Department of Computer Science	Computer Networks
Vrije Universiteit	01.06.2006

Always explain your answers concisely and be sure to be to-the-point.

Part I

This part covers the same material as the midterm exam.

1a List the seven layers of the OSI reference model and briefly explain the purpose of each layer. *7pt*

1b Explain the difference between a **(communication) service** and a **(communication) protocol**. *5pt*

1c The Berkeley *socket* interface offers a connect primitive to associate a receiver's address with a local communication endpoint. This primitive can be used for TCP as well as for UDP, as shown for UDP in the example below. Does this mean that UDP is now offered as a connection-oriented service? *5pt*

```
struct sockaddr_in serv_addr = ...;   /* Initialize to the server's address     */
sd = socket(PF_INET, SOCK_DGRAM, 0);  /* Create a communication endpoint        */
connect(sd, serv_addr, ...);          /* Associate the server's address with sd */
send(sd, &data, ...);                 /* Send data to the server                */
connect(sd, 0, ...);                  /* Remove the association                 */
```

2a Consider a sliding window protocol, and explain how the window size should be changed when (1) the signal propagation delay between sender and receiver increases, and (2) when the transmission rate increases. Explain your answers! *4pt*

2b Show that when the maximum window size is larger than half the range of sequence numbers in a sliding window protocol, it may be impossible to detect duplicate packets. *6pt*

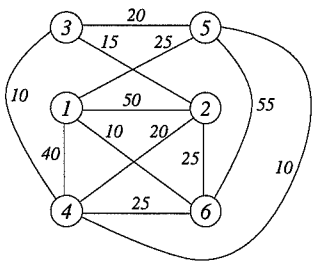
3a Explain why a contention slot in Ethernet must last at least 2τ time units, where τ is the maximum (allowed) signal delay on a cable. *6pt*

3b Ethernet uses a **binary exponential backoff algorithm** after detecting a collision. How does this work? *6pt*

3c What is meant by the problem of hidden or exposed stations in wireless networks, and how can it be solved? *6pt*

Part II

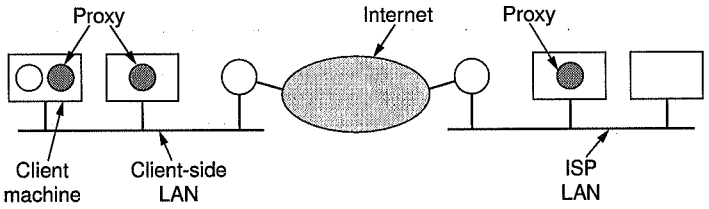
4a Explain how Dijkstra's algorithm works for node #1 in the following network. *5pt*



4b Assume that distance vector routing is used in the above network. How will node 2 discover its shortest path to node 1? *5pt*

4c Explain what the count-to-infinity problem is. *5pt*

5a The figure below shows three **proxies** for improving Web performance. Explain how this improvement is established. *5pt*



5b Consider a content delivery network (CDN) with proxies at numerous ISPs. Explain how CDNs help in improving performance by detailing the steps that are made when fetching the main page of a site that is supported by a CDN. *10pt*

6a What are the four important properties of a **message digest**? *5pt*

6b Consider a communication system in which Bob wants to know for sure whether a message he receives is genuine. Explain how we can accomplish such guarantees on message integrity. *5pt*

6c A **certification authority** (CA) certifies public keys. How does it actually do this, and how is the public key of a CA certified? Be precise! *5pt*

Final grade: *(1) Add, per part, the total points. (2) Let T denote the total points for the midterm exam ($0 \leq T \leq 50$); $D1$ the total points for part I; $D2$ the total points for part II. The final number of points E is equal to* $\max\{T, D1+5\}+D2+5$.