LINKÖPINGS UNIVERSITET

Exam in TSDT74 Radio Communication

Date:	2015-06-01 **Time:** 14.00-18.00
Teacher:	Danyo Danev, tel: 013-281335
Place:	TER2
Allowed aids:	
Part A:	No aids allowed except pocket calculators.
Part B:	The course book "Principles of Wireless Communications", mathematical tables and handbooks, lecture notes, dictionaries, pocket calculators.
Instructions:	Start by answering the questions in part A. Usually 2-3 sentences are enough to correctly answer these questions. No helping aids (besides pocket calulator) will be allowed for part A. After handing in the part A answers you'll get the problems of part B and you'll be able to use the aids according to the list above.
Grading:	Each correctly answered question in part A yields 0.5 points. Each correctly solved problem in part B yields 5 points. For grade 3 you need 11 points with at least 2 points on part A, for grade 4 you need 16(3) points, for grade 5 you need 21(3.5) points. Sloppy solutions and solutions that are hard to read are subject to hard judgement, as are unreasonable answers.
Project work:	Gives extra $0-4$ points to part B.
Solutions:	Will be published after the exam at http://www.commsys.isy.liu.se/en/student/kurser/tentor?TSDT74
Grading list:	A preliminary grading list will be send to all registered for the exam no later than 2015-06-11. Others can get information about the results from the course leader or at the exam return.
Exam return:	2015-06-12, kl. 12.00-12.30 in Filtret, house B, entrance 29, 1st floor.
Complaints:	No later than 2015-06-12.

Good luck!

PART A

A.1 Give a definition of the term "noise figure".

A.2 What does the coherence time represent for a WSSUS stochastic channel model?

A.3 Provide three different definitions for the bandwidth of a signal. The names as well as short desription is enough.

A.4 What is the length of the cyclic prefix for an OFDM symbol if the guard time is $T_G = 0.15\ ms$ and the smapling frequency is $f_s = 180\ kHz$?

A.5 Calculate the coherence bandwidth of a WSSUS channel with coherence time 45 ms and multipath (delay) spread of 20 μs.

A.6 What is the efficiency of a selective-repeat ARQ scheme which exploits error-detecting code of rate 7/8 and the probability for acceptance of a received packet is 80%? What is the expected message delay if the round-trip delay is 15 ms and the transmission of one packet takes 50 ms?

A.7 Selection combining and maximal-ratio combining are two techniques for space diversity on receive. Which one have better performance if the same number of receive antennas are used? We can expect that the technique with the better performance have larger implementation complexity. How can this complexity be decreased while keeping the superiority in performance over the other technique?

A.8 Describe briefly the differences between convolutional interleaving and block interleaving.

A.9 Which factors cause the fast fading in wireless communications?

A.10 Describe briefly the principle of frequency hopping CDMA system.

PART B

B.1 In an ALOHA communication system, the transmitted packets are passing Rayleigh fading fading channel. We assuming that the packet transmissions are independent and that the average received power is the same for each transmission.

a) What is the probability that a collision between two packets can be resolved if the required signal to interference ratio (SIR) for successful resolution is at least 13 dB. (2 p)

b) Calculate the the packet loss probability for a single transmission if it is known that the average signal-to-noise ratio (SNR) is 23 dB, and that an SNR of 13 dB is sufficient for error-free packet reception, i.e. SNRs below 13 dB lead to packet loss with probability one. (1 p)

c) Estimate the maximum throughput in a ALOHA system with both capture and packet losses as in a) and b). (2 p)

B.2 A communication system with coherent BFSK is used over flat Rayleigh fading channels. The average SNR per information bit is 10 dB.

a) Determine the average bit error probability. (2 p)

b) To improve the performance, an error correcting code $(15, 11, 3)$ is used. Assume that full interleaving is applied. Compute the codeword error probability and bit error probability for this coded system. (3 p)

B.3 Consider a communication between transmitter and receiver at a distance of 10 km. The bandwidth of the used signal is 50 KHz and the carrier frequency used for the communication is 1 GHz. The transmitter has its antenna mounted at h_T elevation with an antenna gain of 4 dBd. The receiver has its antenna mounted at $h_R = 10$ m elevation with an antenna gain of 2.5 dB. From the receiving antenna, a 2.5 m coaxial cable is used with an antenna attenuation of 20 dB/ 100 m. The noise figure of the receiver is 20 dB. The transmission is successful if the received if the received SNR is greater than or equal to 30 dB. Assume the plane-earth model. The Boltzmann's constant is $k = 1.38 \times 10^{-23}$.

a) Determine the minimum transmit power P_T so that the transmission is successful if $h_T = 25$ m. (2 p)

b) Assume that the transmit power is limited to 10 W. Compute the minimum possible h_T so that the transmission is successful. (3 p)

B.4 Consider a two branches diversity system with the switched combining scheme. More precisely, a branch with good quality (SNR) is chosen and used until the SNR drops below 10 dB. The modulation method is binary DPSK. Assume that the two branches are subject to independent Rayleigh fading channels with the same mean-SNR $\gamma_0 = 10$ dB.

a) Determine the average bit error rate (BER). (2 p)

b) Compute the average BER if the maximum ratio combing scheme is used. Compare this BER with the BER obtained in a). Justify the results! (3 p)