**CS 372 Introduction to Computer Networks**
**Self-Check Exercises: Lecture 19** **Solutions**

1) What is the purpose of the TCP countdown timer?
The countdown timer is used in RDT to help determine if a packet has dropped. TCP will retransmit a packet, and restart the timer, upon a timer interrupt.

2) What is the key point of a cumulative acknowledgement scheme?
The ACK you receive is for the next expected byte number. This means that an ACK for byte #N means that all bytes (N-1, N-2, … 1) have already been received.

3) If a TCP sender sends packets with sequence numbers 100, 200, and 300, and has several more packets (all of 100 bytes) waiting in the sending buffer, and two ACKs are received back, with ACK numbers 200 and 300, what is the next step for the sender?
Re-transmit packet with sequence number 300.

4) If a TCP sender sends packets with sequence numbers 100, 200, and 300, and has several more packets (all of 100 bytes) waiting in the sending buffer, and only one ACK is received, with ACK number 400, what is the next step for the sender?
Send packet with sequence number 400

5) If a TCP sender sends packets with sequence numbers 100, 200, and 300, and has several more packets (all of 100 bytes) waiting in the sending buffer, and no ACKs are received back, what is the next step for a TCP sender?
Wait for a timer interrupt. If countdown timer expires, re-send packet with sequence number 100.

6) What are the key points of a Selective Repeat retransmission scheme.
Selective repeat retransmission will keep a countdown timer for each un-ACK'd segment. When the protocol calls for a retransmission, it will only re-transmit un-ACK'd segments individually, rather than a bulk dump of all un-ACK'd segments.

7) What is the purpose of fast retransmit? How is it implemented?
Fast retransmit was originated to streamline the process of retransmissions, to increase utilization. If a TCP sender sees three duplicate ACKs (so four ACKs total) for the same segment, it assumes the segment was dropped, and retransmits, even if the countdown timer hasn't expired.

8) HostA has established a TCP connection with HostB in a remote network. HostA is sending packets to HostB, and HostB immediately acknowledges every packet. Assume that the timeout is the same for all packets. HostB's "window size" is 2000 bytes. HostB has already received and acknowledged everything sent by HostA's application up to and including byte #140. HostA now sends packets of the same application data stream in order: P (50 Bytes), Q (60 Bytes), and R (100 Bytes).

   a. What are the sequence numbers on packets P, Q, and R?
      P: 141 Q: 191 R: 251

   b. Suppose that packets P, Q, and R arrive in order at HostB. What are the acknowledgement numbers in the ACK's for packets P, Q, and R?
      P: 191 Q: 251 R: 351

   c. Suppose that packet Q arrives at HostB before packet P. What is the acknowledgement number in the ACK for packet Q? If packet P arrives after packet Q (but before packet R), what is the acknowledgement number in the ACK for packet P?
      Q: 141 (still expecting packet P)
      P: 251 (cumulative ACK for P and Q)

   d. Suppose that packet P is lost, but packets Q and R are received. What is the acknowledgement number in the ACK for packet R?
      R: 141 (still expecting packet P)