SOLUTION ASSIGNMENT-03 (BCS 5A & 5C)

PART-01

REVIEW QUESTIONS

R3.

Source port number y and destination port number x.

PROBLEMS

Problem 2.

Suppose the IP addresses of the hosts A, B, and C are a, b, c, respectively. (Note that a, b, c are distinct.)

To host A: Source port =80, source IP address = b, dest port = 26145, dest IP address = a

To host C, left process: Source port =80, source IP address = b, dest port = 7532, dest IP address = c

To host C, right process: Source port =80, source IP address = b, dest port = 26145, dest IP address = c

Problem 3.

Note, wrap around if overflow.

$$
\begin{array}{ccccccccc}
 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 1 \\
+ & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 \\
\hline
 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 1
\end{array}
$$

$$
\begin{array}{ccccccccc}
 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 1 \\
+ & 0 & 1 & 1 & 1 & 0 & 1 & 0 & 0 \\
\hline
 & 0 & 0 & 1 & 0 & 1 & 1 & 1 & 0
\end{array}
$$

One's complement = 1 1 0 1 0 0 0 1.
To detect errors, the receiver adds the four words (the three original words and the checksum). If the sum contains a zero, the receiver knows there has been an error. All one-bit errors will be detected, but two-bit errors can be undetected (e.g., if the last digit of the first word is converted to a 0 and the last digit of the second word is converted to a 1).

Problem 4.

a) Adding the two bytes gives 11000001. Taking the one's complement gives 00111110.

b) Adding the two bytes gives 01000000; the one's complement gives 10111111.

c) First byte = 01010100; second byte = 01101101.

Problem 26.

There are $2^{32} = 4{,}294{,}967{,}296$ possible sequence numbers.

a) The sequence number does not increment by one with each segment. Rather, it increments by the number of bytes of data sent. So the size of the MSS is irrelevant -- the maximum size file that can be sent from A to B is simply the number of bytes representable by $2^{32} \approx 4.19$ Gbytes.

b) The number of segments is $\left\lceil \frac{2^{32}}{536} \right\rceil = 8{,}012{,}999$. 66 bytes of header get added to each segment giving a total of 528,857,934 bytes of header. The total number of bytes transmitted is $2^{32} + 528{,}857{,}934 = 4.824 \times 10^{9}$ bytes.
Thus it would take 249 seconds to transmit the file over a 155~Mbps link.

Problem 40.

a) TCP slowstart is operating in the intervals [1,6] and [23,26]
b) TCP congestion avoidance is operating in the intervals [6,16] and [17,22]
c) After the 16th transmission round, packet loss is recognized by a triple duplicate ACK. If there was a timeout, the congestion window size would have dropped to 1.
d) After the 22nd transmission round, segment loss is detected due to timeout, and hence the congestion window size is set to 1.

e) The threshold is initially 32, since it is at this window size that slow start stops and congestion avoidance begins.
f) The threshold is set to half the value of the congestion window when packet loss is detected. When loss is detected during transmission round 16, the congestion windows size is 42. Hence the threshold is 21 during the 18^{th} transmission round.
g) The threshold is set to half the value of the congestion window when packet loss is detected. When loss is detected during transmission round 22, the congestion windows size is 29. Hence the threshold is 14 (taking lower floor of 14.5) during the 24^{th} transmission round.
h) During the 1^{st} transmission round, packet 1 is sent; packet 2-3 are sent in the 2^{nd} transmission round; packets 4-7 are sent in the 3^{rd} transmission round; packets 8-15 are sent in the 4^{th} transmission round; packets 16-31 are sent in the 5^{th} transmission round; packets 32-63 are sent in the 6^{th} transmission round; packets 64 – 96 are sent in the 7^{th} transmission round. Thus packet 70 is sent in the 7^{th} transmission round.
i) The threshold will be set to half the current value of the congestion window (8) when the loss occurred and congestion window will be set to the new threshold value + 3 MSS . Thus the new values of the threshold and window will be 4 and 7 respectively.
j) threshold is 21, and congestion window size is 1.
k) round 17, 1 packet; round 18, 2 packets; round 19, 4 packets; round 20, 8 packets; round 21, 16 packets; round 22, 21 packets. So, the total number is 52.

PART-02

Question 1

(1) 161
(2) 1014
(3) 1867
(4) 2720
(5) 3573
(6) 1014
(7) 1867
(8) X (Segment Loss)
(9) X (Segment Loss)
(10) 1867
(11) 4426
(12) 5279
(13) X (ACK Never Arrives)
(14) X (ACK Never Arrives)
(15) X (ACK Never Arrives)

Question 2

(1) 1,2,3,10,11,12,15,16,17,18
(2) 4,5,6,7,8,9,13,14,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,37,38,39,40
(3) 36
(4) 9,14,17
(5) 35
(6) 10,15,18,36

Question 3

If the probability of packet loss is 0.2, the probability that a packet will be successfully transmitted and acknowledged without retransmission is: $P(\text{success})=(1-0.2)\times(1-0.2)=0.64$

Thus, there is a 64% chance that a single packet will be successfully transmitted and acknowledged without retransmission.

Question 4

(a) The congestion window size determines the throughput:
Throughput = Window Size / RTT = (10 x 1500 bytes) / (100 ms) = 150000 bytes / sec

(b) When a packet loss occurs, TCP reduces the congestion window size to half. So, the throughput will approximately halve in the next RTT. Fast retransmit and fast recovery will allow the connection to recover faster than with slow start, but there will still be a noticeable decrease.

(c) As RTT increases, the throughput decreases since the sender must wait longer for ACKs.

Question 5

- After the first RTT estimate is made: Estimated RTT = 218.75 msec Dev RTT = 52.06 msec Timeout Interval = 427 msec
- After the second RTT estimate is made: Estimated RTT = 217.66 msec Dev RTT = 40.96 msec Timeout Interval = 381.50 msec