Birla Institute of Technology & Science, Pilani
Work Integrated Learning Programmes Division
First Semester 2022-2023

Comprehensive Examination
(EC-3 Regular)

Course No.	:	CSI ZG520
Course Title	:	Wireless and Mobile Communications
Nature of Exam	:	Open Book
Weightage	:	50%
Duration	:	2 ½ Hours
Date of Exam	:	27/11/2022 (FN)

No. of Pages = 2
No. of Questions = 6

Note to Students:
1. Please follow all the *Instructions to Candidates* given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. Assumptions made if any, should be stated clearly at the beginning of your answer.

Q. 1 Consider the design of an OFDM system. The goal is to transmit data at a rate of 2.4 MBPS using 16-QAM with an available bandwidth of 600 KHz. It is known that the delay spread of the channel is up to a maximum of 20μ seconds. You can assume a cyclic prefix interval equal to the max delay spread. Four guard channels at each end of the signal spectrum also required. Find the total number of subcarriers and total transmission time of an OFDM symbol. **(8 marks)**

Q. 2 Consider an angle modulated signal

$$x_c(t) = 10\cos(\omega_c t + 3\sin\omega_m t)$$

where, f_m = 1k Hz **(8 marks)**

(a) Determine modulation index and bandwidth when (i) f_m is doubled, and (ii) f_m is reduced by half. Considering $X_c(t)$ is PM signal.
(b) Determine modulation index and bandwidth when (i) f_m is doubled, and (ii) f_m is reduced by half. Considering $X_c(t)$ is FM signal.
(c) Determine power of the angle modulated signal
(d) Show that the narrowband FM signal converges to an amplitude modulated signal.

Q. 3 (a) Consider a random process $X(t)$ given by

$$X(t) = A\cos(\omega t + \theta)$$

where ω and θ are constants and A is a random variable.
Determine whether $X(t)$ is WSS? **(3 marks)**
(b) A binary signal $S_i(t)$ is a +1 Volt or -1 Volt pulse during the interval (0, T). AWGN with PSD $N_0/2 = 10^{-15}$ Watts/Hz is added to the signal. Determine the minimum bit rate that can be sent with a bit error probability of $P_b \leq 10^{-4}$. **(5 marks)**

Q. 4 (a) We wish to send at a rate of 10Mb/s over a bandpass channel. Assuming that an excess bandwidth of 50% is used, how much bandwidth is needed for each of the following schemes: QPSK, 64-QAM. **(3 marks)**
(b) Repeat part (a) for baseband channel. **(3 marks)**
(c) Assuming that it is desired to transmit information at a rate of R bits/sec. Determine the required transmission bandwidth of each of the following six communication systems (orthogonal BFSK, 8PSK, QPSK, 64-QAM, BPSK, Orthogonal 16-FSK), and arrange them in order of bandwidth efficiency, starting from the most bandwidth efficient and ending at the least bandwidth efficient. **(4 marks)**

Q. 5 For the waveforms given in Fig. 1, find the basis function using GS method, also provide their vector representation. (8 **marks)**

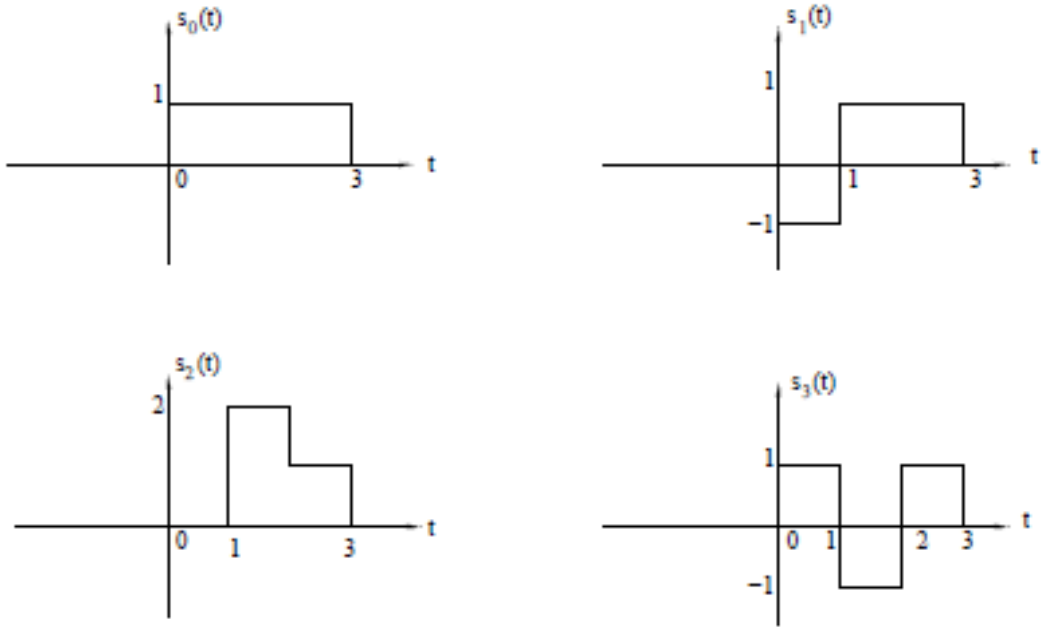

Fig. 1

Q. 6 (a) Cellular service provider decides to use a digital TDMA scheme which can tolerate a signal-to-interference ratio of 15 dB in the worst case. Find the optimal value of *N* for (i) omni-directional antennas, (ii) 120^0 sectoring, and (iii) 60° sectoring. Assume that there are 6 co-channels cells in the first tier for omni-directional antenna, and all of them are at the same distance from the mobile. Given a path loss exponent $n = 4$.
Hint: Sectoring reduces the number of interferer cells. For eg., for 120^0 sectoring, the number of interferers in the first tier reduced from 6 to 2. **(4 marks)**
(b) Write time domain and frequency domain equations for the single toned SSB-USB modulated signal. Plot the spectrum as well. **(2 marks)**
(c) Write a short note on VSB. What is the practical use of VSB signal. **(2 marks)**
