Thapar Institute of Engineering & Technology, Patiala

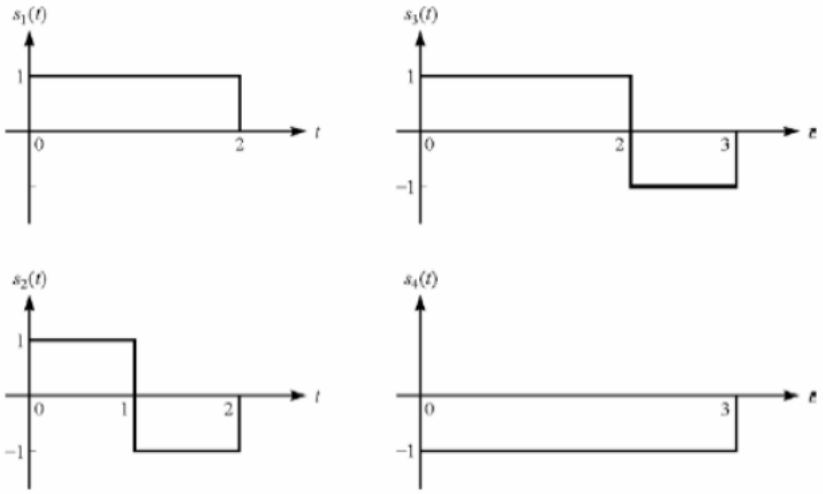
Department of Electronics and Communication Engineering

UEC639 – Digital Communication

B. E. (Third Year): Semester-V (ENCE)

Tutorial-6

Q1	Determine the total number of channels that can multiplex to achieve a bit rate of 906 kbps. Assume 5 bit PCM system and sampling frequency of 6 kHz and one additional bit for synchronization. (Answer = 30 channels).
Q2	A signal $x_1(t)$ is band-limited to 3.6 kHz, and three other signals - $m_2(t), m_3(t), and\ m_4(t)$ are band-limited to 1.2 kHz each. These signals are to be transmitted using TDM. (a) Setup a scheme for accomplishing the TDM with each signal sampled at its Nyquist rate. (b) What must be the speed of the commutator (in samples per sec)? (c) If L = 512 then what is the bit rate and transmission bandwidth?
Q3	The T1 carrier system used in digital telephony multiplexes 24 voice channels based on 8-b PCM. Each voice signal is usually put through a low-pass filter with the cutoff frequency of about 3.4 kHz. The filtered voice signal is sampled at 8 kHz. In addition, a single bit is added at the end of the frame for the purpose of synchronization. Calculate (*a*) the duration of each bit, (*b*) the resultant transmission rate, and (*c*) the minimum required transmission bandwidth (Nyquist bandwidth).
Q3	**Given a set of signals** $$s_i(t) = 2\,Cos\left(2\pi f_c t + \frac{\pi\, i}{4}\right), \quad for\ i = 0, 1, \dots, 3$$ (i) What is the dimensionality, "N", of the space spanned by this set of signals? (ii) Find a set of orthonormal basis functions using Gram Schmidt Procedure to represent this set of signals. (iii) Draw the constellation diagram of this signal set (iv) Determine the norms of signal vector s_i
Q4	Apply Gram-Schmidt orthogonalization procedure to obtain the orthonormal basis functions require to represent the following function. Then, determine the vector representations of the signals and determine the signal energies.


$s_1(t)$
1
0
2
t
$s_3(t)$
1
0
2
3
t
−1
$s_2(t)$
1
0
1
2
t
−1
$s_4(t)$
0
3
t
−1