COLLEGE OF ENGINEERING TRIVANDRUM
Dept. of Electronics & Communication Engineering
First Internal Examination – March/April 2023

Max. Marks: 50

Class: S8ECE

ECT402: Wireless Communication

Time: 2 Hours

Part A: Answer all questions (18 Marks)

Q. No	Questions	Marks	COs	KL
1	Prove that the reuse factor $N = i^2 + ij + j^2$ for a hexagonal cellular system.	3	CO1	K3
2	Find the minimum reuse factor of a hexagonal cellular system if the desired SIR at a user is 16dB.	3	CO1	K3
3	If a 100 MHz of a total spectrum is allocated for a duplex wireless cellular system and each simplex channel has 125 kHz RF bandwidth, find the (a) the total number of duplex channels and (b) the total number of channels per cell site, if N=4 reuse is used.	3	CO1	K3
4	Compute the SIR for a TDMA cellular system with diamond-shaped cells, where the cell radius R = 10 m and the reuse distance D = 50 m. Assume that the path-loss exponent within the cell is n_I = 2 but that the intercell interference has path-loss exponent n_0 = 3.	3	CO1	K3
5	If a signal-to-interference ratio of 20 dB is required for satisfactory forward channel performance of a hexagonal cellular system, what is the frequency reuse factor and cluster size that should be used for maximum capacity if the path loss exponent n=4.	3	CO1	K3
6	Consider a cellular system with diamond-shaped cells of radius R = 50 m. Suppose the minimum distance between cell centers using the same frequency must be D = 300 m to maintain the required SIR find the required reuse factor N and number of cells per cluster.	3	CO1	K3

Answer any one full question from Parts B and C (32 marks)

Part B

7 The base stations (BS) require a fixed amount of time to complete the Handoff process once initiated. If the received signal power falls below the Handoff threshold ($P_{r,HO}$) before the Handoff is successful, then the call will be lost.

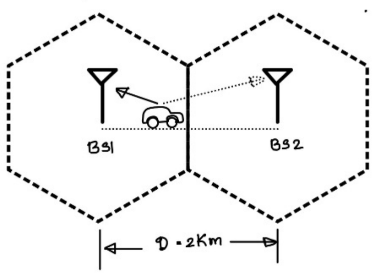

Figure 1

Consider the figure 1. There are two base stations BS1 and BS2 at a distance D = 2Km and transmits the signal with equal power. A car is travelling from a point near to BS1 to a point near to BS2 at a speed of 80 Km/hr. A person inside the car measured the receiver power at 1m from BS1 and found to be 0dBm. The BS initiates a Handoff if the signal falls below $P_{r,min}$= -88dBm. The time required to complete the Handoff is 4 seconds. Assume the path loss exponent $n = 2.9$.

7a	Determine the minimum required margin $\Delta = P_{r,\min} - P_{r,HO}$ to assure that calls are not lost due to weak signal during Handoff.	10	CO1	K3
7b	If the car was travelling at a speed of 160Km/hr how does Δ change and explain how the value of Δ affects the performance.	6	CO1	K3

OR

8 A transmitted signal will reach the receiver after reflections from different surfaces along its path. In the simplest of cases there will be ground reflected component along with the direct LoS component. At the receiver these components will be superimposed.

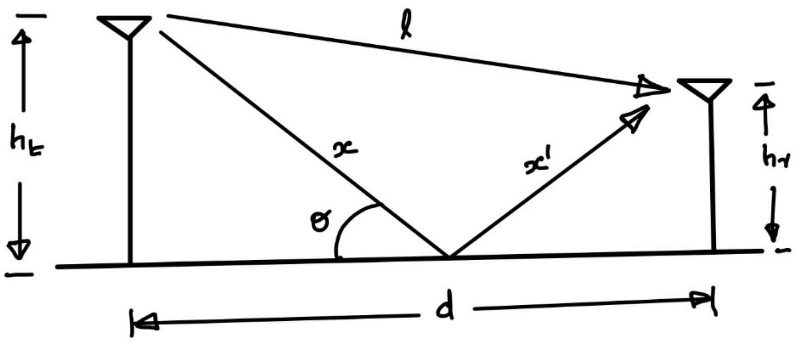

Figure 2

Consider a receiver of height h_r situated at a distance d from the transmitter of height h_t, as shown in figure 2. The gain of the transmit antenna is G_t and that of the receive antenna is G_r. Let λ be the wavelength of the signal, θ the angle made by the NLoS component with respect to ground, the distance traversed by the LoS signal is l and that by NLoS is $x + x'$.

8a	Derive the expression for the phase difference $\Delta\phi = \frac{2\pi(x+x'-l)}{\lambda}$ of the two components in terms of the heights of the two antennas and the distance between them.	10	CO1	K3
8b	If P_t is the transmit power, derive the expression for the received signal power in terms h_t, h_r, and d assuming the ground reflection coefficient is -1, and $G_t = G_r = 1$.	6	CO1	K3

Part C

9a	A cellular service provider decides to use a digital TDMA scheme which can tolerate an SIR of 15 dB in the worst case. Find the optimal value of N for (a) omnidirectional antennas, (b) 120° sectoring, and (c) 60° sectoring. Should sectoring be used? If so, which case (60° or 120°) should be used? (Assume a path loss exponent of n = 4).	8	CO1	K3

9b	Consider a path loss model called as simplified path loss model where $P_r = P_t K \left(\frac{d_0}{d}\right)^n$ and $K\ (in\ dB) = 20\log_{10}\frac{\lambda}{4\pi d_0}$. Consider a receiver with noise power −160 dBm within the signal bandwidth of interest. Assuming a simplified path-loss model with d_0 = 1 m, and f_c = 1 GHz, and n = 4. For a transmit power of P_t = 10 mW, find the maximum distance between the transmitter and receiver such that the received signal-to-noise power ratio is 20 dB.	8	CO1	K3
	OR			
10	Consider a hexagonal cellular system with cluster size N. Suppose that the BS of first p tiers produce significant interference for a user situated at the boundary of the cell. Assume path loss exponent $n = 3$, all the cells have the same radius and the BS located at the center of the cells transmit the same power.			
10a	Derive the expression for SIR for a user located at the edge of a cell.	8	CO1	K3
10b	If the signal power measured at 1m from a BS is 1dBm for $p = 4$ number of interfering tiers, compute the contribution of 2^{nd} tier BS to the total co-channel interference for the user. Assume N=7, the distance between a BS and it's first tier is 1Km and the distance doubles for each tier.	8	CO1	K3