Indian Institute of Engineering Science and Technology, Shibpur
B.Tech. (CST) 6th Semester End-Semester Examination, May 2021
Subject: Computer Networks (CS - 602)

Time: 1.5 hours **Full Marks: 70**

Answer *all* Questions
(Write all parts of the same question together. Start every question in a new page)

1. Answer the following (in brief) [20]
   a) Name three mechanisms by which TCP ensures reliable data transfer. [3]
   b) What is the difference between routing and forwarding? [2]
   c) Do routers have IP addresses? If so, how many? [2]
   d) Name one inter-AS and one intra-AS routing protocols. [2]
   e) What are the different parts and planes in a router? Name the type of network where a part of the router's control plane is implemented externally in a centralized server. [4+1]
   f) What kind of routing protocol is the *Reverse Path Forwarding (RPF)*? Briefly write its forwarding mechanism. [1+3]
   g) Give examples of network architecture which uses (i) connection and (ii) connection-less service at the network layer. [2]

2. 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 that k DNS servers are visited before your host receives the IP address from DNS; the successive visits incur round-trip times (RTT) of $RTT_1, \ldots, RTT_k$, respectively. Let RTT_0 denote the *RTT* between the local host and the server containing the object. Suppose the Web page associated with the link contains a HTML file that references five very small objects on the same server. Neglecting transmission times, how much time elapses with:
   i. Non-persistent HTTP with no parallel TCP connections?
   ii. Non-persistent HTTP with the browser configured for three parallel connections?
   iii. Persistent HTTP?

   [4+4+4 = 12]

3. a) Suppose that the three measured `SampleRTT` values are 106 ms, 120 ms, and 140 ms.
   i. Compute the `EstimatedRTT` after each of these `SampleRTT` values is obtained, using a value of $\alpha = 0.15$ and assuming that the value of `EstimatedRTT` was 100 ms just before the first of these three samples were obtained.
   ii. Compute also the `DevRTT` after each sample is obtained, assuming a value of $\beta = 0.25$ and assuming the value of `DevRTT` was 5 ms just before the first of these three samples was obtained.
   iii. Finally, compute the TCP `TimeoutInterval` after each of these samples is obtained.

   b) Consider Fig. 1 given below. Assuming `TCP Reno` is the protocol experiencing the behavior shown below, answer the following questions (give brief justifications wherever necessary).

i. Identify the intervals of time when TCP slow start is operating.
ii. Identify the intervals of time when TCP congestion avoidance is operating.
iii. After the 16th transmission round, is segment loss detected by a triple duplicate *ACK* or by a timeout?
iv. After the 22nd transmission round, is segment loss detected by a triple duplicate *ACK* or by a timeout?
v. What is the initial value of `ssthresh` at the first transmission round?

[(3+3+3) + (1x5) = 14]

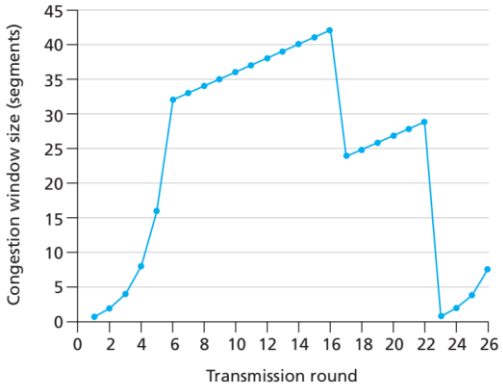

Figure 1: TCP window size as a function

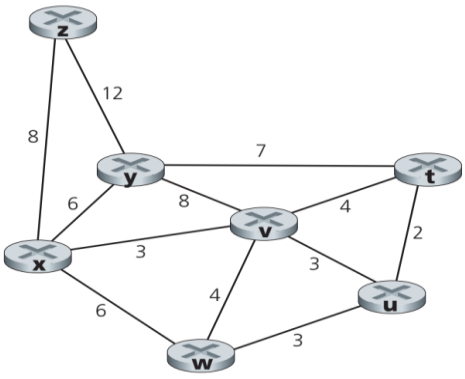

Figure 2: Example Network

4. a) Suppose an organization has network address 202.55.12.0/28. Find the following:
   i. Number of subnets and number of hosts in each subnet.
   ii. Network prefixes (of the form *a.b.c.d/x*) of first three subnets.
   iii. Host address range for first three subnets.

   b) Let a datagram (packet id: 777) of size 1024 bytes has to pass through two different networks (*N1* and *N2*) whose MTUs are 600 and 400 bytes respectively, to reach the destination (see Fig. 3). Specify the IP datagram fields (`length, offset, flag`) related to fragmentation: (i) while passing through the network whose MTU is 600 and (ii) while passing through the network whose MTU is 400.

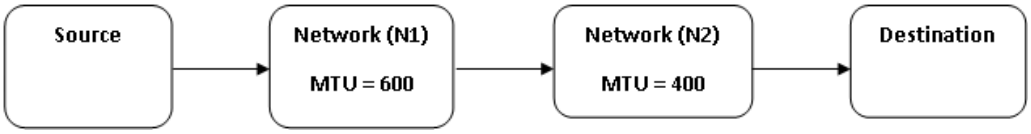

Figure 3: Maximum Transfer Unit (MTU)

   c) Consider the network shown in Fig.2. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from `x` to all network nodes. Show how the algorithm works by computing the following table where `N'` is the subset of nodes visited till now, `D(v)` is the cost of the least-cost path from the source node to any destination `v`, and `p(v)` is the previous node (neighbor of `v`) along the current least-cost path from the source to `v`.

Step	*N'*	*D(t), p(t)*	*D(u), p(u)*	*D(v), p(v)*	*D(w), p(w)*	*D(y), p(y)*	*D(z), p(z)*	*Shortest Path Tree*

[(2+3+3) + (3x2) + 10 = 24]