Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIRST SEMESTER M.TECH. (DEC) DEGREE END SEMESTER EXAMINATION
DECEMBER 2018/JANUARY 2019
SUBJECT: ADVANCED DIGITAL COMMUNICATION (ECE - 5101)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. Consider the four waveforms $S_1(t), S_2(t), S_3(t)\ and\ S_4(t)$ shown in **Figure 1A.** The 4 basis functions are defined as:
$f_1(t) = 1, 0 \le t \le 1$, & 0 elsewhere; $f_2(t) = 1, 1 \le t \le 2$, & 0 elsewhere
$f_3(t) = 1, 2 \le t \le 3$, & 0 elsewhere; $f_4(t) = 1, 3 \le t \le 4$, & 0 elsewhere.

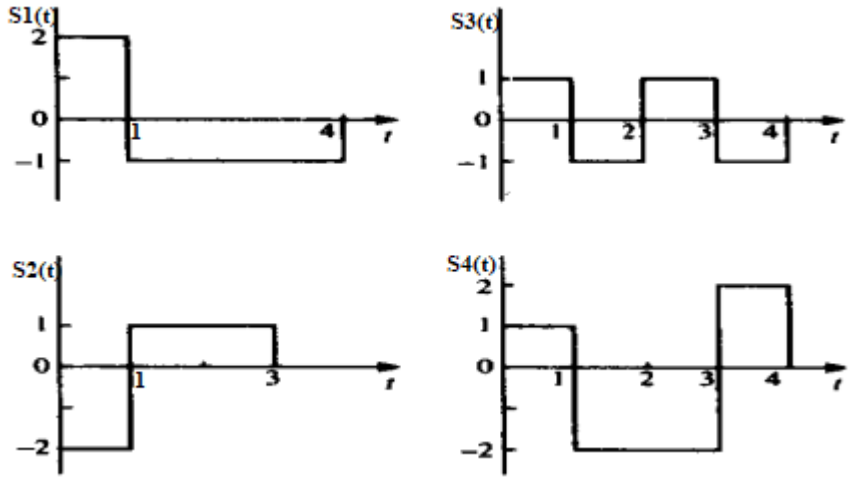

Figure 1A

Use the given basis functions to represent these signals as vectors in the signal-space. Determine correlation coefficient and minimum distance between any pair of vectors.

1B. Explain minimum shift keying technique with relevant diagrams for the binary data sequence 11010100.

1C. The random process *v (t)* is defined as $v(t) = Xcos2\pi f_c t - Ysin2\pi f_c t$ where X and Y are random variables. Show that *v (t)* is wide-sense stationary if and only if $E(X) = E(Y) = 0, E(X^2) = E(Y^2)$ and $E(XY) = 0$.

(5+3+2)

2A. Derive an expression for the probability of symbol error in the case of Multilevel-PAM modulated signals in the presence of AWGN noise.

2B. For the 8-PSK shown in Figure 2B, find the radius of the circle if the distance between adjacent points is 2A units. Calculate the average power transmitted by this constellation.

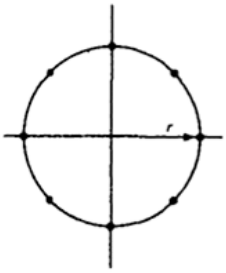

Figure 2B

2C. With the help of block diagram, explain DPSK technique to transmit and receive data sequence 110100010110. Show the transmitted phase for the given sequence.

(5+3+2)

3A. Consider a (7, 4) code whose Generator matrix is:

$$G = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

i. Find parity check matrix, H and generate all code words.

ii. How many errors can be detected and corrected by this code

iii. Find whether the received vectors 1101101 is a valid code word by using Syndrome decoding.

3B. A cyclic coder for (8, 5) block code is as shown in **Figure 3B**. Generate the code words for messages 10101, 11101

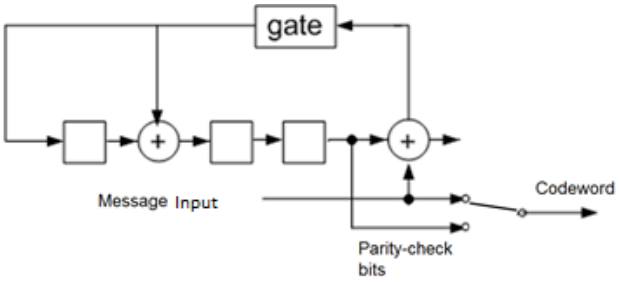

Figure 3B

3C. The trellis diagram for a certain convolutional encoder is as shown in **Figure 3C**. The numbers on each branch represents the Euclidian distance between the corresponding states. Using Viterbi algorithm, find the survivor paths to determine the shortest path between state A and state D.

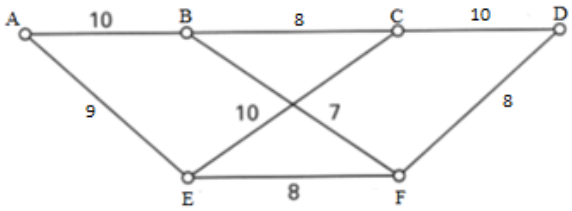

Figure 3C

(5+3+2)

4A. Define coherent time, coherent bandwidth, multipath spread and Doppler spread. Explain different manifestations of fading in wireless channels for the following cases in terms of the above parameters:

i. Frequency selective and flat fading
ii. Fast and slow fading

4B. A signal within a mobile wireless system undergoes time spreading. The symbol rate $R_s = 20k$ symbols/sec. Channel measurements indicate that the mean excess delay is 5μS, while the second moment of the excess delay is $1.0 \times 10^{-10} S^2$.

i. Calculate the coherence bandwidth f_o if it is defined as the frequency interval over which the channel's complex frequency transfer function has a correlation of at least 0.9.
ii. Is the channel frequency selective or not? Justify.

4C. Illustrate with example, the relationship between:

i. Signal power density profile as measured by the rms delay σ_τ and the Doppler power spectral density as measured by the fading bandwidth f_d
ii. Spaced frequency correlation function as measured by the coherence bandwidth f_o and the spaced time correlation function as measured by the coherence time, T_o.

(5+3+2)

5A. Explain the Trellis coded modulation technique for coded 8-PSK signal set and Find the coding gain with respect to an uncoded 4-PSK signal set.

5B. Consider a cellular telephone that is located in a vehicle travelling at 96 km/hr. The carrier frequency is 1900MHz, Use the GSM equalizer test profile shown in **Figure 5B**, to determine the following:

i. RMS delay spread
ii. Maximum allowable signal bandwidth, W that does not require the use of an equalizer
iii. Total time delay (transmitter plus receiver) caused by the interleaver when the ratio of interleaver span to coherence time T_{IL}/T_O is equal to 10.

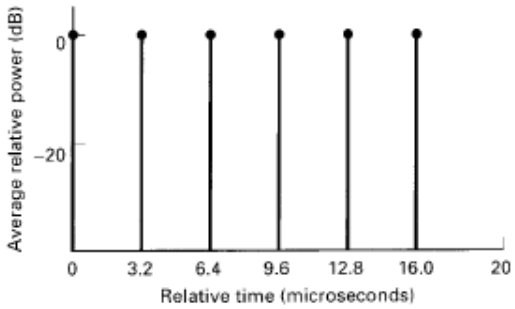

Figure 5B

5C. Explain with a relevant block diagram, how Viterbi equalizer mitigates the fading channel effects in GSM.

(5+3+2)