COLLEGE OF ENGINEERING & TECHNOLOGY

Department : Graduate Studies

Electronics & Communications Engineering

Lecturer : Prof. Mohamed Essam Khedr

Course : Wireless Communications

Course Code : EC 744

Midterm Exam (Take home). Only lecture slides and textbooks, No Internet is allowed
Time : 3-5 hours, Please be punctual

Question one: (probability, random variables and random process)

I- Consider the following experiment involving four urns {A, B, C, D}. A ball is chosen from urn A, which contains six balls labelled B, three balls labelled C and three balls labelled D. The chosen ball specifies the urn from which the second drawing is made. Urn B contains five red balls and five white balls. Urn C contains four red and six white balls and urn D contains two red and eight white balls.

a- Construct the sample space and probability assignment that describes the experiment.

b- Given that the second ball drawn is red, what is the conditional probability that the first drawing yielded B?

II- Let X, Y be two random variables with finite second moments and define Z=X+Y

Prove $\sigma_x^2 + \sigma_y^2 - 2\sigma_x\sigma_y \le \sigma_z^2 \le \sigma_x^2 + \sigma_y^2 + 2\sigma_x\sigma_y$

III- Let X(t) and Y(t) be independent Gaussian random process with zero means and same covariance function $C(t_1,t_2)$, define $Z(t) = X(t)\cos(wt) + Y(t)\sin(wt)$

Find the mean and autocovariance of Z(t)

Question Two: (Cellular systems)

A cellular system with a frequency reuse of 28 is considered.

a- What are the values of i, j, D, and D/R

b- Sketch the system layout on the attached figure

c- Calculate the C/I ratio for path loss equal to 3

d- If the total coverage area is 300 km2, 2800 duplex channels, Cell radius = 1 km , what is the capacity of the system.

Question three: (Wireless channels)

I- The scattering function S(τ,λ) for a fading multipath channel is non zero for the range of values $0 \le \tau \le 1ms$ and $-0.1Hz \le \lambda \le 0.1Hz$. Assume that the scattering function is approximately uniform in the two variables

a- find the value of the multipath spread of the channel

b- the Doppler spread of the channel

c- the coherence time of the channel

d- the coherence bandwidth of the channel

e- when the channel will be frequency selective

f- when the channel will be flat fading

g- when the channel will be slowly fading

II- Suppose that a binary signal $\pm s_i(t)$ is transmitted over a fading channel and that the received signal is

$r(t) = \pm a s_i(t) + n(t) \quad 0 \le t \le T$, where n(t) is zero mean white Gaussian noise with PSD = No.

The channel gain "a" is specified by the probability density function

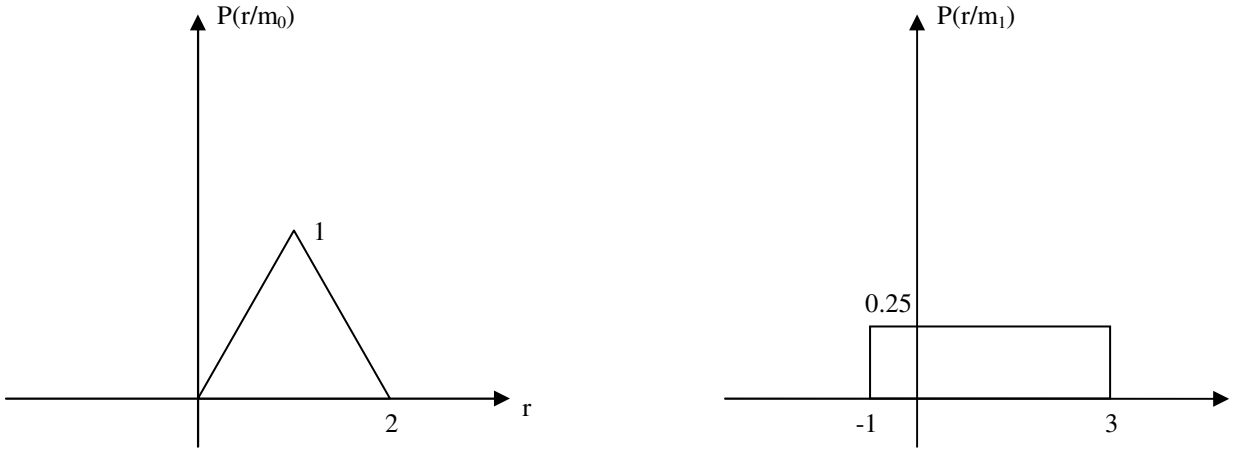
$$p(a) = 0.1\delta(a) + 0.9\delta(a-2)$$

a- Determine the average probability of error for a demodulated matched to $s_i(t)$

b- What value does P[E] approaches as E_b/N_o approaches infinity

Question Four: (Modulation/Demodulation)

I- A communication system is used to transmit one of the two equally likely messages, m_0, m_1. the channel output is a continuous random variable "r". The conditional density function of which is shown in the following figure. Determine the optimum receiver decision rule and compute the resulting probability of error.



II- Consider the octal signal point constellations in the following figure

a- The nearest neighbour signal points in the signal constellations are separated in distance r by A unites, Determine the radii r of the first circle and a and b of the inner and outer circles.

b- Determine the average transmitted powers of the two signal constellations and compare the two powers.

c- Sketch the decision boundaries for both constellations

d- Find the average probability of error of both constellations.