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

REG.NO.: 21BEC0765

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

SLOT: A1

Programme Name & Branch	**: B.Tech - ECE**
Course Code and Course Name	**: BECE307L/ Wireless and Mobile Communications**
Faculty Name(s)	**: BUDHADITYA BHATTACHARYYA, PRAKASAM P, ABHIJIT BHOWMICK, VINOTH BABU K, CHRISTOPHER CLEMENT J, VIJAYA DURGA CHINTALA, ASHISH P, VIVEK RAJPOOT, INDRASEN SINGH, PREETHA K.S**
Class Number(s)	**: VL2024250102758, 2746, 2760, 2749, 2753, 2775, 2767, 2770, 2763, 2765**
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	CO	BL
1.	a) Two raw OFDM symbols, each 32 characters long (including spaces) are given below: Symbol 1: YOU ARE A SINCERE INDIAN CITIZEN Symbol 2: WHAT IS YOUR CHILDHOOD FAVOURITE Rewrite the above symbols by adding respective cyclic prefixes (CP). Assume CP length to be 1/8th of the total characters.	5	3	3
	b) "For a given channel delay spread L (CP duration = L samples), the loss in spectral efficiency approaches to zero as the number of subcarriers N increase to ∞". Inspired by the above fact, a student-designed an OFDM system with 8192 subcarriers for a channel whose delay spread lasted for 32 samples. Determine the loss in spectral efficiency for this system. Although the designed system looks good, can you foresee any design flaws that can create troubles during signal reception at the receiver? Explain.	5		
2.	a) Consider a BPSK-modulated OFDM system with $N = 4$ subcarriers and the wireless channel with channel coefficients $h(0) = \frac{1}{2}$ and $h(1) = \frac{1}{2}$. Let noise power per subcarrier (i.e., after the FFT at the receiver) be σ^2 = 3 dB. The total transmit power $P_T = 18\,dB$ is equally divided and provided to each sub-carrier for transmission. Calculate average BER for the OFDM system.	5	3	3
	b) The IEEE 802.11a Wireless LAN standard, which occupies 20 MHz of bandwidth in the 5 GHz unlicensed band is based on OFDM. In 802.11a, $N = 64$ subcarriers are generated, although only 48 are actually used for data transmission. In the system if the carrier frequency offset is accurate to 0.1 parts per million (ppm). Calculate the value of normalized frequency offset ε.	5		

VIT

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

REG.NO.:

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

SLOT: A1

3.	a) A wired communication system aims for a BER of 2×10^{-6}. If the noise variance is 0.001, what would be the transmit power in dB? At what signal-to-noise ratio (SNR) can a wireless channel that has been Rayleigh faded achieve the same BER?	5	4	3
	b) A SIMO system's transmit SNR is 13.01 dB. How many antennas should be used at the receiver if the expected deep fade probability is 0.0013? What could be the minimum spacing between antennas if the system is operated at 900 MHz?	5		
4.	Consider a wireless communication scenario 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. Consider an Equal Gain Combining (EGC) diversity technique applied at the receiver, derive the optimal weight vector w_{opt} for constructive addition. Prove that the magnitudes of all the elements of w_{opt} remain constant. ii. If SNR at the output of the EGC combiner is found to be 10 dB, then find $E\{|x(k)|^2\}$? iii. Calculate the instantaneous BER at the output of the EGC combiner. iv. If a fourth receive antenna is added in the EGC combiner, with the channel coefficient $h_4 = \frac{1}{\sqrt{3}} + j\frac{1}{\sqrt{3}}$, then evaluate how the addition of this fourth antenna affects the instantaneous BER compared to the previous configuration. Calculate the percentage improvement in BER performance.	10 (2+ 2+2 +4)	4	3
5.	a) Consider a MIMO wireless system in which a zero-forcing (ZF) receiver decodes the transmitted vector $\boldsymbol{x}$ from the received vector $\boldsymbol{y}$. Calculate pseudo-inverse matrix if the channel fading coefficients are $h_{11} = 2, h_{12} = 3, h_{21} = 1, h_{22} = 3, h_{31} = 4$ and $h_{32} = 2$.	5	5	3
	b) Let 2×2 channel matrix $\boldsymbol{H}$ be given as, $\boldsymbol{H} = \begin{bmatrix} 1 & 0 \\ 0 & \sqrt{7} \end{bmatrix}$ Decompose it into $\mathbf{U}, \Sigma, \boldsymbol{V^H}$ matrices using SVD technique. Show matrices satisfying required properties.	5		

****