DATA COMMUNICATION – EDA415

Re-Examination 19 August 2000, 8.45 – 12.45 in MG

Examinator:

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Allowable means of assistance:

Only writing tools and accessories, word lists and dictionaries are allowed.

Content:

The exam consists of 9 (nine) 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 Monday Aug. 19, 15.00 on the department notice board as well as on the web page of the course.

Results:

Available Monday Aug. 26, 9.00 on the department notice board.

Questions concerning grading (granskning): ONLY Monday Aug. 26, 13.00-14.00, ED-huset, room 6340. After 14.00, no more "granskning" is possible.

Language:

The assignment is written in English. You may write your solution in either English or Swedish.

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) In a trellis coded system, the data rate can be increased by increasing the signal-to-noise ratio.

b) The concepts of QAM and PAM signalling can be combined to obtain QPSK signalling.

c) Convolutional codes are usually decoded using maximum-likelihood sequence detection and therefore do not offer any explicit error detection capabilities.

d) The 1-persistent CSMA/CD scheme is also known as an ethernet.

e) The transport layer bridges the gap between delivered network performance and application requirements.

f) The crypto system DES is rather slow and therefore only used to distribute secret keys.

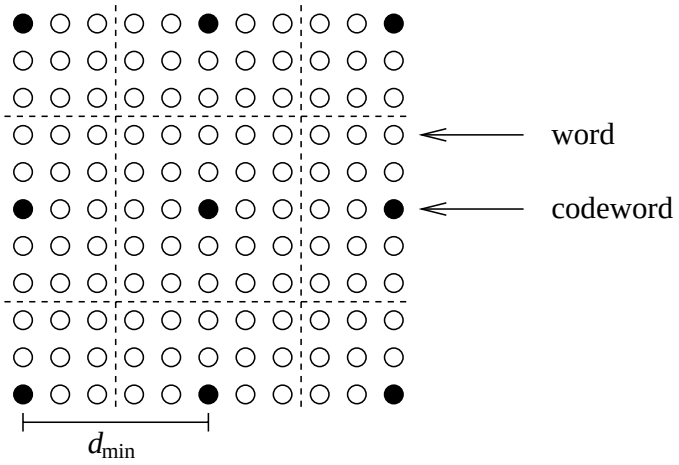
Problem 2

a) Explain the differences between a message, a packet and a frame. (2 marks)

b) Explain the concept of character stuffing. What is it used for and what kind of symbol representation is it intended for? (2 marks)

c) Two fundamental strategies are used for forward error control coding, convolutional coding and block coding. Explain briefly the differences between the two. (2 marks)

d) Refering to the figure below, explain how many errors can be detected, respectively corrected as a function of the minimum distance of the code. (2 marks)



Problem 3

a) Explain the differences between a LAN, a MAN and a WAN. (2 marks)

b) Name 3 of the most vital demands on modern communication networks. Explain each item in some detail. (2 marks)

c) Name 3 examples of channel impairments and explain how each affects the transmission. (2 marks)

d) Name 3 possible transmission media and give justified estimates of the approximate data rates that can be supported by each of them. (2 marks)

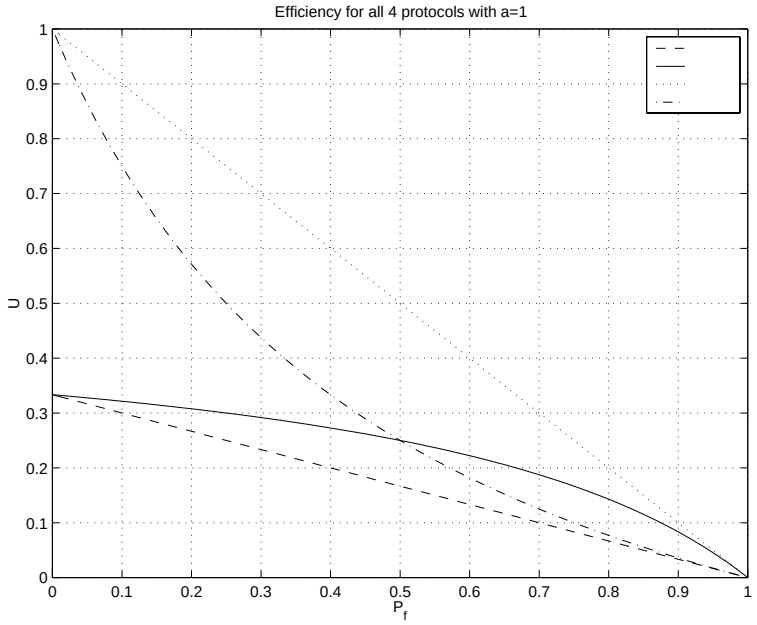
Problem 4

a) Describe in principle how ARQ error control coding works. (1 mark)

b) Explain the fundamental differences between stop-and-wait (SWP), alternative-bit, go-back-N and selective-repeat ARQ protocols. (2 marks)

c) Consider an SWP scheme where we successfully receive a frame with probability $1 - P_f$, retransmission requests are generated after a time-out of T, the round-trip delay is S and X denotes the time it takes for successfully completing the transmit/receive prodecure for one frame. Based on the above, derive an expression for the average time $\mathrm{E}\{X\}$ it takes for successfully completing the transmit/receive prodecure for one frame. (4 marks)

d) Below is a plot of the efficiencies of the 4 ARQ protocols considered in question b) above. Determine which protocol is associated with which curve and explain why you think so. The figure is also found on page 7. Feel free to write part of your solution on that sheet and hand it in for marking together with the rest of your solution. (3 marks)



Problem 5

a) Name 2 issues that can lead to network congestion. Explain how congestion occurs in the two cases. (1 mark)

b) Congestion can be alleviated by increasing available resources or decreasing the offered load. Name 2 ways to increase available resources and 2 ways to decrease offered load. Explain the effects that each measure has. (2 marks)

c) Suppose that data arrives at 25 MBps in 40 msec bursts every second. To reduce the rate to 2 MBps, we can use a leaky bucket. A leaky bucket is described by a constant output rate ρ and a buffer capacity C. How big must C be to avoid that data is lost? How long does it take to transmit all the data in each burst? (3 marks)

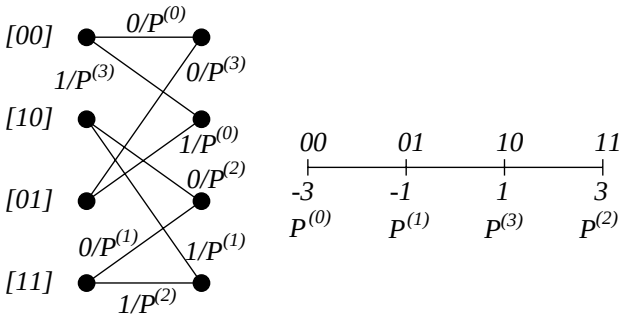
d) Assume instead that we use a token bucket with a capacity of 500 KB for the scenario in problem c) above. Tokens arrive at a rate of 2 MBps. Assuming that the token bucket is full when the data burst arrives, how long does it take to transmit the entire burst? (4 marks)

Problem 6

a) Explain in detail the relationship between data rate and Baud rate. (2 marks)

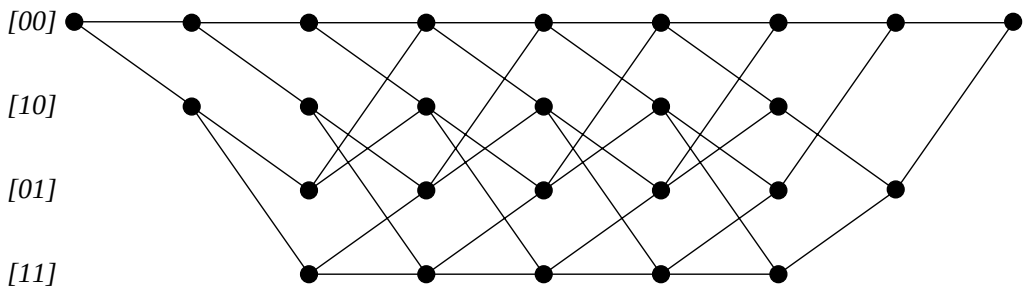
b) How do you increase the actual data rate in an AWGN channel? What are the consequences on the bit error rate? (3 marks)

c) Consider the following example of trellis coded modulation. In this case, 6 information bits are encoded by a 4-state rate 1/2 convolutional code and transmitted using 4-level PAM symbols. The assignment of PAM symbols to trellis transitions, the PAM constellation and a table of metrics calculated based on the received signal are shown in the figure below, respectively.



	$P^{(0)}$	$P^{(3)}$	$P^{(1)}$	$P^{(2)}$
$\mu_1^{(il)}$	13.7	0.10	2.90	5.30
$\mu_2^{(il)}$	2.90	5.30	0.10	18.5
$\mu_3^{(il)}$	0.10	13.7	2.90	32.5
$\mu_4^{(il)}$	36.0	4.00	16.0	0.00
$\mu_5^{(il)}$	19.4	0.20	5.80	2.60
$\mu_6^{(il)}$	5.80	2.60	0.20	13.6
$\mu_7^{(il)}$	2.60	5.80	0.20	19.4
$\mu_8^{(il)}$	16.0	0.00	4.00	4.00

The branch metrics, representing the Euclidean distance between the received signal and the symbol hypothesis, required for Viterbi decoding, are pre-calculated and found in the table. Use all the above information to complete the decoding of the 6 information bits, using the Viterbi algorithm applied to the trellis below. The trellis has been terminated by transmitting two zero bits after the 6 information bits. Give estimates of the 6 information bits. The figure of the trellis is also found on page 9. Feel free to do your decoding on that figure and hand it in for marking with the rest of your solution. (5 marks)

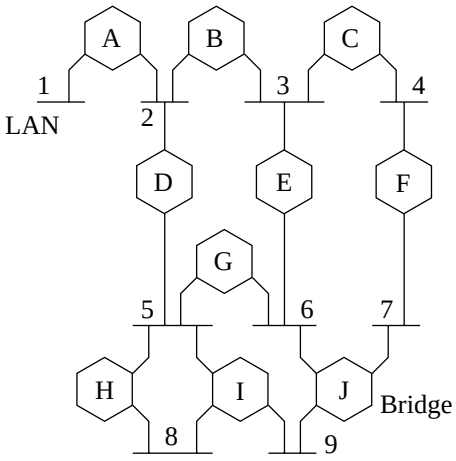


Problem 7

a) Explain the differences between fixed routing and flooding. When is it appropriate to use flooding? (2 marks)

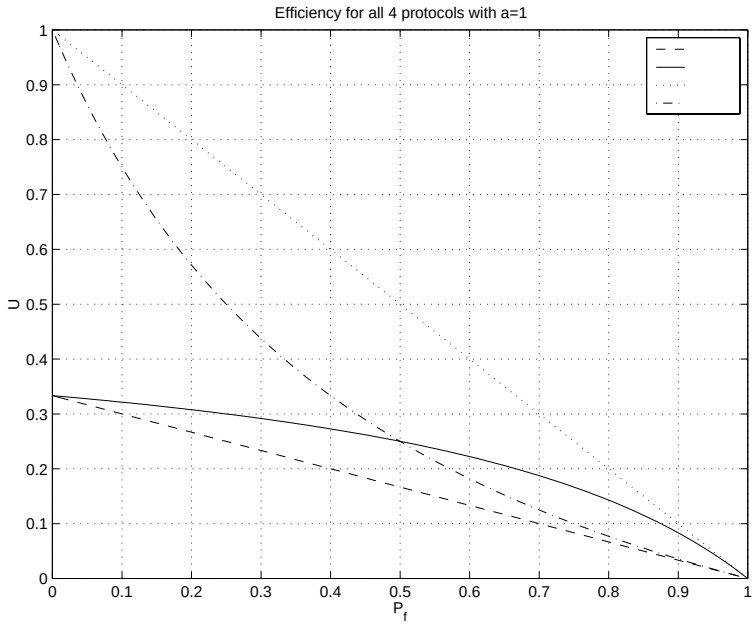
b) What is backward learning and what is it used for? (2 marks)

c) Consider the interconnected network below. Determine a spanning tree for the network. (2 marks)

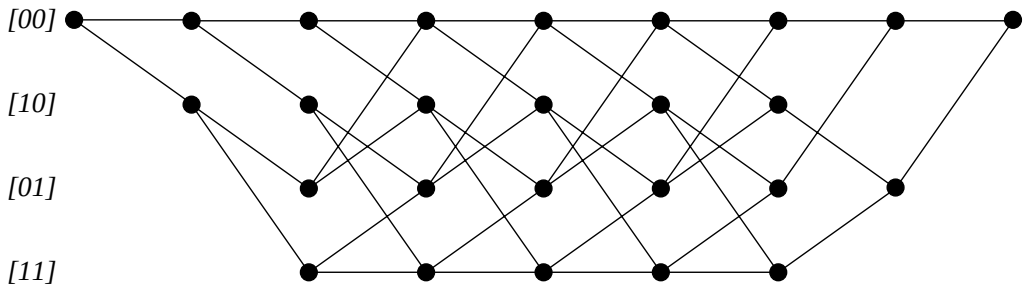


Interconnected LAN's

d) What is the difference between a router and a bridge? (2 marks)



An extra copy of the plot in question 5.d).



An extra copy of the decoding trellis in question 6.c).