1. Explain briefly what is ISO/OSI 7-layer protocol reference model? What are the advantages of dividing the network protocol into layers? What are the possible problems behind it?
2. What is CSMA/CD? What is CSMA/CA? Please explain their operations briefly. What is hidden terminal problem and what is exposed terminal problem of CSMA/CA? Please draw pictures to explain them briefly.
3. What is circuit switching? What is packet switching? What is FDM? What is TDM? And what is CDMA?
4. What is P2P architecture? What is client-server architecture? Pleas also give an example for both. What is hybrid of client-server and P2P?
5. Please draw diagrams to show input port functions and output port functions for a router and explain their functions briefly.
6. Please write pseudo codes for link state algorithm and Bellman-Ford algorithm, respectively.
7. In the class we describe how to Google a web page in a day in the life of a web request. Please explain it as detailed as you remember.
8. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters. And suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to host B.
   (a) Express the propagation delay, d_{prop}.
   (b) Determine the transmission time of the packet, d_{trans}.
   (c) Suppose d_{trans} is less than d_{prop}. At time t= d_{trans}, where is the first bit of the packet?
   (d) Suppose $s=2.5x10^8$, L=120 bits and R= 56 Kbits. Find the distance m so d_{trans} equals d_{prop}.
9. Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose n DNS severs are visited before your host receives the IP address from DNS; visiting k of them incurs an RTT of D_1 per DNS and visiting each of the remaining incurs an RTT of D_2. Further suppose that the Web page associated with the link contains m very small objects. Suppose the HTTP running is non-persistent and let RTT_0 denote the RTT between the local host and the server for each object.
   (a) Assuming zero transmission time of each object, how much time elapses from when the client clicks on the link until the client receives all the objects?
   Suppose the HTML file references three very small objects on the same server. Neglecting transmission times, how much time elapses with
   (b) Non-persistent HTTP with no parallel TCP connections?
   (c) Non-persistent HTTP with the browser configured for five parallel connections?
   (d) Persistent HTTP?
10. In the problem, we consider the delay introduced by the TCP slow-start phase. Consider a client and a web server directly connected by one link of rate R. Suppose the client wants to retrieve an object whose size is exactly equal to 15 S, where S is the maximum segment size (MSS). Denote the round-trip time between client and server as RTT (assumed to be constant). Ignoring protocol headers, determine the time to retrieve the object (including TCP connection establishment) when
    (a) 4S/R>S/R+RTT>2S/R
    (b) S/R+RTT>4S/R
    (c) S/R>RTT