Question Paper

Exam Date & Time: 02-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

SIXTH SEMESTER B.TECH. (ELECTRONICS AND COMMUNICATION ENGINEERING) DEGREE EXAMINATIONS - APRIL / MAY 2024

SUBJECT: ECE 3252/ECE_3252 - WIRELESS COMMUNICATION

Marks: 50 **Duration: 180 mins.**

Answer all the questions.

Missing data may be suitably assumed.

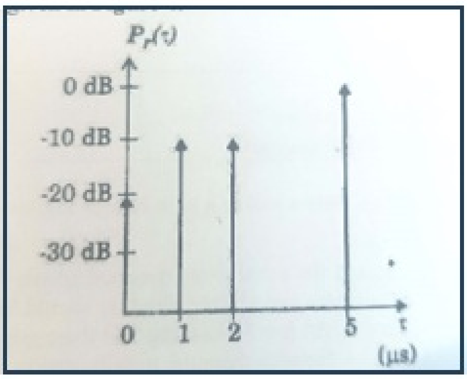
1A) From the Friis free space formula, obtain the equation to calculate free space loss (FSL) in dB in terms of distance (in km) and frequency (in GHz). Assume that the antennas have unity gain. Also, calculate the free space loss of WiFi signal over a distance of 250m. (4)

1B) A mobile is located 5 km away from a base station and uses a vertical $\lambda/4$ monopole antenna with a gain of 2.55 dB to receive cellular radio signals. The E-field at 1 km from the transmitter is measured to be $10^{-3}\mathrm{V/m}$. The carrier frequency used for this system is 900 MHz. (3)

i) Find the length and the gain of the receiving antenna.
ii) Find the received power at the mobile using the 2-ray ground reflection model assuming the height of the transmitting antenna is 50 m and the receiving antenna is 1.5 m above ground.

1C) Consider log normal shadowing. Given path loss, Ls(1m)= 40 dB. (3)
i) If the path loss exponent is 3, compute the mean path loss at 100m. The zero-mean Gaussian random variable representing shadowing produces 2 dB loss.
ii) How does the utilization of the log-normal shadowing model enhance the understanding and management of signal fluctuations in wireless communication systems?

2A) Given the power delay profile as below, (4)



If BPSK modulation is used analyze the maximum bit rate possible without the use of any channel equalizer.

2B) Deduce the Doppler shift equation by applying its geometric principles and provide a detailed justification for the scenarios of positive and negative Doppler shifts in varying situations. (3)

2C) Develop the mathematical formulation for the impulse response model of a multipath radio channel. (3)

3A) Consider the MIMO channel with channel matrix H given as (4)

$$H = \begin{bmatrix} 2 & -6 & 0 \\ 4 & 3 & 0 \\ 0 & 0 & 2 \end{bmatrix}$$

Compute the capacity and optimal power allocation for a total transmit power –3 dB and noise power 3 dB.

3B) Consider the 1 × 2 wireless system given as (3)

$$y = [3 - 4j \quad 1 - j] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}] + n$$

Indicate the processing at the transmitter and the receiver for the above system using the Alamouti code.

3C) Using the technique of singular value decomposition, explain the concept of spatial multiplexing in a wireless MIMO channel. (3)

4A) Using the wireline system model, evaluate how the Bit Error Rate (BER) varies with Signal-to-Noise Ratio (SNR). Validate this model to establish that the Q function decreases as SNR increases. (4)

4B) The vectors corresponding to the transmitted and received pilot symbols across the standard Rayleigh fading wireless channel is given as, (3)

$$y^{(p)} = \begin{bmatrix} -0.6443 + j0.3136 \\ 0.4006 - j0.5777 \\ 0.7204 + j0.9532 \\ 0.8705 + 0.2882 \end{bmatrix}, \quad X^{(p)} = \frac{1}{\sqrt{2}} \begin{bmatrix} -2+2j \\ 2+2j \\ 2-2j \\ 2+2j \end{bmatrix}$$

Compute the channel estimate fading channel coefficient h for the given model assuming AWGN noise.

4C) Calculate the Signal-to-Noise Ratio (SNR) in dB needed to attain a bit error rate of 10^{-3} when transmitting over a Rayleigh fading wireless channel. (3)

5A) Consider a selection diversity system with 5 branches, where each branch receives an independent Rayleigh fading signal. If the average SNR is 25dB determine the probability that the SNR will drop below 6dB. Compare this with the case of no diversity. (4)

5B) Differentiate between selection diversity and feedback diversity. Compare their performances. (3)

5C) With the help of a block diagram, explain the concept of adaptive equalization in a wireless communication system. (3)

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