Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

Program: B Tech Mechtronics **Semester: VIII**

Course: Analog and Digital Communication system **Time 03 hrs.**

Course Code: ELEG338 **Max. Marks: 100**

Number of pages: 4

Instructions:

- Attempt all questions as per the instruction.
- Assume any data if required and indicate the same clearly.
- Unless otherwise indicated symbols and notations have their usual meanings.
- Use Q-function table given in page no.4 if it is required.
- Strike off all unused blank pages

SECTION A (20 Marks)

S. No.		Marks	CO
Q 1	Draw the circuit of a balanced modulator and prove that this circuit produces an output consisting of side bands only, with the carrier removed.	4	CO1
Q 2	Draw the block diagram of a basic PLL system and explain its ability to track the frequency changes in the input signal.	4	CO1
Q 3	What are noise temperature and equivalent noise? A resistor of value R ohms is connected across a capacitance C. What is the RMS value of the noise voltage - across the circuit?	4	CO2
Q 4	What are the different types of errors in delta modulation? How these can removed?	4	CO3
Q 5	Draw the modulator and demodulator circuits for PSK transmission of digital signals. Compare its error rate performance with that of FSK transmission	4	CO4

SECTION B (40 Marks)

Q 6	(a) The antenna current of an AM broadcast transmitter modulated to a depth of 40% by an audio sine wave is 11 A. it increases to 12 A as a result of simultaneous modulation by another audio sine wave. What is the modulation index due to this second wave? (b) Consider a modulating signal $m(t)=10\sin(2\pi\times10^4 t)$ that is used to modulate a carrier frequency of 25 MHz. (i) Find the bandwidth for 98% power transmission for phase modulation and frequency modulation using $\beta_p=10$ and $\beta_f=10$. (ii) repeat (i) when modulating frequency is doubled	4+4	CO1

Q 7	(a) Let the AM signal at the input to envelope detector has the modulation index of 0.5 with the carrier amplitude of 2 V, the message signal m(t) of frequency 5 kHz. If the (two-sided) noise power spectral density at detector input is 10^{-8} watt/Hz. What is the expected output signal to noise ration $(SNR)_0$ of the scheme. (b) The signal $m(t)=\cos(400\pi t)$ is transmitted via FM. There is an ideal band-pass filter passing $100 \leq f \leq 300$ at the discriminator output. Calculate the post-detection $(SNR)_0$ given that $k_f = 1\,kHz$ per volt, and the pre-detection $(SNR)_i$ is 500. Use Carson's rule to estimate the pre-detection bandwidth	**4+4**	**CO2**
Q 8	Draw the block diagram of complete pulse code modulation (PCM) system and explain its working. Derive an expression for the output signal-to-quantization noise ratio if the message signal is sinusoidal.	**8**	**CO3**
Q 9	Compute the noise performance in digital communication systems. **OR** **(a)** The binary sequence 11100101 is applied to an ASK modulator. The bit duration is 1µs and the sinusoidal carrier wave used to represent symbol '1' has a frequency equal to 7 MHz. (i) Find the transmission bandwidth of the transmitted signal. (ii) Plot the waveform of the transmitted ASK signal. **(b)** Two quadrature carriers $\cos(2\pi f_c t)$ and $\sin(2\pi f_c t)$ are used to transmit digital information through an AWGN channel at two different data rates, 10 kbits/s and 100 kbits/s. Determine the relative amplitudes of the signals for the two carriers so that E_b/N_0 for the two channels is identical.	**8**	**CO4**
Q 10	Write short notes on (a) Time division multiplexing (b) Angle modulation	**8**	**CO1, CO3**
	SECTION-C (40 Marks)		
Q 11	(a) A signal $m(t)=4\cos(2\pi \times 10^4 t)$ is transmitted through a channel using 3-bit PCM, the sampling rate is twice the Nyquist rate. (i) Determine all parameters of the PCM signal. (ii) If the sampled values are 3.9, 2.1, 0.5, -1.1, -3.2, and 1.7, determine the quantizer output, encoder output and quantization error for each sampled value. (b) A video signal is bandlimited to 4.5 MHz and transmitted through a channel using PCM. (i) Determine the sampling rate if the signal is to be sampled at least 20% higher than the Nyquist rate. (ii) If the number of quantization levels are 1024, determine the signal to quantization noise ratio , bit rate and minimum bandwidth of the PCM signal. (c) The digital telephony T1 system carries a 24 voice channels with word length of 8-bit and a single bit added for frame synchronization. Find the bit rate of the T1 system.	**10+7+3**	**CO3**
Q 12	(a) A discrete memory less source generates either 0 or 1 at a rate of 160 kbps. 0 is	**10+10**	**CO4**

generated three times more frequently than 1. A binary PSK modulator is employed to transmit these bits over a noisy channel. The 0 an 1 are represented by S_0 and S_1:

$S_0 = 6\sqrt{2}\cos\left(640\pi \times 10^3 t\right) volt$ and $S_0 = 6\sqrt{2}\sin\left(640\pi \times 10^3 t\right) volt$ respectively.

(i) The transmitted signal energy per bit

(ii) Determine the basis functions for this BPSK scheme

(iii) Determine the probability error when the channel is assumed to be zero mean AWGN noise with power spectral density of $\frac{N_0}{2} = 3.125 \times 10^{-4}\, W/Hz$

(b) The binary data are transmitted over a microwave link at the rate of 1 Mbps and the power spectral density of the noise at the receiver input is $10^{-10}\, W/Hz$. Find the average carrier power required to maintain an average probability of error $P_e \leq 10^{-4}$ for coherent BPSK and DPSK

OR

Consider a digital communication system that transmits information via QAM over a voice-band telephone channel at a rate of 2400 symbols/s. The additive noise is assumed to be white and Gaussian.

(a) Determine the *Eb/N*0 required to achieve an error probability of 10^{-5} at 4800 bits/s.

(b) Repeat part 1 for a rate of 9600 bits/s.

(c) Repeat part 1 for a rate of 19,200 bits/s.

(d) What conclusions do you reach from these results?

Table of the Q Function

To find Q(1.36) look under column x to find 1.3. Then proceed on this row till you come to the column under 0.06. Read off the value 8.692E-2.

$$Q(x) = \frac{1}{\sqrt{2\pi}} \int_{x}^{\infty} e^{-t^2/2}\, dt$$

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	5.000E-01	4.960E-01	4.920E-01	4.880E-01	4.840E-01	4.801E-01	4.761E-01	4.721E-01	4.681E-01	4.641E-01
0.1	4.602E-01	4.562E-01	4.522E-01	4.483E-01	4.443E-01	4.404E-01	4.364E-01	4.325E-01	4.286E-01	4.247E-01
0.2	4.207E-01	4.168E-01	4.129E-01	4.090E-01	4.052E-01	4.013E-01	3.974E-01	3.936E-01	3.897E-01	3.859E-01
0.3	3.821E-01	3.783E-01	3.745E-01	3.707E-01	3.669E-01	3.632E-01	3.594E-01	3.557E-01	3.520E-01	3.483E-01
0.4	3.446E-01	3.409E-01	3.372E-01	3.336E-01	3.300E-01	3.264E-01	3.228E-01	3.192E-01	3.156E-01	3.121E-01
0.5	3.085E-01	3.050E-01	3.015E-01	2.981E-01	2.946E-01	2.912E-01	2.877E-01	2.843E-01	2.810E-01	2.776E-01
0.6	2.743E-01	2.709E-01	2.676E-01	2.643E-01	2.611E-01	2.578E-01	2.546E-01	2.514E-01	2.483E-01	2.451E-01
0.7	2.420E-01	2.389E-01	2.358E-01	2.327E-01	2.296E-01	2.266E-01	2.236E-01	2.206E-01	2.177E-01	2.148E-01
0.8	2.119E-01	2.090E-01	2.061E-01	2.033E-01	2.005E-01	1.977E-01	1.949E-01	1.922E-01	1.894E-01	1.867E-01
0.9	1.841E-01	1.814E-01	1.788E-01	1.762E-01	1.736E-01	1.711E-01	1.685E-01	1.660E-01	1.635E-01	1.611E-01
1.0	1.587E-01	1.562E-01	1.539E-01	1.515E-01	1.492E-01	1.469E-01	1.446E-01	1.423E-01	1.401E-01	1.379E-01
1.1	1.357E-01	1.335E-01	1.314E-01	1.292E-01	1.271E-01	1.251E-01	1.230E-01	1.210E-01	1.190E-01	1.170E-01
1.2	1.151E-01	1.131E-01	1.112E-01	1.093E-01	1.075E-01	1.056E-01	1.038E-01	1.020E-01	1.003E-01	9.853E-02
1.3	9.680E-02	9.510E-02	9.342E-02	9.176E-02	9.012E-02	8.851E-02	8.692E-02	8.534E-02	8.379E-02	8.226E-02
1.4	8.076E-02	7.927E-02	7.780E-02	7.636E-02	7.493E-02	7.353E-02	7.215E-02	7.078E-02	6.944E-02	6.811E-02
1.5	6.681E-02	6.552E-02	6.426E-02	6.301E-02	6.178E-02	6.057E-02	5.938E-02	5.821E-02	5.705E-02	5.592E-02
1.6	5.480E-02	5.370E-02	5.262E-02	5.155E-02	5.050E-02	4.947E-02	4.846E-02	4.746E-02	4.648E-02	4.551E-02
1.7	4.457E-02	4.363E-02	4.272E-02	4.182E-02	4.093E-02	4.006E-02	3.920E-02	3.836E-02	3.754E-02	3.673E-02
1.8	3.593E-02	3.515E-02	3.438E-02	3.362E-02	3.288E-02	3.216E-02	3.144E-02	3.074E-02	3.005E-02	2.938E-02
1.9	2.872E-02	2.807E-02	2.743E-02	2.680E-02	2.619E-02	2.559E-02	2.500E-02	2.442E-02	2.385E-02	2.330E-02
2.0	2.275E-02	2.222E-02	2.169E-02	2.118E-02	2.068E-02	2.018E-02	1.970E-02	1.923E-02	1.876E-02	1.831E-02
2.1	1.786E-02	1.743E-02	1.700E-02	1.659E-02	1.618E-02	1.578E-02	1.539E-02	1.500E-02	1.463E-02	1.426E-02
2.2	1.390E-02	1.355E-02	1.321E-02	1.287E-02	1.255E-02	1.222E-02	1.191E-02	1.160E-02	1.130E-02	1.101E-02
2.3	1.072E-02	1.044E-02	1.017E-02	9.903E-03	9.642E-03	9.387E-03	9.137E-03	8.894E-03	8.656E-03	8.424E-03
2.4	8.198E-03	7.976E-03	7.760E-03	7.549E-03	7.344E-03	7.143E-03	6.947E-03	6.756E-03	6.569E-03	6.387E-03
2.5	6.210E-03	6.037E-03	5.868E-03	5.703E-03	5.543E-03	5.386E-03	5.234E-03	5.085E-03	4.940E-03	4.799E-03
2.6	4.661E-03	4.527E-03	4.397E-03	4.269E-03	4.145E-03	4.025E-03	3.907E-03	3.793E-03	3.681E-03	3.573E-03
2.7	3.467E-03	3.364E-03	3.264E-03	3.167E-03	3.072E-03	2.980E-03	2.890E-03	2.803E-03	2.718E-03	2.635E-03
2.8	2.555E-03	2.477E-03	2.401E-03	2.327E-03	2.256E-03	2.186E-03	2.118E-03	2.052E-03	1.988E-03	1.926E-03
2.9	1.866E-03	1.807E-03	1.750E-03	1.695E-03	1.641E-03	1.589E-03	1.538E-03	1.489E-03	1.441E-03	1.395E-03
3.0	1.350E-03	1.306E-03	1.264E-03	1.223E-03	1.183E-03	1.144E-03	1.107E-03	1.070E-03	1.035E-03	1.001E-03
3.1	9.676E-04	9.354E-04	9.043E-04	8.740E-04	8.447E-04	8.164E-04	7.888E-04	7.622E-04	7.364E-04	7.114E-04
3.2	6.871E-04	6.637E-04	6.410E-04	6.190E-04	5.976E-04	5.770E-04	5.571E-04	5.377E-04	5.190E-04	5.009E-04
3.3	4.834E-04	4.665E-04	4.501E-04	4.342E-04	4.189E-04	4.041E-04	3.897E-04	3.758E-04	3.624E-04	3.495E-04
3.4	3.369E-04	3.248E-04	3.131E-04	3.018E-04	2.909E-04	2.803E-04	2.701E-04	2.602E-04	2.507E-04	2.415E-04
3.5	2.326E-04	2.241E-04	2.158E-04	2.078E-04	2.001E-04	1.926E-04	1.854E-04	1.785E-04	1.718E-04	1.653E-04
3.6	1.591E-04	1.531E-04	1.473E-04	1.417E-04	1.363E-04	1.311E-04	1.261E-04	1.213E-04	1.166E-04	1.121E-04
3.7	1.078E-04	1.036E-04	9.961E-05	9.574E-05	9.201E-05	8.842E-05	8.496E-05	8.162E-05	7.841E-05	7.532E-05
3.8	7.235E-05	6.948E-05	6.673E-05	6.407E-05	6.152E-05	5.906E-05	5.669E-05	5.442E-05	5.223E-05	5.012E-05
3.9	4.810E-05	4.615E-05	4.427E-05	4.247E-05	4.074E-05	3.908E-05	3.747E-05	3.594E-05	3.446E-05	3.304E-05
4.0	3.167E-05	3.036E-05	2.910E-05	2.789E-05	2.673E-05	2.561E-05	2.454E-05	2.351E-05	2.252E-05	2.157E-05
4.1	2.066E-05	1.978E-05	1.894E-05	1.814E-05	1.737E-05	1.662E-05	1.591E-05	1.523E-05	1.458E-05	1.395E-05
4.2	1.335E-05	1.277E-05	1.222E-05	1.168E-05	1.118E-05	1.069E-05	1.022E-05	9.774E-06	9.345E-06	8.934E-06
4.3	8.540E-06	8.163E-06	7.801E-06	7.455E-06	7.124E-06	6.807E-06	6.503E-06	6.212E-06	5.934E-06	5.668E-06
4.4	5.413E-06	5.169E-06	4.935E-06	4.712E-06	4.498E-06	4.294E-06	4.098E-06	3.911E-06	3.732E-06	3.561E-06
4.5	3.398E-06	3.241E-06	3.092E-06	2.949E-06	2.813E-06	2.682E-06	2.558E-06	2.439E-06	2.325E-06	2.216E-06
4.6	2.112E-06	2.013E-06	1.919E-06	1.828E-06	1.742E-06	1.660E-06	1.581E-06	1.506E-06	1.434E-06	1.366E-06
4.7	1.301E-06	1.239E-06	1.179E-06	1.123E-06	1.069E-06	1.017E-06	9.680E-07	9.211E-07	8.765E-07	8.339E-07
4.8	7.933E-07	7.547E-07	7.178E-07	6.827E-07	6.492E-07	6.173E-07	5.869E-07	5.580E-07	5.304E-07	5.042E-07
4.9	4.792E-07	4.554E-07	4.327E-07	4.111E-07	3.906E-07	3.711E-07	3.525E-07	3.348E-07	3.179E-07	3.019E-07