Name: ___________________
Student #: ________________

King Fahd University of Petroleum and Minerals
College of Computer Sciences and Engineering
Department of Computer Engineering

COE 344 – Computer Networks (T072)

Major Exam # 01

Date & Time: Sunday March 30, 2008 (8:00 PM – 10:00 PM)

- **This is a CLOSED books, CLOSED notes exam.**
- **Show all your work. NO credit will be given if work is not shown.**
- **Answer ALL problems.**

Problem #	Mark	Score
1	6	
2	4	
3	15	
4	35	
5	30	
6	10	
Total	**100**	

Problem # 1 (6 points; 1 point each): Mark the following with TRUE or FALSE:

	Statement	***TRUE/FALSE***
1.	Suppose a user requests a Web page that consists of some text and two referenced images. For this page the client will send one request message and receive three response messages.	
2.	Two distinct Web pages (*www.kfupm.edu.sa* and *www.hotmail.com*) can be sent over the same persistent connection.	
3.	In datagram networks, the destination address in the packet determines the next hop. Furthermore, routers may change during the session.	
4.	Packets queue in router buffers if the packet arrival rate to the link exceeds the output link capacity.	
5.	The IP address of the host on which the process runs is not sufficient for identifying the process.	
6.	In Web caching, the user agent directs all requests to a local proxy server. If the proxy server does not have the requested object it directs the user agent to contact the origin server directly.	

Problem # 2 (4 points; 1 point each): For each of the following questions select the most appropriate answer:

i. Connection-oriented service guarantees _______________.
   a. handshaking
   b. reliable data transfer
   c. congestion control
   d. both a. and b.
   e. both a. and c.
   f. both b. and c.
   g. all of a., b., and c.
   h. none of the above

ii. _________________________ is/are considered time insensitive application(s).
   a. HTTP
   b. FTP
   c. Audio streaming
   d. both a. and b.
   e. both a. and c.
   f. both b. and c.
   g. all of a., b., and c.
   h. none of the above

iii. A resource record for a hostname will always be found in _______________ DNS name server.
   a. local
   b. root
   c. authoritative
   d. both a. and b.
   e. both a. and c.
   f. both b. and c.
   g. all of a., b., and c.
   h. none of the above

iv. _______________ can be used as mail access protocol.
   a. HTTP
   b. SMTP
   c. POP3
   d. both a. and b.
   e. both a. and c.
   f. both b. and c.
   g. all of a., b., and c.
   h. none of the above

Problem # 3 (15 points; 5 points each):

Consider two hosts each sending a file of $F = M * L$ bits to the same destination host over a path of Q links. Each link transmits at $\boldsymbol{R}$ bps. The network is lightly loaded so that there are no queuing delays. Packet switching is used and the $M * L$ bits are broken up into M packets, each packet with L bits. Both propagation and processing delays are negligible. Assume that the transmissions of the two hosts alternate on each of the Q links of the path (i.e. on each link, the transmission of a packet of the first host is always followed by the transmission of a packet of the second host).

a. Suppose the network is a packet-switched virtual-circuit network. Denote the VC set-up time by $\boldsymbol{t_s}$ seconds. Suppose to each packet the sending layers add a total of $\boldsymbol{h}$ bits of header. How long does it take to send the file from each source to destination?
b. Suppose the network is a packet-switched datagram network, and a connectionless service is used. Now suppose each packet has $\mathbf{2}\boldsymbol{h}$ bits of header. How long does it take to send the file from each host?
c. Repeat (b), but assume message switching is used (i.e., $\mathbf{2}\boldsymbol{h}$ bits are added to the message, and the message is not segmented).

Problem # 4 (35 points; 7 points each):

a. Suppose within your web browser you click on a link to obtain a web page. Suppose that the IP address for the associated URL is not cached in your local host, so that a DNS look-up is necessary to obtain the IP address. Suppose that three (3) DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of RTT_1, RTT_2, and RTT_3. Further suppose that the web page associated with the link contains exactly one object, the base HTML file. Assume that a proxy server is used and the requested web page is not cached by the proxy server. Let RTT_0 denote the RTT between the local host and the proxy server. Likewise, let RTT_0 denote the RTT between the proxy server and the server containing the object. Assuming zero transmission time of the object (i.e. base HTML file), find the amount of time that elapses from when the client clicks on the link until the client receives the object.

b. Suppose the base HTML file of part (a) indexes two (2) objects that reside on a ***different*** server than the server hosting the base HTML file, and the IP address of such a server is not cached in your local host. Assume that the proxy server already have a cached copy of the two indexed objects. Let RTT_0 denote the RTT between the local host and the proxy server. Likewise, let RTT_0 denote the RTT between the proxy server and the server containing the two indexed objects. Assuming the transmission time for each of the two indexed objects is $\boldsymbol{t_{trans}}$, find the total amount of time that elapses to obtain the two objects, including the time to obtain the base HTML file found in part (a), with:

   i. nonpersistent HTTP with no parallel TCP connections

   ii. nonpersistent HTTP with parallel TCP connections

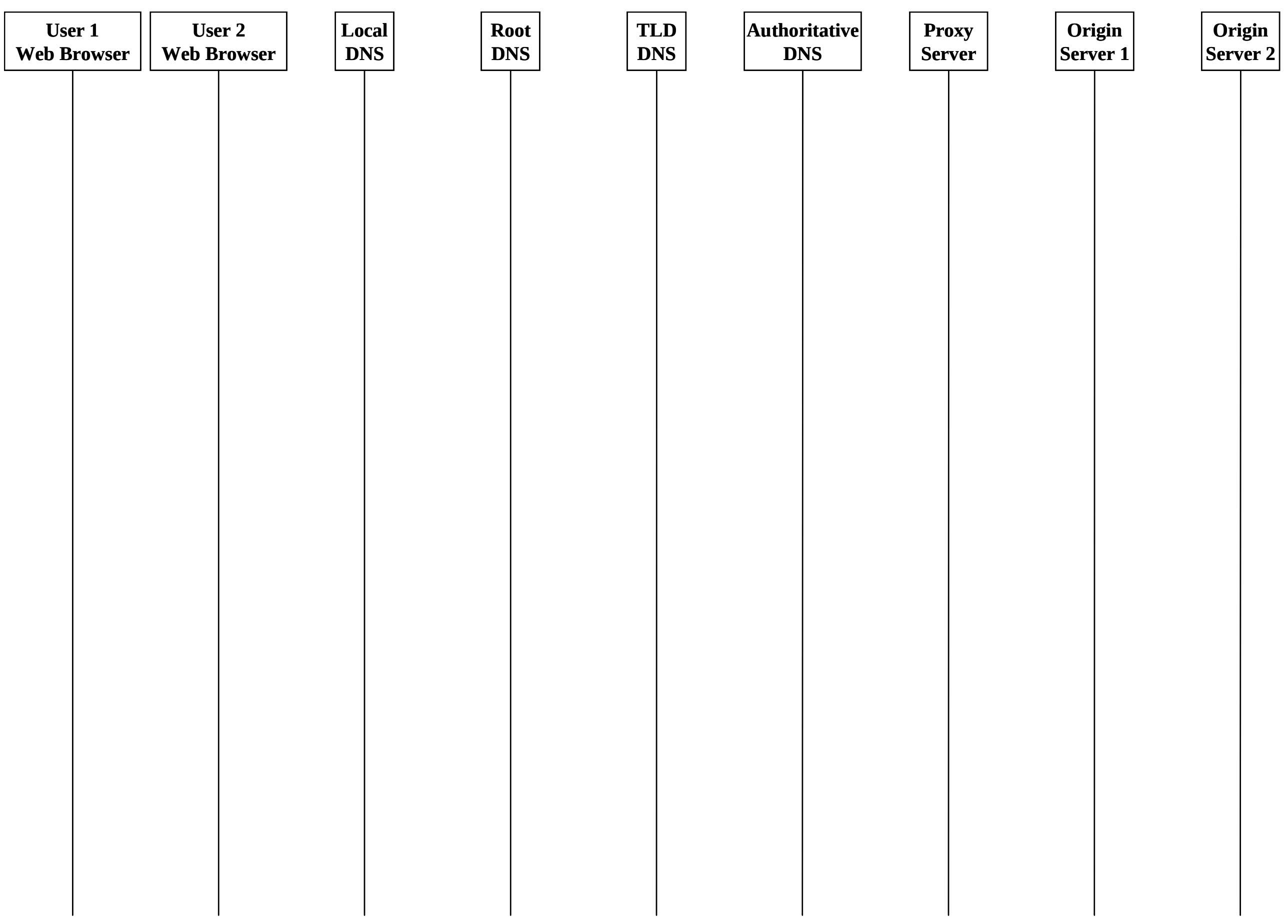
   iii. persistent HTTP without pipelining

   iv. persistent HTTP with pipelining

Problem # 5 (30 points; 10 points each):

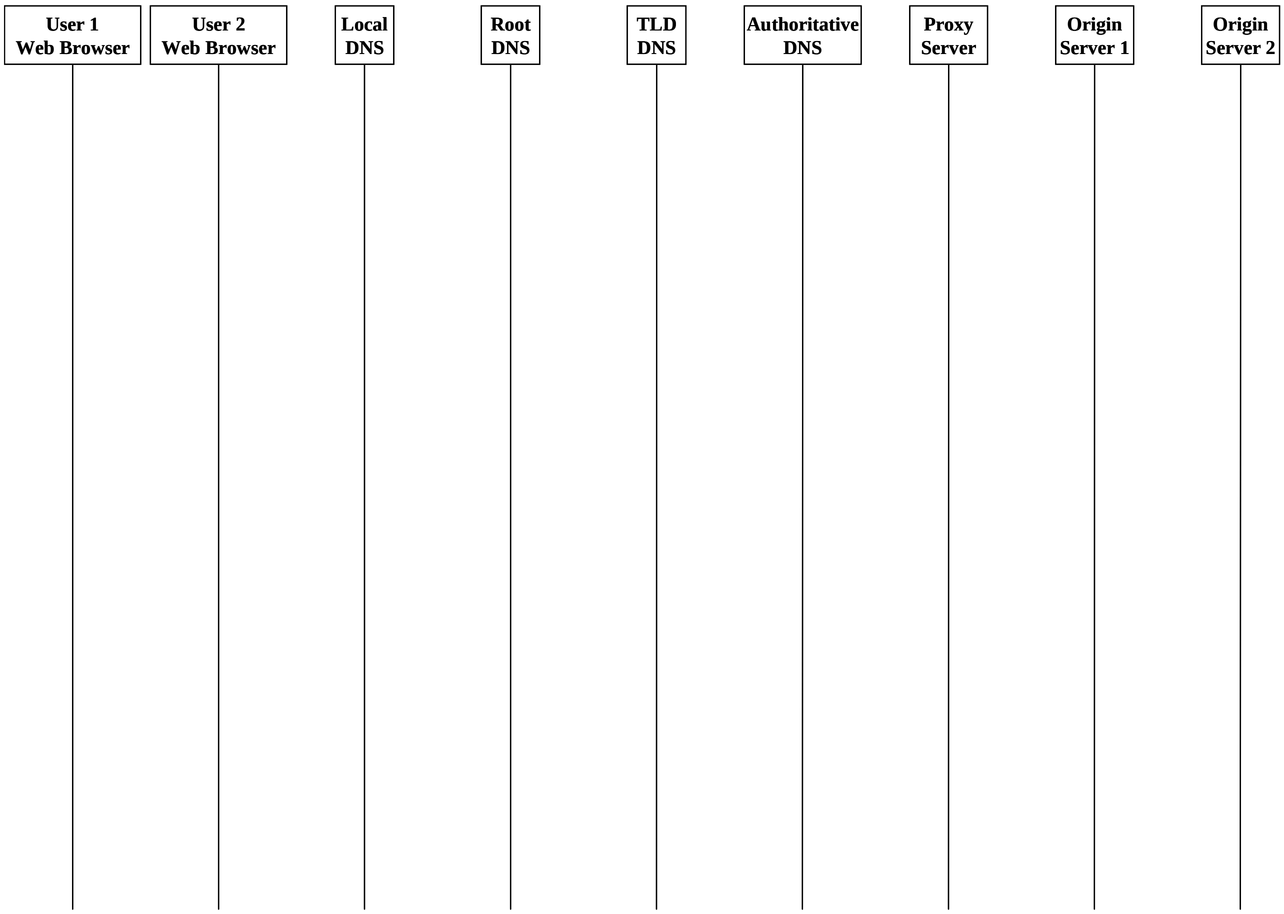
1. Suppose two users request the same web page. Assume the following:
    a. The second user requests the web page after the first user finishes receiving the requested web page.
    b. The IP address of the server hosting the requested web page is initially not known to the web browser of both users.
    c. If needed, an iterative DNS query is used. The IP address of the requested web page will always be found after querying the authoritative DNS server.
    d. Both users are configured to use the same local DNS server and that the local DNS server initially contains no resource records.
    e. The local proxy server is bypassed (i.e. not used).
    f. Persistent HTTP with pipelining is used.

Utilizing the following diagram, use labeled arrows to show the complete sequence of messages from the moment the first user requests the web page until the second user receives the requested web page. (note that the names of possible messages that can be used are *TCP connect. request*, *TCP connect. granted*, *HTTP request*, *HTTP response*, *DNS query*, *DNS reply*)



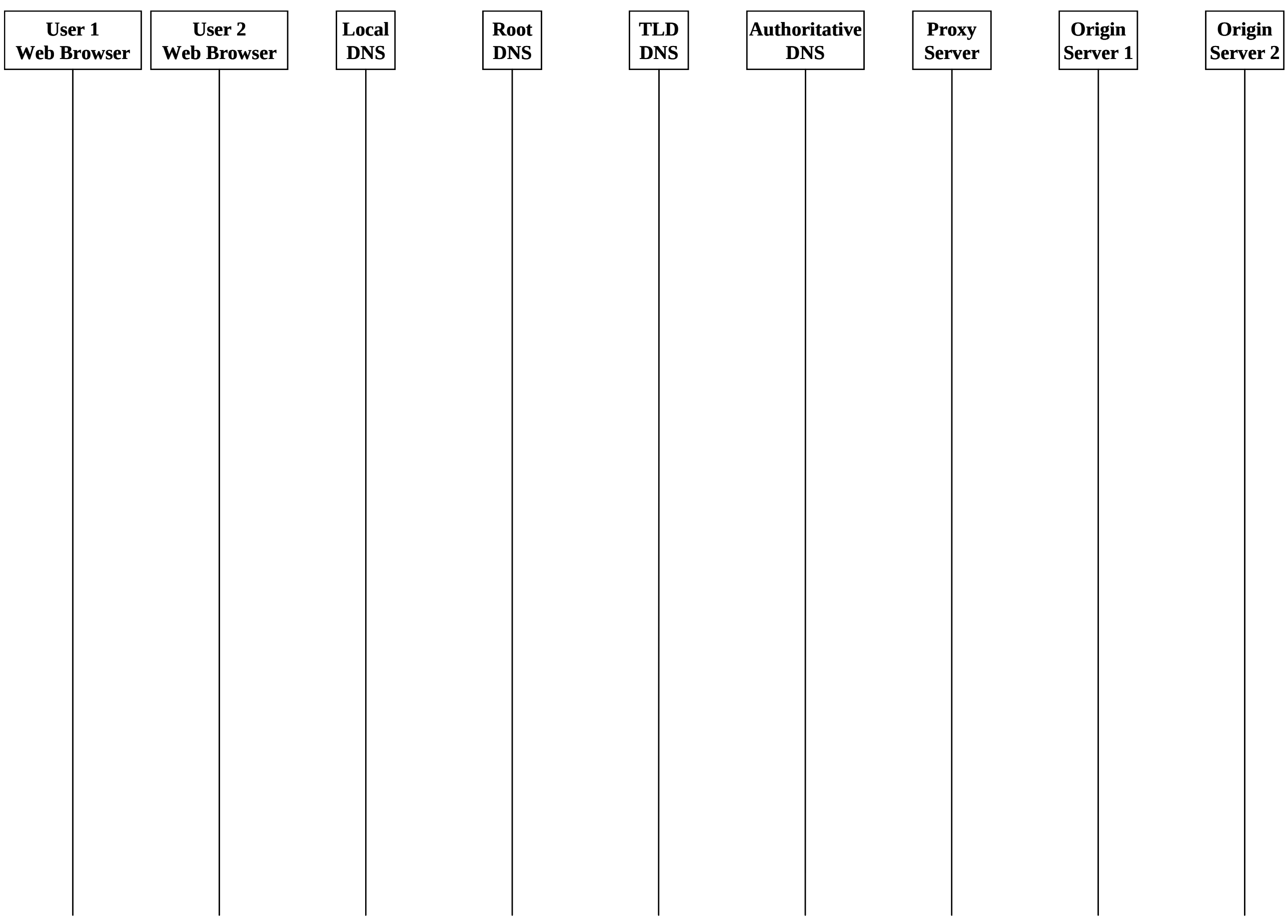
2. Suppose two users request the same web page. Assume the following:
    a. The second user requests the web page after the first user finishes receiving the requested web page.
    b. The IP address of the server hosting the requested web page is initially not known to the web browser of both users.
    c. If needed, an iterative DNS query is used. The IP address of the requested web page will always be found after querying the authoritative DNS server.
    d. Both users are configured to use the same local DNS server and that the local DNS server contains the resource record for the requested web page.
    e. The local proxy server is bypassed (i.e. not used).
    f. Persistent HTTP with pipelining is used.

Utilizing the following diagram, use labeled arrows to show the complete sequence of messages from the moment the first user requests the web page until the second user receives the requested web page. (note that the names of possible messages that can be used are *TCP connect. request, TCP connect. granted*, *HTTP request*, *HTTP response*, *DNS query*, *DNS reply*)



3. Suppose two users request the same web page. Assume the following:
   a. The second user requests the web page after the first user finishes receiving the requested web page.
   b. The IP address of the server hosting the requested web page is initially not known to the web browser of both users.
   c. If needed, an iterative DNS query is used. The IP address of the requested web page will always be found after querying the authoritative DNS server.
   d. Both users are configured to use the same local DNS server and that the local DNS server contains the resource record for the requested web page.
   e. The local proxy server is used and the requested web page is not cached.
   f. Persistent HTTP with pipelining is used.

Utilizing the following diagram, use labeled arrows to show the complete sequence of messages from the moment the first user requests the web page until the second user receives the requested web page. (note that the names of possible messages that can be used are *TCP connect. request*, *TCP connect. granted*, *HTTP request*, *HTTP response*, *DNS query*, *DNS reply*)



Problem # 6 (10 points; 5 points each):

Consider the figure shown below, for which there is an institutional network connected to the Internet. Suppose that the average object size is 900,000 bits and that the average request rate from the institution's browsers to the origin servers is 1.5 requests per second. Also suppose that the amount it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is three (3) seconds on average. Model the total average response time as the sum of the average access delay (i.e. the delay from Internet router to institution router), and the average Internet delay. For the average access delay, use $\Delta / (1 - \Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link.

a. Find the total average response time.
b. Now suppose a cache is installed in the institutional LAN. Suppose the hit rate is 0.6, and, on a hit, the response time is 10 milliseconds. Find the total response time.