Mansoura University
Department of Electronics and Comm. Engineering
Communications systems
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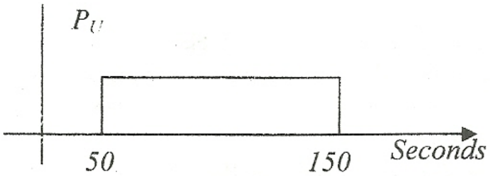
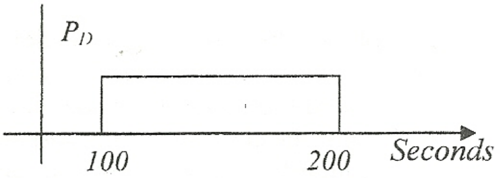
Faculty of Engineering
Fourth year
3 hour
110 points

4 pages exam

Answer the following questions (Assume any missing data)
Organized answers *(10 points)*

Q1- Consider a GSM cell that has 6 radio frequencies. The PDF of the call holding times for the users originating calls, P_U, and the users receiving calls, P_D are shown below.





The number of calls generated per hour for the users originating calls is a Poisson random variable with mean equals ½ calls/hour/user. The call arrivals per hour for the users receiving calls is a Poisson random variable with mean equals 0.25 calls/hour/user. The probability for a user to receive a call or generate a call is similar.

(a) Calculate the number of mobile users that can be served with zero blocking probability.
(b) If the call arrivals per hour for the downlink users is changed to a Poisson random variable with mean equals 0.75 calls/hour/user, how many new radio frequency should be added to the base station to serve the same number of users found in (a) with zero blocking probability? *(20 points)*

Q2- A GSM cell has the following empirical power measurements at different distances from the base station transceiver. The system operates at a frequency of 900 MHz

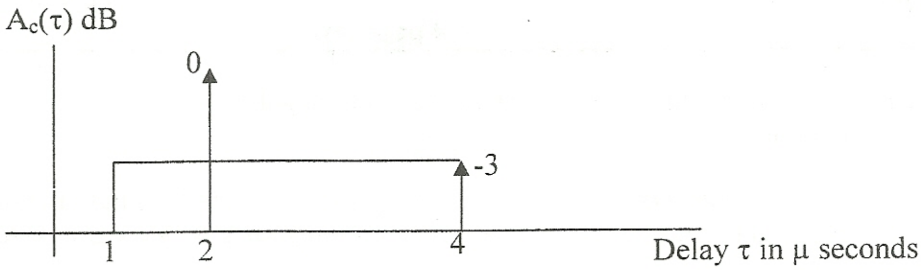
Distance from basestation	P_r/P_t
30m	-65 dB
80m	-80 dB
110m	-93 dB
220m	-100 dB
450m	-111 dB
850m	-120 dB
1200m	-135 dB

Assuming the simplified pathloss model is valid and d_o=20m.

a) Find the path loss exponent γ that minimizes the MSE between the model and the empirical power measurements.
b) Find the standard deviation of the log-normal shadowing.
c) Suppose that for acceptable voice quality a signal-to-noise power ratio of 10 dB is required at the mobile. Assume the base station transmits at 20 W and its antenna has a 3 dB gain. There is no antenna gain at the mobile and the receiver noise in the bandwidth of interest is -80 dBm. Find the maximum cell size such that a mobile on the cell boundary will have acceptable voice quality 90% of the time.

(20 points)

Q3- Consider a channel having the following power delay profile.



a- Compute the channel's mean delay spread, and rms delay spread.

b- What is the maximum symbol rate such that a linearly modulated signal transmitted through this channel does not experience ISI. (use the rms delay)

c- What is the channel 50% coherence bandwidth.

d- If a mobile is traveling at a speed of 60 Km/hour, what is the channel coherence time when the operating frequency is 900MHz. *(20 points)*

Q4- The following figure shows a two-tier architecture that is widely used in 3G networks. The first tier is macro cell that is 1.5 Km in radius, and the second tier is a micro cell that is 100m in radius. The micro-cell has N users that are located at a distance of 50m from the base station, and the macro cell has three users that are located at a distance of 1000m from its base station (all the users lie on a line that connects the two base stations). Neglecting the effect of out of cell interference due to the micro cell. Assume the following data:

Operating frequency: 2 GHz

Simplified path loss model with d_o=10m and pathloss exponent=3 is valid.

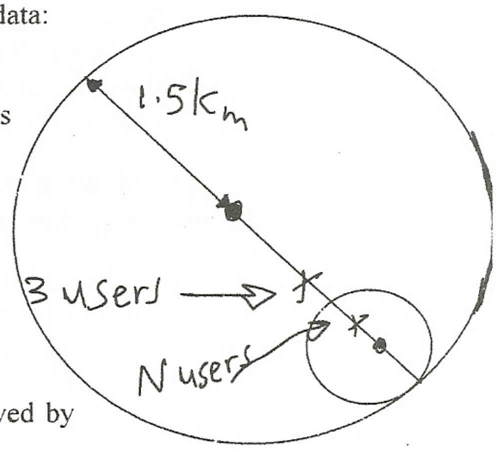
Minimum acceptable E_b/N_o=7 dB

RF bandwidth = 5 Mhz.

PG=400.

Single sided noise spectral density= 10^{-16} W/Hz.

When using perfect power control, the transmitted power of the micro-cell users are 50 mW. *(20 points)*



a- Find the maximum number of users, N, that can be served by the micro-cell.

b- If a new user is accepted at the macro cell that is located at the same location as the other three users, what is the percentage increase of the micro-cell users power to keep the same value of N? Is the assumption that the effect of micro-cell out of cell interference still valid?

Q5- Consider a flat-fading channel where for a fixed transmit power S, the received SNR is one of four values: γ_1 = 25 dB, γ_2 = 20 dB, γ_3 = 15 dB, and γ_4 = 10 dB. The probability associated with each state is p_1 = .3, p_2 =0.3, p_3 = .2, and p_4 = .2. Assume a channel bandwidth of 200 KHz. *(20 points)*

a-Find the Shannon capacity of this channel and compare with the capacity of an AWGN channel with the same average SNR.

b- Find and plot the capacity versus outage for this channel, and find the average rate correctly received for outage probabilities p_{out} = 0.3.

Q6- Choose the most accurate answer **(copy the following table to your answering sheet filling the answer A, B, C, or D)** *(12 points)*

No	1	2	3	4	5	6	7	8	9	10	11	12
Ans.												

1- When transmitting using EDGE technology the RF signal bandwidth is
a) 384 KHz b) 5 MHz c) 1.25 MHz d) 200KHz

2- GPRS enhances the bit rate dedicated to a user by
a) increasing the RF bandwidth b) combining the time slots c) reducing the bit duration d) using QAM

3- Which of the following is true for 3G networks
a) have a BW of 5 MHz b) use FDD c) use QPSK d) all of that

4) ZigBee is most suited to
a) long rang transmission b) high data rate transmission c) low power transmission
d) TV broadcasting

5) Which of the following is true for Ad-Hoc networks
a) Have peer-to-peer communications. b) Have no backbone infrastructure.
c) Routing can be multihop d) All of that

6) If the variance-to-mean ratio, VMR, is less than 1. The probability that x subscribers will be engaged in a conversation is
a) Binomial distribution b) Poission distribution c) Erlang B d) None of that.

7) The Erlang C formula assumes that
a) Blocked calls are cleared b) a queue is formed to hold all requested calls that cannot be served immediately c) user will try again in a period of time d) None of that

8) The best method to reduce the effect of shadowing is to
a) increase the transmitted power b) change the location of base stations c) change the modulation method d) use macroscopic diversity

9) Frequency selective channels produce
a) ICI b) ISI c) Power loss d) None of that

10) If we have a line of sight, LOS, component then the channel could be represented using
a) Rician fading b) Rayleigh fading c) Shadow fading d) None of that

11) OFDM allows
a) the use of simple receivers b) Reduction of ISI c) High data rate transmission
d) None of that

12) CSMA/CA is used in
a) IEEE 802.11 b) Ethernet c) Bluetooth d) None of that

Good Luck
Sherif Kishk

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

The definition of Q function is:

$$Q(z) = \int_z^\infty \frac{1}{\sqrt{2\pi}} e^{-y^2/2} dy$$

Two important properties of $Q(z)$ are

$$Q(-z) = 1 - Q(z)$$

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