Question Paper

Exam Date & Time: 04-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

VI SEMESTER B.TECH. (COMPUTER COMMUNICATION ENGINEERING)

END SEMESTER EXAMINATIONS - April / May -2024

WIRELESS COMMUNICATION AND COMPUTING [ICT 3272]

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

PART-A

Answer all the questions.

Missing data, if any may be suitably assumed.

1) A) Consider a wireless communication scenario where a Mobile Station (MS) is stationary and is receiving the signal from the fixed base station. In addition, the MS is also receiving a second signal due to the presence of a reflective object. Derive the wireless channel model and an expression for Doppler spread. (5)

B) Explain the terms: free space loss and antenna gain with respect to wireless communication. Consider a wireless transmission scenario where the transmitter antenna and receiver antennas are directional antennas with the gain G_T and G_R. Analyse the effect on free space loss when the frequency of transmission is varied with and without the directional antennas. (3)

C) Consider an access point/client emitting 900-MHz carrier frequency, it is affected only by thermal noise. The transmission power at access point Tx is 316 mW, client-side Tx is 63 mW, and cable loss at both side is 3 dB. Antenna gains at the access point and client sides are 14 dBi and 13 dBi respectively. The free space path loss for the coverage range of 5 km, the receiving sensitivity at the access point is -72 dBm, and the receiving sensitivity at client side is -79 dBm. Determine the following: (2)

i. Estimate the Rx signal level at access point.

ii. The link margin of the network.

2) A) Assume that there are six co-channel cells in the first tier, and all of them are at the same distance from the mobile. Use suitable approximations. (5)

i. If a signal-to-interference ratio of 15 dB is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor and cluster size that should be used for maximum capacity if the path loss exponent is n = 4.

ii. A person is moving from cell A to cell B at the speed of 150 km/hr. The distance between the 2 cell is 2500 m and handoff occurs at a time of 6s. Assuming minimum usable power to be -92 dBm, path loss to be 3. Calculate the distance before which handoff must be completed and minimum required margin of handoff. [Assume d_0 =1 P_0=0 dBm].

B) Consider a convolutional code with a constraint length of K=3 and a receiver received sequence of 110101110101. Apply the Viterbi decoding algorithm using hard decision path metric to find the most likely transmitted sequence and its bit error. (3)

C) Briefly explain four mitigation strategies to minimize the impact of adjacent channel interference on (2)

cellular communication.

3) Draw and analyze the four types of handover management in GSM. (5)

A)

B) Illustrate the working principle of the *Mobile System* (MS) in its three states. (3)

C) A cellular service provider decides to use GSM with TDMA which can tolerate the signal-to-interference ratio of 22 dB in worst case. Find optimal value of N assuming n =4 for 60-degree sectoring. (2)

4) Consider a 4G wireless WiMAX standard with fixed profile. The numbers of subcarriers are 256 and the bandwidth associated with each subcarrier is 15.625 KHz. Assume the cyclic prefix (CP) duration in WiMAX is 12.5% of the OFDM symbol duration without the CP. Calculate the following! (5)

A)

i. Bandwidth of broadband WiMAX system

ii. Symbol duration of OFDM signal without CP

iii. Duration of CP

iv. Total duration of OFDM with CP

v. Number of samples in CP

vi. Number of samples in OFDM with CP

vii. Loss in efficiency.

B) Why do primary users agree to allow the secondary users to employ their spectrum in the cognitive radio networks? (3)

C) Compare and contrast TDMA (Time Division Multiple Access), and CDMA (Code Division Multiple Access) in terms of their principles, advantages, and disadvantages. (2)

5) The channel matrix representing the channel coefficient between the transmit and receive antenna of 2x2 MIMO system is given as (5)

A)

$$\mathbf{H} = \begin{bmatrix} 0.8 & 0.2 \\ 0.3 & 0.9 \end{bmatrix}.$$

The signals transmitted by each of the transmitting antenna at the transmitter side are denoted as x_1=1 and x_2=2, respectively. The noise added at the receiver side is AWGN with zero mean and 0.1 variance value. Calculate the following:

i. The value of **Hx,**

ii. The value of y_1 and y_2, if n_1=0.15 and n_2=-0.5,

iii. The capacity per unit bandwidth of MISO system, assuming the signal transmitted at power of 1 watt, assuming H= $[0.8\ 0.8]^T$

iv. The capacity per unit bandwidth of SIMO system, assuming the signal transmitted at power of 1 watt, assuming H= $[0.2\ 0.2]^T$

where T represents the transpose of the matrix.

B) Consider a scenario with are three nodes: A, B, and C. Node A wants to communicate with node B. To avoid deep fade conditions and obtain better reliability, node B receives two copies of the same signal: one copy of the signal coming directly from node A and the second copy of the signal (3)

coming via node C. However, node C re-transmits the second copy of the signal after applying perfect decoding to the signal coming from node A.

Assume the following:

- Distance between A and C: 100 meters
- Distance between B and C: 120 meters
- Distance between A and B: 150 meters
- Transmit power of each node: 10 dBm
- Path loss exponent: 2
- Noise power: -100 dBm
- Required signal-to-noise ratio (SNR) for successful communication: 10 dB
- Large scale fading.
- Neglect small scale fading.

Calculate the following.

i. Signal-to-noise ratio (SNR) at node B whenever the signal comes directly and via node C

ii. Sum of the SNR at node B

iii. Capacity per unit bandwidth in case the signal comes from node A and node C.

C) A SISO system where the signal is transmitted at a power of 1 mW. The channel coefficient between the transmitter and receiver nodes is 0.3. Let us assume that the noise variance at the receiving node is 0.1. Calculate the probability of deep fade for this SISO system. (2)

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