1.) The socket interface is useful for network programming.

a.) What function is used to associate the socket descriptor to the IP address of the host?

b.) What information structure is returned by the DNS server?

c.) What are the main purposes of the htonl() and the ntohl() functions?

2.) Consider the Web proxy server.

a.) Describe how the Web proxy server ensures that its copy of a Web page in its cache is up-to-date and that the Web page in the origin server is not modified since its copy was cached.

b.) Show the messages that must be exchanged between the Web proxy server and the origin server in the timeline below. In the messages, show the field in the HTTP header that must be used and the important content of the messages. In the diagrams below, show the above message exchanges for two cases:

i.) The Proxy server Web page is up-to-date.

ii.) The Proxy server Web page is out-of-date.

3.) Consider the following institutional network that is connected to the Internet (Figure 2). Suppose that the average object size is 450,000 bits and that the average request rate from the institution's browsers to the origin servers is 32 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is 3 seconds on average. Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institutional router) and the average Internet delay. Assume that if the utilization at the access link is less than 60%, then the queuing delay is 0.

a.) Calculate the access link utilization.

b.) Estimate the total average resposne time. Justify your answers.

c.) Now suppose a cache is installed in the institutional LAN. Suppose the cache hit rate is 0.4. Find the total response time.

4.) To determine the appropriate timeout value to use for TCP, a sender X must estimate the round trip time (RTT) by sampling the RTT.

a.) Suppose X tries to compute a sample RTT by sending a segment S at time t0 to Y but X did not receive the ACK before it times out and retransmits S at time t1. It then receives an ACK from Y at time t2. Suppose, X then computes the sample RTT as t2 - t1. Is this computed sample RTT correct? If so, explain why. If not, explain why not and what is the correct way to compute the sample RTT if any. Use diagrams in your explanations.

b.) How does TCP handle the above scenario so that it can compute the average RTT correctly? Justify your answer.

c.) How does TCP calculate the estimated RTT from the sample RTT? Give the formula that TCP uses.

5.) Consider the following transmission of data segments and ACK in TCP to ensure reliable data transfer.

a.) What should be the values of the following segment and ACK numbers?

i.) X1 =

ii.) X2 =

iii.) X3 =

iv.) X4 =

b.) What should be the values of the following segment and ACK numbers?

i.) Y1 =

ii.) Y2 =

iii.) Y3 =

iv.) Y4 =

v.) Y5

c.) Does TCP use go-back-N or Selective Repeat protocol for reliable data transfer? Why does TCP use that protocol?

6.) Consider fast retransmit feature of TCP.

a.) Describe in detail the fast retransmit method; explain how it is triggered.

b.) Is the performance of TCP better with fast retransmit or with timeout? Explain why.

c.) Is the congestion in the network more severe when fast retransmit is triggered or when timeout occurs? Explain why.