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National Institute of Technology Hamirpur (HP) Electronics & Communication Engineering Department End Semester Examination, May 2023 B.Tech./Dual Degree (ECE) – 6<sup>th</sup> Semester Wireless Communication (EC-322)

Max. Marks: 50

Time: 3 Hrs. Note:All questions are compulsory. The symbols and variables used have their usual meaning.

- Q1. (a) Prove that for a hexagonal geometry, the co-channel reuse ratio is given by  $Q = \sqrt{3N}$ , where  $N = i^2 + j^2 + ij$  and i, j are nonnegative integers. A cellular system is planned having a cluster of size N = 7 cells. Form a proper cluster with cells numbered from 0 to 6 for this cellular system, assuming i > j and j = 1 for computing convenience. [5]
  - (b) Given a cellular system in which there are a total of 1001 duplex radio channels available for handling traffic. It is also given that the area of a cell is 6 km<sup>2</sup> and the area of the entire system is 2100 km<sup>2</sup>.
    - i) Calculate the system capacity if the cluster size is 7.
    - ii) How many times would the cluster of size 4 have to be replicated in order to approximately cover the entire cellular area? Calculate the system capacity if the cluster size is 4.
- Q2. Using Okumura model, calculate the mean path loss in dB for d = 50 km,  $h_{te} = 200 \text{ m}$ ,  $h_{re} = 3 \text{ m}$  in a suburban environment. If the base station transmitter radiates an EIRP of 60 dBm at a carrier frequency of 900 MHz, find the power at the receiver when gain of the receiving antenna is 12 dB. Given that the median attenuation relative to free space at d = 50 km for carrier frequency of 900 MHz is 43 dB and the correction factor due to the type of environment (area) is 9 dB. ( $h_{te}$  is the base station (transmitter) effective antenna height,  $h_{re}$  is the mobile station (receiver) antenna height and d is the separation distance between the transmitter and the receiver) [10]
- Q3. (a) A local spatial average of a power delay profile measured at 900 MHz is given below:

Delay [ $ au$ ] in $\mu s$	Power level $[P_r(\tau)]$ in $dB$
0	0
1	-10
2	-20

Determine the mean excess delay ( $\overline{ au}$ ) and the rms delay spread ( $\sigma_{ au}$ ) for the channel. [5]

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- (b) Space diversity is one of the most popular forms of diversity used to provide wireless link improvement in wireless systems. Explain various space diversity reception methods which can be used in wireless communications. [5]
- Q4. Draw and explain an adaptive linear equalizer during training mode, and determine the optimal solution for the weight vector (in terms of the input correlation matrix, and the cross-correlation vector between the desired response and the input signal) by minimizing its mean square error. [10]
- Q5. Discuss about the time division multiple access (TDMA) technique used in wireless communications. If GSM uses a frame structure where each frame consists of eight time slots, and each time slot contains 156.25 bits (assuming a normal GSM time slot consists of 6 trailing bits, 8.25 guard bits, 26 training bits, and two traffic bursts of 58 bits of data), and data is transmitted at 270.833 kbps in the channel, then find (i) the time duration of a slot, (ii) the time duration of a frame, (iii) the frame efficiency. [10]