Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIFTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION

JANUARY/FEBRAURY 2021

SUBJECT: ANALOG AND DIGITAL COMMUNICATION (ECE - 3151)

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

Instructions to candidates

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

1A Find out whether the signal $g(t) = e^{-at}u(t)$ is energy signal or a power signal. Determine and sketch the autocorrelation function and the spectral density and hence determine its energy/ power. Determine the energy/ power of this signal contained in a band$[-W, W]$. Determine the bandwidth, W of this signal such that 90% of total energy/ power is contained in this band.

1B Consider a message signal m(t) of unit amplitude containing frequency components 0.1KHZ, 0.2KHZ and 0.4KHZ. The signal is applied to a SSB modulator together with a carrier of 100KHZ with only upper side band retained. The local oscillator used at coherent detector to recover m(t) delivers a frequency of 100.02KHZ.

i. Write down the expression of $S_{usb}(t)$.
ii. Determine the expression for output of multiplier $V_0(t)$.
iii. Determine the LPF output V(t).
iv. Determine the frequency components at detector output.

(5+5)

2A Consider a frequency modulated wave described by $s(t) = 5\cos(10^6 \pi t + 0.1\sin(10^3 \pi t))$. Determine the message signal m(t), modulation index, band-width of FM wave, average power of s(t) and frequency deviation assuming $k_f = 10\,Hz/Volt$. If s(t) represents a phase modulated wave with $k_p = 10^{-2}\,radian/volt$, then what is the message signal m(t)?

2B The overload level of a two bit encoded midriser quantizer is 4Volts. Let input to this quantizer be x which is the sample value of a random variable X whose probability density function is defined as follows: $f_X(x) = A - \frac{A}{4}|x|, \quad for\ |x| \leq 4$

$= \quad 0, \qquad otherwise$

i. Determine the value of A.
ii. Draw the pdf, $f_X(x)$ and the transfer characteristic of given quantizer.
iii. Compute the variance of the quantization noise.
iv. Compute the signal to quantization noise ratio at the output.

(5+5)

3A Consider the binary data sequence **0011010010011** which is applied to the input of a duo binary system.

i. Determine the output of the duo-binary coder and the corresponding receiver output, without a precoder.

ii. Suppose that due to the error during transmission, the level at the receiver input produced by the fourth digit is reduced to zero. Construct the new receiver output.

3B A signal $s(t) = \begin{cases} 1, & 0 \le t \le T \\ 0, & otherwise \end{cases}$

It is proposed to approximate the matched filter for this signal by a low pass RC filter defined by the transfer function $H(f) = \frac{1}{1+j\frac{f}{f_0}}$, where $f_0 = 1/2\pi RC$ is the cut off frequency of that filter.

i. Determine the optimum value of f_0 for which the RC filter becomes the best approximation for matched filter.

ii. Determine the peak output signal to noise ratio assuming noise is AWGN of zero mean and power spectral density, $N_0/2$.

(5+5)

4A A sinusoidal signal, $x(t) = 2cos\ (\pi t)$ is sampled at 8 samples per second and quantized using memoryless mid-riser quantizer of step size 0.34V.

i. Draw the transfer characteristic of the quantizer properly indicating peak to peak excursion and overload level.

ii. Tabulate the output of the quantizer and quantization error for one cycle of the input.

iii. What is the average information content of this quantizer output.

iv. Compute the signal to quantization noise ratio.

4B Elaborate the role of differential encoding in modulating the carrier for DPSK. Justify your answer with a proper example and necessary diagrams.

(7+3)

5A Consider a speech signal with maximum frequency of 3.4 KHz and maximum amplitude of 1Volt. This signal is applied to a delta modulator whose bit rate is set at 20Kbits per second. Discuss the choice of an appropriate step size for the modulator. If there is a silence in the speech signal for around 5 seconds, what will be the effect of this silence on the output of the delta modulator? Will the silence degrade the performance of the DM system? Justify your answer.

5B Consider a discrete memoryless source with source alphabet $S = \{s_0, s_1, s_2\}$ and source statistics $\{0.7, 0.15, 0.15\}$.

i. Construct a second extension for this source and hence compute the entropy.

ii. Construct a minimum variance Huffman code for this extended source.

(5+5)