 (0.9) (0.8) (0.3) (0.6) = 0.1296
For S_4 (0.9) (0.8) (0.7) (0.4) = 0.2016

0.4404
Probability for any one station among S_i, S_2, S_3, S_4 to send a frame without collision = 0.4404.

10. Ans: 81 to 85
Sol: B = 10 Mbps
Slot time = 51.2 \mu sec, L = 512 bytes
Number of slots = 1.716
Transmission time = \frac{L}{B} = \frac{512 \times 8 \text{(bits)}}{10 \times 10^6} = 4.096 \times 10^{-4} \text{sec}
Contestion width = no. of slots \times slot time = 1.716 \times 51.2 = 87.85 \mu sec
= 87.85 \times 10^{-6} \text{ seconds}
$$\eta = \frac{\frac{L}{B}}{\text{contention width} + \frac{L}{B}}$$

$$\eta = \frac{4.096 \times 10^{-4}}{4.096 \times 10^{-4} + 87.85 \times 10^{-6}} = 82.3\%$$

11. Ans: (c)
Sol: When the transmission delay is high and propagation delay is low the number of collisions decreases. When the collision decreases throughput increases.

### 3. Basics of Wi-Fi

01. Ans: (b)
Sol: RTS and CTS mechanism is used for collision avoidance, not collision detection.

02. Ans: (d)

03. Ans: (c)
Sol: In wireless LANs it is difficult to detect the collision rather than to avoid it. So the access method for wireless LANs as define by IEEE 802.11 is based on collision avoidance i.e CSMA/CA.

04. Ans: (c)
Sol: IEEE 802.11 uses CSMA/CA protocol
CSMA/CA uses RTS-CTS Mechanism to avoid collision.
RTS-Request to send,
CTS-Clear to send.

05. Ans: (d)
Sol: Network allocation vector (NAV) Restrict the stations to sense the medium, when medium is busy.
Like counter, decreases at constant rate.
If zero means medium is idle if non zero means medium is busy.

### 4. Switching (Circuit, Packet)

01. Ans: (a)
Sol: Given data
Circuit setup time = ‘S’ sec
Bandwidth = bit rate = ‘b’ bps
Path = ‘k’-hop
Propagation delay = ‘d’ sec per hop
Connection release = not given
Packet size = ‘p’ bits
Message size = ‘x’ bits

$$k = 3$$

k – hop path (hop means jump)

$$T_p = \frac{d}{v} = \frac{m}{m/s} = \text{sec}$$

Total delay = I + II + III

I. Circuit setup time = S

II. $$T_x = \frac{L}{B} = \frac{\text{messagesize}}{\text{bit rate}} = \frac{x}{b}$$

III. $$T_p=\text{one hop} \rightarrow \text{propagation time}=‘d’ \text{ sec}$$
For k hop → propagation time ?

$$= k \times d$$

$$\therefore \text{Total delay} = S + \frac{x}{b} + k.d$$
01. Ans: (b)
Sol: Stuffed bit is 4\textsuperscript{th} bit from the last.

02. Ans: (c)
Sol: 
\begin{align*}
1011 & \mid 01011011000 (01000011) \\
& \text{1011} \\
& \text{1100} \\
& \text{1011} \\
& \text{1110} \\
& \text{1011} \\
& \text{101} \\
\end{align*} 
CRC

02. Ans: (d)
Sol:
- The last packet is getting retransmitted at k – 1 hops so the delay is (k – 1) \( \frac{P}{b} \).
- There is no set of time (NOS)
- Transmission delay is \( x/b \)
  \[
  = \frac{p_1 + p_2 + \ldots + p_n}{b}
  \]
- Message
  For k hop → propagation time?
  \[
  = k \times d
  \]
- Total time = \( x/b + k.d + (k – 1) \frac{P}{b} \)

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**5. Data Link Layer**

01. Ans: (b)
Sol: Stuffed bit is 4\textsuperscript{th} bit from the last.

02. Ans: (c)
Sol:
\begin{align*}
1011 & \mid 01011011000 (01000011) \\
& \text{1011} \\
& \text{1100} \\
& \text{1011} \\
& \text{1110} \\
& \text{1011} \\
& \text{101} \\
\end{align*} 
CRC
03. Ans: (a)
Sol:

<table>
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<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
<td>1</td>
<td>2^0</td>
<td>2^1</td>
<td>2^2</td>
<td>2^3</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

3=1+2
5=1+4
6=2+4
7=1+2+4
9=1+8
10=2+8
11=1+2+8

Even parity

Hamming code = 10110101111

04. Ans: 4.76
Sol:

L = 1000 bits
d = 100 \times 10^3 m
V = 2 \times 10^8 m/sec
B = 20 Mbps = 20 \times 10^6 bps

\[ T_x = \frac{L}{B} = \frac{1000 \text{bits}}{20 \times 10^6 \text{bps}} = 5 \times 10^{-5} \text{sec} \]

\[ T_p = \frac{d}{V} = \frac{100 \times 10^3 \text{m}}{2 \times 10^8 \text{m/sec}} = 5 \times 10^{-4} \text{sec} \]

\[ a = \frac{T_p}{T_x} = \frac{5 \times 10^{-4}}{5 \times 10^{-5}} = 10 \]

Efficiency (\(\eta\)) = \frac{1}{1+2a} = \frac{1}{1+2 \times 10} = \frac{1}{21} = 0.047 = 4.7% 

05. Ans: 47.6

06. Ans: 160
Sol: B = 4 Kbps

Propagation delay = 20 msec
\(\eta\) = 50%

RTT = 2 \times \text{Propagation delay}
= 40 msec

N = 50 then L = BR
= 4 \times 10^3 \times 40 \times 10^{-3}
= 160 bits

07. Ans: 10.8
Sol: B = 1.5 Mbps

RTT (Round Trip Time) = 45ms
L = 1 KB

Link utilization = \frac{L}{L + BR}
= \frac{1024 \times 8}{(1024 \times 8) + 1.5 \times 10^6 \times 45 \times 10^{-3}}
= \frac{8192}{8192 + 67500} = \frac{8192}{75692} = 0.108 = 10.8%

08. Ans: 2500
Sol: B = 80 kbps

L = 1000 bytes
T_p = 100 ms
T_x = L/B = 100 ms

T_{ax} = \text{ack size/ bandwidth} = 100 ms

\[ \text{Efficiency} = \frac{T_x}{T_x + 2T_p + T_{ax}} = \frac{100}{400} = 0.25 \]

Throughput = efficiency \times \text{bandwidth}
= 0.25 \times 10^4 \text{bytes}
= 2500 \text{bytes}
09. Ans: 89.33
Sol: B = 1 Mbps
\[ T_p = 0.75 \text{ ms} \]
\[ T_{\text{proc}} = 0.25 \text{ ms} \]
Payload = 1980 B
Ack = 20 B
OH = 20 B
\[ L = \text{Payload} + \text{OH} = 1980 + 20 \]
\[ = 2000 \text{ Bytes} \]
\[ T_x = \frac{L}{B} \]
\[ = \frac{2000 \times 8}{1 \times 10^6} = 16 \text{ ms} \]
\[ T_{ax} = \frac{20 \times 8}{1 \times 10^6} \]
\[ = 160 \mu\text{sec} \]
\[ = 0.16 \text{ msec} \]
Total time = \( T_x + T_p + T_{\text{proc}} + T_{ax} + T_{\text{proc}} \)
\[ = 16 \text{ ms} + 0.75 \text{ ms} + 0.25 \text{ ms} \]
\[ + 0.16 \text{ ms} + 0.75 \text{ ms} \]
\[ = 17.91 \text{ ms} \]
\[ \eta = \frac{T_x}{\text{Total Time}} \]
\[ = \frac{16}{17.91} = 89.33\% \]

10. Ans: (d)
Sol: 512 bytes \( \times \) 8 bits/B = 4096 bits per frame
4096/64000bps = 64 msec to send one frame
Round trip delay = 540 msec
Window size 1: send 4096 bits per 540msec
4096bits/540msec = 7.585 \times 103 bps throughput
Window size 7: 7585 \times 7 = 53096 bps

Window size 9 and greater:
7585 \times 9 = 68265 bps but the maximum capacity is 64 kbps so for window size greater than 9 the maximum throughput is 64 kbps

11. Ans: 21

13. Ans: (d)
Sol: B = 1 Mbps
Latency delay (or)
Propagation delay = 1.25 sec
L = 1 KB
(1) \( RTT = 2 \times 1.25 \)
\[ = 2.5 \text{ sec} \]
(2) 1 sec = 1 \times 10^6 \text{ bits}
2.5 sec =?
(3) \( w_p = \frac{w \text{ bits}}{\text{pkt size}} \)
\[ = \frac{2.5 \times 10^6}{1024 \times 8} = 305 \]
(4) sequence no. = \( w_p = 305 \)
\[ \therefore 2^k = 305 \]
\[ \therefore k = 9 \text{ bits for GBN} \]
for SR
\( W_p = 610 \)
so \( k = 10 \) bits

14. Ans: (c)
Sol: \( d = 3000 \) km
B = 1.536 Mbps
L = 64 bytes
Propagation speed = 6 \mu\text{sec/km}
Propagation delay for 3000 km
\[ \Rightarrow 3000 \times 6 \mu\text{sec} \]
(1) RTT = 2 \times 18000 \ \mu\text{sec} \\
= 36000 \times 10^6 \\
= 36 \ \text{msec} \\
(2) 1 \ \text{sec} \rightarrow 1.536 \times 10^6 \ \text{bits} \\
36 \ \text{ms} \rightarrow ? \\
(3) w_p = \frac{w \ \text{bits}}{(\text{pktsize})} \\
\text{(4) Sequence number } w_p = 108 \\
\text{(5) } 2^k = w_p \Rightarrow 2^k = 108 \Rightarrow 2^k = 2^7 \Rightarrow k = 7 \\

12. \ \text{Ans: 16} \\
\text{Sol: } w = 3 \\
\text{Total 9 packets} \\
\text{Every fifth packet lost} \\
\begin{array}{cccccccccccc}
\text{Packets} & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 \\
\text{Attempts} & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 \\
\end{array} \\
\text{Total 16 attempts} \\

15. \ \text{Ans: 4} \\
\text{Sol: 5 step problem} \\
1. \ \text{Calculate } \text{RTT} = 2(T_p) \\
2. \ \text{Calculate } \text{BR, window size in bits} \\
3. \ \text{Calculate } W = \text{window in packets} = \text{BR/L} \\
4. \ \text{For selective repeat, } \text{ASN is set to } 2W \\
5. \ \text{Sequence number, } k \\
\text{Bandwidth (B) = } 128 \times 10^3 \ \text{bps} \\
\text{Propagation delay (T_p) = 150 msec} \\
\text{Packet size(L) = 1 kilobyte} \\
\text{Transmission delay (T_t) = } \frac{L}{B} \\
\Rightarrow T_t = \frac{1 \times 8 \times 10^3 \ \text{bits}}{128 \times 10^7 \ \text{bps}} \\
\Rightarrow T_t = \frac{1}{16} \ \text{sec} \\
T_t = 64 \ \text{msec} \\
W_S = \text{sender window size} \\
\eta = \frac{W_S \times T_t}{T_t + 2T_p} \\
1 = \frac{W_S \times 64}{64 + 2 \times 150} \\
364 = W_S \\
W_S = 5.6875 \\
W_S + W_R = \text{Available sequence numbers for SR} \\
W_S = W_R \\
\text{ASN = } 2 \times W_S \\
\text{ASN = } 2 \times 5.6875 \\
\text{ASN = 11.375} \\
\text{No. of bits in the sequence number} \\
\text{= } \left[ \log_2 \text{ASN} \right] \\
\text{= } \left[ \log_2 11.375 \right] = 4

01. Ans: (b)
Sol:
1100 0010. 0010 1111. 0001 0101. 1000 0010
C 2 2 F 1 5 8 2
C 2 2 F 1 5 8 2
12×16¹ 2×16¹ 1×16¹ 8×16¹
+ 2×16⁰ +15×16⁰ +5×16⁰ +2×16⁰
= 194 = 47 = 21 = 130
∴ 194.47.21.130

02. Ans: (b)
Sol:
0001 0111. 0010 1010. 1000 0100. 1100 1000
1 7 2 A 8 4 C 8
1 7 2 A 8 4 C 8
1×16¹ 2×16¹ 8×16¹ 12×16¹
+ 7×16⁰ +10×16⁰ +4×16⁰ +8×16⁰
= 23 = 42 = 132 = 200
∴ 23.42.132.200

03. Ans (c)
Sol: In given problem network part is of 20 bits.

04. Ans: (c)
Sol:
Class C
NID
3 + 21
HID
8

From NID, 3 bits are reserved for prefix of class C address therefore number of networks all allowed under class C address are \(2^{24-3} = 2^{21}\).

05. Ans: (b)
Sol:
Class B
NID
32
HID
32 – 16 = 16

Hosts per subnet = \(2^4 – 2\)
06. Ans: (c)
Sol:

\[
\begin{align*}
2^x &= 7 \\
\therefore x &= 3 \\
2^3 &= 8 \text{ subnets can be formed} \\
2^5 - 2 &= 30 \text{ hosts per subnet}
\end{align*}
\]

<table>
<thead>
<tr>
<th>Class C</th>
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<tbody>
<tr>
<td>32</td>
</tr>
<tr>
<td>NID</td>
</tr>
<tr>
<td>3 + 21</td>
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<tr>
<td>HID</td>
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<tr>
<td>8</td>
</tr>
<tr>
<td>SID</td>
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<tr>
<td>3</td>
</tr>
<tr>
<td>HID</td>
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<tr>
<td>5</td>
</tr>
</tbody>
</table>

1111 1111. 1111 1111 1111 1111 0000
255. 255. 255. 224
(or)

Given 25 hosts per subnet
\[2^x = 25\]
\[x = 5 \text{ hosts per subnet}\]

07. Ans: (d)
Sol:

\[
\begin{align*}
\begin{align*}
64 \text{ departments} &= 2^6 \\
1111 1111. 1111 1111 1111 1100. 0000 0000 0000 0000
255. 255. 252. 0
\end{align*}
\end{align*}
\]

Given 100 LAN’s
\[2^x = 100 \text{ hosts}\]
\[\therefore x = 7\]

<table>
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<td>2 + 14</td>
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<td>HID</td>
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<td>16</td>
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<tr>
<td>SID</td>
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<tr>
<td>9</td>
</tr>
<tr>
<td>HID</td>
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<tr>
<td>7</td>
</tr>
</tbody>
</table>

\[/25 \Rightarrow 255.255.255.128\]

08. Ans: 255.255.255.128
Sol:

\[2^x = 150 \text{ LANs}\]
\[\therefore x = 8\]

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<td>3</td>
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<tr>
<td>HID</td>
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<td>5</td>
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</table>

Subnet mask \[\rightarrow /27\]
10. **Sol:**

\[
\text{SM} = 255.255.255.192
\]

\[
192 = 11000000
\]

Class C network has 24-bits NID and 8 bit HID

(a) 2 bits are borrowed from HID

(b) no. of subnets = \(2^2 = 4\)

(c) no. of systems per subnet = \(2^6 - 2 = 64 - 2 = 62\)

11. **Ans:** 158

**Sol:**

/27 clearly indicates that first 3 bits (128, 64, 32) in the last octet are borrowed for subnet, 5 bits for Host ID. and mask is 255.255.255.224. If you perform AND operation between IP (200.10.11.144) and Subnet mask (255.255.255.224) then we get 200.10.11.128. So subnet ID is 128 and network ID is 200.10.11.

We have 5 bits for host ID. We cannot have all 1’s in host ID, therefore we will have 11110 (last 5 bits) for the last IP address. Therefore in last octet we will have 10011110, it is 158

12. **Ans:** (a)

**Sol:**

(b) 245.248.128.0/21 and 245.248.128.0/22

\[\rightarrow \text{same 128 can not be given to two subnets}\]

(c) 245.248.132.0/22 and 245.248.132.0/21

\[\text{same 132 can not be given to two subnets}\]

(d) 245.248.136.0/24 and 245.248.132.0/21

\[\text{same /24 will not be required}\]

13. **Ans:** (c)

**Sol:** For the first network the maximum allowed payload size = 1200 bytes per frame and for the second network the maximum allowed payload size = 400 bytes per frame.

Per packet IP overhead is given as 20 bytes. So first we will calculate the total number of packets formed.

**Note:** If first network consider:

For first network 2100 bytes will be divided into 2 packets of size 1200 and 900 bytes.

So IP overhead of 1st network

\[= (2*20)=40 \text{ bytes}\]

But given is second network.
For second network 2100 bytes will be divided into 6 packets 5 of 400 bytes and 1 of 100 bytes.
So, IP overhead of the 2nd network = (6*20 = 120 bytes)
Thus, the maximum IP overhead for the 2nd network = 120 bytes

14. Ans: (a)
Sol: Perform AND operation Given IP address and net mask, and compare results with network number. If it matches with network number, then forward packet through that interface. If not matched with any entry then use default route.
Ex: 128.96.171.92 AND 255.255.254.0 = 128.96.170.0
Hence packet must be transferred through Interface 0. Sometimes result matches with multiple network number, if so use interface that has longest length subnet mask.

15. Ans: 1
Sol: Perform AND operation between IP and /12, /14, /16, /15 mask. If result matches with “prefix” given in the table then that should be the interface packet is forwarded. If it matches with multiple masks then use longest length mask.
Ex: Here it matches with /12 & /15, so use /15.

16. Ans: 26
Sol: For each hop TTL is reduced by 1 (minimum) and there are 6 hops here hence 32 – 6 = 26.

17. Ans: 800 bytes
Sol: Offset 100 means there are 100 fragments before this, 8 bytes for each fragment 800 bytes.

18. Ans: (c)
Sol: For last fragment always M = 0. If HLEN is 10 then header length is 40 bytes (We use scale factor of 4 in HLEN). Therefore total data in fragment is 400 – 40 = 360 bytes. Since offset is 300 total bytes ahead of this fragment is 8×300 = 2400 bytes (we use scale factor of 8 in offset). Therefore it is last fragment, starting byte is 2400 and ending byte is 2759 (Actually 2400 + 360 = 2760 bytes but byte number starts with zero, so it is from 2400 to 2759)

7. Routing Algorithms

01. Ans: (c)
Sol: Going via B gives (11, 6, 14, 18, 12, 8).
Going via D gives (19, 15, 9, 3, 9, 10).
Going via E gives (12, 11, 8, 14, 5, 9).
Taking the minimum for each destination except C gives (11, 6, 0, 3, 5, 8).
The outgoing lines are (B, B, -, D, E, B).

02. Ans: (a)
Sol: RIP is based hop count, hence uses distance vector. OSPF is based on cost, and hence uses link state.
03. Ans: (c)  
Sol: RIP uses distance vector routing  
RIP packets are sent using UDP  
OSPF doesn’t use UDP or TCP and sends directly via IP  
OSPF operation is based on LSR

04. Ans: 51

8. TCP/UDP & Sockets, Congestion Control

01. Ans: (c)  
Sol: TCP pseudo Header Format

<table>
<thead>
<tr>
<th>Source IP</th>
<th></th>
<th>Destination</th>
<th></th>
<th>TCP Header</th>
<th></th>
</tr>
</thead>
</table>

Pseudo header

02. Ans: (b)  
Sol: Each socket is binded with a port

03. Ans: (d)

04. Ans: (b)  
Sol: RTT = 10 msec  
Scap = 24 KB  
Lcap = 2 KB

05. Ans: (c)  
Sol:

When timeout occurs threshold = \( \frac{1}{2} \times 18 = 9 \)  
Minimum (Congestion Window, Receiver Window)

1. Minimum (1, –)
2. Minimum (2, −) 
3. Minimum (4, −) 
4. Minimum (8, −) 

\[
\frac{16}{9}
\]

Since it is crossing threshold, instead of 16 KB it sent 9 KB

06. **Ans: 10**

**Sol:** 
1 sec \( \ldots \ldots \ldots \ldots 200 \times 10^6 \)

\[
\Rightarrow \frac{200 \times 10^6}{8} = 25 \times 10 \text{ sequence}
\]

\[
= \frac{2^{28}}{25 \times 2^{20}} = \frac{2^8}{25} = \frac{250}{25} = 10 \text{ sec}
\]

07. **Ans: 34**

**Sol:**

Given, Bandwidth = \( 10^9 \) bps

Session start with sequence number = 1234

Wraparound time calculation = ?

In TCP sequence number of each byte = 32 bits.

So, \( 2^{32} \) bytes are to be transmitted in a warp around time.

\[
\frac{10^9}{8} \text{ bytes} \quad \ldots \ldots \ldots \ldots 1 \text{ sec}
\]

\[
2^{32} \text{ bytes} \quad \ldots \ldots \ldots \ldots ?
\]

\[
= \frac{2^{32}}{\frac{10^9}{8}} = \frac{2^{32}}{125 \times 10^6} = \frac{4294967296}{125 \times 10^6} = 34.35 \text{ sec}
\]

08. **Ans: (b)**

**Sol:**

Given \( \Rightarrow M = \text{max burst} = 6 \text{ Mbps} \)

\( \rho = \text{constant rate} \)

\( = \text{token arrive rate} 1 \text{ Mbps} \)

\( C = 8 \text{ Mbps} \)

\( S = ? \)

\[
S = \frac{C}{M - \rho} = \frac{8 \text{ Mbits}}{(6-1) \text{ Mbits/sec}}
\]

\[
= \frac{8}{5} \text{ sec} = 1.6 \text{ sec}
\]

09. **Ans: (c)**

**Sol:**

Given \( L = 1000 \) bytes

\( M = 50 \text{ million bytes/sec} \)

\( \rho = 10 \text{ million bytes/sec} \)

\( C = 1 \times 10^6 \text{ bytes} \)

\( S = ? \)

\[
S = \frac{C}{M - \rho} = \frac{1 \times 10^6}{50 \times 10^6 - 10 \times 10^6} = \frac{1}{40}
\]

\[
= 25 \text{ msec}
\]
10. **Ans: 1.1**  
**Sol:** Given  
- Maximum burst rate, \( M = 20 \text{ MBPS} \)  
- Token arrival rate, \( P = 10 \text{ MBPS} \)  
- Constant rate(bucket o/p), \( P = 10 \text{ MBPS} \)  
- Bucket capacity, \( C = 1 \text{ MB} \)  

Time for 1 MB, \( S = \frac{C}{(M - P)} \)  
\[ = \frac{1}{(20 - 10)} \]  
\[ = 0.1 \text{ sec} \quad \text{eq (1)} \]

For the total message of 12 MB  
So with the bursty rate (20Mbps), the transmission of data during 0.1 sec is  
\[ = 20\text{MBps} \times 0.1 \text{ sec} = 2\text{MB} \]

The remaining message = \(12\text{MB} - 2\text{MB} = 10\text{MB} \)

So time taken required to transmit the remaining data of 10MB with token arrival rate of 10 MBPS is  
data/data rate = \(10\text{MB}/10\text{MBps} = 1\text{sec} \) \( \text{(2)} \)

Total time is = equation (1) + equation (2)  
\[ = 0.1 + 1\text{s} = 1.1\text{sec} \]

11. **Ans: (d)**  
**Sol:** Data in 1st segment is from byte number 230 to byte number 289, that is 60 bytes  
As 1st is lost so, TCP will send ACK for the next in-order segment receiver is expecting.  
So it will be for 230.

12. **Ans: 29.256**  
**Sol:**  
- \( \text{RTT} = 30 \text{ msec}, \alpha = 0.9 \)  
- \( \text{NRTT} = 26 \)  

Basic algorithm = \( \alpha (\text{IRTT}) + (1-\alpha) (\text{NRTT}) \)  
\[ = 0.9 \times 30 + (1 - 0.9) (26) \]  
\[ = 29.6 \text{ msec} \]

2nd round = 29.84 msec  
3rd round = 29.256 msec

9. **Application Layer Protocols**

01. **Ans: (b)**  
**Sol:** Refer page 90 for the concept of base 64 encoding.

02. **Ans: (c)**  
**Sol:** The concept to be followed.  

**Step 1:** The client(browser) initiates a DNS query for remote server. It may be that they already have this server in their DNS cache, in which case the client may simply send a TCP SYN directly to the application server.  

**Step 2:** The client will next send a connection request to the application server. This will be a TCP SYN packet, the first in the TCP three-way handshake.  

**Step 3:** Next, after the TCP connection has been established, the client will request data from the server. In the web-based application, the client performs an HTTP GET.
03. Ans: (c)
Sol: In DNS we need quick response than reliability hence it uses UDP.

04. Ans: (d)

10. Network Security

01. Symmetric in nature

\[
\begin{array}{cccccc}
0 & 1 & 2 & 3 & 4 & 5 \\
1 & 0 & 3 & 2 & 5 & 4 \\
0 & 1 & 2 & 3 & 4 & 5 \\
\end{array}
\]

Both are in symmetric nature. Hence IP = IP^1

02. Ans: (c)
Sol: 2 nodes

\[
\begin{array}{cccc}
1 & 1 \text{ key} & 2 \\
\end{array}
\]

3 keys \(\Rightarrow 1 + 2\)

4 nodes

\[
\begin{array}{cccc}
1 & & 2 \\
& 3 & \\
\end{array}
\]

\[1 + 2 + 3 = 6 \text{ keys}\]

\[N \text{ nodes } \Rightarrow 1 + 2 + \ldots + (N-1) = \frac{N(N-1)}{2}\text{ keys}\]

03. Ans: (a) & (d)
Sol: Property for good candidate
Choose ‘n’ in such a way that \[n, \left(\frac{n-1}{2}\right)\]
both should be prime.
(a) \[7, \frac{7-1}{2} = 3 \Rightarrow (7, 3)\]
(b) \[33 \text{ is not prime}\]
(c) \[37, \frac{37-1}{2} = 18 \Rightarrow (37, 18)\]
(d) \[47, \frac{47-1}{2} = 23 \Rightarrow (47, 23)\]
\[\therefore \text{ Option (a) & (d) is correct}\]

04. Ans: (b)
Sol: \[p = 7, a = 3 \text{ primitive root}\]
\[X_A = 2, X_B = 5\]
Public key \[y_A = a^{X_A} \mod p = 3^2 \mod 7 = 2\]
Public key \[y_B = a^{X_B} \mod p = 3^5 \mod 7 = 5\]
Shared key \[K_{AB} = (y_A)^{X_B} \mod p = 2^5 \mod 7 = 4\]
05. Ans: (b)  
Sol:  
(I) \[ M' = M^e \mod n \] Encryption and Decryption  
\[ M = (M')^d \mod n \]  
(II) Is false  
(III) Is true  
\[ ed = 1 \mod \phi(n) \]  
\[ d \] is the inverse of \( e \)  
\[ e \] is public key  
\[ d \] is private key  
(IV) Is false  

06. Ans: (d)  
Sol:  
RSA Algorithm:  
Step: (I) \( p = 3, q = 11 \)  
Step: (II) \( n = p \times q = 3 \times 11 = 33 \)  
\[ z = (p - 1)(q - 1) \]  
\[ = (3 - 1)(11 - 1) \]  
\[ = (2 \times 10) \]  
\[ = 20 \]  
\[ z = 20 \]  
Step: (III) Given \( e = 3 \): Public key  
Step: (IV) \( (d \times e) \mod z = 1 \)  
\( (d \times 3) \mod 20 = 1 \)  
\( 21 \mod 20 = 1 \)  
\( (d \times 3) = 21 \)  
\( d = \frac{21}{3} = 7 \)  
private key = 7  

07. Ans: 11  
Sol: \( p = 13, q = 17 \)  
\( K_u = \{e, u\} = \{35\} \)  
\( K_r = d = ? \)  
RSA steps  
1. \( p = 13 \) \( q = 17 \)  
2. \( n = 13 \times 17 \)  
\[ \phi(n) = (p - 1)(q - 1) \]  
\[ = 12 \times 16 \]  
\[ = 192 \]  
\( d = ? \)  
\( e = 35 \)  
\( So (e \times d) \mod \phi(n) = 1 \)  
\( (35 \times d) \mod 192 = 1 \)  
\[ d = 11 \]  

08. Ans: (d)  
Sol: Definition of Digital sign and PKC230  

09. Ans: (b)  
Sol: A birthday attack is a type of cryptographic attack that exploits the mathematics behind the birthday problem in probability Theory. The attack depends on the higher likelihood of collisions found between random attack attempts and a fixed degree of permutations.  
1: Sender can launch the attack  
Digital signatures can be susceptible to a birthday attack. A message \( m \) is typically signed by first computing \( f(m) \), where \( f \) is a cryptographic hash function, and then using some secret key to sign \( f(m) \). Suppose Alice(sender) wants to trick Bob (receiver) into signing a fraudulent contract. Alice
prepares a fair contract $m$ and a fraudulent one $m'$. She then finds a number of positions where $m$ can be changed without changing the meaning, such as inserting commas, empty lines, one versus two spaces after a sentence, replacing synonyms, etc. By combining these changes, she can create a huge number of variations on $m$ which are all fair contracts.

In a similar manner, Alice also creates a huge number of variations on the fraudulent contract $m'$. She then applies the hash function to all these variations until she finds a version of the fair contract and a version of the fraudulent contract which have the same hash value, $f(m) = f(m')$. She presents the fair version to Bob for signing. After Bob has signed, Alice takes the signature and attaches it to the fraudulent contract. This signature then "proves" that Bob signed the fraudulent contract. This way the sender launches the Birthday attack.