INSTITUTE OF TECHNOLOGY
LINKÖPINGS UNIVERSITET

Exam in TSKS04 Digital Communication Continuation Course

Exam code:	TEN1
Date:	2014-06-09 **Time:** 14:00–18:00
Place:	TER2
Teacher:	Mikael Olofsson, tel: 281343
Visiting exam:	15 and 17
Administrator:	Carina Lindström, 013-284423, carina.e.lindstrom@liu.se
Department:	ISY
Allowed aids:	Olofsson: *Tables and Formulas for Signal Theory* Upamanyo Madhow: *Fundamentals of Digital Communication*, Cambridge University Press, 2008.
Number of tasks:	5
Solutions:	Will be published within three days after the exam at http://www.commsys.isy.liu.se/TSKS04
Result:	You get a message about your result via an automatic email from Ladok. Note that we cannot file your result if you are not registered on the course. That also means that you will not get an automated email about your result if you are not registered on the course.
Exam return:	2014-06-16, 12.15–13.00, Mikael Olofssons office, Building B, top floor, corridor A between entrances 27–29. After that in the student office of Dept. of EE. (ISY), Building B, Corridor D, between Entrances 27–29, right next to Café Java.

Important:	**Solutions and answers must be given in English.**

Grading: This exam consists of five problems. You can get up to five points from each problem. Thus, at most 25 points are available. Grade limits:

- Grade three: 12 points,
- Grade four: 16 points,
- Grade five: 20 points.

Sloppy solutions and solutions that are hard to read are subject to hard judgement, as are unreasonable answers.

1   Consider communicating data using 8-ASK with symbol rate $1/T$. The   (5 p)
transmit filter, channel and receive filter have the impulse responses

$$g_{\text{TX}}(t) = \text{rect}\left(\frac{t}{T}\right), \quad g_{\text{C}}(t) = \text{rect}\left(\frac{t}{2T}\right), \quad g_{\text{RX}}(t) = \text{rect}\left(\frac{t}{T/2}\right),$$

respectively. The channel also adds white Gaussian Noise. Let $z[k]$ denote the receive filter output sampled at time instance $kT_{\text{s}} + \tau$, where T_{s} is a sampling interval to be chosen and τ is some time-shift, also to be chosen.

a. Show that ML sequence detection using the samples $\{z[k]\}$ is possible, given an appropriate choice of T_{s} and τ. Specify the corresponding choice of T_{s} and τ.
*If ML sequence detection is not possible for any choice of T_{s} and τ, then show that that is the case.*

b. How many states are needed in the trellis for implementing ML sequence detection using the Viterbi algorithm?
In the case that ML detection is not possible, suggest an alternative choice of sender and/or receiver filter to make ML sequence detection possible.

Note: There may very well be more than one solution to this problem. It is enough to find one of them.

2   The following convolutional encoder is used to encode 8 information bits.   (5 p)
The code is then terminated by feeding as many dummy zeros needed to
force the encoder to the all-zero state.
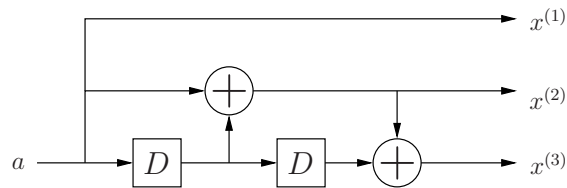
   a. Determine the Extended Path Enumerator $T(W, L, I)$ of the convolutional encoder, where W enumerates codeword weight, L enumerates deviation (from all-zero state) length and I enumerates information weight.   (4p)

   b. The resulting code is a block code since its length is finite (and constant). Determine the parameters (length, dimension and minimum distance) of that block code.   (1p)

3   Solve task 3.9 on pages 139–140 in Madhow.   (5 p)

4   Solve task 4.7 on page 194 in Madhow.   (5 p)

5   Solve task 5.9 (parts a and b) on page 247 in Madhow.   (5 p)