CS 372 Introduction to Computer Networks
Self-Check Exercises: Lecture 23 **Solutions**

1) Describe the steps of the TCP connection setup.
   1) SYN: Client host sends a segment to the Server host with the SYN bit set, the ACK bit cleared, and some pre-generated sequence number.
   2) SYN ACK: Server host sends a segment to the Client host with the SYN and ACK bits set, a locally generated sequence number, and an ACK number equal to the first segment's sequence number plus one.
   3) ACK: Client host sends a segment to the Server host with the ACK bit set, the SYN bit cleared, and the ACK number is the previous segment's sequence number plus one. Note that this segment may contain actual application data in the payload.

2) Describe the steps of the TCP connection takedown.
   1) FIN: Client host sends a segment to the Server host with the FIN bit set, the ACK bit cleared, and its next sequence number.
   2) FIN ACK: Server host sends a segment to the Client host with the ACK bit set and Fin bit cleared. The ACK number is the next expected sequence number. (This is a normal TCP ACK segment).
   3) FIN: Server host sends a segment to the Client host with the FIN bit set, the ACK bit cleared, and its next sequence number.
   4) FIN ACK: Client host sends a segment to the Server host with the ACK bit set and the FIN bit cleared, and the ACK number is the previous segment's sequence number plus one. (This is a normal TCP ACK segment)

3) What is fairness in TCP?
   The goal is to share bandwith evenly amongst all connections through a router. TCP works toward fairness due entirely to its congestion window size algorithm. This is on a per-connection basis, so for example a web browser which spins off a connection for every image it has to download (in parallel) would not be "fair" to a single-connection FTP transfer.

4) Is the UDP protocol fair?
   No, UDP does not utilize any fairness-allowing schemes.

5) What does TCP do better than UDP?
   While there are quite a number of answers to this question, the basics are that TCP's reliable data transfer is the most endearing aspect it has to an end user, and congestion control for the network core.

6) What does UDP do better than TCP?
   Throughput.

7) Fill in the missing values and flags in the following connection setup ("handshake") between client and server. ('X' means "not required".)

Event	Seq#	ACK#	ACK	SYN	FIN
Client requests connection to server.	72	X	0	1	0
Server responds to request, allowing connection.	25	73	1	1	0
Client confirms connection.	0	26	1	0	0

8) Fill in the missing values and flags for the client closing the connection ("teardown") between client and server. ('X' means "not required".)

Event	Seq#	AC #	ACK	SYN	FIN
Client closes connection.	72	X	0	0	1
Server ACK's request.	X	73	1	0	0
Server closes its side of the connection.	25	X	0	0	1
Client ACK's, and times out.	0	26	1	0	0

9) Given a 1 Gbps link with TCP applications A, B, and C. Application A has 3 TCP connections to a remote web server; application B has 1 TCP connection to a mail server; application C has 4 connections to a remote web server. According to TCP "fairness" … during times when all connections are transmitting, how much bandwidth should each application have?

There are 8 connections, so TCP will rotate among the connections. The effect is that each connection gets 1/8 of the total bandwidth, i.e., 125 Mbps.

A gets 3/8 = 375 Mbps

B gets 1/8 = 125 Mbps

C gets 1/2 = 500 Mbps