Mansoura University
Dept. of Electrical Communications and Electronics
Communications Systems
(COM9423)

Faculty of Engineering
Fourth year
3 hours exam
Final Exam
June 2013

<u>Two pages Exam</u>
Answer the following questions
All drawing should be drawn to scale with appropriate numbers if available
Assume any missing data, and make your assumptions clear
Use a carrier frequency of 900 MHz unless other values are given
Please answer each question at the beginning of a new page
Don't use red colors in answering
100 points

Q1) A wireless communication system that operates at a frequency of 1.8 GHz and the wireless channel can be modeled using the following model

$$\text{Path Loss(dB)} = C + 26\log(d) + 20\log(f_c)$$

Where f_c is the carrier frequency in MHz, C is a loss that varies with the channel, and d is the distance between the transmitter and receiver in Km. If the following data were measured for this wireless channel

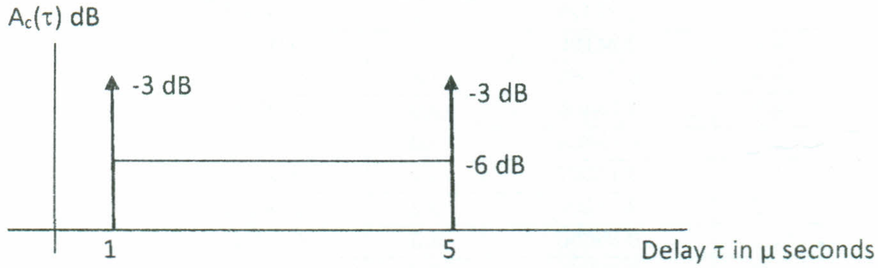
a) What is the value of C that minimizes the mean square error between the model and the measured data
b) What is the shadowing standard deviation
c) If the transmitted power is 1W and the receiver sensitivity is -90 dBm, what is the cell radius for an outage probability of 10%.

d in meters	P_r/P_t
50m	-75 dB
100m	-80 dB
200m	-90 dB
400m	-100 dB
800m	-105 dB

(20 points)

Q2) A channel has the following power delay profile

a) Determine the mean excess delay time and the rms delay spread.
b) If 16-QAM is used, what is the maximum possible bit rate without the need of an equalizer? Suggest a method to double this bit rate without needing an equalizer? What is the disadvantage of your suggested method?
c) If a mobile is traveling through the channel with a velocity of 100 Km/hr, what is the time at which the channel could be considered stationary if the carrier frequency is 900 MHz?



(20 points)

Q3) A direct sequence spread spectrum signal that is using maximal length PN codes, operated at a frequency of 1 GHz, has a chip rate of 1 Mb/s, and a source data rate of 10 Kb/s. The wireless channel has an impulse response of $h(\tau) = \delta(\tau) + 0.5\delta(\tau-\tau_1) + 0.5\delta(\tau-\tau_2)$ where $\tau_1 = 1\ \mu s$ and $\tau_2 = 2\ \mu s$.

a) Draw a relation for the autocorrelation of maximal length PN code.
b) If the transmitted signal is a periodic square wave of 1, and -1 draw the spectral density of the spread spectrum signal
c) Assume the receiver is synchronized to the first component, find a relation for the demodulator output, find the signal to interference ratio at the receiver output. Can you suggest a method to make better use of multipath reception
d) Repeat part (c) if $\tau_1 = 0.5$ μs and $\tau_2 = 1.5$ μs. ***(20 points)***

Q4) Consider a flat-fading channel where for a fixed transmit power P, the received SNR is uniformly distributed between 0 and 20 dB (the distribution is uniform on the linear scale). Assume only the receiver has CSI. Channel BW=100 KHz.
a) Find the Shannon capacity of this channel.
b) Plot the correctly received capacity versus outage for $0 \leq \text{pout} < 1$.

(15 points)

Q5) Assume a spatial diversity receiver that has two antennas. Assume threshold combining is used. The received signals SNR has i.i.d. Rayleigh fading distribution with a mean of 10 dB.
a) Find a relation for the outage probability of the system.
b) If the minimum acceptable SNR is 7 dB and switching threshold is 8 dB find the outage probability
c) Find the bit error rate if DPSK is used
d) What is the optimal switching threshold that you could use
e) Repeat part (b), (c) and (c) if the SNR is uniformly distributed from 5 to 10 dB(the distribution is uniform on the linear scale) ***(20 points)***

Q6) A wireless channel that has a coherence time of 2 mS and a rms excess delay of 1 μS. 64-QAM signaling is used to transmit a bit rate of 16 Mbps. Suggest the parameters of an OFDM system, and draw its spectrum, that could be used to transmit this signal avoiding the wireless channel problems (Suggest two designs and compare the advantages of each solution). ***(15 points)***

Tabulation of the Q-function

z	$Q(z)$	z	$Q(z)$
0.0	0.50000	2.0	0.02275
0.1	0.46017	2.1	0.01786
0.2	0.42074	2.2	0.01390
0.3	0.38209	2.3	0.01072
0.4	0.34458	2.4	0.00820
0.5	0.30854	2.5	0.00621
0.6	0.27425	2.6	0.00466
0.7	0.24196	2.7	0.00347
0.8	0.21186	2.8	0.00256
0.9	0.18406	2.9	0.00187
1.0	0.15866	3.0	0.00135
1.1	0.13567	3.1	0.00097
1.2	0.11507	3.2	0.00069
1.3	0.09680	3.3	0.00048
1.4	0.08076	3.4	0.00034
1.5	0.06681	3.5	0.00023
1.6	0.05480	3.6	0.00016
1.7	0.04457	3.7	0.00011
1.8	0.03593	3.8	0.00007
1.9	0.02872	3.9	0.00005

Good Luck
Sherif Kishk