Dept. Math. & Comp. Sc.	**Midterm Computer Networks**
Vrije Universiteit	**01.04.2005**

1a List the layers of the OSI reference model, and briefly describe each of them. *10pt*

(1) Physical layer: describes the transmission/encoding of the bits. (2) Data link layer: groups bits into frames in order to allow for error correction and detection. Also handles flow control. (3) Network layer: contains the protocols for routing packets from A to B. (4) Transport layer: provides services for connection-oriented and connectionless communication. It essentially contains those protocols that enable applications to send messages to each other. (5) Session layer: contains special protocols that support the notion of a session, which consists perhaps of multiple TCP connections. (6) Presentation layer: contains the protocols for representing data in a platform or network-independent way. (7) Application layer: all other protocols, including DNS, E-mail, NNTP, etc.

1b Explain the role of a backbone in the Internet. *5pt*

A backbone is a long-haul network that is generally operated by one of the larger telecoms. Its main function is to provide regional ISPs with a service for forwarding traffic to other ISPs, possibly located at remote places in the Internet.

2a What does Fourier analysis actually tell us about digital signals? *5pt*

It tells us that we can perceive a digital signal as being constructed as an infinite number of regular periodic analog signals (i.e., sines and cosines). This model helps understand why digital signals are distorted due to attenuation and transmission delays, which are both frequency dependent.

2b There are three different modulation techniques. Describe each of them briefly. *5pt*

(1) Frequency modulation: encode the difference between a binary 1 and a binary 0 by using different frequencies. (2) Amplitude modulation: encode the difference by using different signal amplitudes. (3) Phase modulation: encode the difference by sudden phase shifts.

2c What is the role of a splitter in ADSL? *5pt*

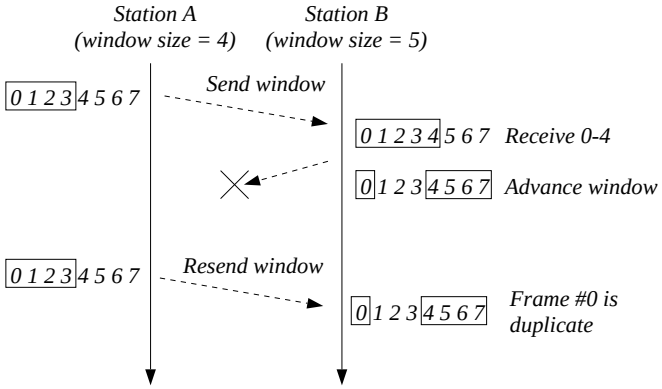
ADSL uses many 4 kHz channels, of which one is used for regular phone conversations. To separate this channel from the other channels, a splitter is used which effectively works as a combined low-band and high-band filter.

3a Assume a frame is delimited by the flag byte 01011011. What would you do when this byte is to be sent as data in the payload of the frame? *5pt*

You could either use a special escape character to indicate that the next byte is special. Alternatively, you could apply bit stuffing, in which case after having put 0101101 into the payload, you would insert a 0 (not a 1!) before storing the last bit in the payload. This bit is automatically removed by the receiver when it detects the pattern 01011010.

3b Explain, by means of an example, why the number of sequence numbers in a sliding window protocol needs to be at least twice as large as the window size. *5pt*

Explain this by drawing something similar to the following figure, and show what happens when the acknowledgement is lost.



3c If the propagation time is high, and the transmission speed is high, we generally prefer a large window size. Why can we reduce the window size if the propagation time decreases? *5pt*

Your answer should include the argument that you would at least need something proportional to the storage capacity *of the transmission medium in bits. When the propagation time decreases, so does the storage capacity, as fewer frames can be simultaneaously in transmission. For this reason, the window size can be reduced.*

Grading: *The final grade is calculated by accumulating the scores per question (maximum: 45 points), and adding 5 bonus points. The maximum total MT is therefore 50 points. The final exam consists of two parts. Part 1 covers the same material as the midterm. Let $P1$ be the number of points for part 1, and $P2$ the number of points for part 2 (each being at most 50 points). The final grade E is computed as $E = \max\{MT, P1\} + P2$. The midterm exam counts only for first full exam.*