REG.NO.:

VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

NAME OF THE SCHOOL
CONTINUOUS ASSESSMENT TEST - II
FALL SEMESTER 2024-2025

SLOT: A2

Programme Name & Branch	: B.Tech - ECE
Course Code and Course Name	: BECE307L/ Wireless and Mobile Communications
Faculty Name(s)	: INDRASEN SINGH, CHRISTOPHER CLEMENT J, ABHIJIT BHOWMICK, ASHISH P, PRAKASAM P, VINOTH BABU K, VIVEK RAJPOOT, PREETHA K.S, SUDHANSHU ARYA, BUDHADITYA BHATTACHARYYA
Class Number(s)	: VL2024250102764, 2756, 2761, 2768, 2748, 2752, 2771, 2766, 2773, 2759
Date of Examination	: 13-10-2024
Exam Duration	: 90 minutes

Maximum Marks: 50

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Course Outcomes

CO3: Demonstrate the principles of multicarrier modulation.

CO4: Select a suitable diversity technique to combat the multipath fading effects.

CO5: Identify suitable MIMO techniques to enhance the spectrum efficiency.

Q. No	Question	M
1.	a) A certain wireless channel has a delay spread of 1 μs. To overcome ISI, the symbol time should at least be 10 times longer than the delay spread i.e., $T_s \geq 10\tau$. Determine i. The maximum allowable bandwidth in the above system. ii. If multicarrier modulation is used and we desire a total bandwidth of 4 MHz, determine the minimum number of subcarriers required. iii. The minimum CP duration. iv. Loss in spectral efficiency.	10 (3+3+ 2+2)
2.	a) Consider a BPSK-modulated OFDM system with $N = 16$ subcarriers over a bandwidth of $B = 5$ MHz. Let the corresponding frequency selective fading channel have an impulse response with multipath components at delays of [0, 0.40 0.60] μs. Noise power at the receiver is $\sigma^2 = 3$ dB. The total transmit power $P_T = 10\,dB$ is equally divided and provided to each sub-carrier for transmission. Calculate the average BER of the OFDM system.	5
	b) Consider $\|H\|^2 = 2$, and the data power $P = 20$ dB with noise power $\sigma^2 = 0$ dB. Calculate the SINR and SNR with and without a carrier frequency offset $\epsilon = 2\%$ in a LTE system.	5
3.	a) A transmitter transmits a BPSK-modulated information with 0.02 mW power to a receiver. How much BER is there on a wired channel and wireless Rayleigh faded channel if the noise variance at the receiver is 0.001 mW.	5
	b) Compare the probability of deep fade of a SISO system with the 2×1 SIMO system for the same wireless communication environment indicated in question 3 (a).	5
4.	Consider a wireless channel with $L = 3$ receive antennas and complex fading channel coefficients $h_1 = 1 + j$, $h_2 = \frac{1}{\sqrt{2}} - \frac{j}{\sqrt{2}}$, and $h_3 = -1 + j$. The transmitted signal, $x(k)$, is BPSK modulated, and the received signals at different antennas are $y_1(k), y_2(k)$, and $y_3(k)$, corrupted by noise $n_1(k), n_2(k)$, and $n_3(k)$, which are Gaussian-distributed	

	independent random variables with variance $\sigma_n^2 = 1$. i. If maximal ratio combining (MRC) diversity technique, with beamforming weight vector $\boldsymbol{w}$, is employed at the receiver, find the optimal beamformer $\boldsymbol{w_{opt}}$ that maximizes the received SNR. Show that, $\left\|\boldsymbol{w_{opt}}\right\| = 1$. ii. If $E\{\|x(k)\|^2\} = 5$, obtain the resulting SNR after MRC diversity technique. iii. If the transmitted signal $x(k)$ is BPSK modulated with channel coefficients amplitude gains $\|h_i\|, i = 1, 2, 3$ are assumed to be independent Rayleigh distributed, calculate the average BER for the above system employing MRC technique at the receiver. iv. For a reliable communication system, if the required BER must always be less than 10^{-6}, find the SNR required in dB.	10 (4+2+ 2+2)
5.	a) Compute the MIMO zero-forcing (ZF) receiver for the channel matrix given below: $\boldsymbol{H} = \begin{bmatrix} 1 & -0.8 \\ 0.2 & -1 \end{bmatrix}$	5
	b) Let 2×2 channel matrix $\boldsymbol{H}$ be given as, $\boldsymbol{H} = \begin{bmatrix} \sqrt{6} & 0 \\ 0 & 1 \end{bmatrix}$ Use the SVD approach to break down $\boldsymbol{H}$. Show matrices satisfying required properties.	5

****