DATA COMMUNICATION – EDA340

Final Exam 14 December 2000, 8.45 – 12.45 in hall V

Examinator:
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Allowable means of assistance: Only writing tools and accessories, word lists and dictionaries are allowed.

Content: The final exam consists of 5 (five) pages (including cover), containing 7 problems worth a total of 60 marks.

Grading:
24–35 $\Rightarrow$ 3
36–47 $\Rightarrow$ 4
48–60 $\Rightarrow$ 5

Solution: Available Thursday December 14, 15.00 on the department notice board as well as on the web page of the course.

Results: Available Monday December 18, 10.00 on the department notice board.

Inspection *(granskning)***:** Monday December 18, 14.30-15.30, ED-huset, Henry Wallmans room.

Language: The assignment is written in English. Your solution MUST also be written in English.

Important Issues

1. Justify all answers. Lack of justification can lead to loss of credit even if the answer might be correct.
2. Explain all calculations thoroughly. If justification and method is correct then simple calculation mistakes does not necessarily lead to loss of credit.
3. If some assumptions in a problem are missing or you consider that the made assumptions are unclear, then please state explicitly which assumptions you make in order to find a solution.
4. Write clearly. If I cannot read your solution, it is wrong.

Good Luck!

Problem 1

Determine whether the following statements are true or false. Each correct answer gives 1 mark, each wrong answer gives -1 mark, each unanswered question gives 0 marks. The total score of this problem cannot be less than zero. (6 marks)

(a). BPSK is referred to as orthogonal signalling.

(b). In load shedding, it is always the oldest datagrams that are discarded.

(c). In transparent fragmentation, every router must be able to re-assemble a datagram.

(d). Bandwidth efficiency is expressed in terms of bits per second per Hertz.

(e). A promiscuous bridge reads all frames regardless of address.

(f). Suppose a user requests a Web page that consists of some text and two images. For this page, the client will send one request message and receive three response messages.

Problem 2

(a). The layered network model is a fundamental concept in all network design. What are the five layers in the Internet protocol stack? What are the principal responsibilities of each of these layers? (3 marks)

(b). Suppose that you send an email from a Web-based email account (such as hotmail.com) to a friend who accesses his mail from his mail server using POP3. Discuss how the message gets from your host machine to your friend's host machine. Be sure to list all application layer protocols as well as transport and network layer protocols used in the transfer of the email. (3 marks)

(c). The email message above is encapsulated into segments and datagrams and eventually it traverses a network using link state routing. The following set of link state packets have been received at router A:

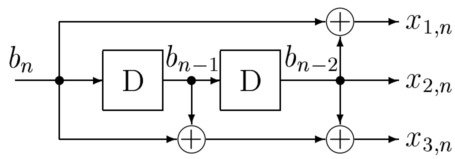
A		B		C		D		E		F	
B	1	A	1	B	5	A	4	B	4	B	2
D	4	C	5	E	1	E	1	C	1	D	4
		E	4			F	4	D	1	E	1
		F	2					F	1		

What is the network topology? You may draw a figure, illustrating the topology. Use Dijkstra's algorithm to find the new routing table for router A. Make sure to show all steps of Dijkstra's algorithm in a convenient table. (4 marks)

Problem 3

(a). What is introduced when coding is used and what potential benefits can be achieved using coding? (2 mark)

(b). Consider the convolutional code shown below.



What is the rate of the code and what are the generators of the code? (2 marks)

(c). Complete the following input/output table for the code and draw the corresponding trellis section with all relevant information inserted at appropriate places. (4 marks)

b_n	0 1 0 1 0 1 0 1
e_n	
$\mathbf{x}_n$	
e_{n+1}	

Here, e_n is the state at time n and $\mathbf{x}_n$ is the output code bits at time n.

Problem 4

(a). Assume that a CRC code is used for error detection. Describe how codewords are generated and how errors are detected. (2 marks)

(b). In a system using $g(x) = x^2 + x + 1$ as the generator polynomial, the following string of bits are received:

1001111

Will any errors be detected? Explain. (3 marks)

(c). The CRC code is used for error detection in a repeat-select ARQ scheme. We have k bits available for sequence numbering. What is the maximum size of the receive window so that the protocol works correctly? Discuss in detail why this is the maximum. You may use illustrating examples. (3 marks)

Problem 5

(a). What kind of medium access control is used in the Ethernet LAN and the token ring LAN, respectively? Explain. (2 marks)

(b). Consider a token ring, where each station introduces a fixed delay. For a fixed ring circumference, are there any limits on the maximum or minimum number of stations that can be accommodated? Why would the token ring protocol be inefficient for large ring perimeters? Explain. (3 marks)

(c). In an Ethernet, the exponential back-off algorithm is used when collision is detected. The random back-off delay is an integral multiple of contention timeslots. The random delay (the number of timeslots), before the nth retransmission attempt, is chosen as a uniformly distributed random integer r in the range $0 \leq r < 2^K$, where $K = \min(n, 10)$.

Assume that 2 stations contend for the channel and collide. They each have one minimum sized packet to transmit. No other stations contend at any point in time. What is the probability that both stations have successfully completed transmission, 6 timeslots after the first collision? (You are not required to simplify your final answer) (5 marks)

Problem 6

(a). Suppose host A sends two TCP segments back-to-back to B. The first segment has sequence number 90. The second has sequence number 110. How much data is included in the first segment transmitted? Suppose that the first segment is lost, but the second segment arrives at B. In the acknowledgment that B sends to A, what will the acknowledgment number be? (2 marks)

(b). When only the mnemonic host name is known, then before a TCP connection can be established, DNS must be used. Explain what the difference is between a recursive and an iterative DNS query/response. (2 marks)

(c). A TCP connection is not secure. In order to make it secure, cryptography can be applied in the application layer. The ciphertext below has been encrypted using a Vigenere cipher (as defined in Lecture 13).

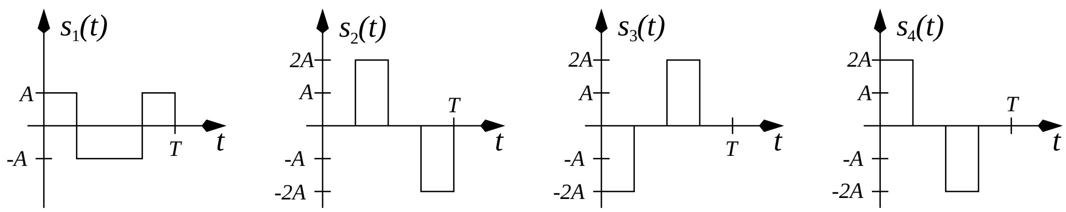
IPMWWSIZTCBMOCBREMXMQLBQNMZRPGA

The encryption alternates between two substitution ciphers. By chance, you have found out that **ZT** maps into *bl*. What is an attack based on this information called? Is this enough for you to recover the plaintext? If so, what is the plaintext? (4 mark)

Problem 7

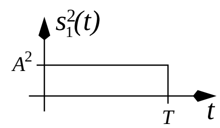
(a). What is the difference between baud rate and bit rate? (1 mark)

(b). What is the dimension of the signal set shown below? (2 mark)



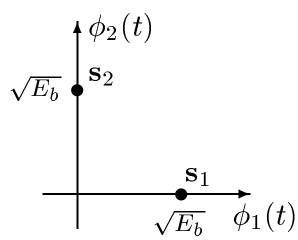
(c). The signal $s_1(t)$ above has unit energy:

$$E_1 = \int_0^T s_1^2(t)dt = 1.$$



Find a set of basis functions and derive a signal space description of each of the signals above (this can be done without the need for taking square roots). If possible, make a sketch of the signal constellation. (3 marks)

(d). For FSK transmission, the signal constellation is as shown below.



The received signal vector is $\mathbf{r} = \mathbf{s}_2 + \mathbf{n}$. Assuming an additive white Gaussian noise channel, the discrete-time noise samples are independent, zero-mean, normal distributed random variables with variance $\sigma^2 = N_0/2$,

$$p(n_i) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{n_i^2}{2\sigma^2}\right)$$

in any set of orthogonal directions. Derive an expression for the bit error probability as a function of the E_b/N_0 using either the complementary error function ($\mathrm{erfc}(z)$) or the Gaussian error function ($Q(z)$). (4 marks)

$$\mathrm{erfc}(z) = \frac{2}{\sqrt{\pi}} \int_x^\infty \exp(-t^2)dt$$

$$Q(z) = \frac{1}{\sqrt{2\pi}} \int_x^\infty \exp\left(-\frac{t^2}{2}\right) dt$$