Total No. of Page(s): 3

Roll No. 272/COE/14

FOURTH SEMESTER **B.E. (COE)**

B.E. END SEM. EXAMINATION, May-2016

COE-215 : Principle of Communication Engineering

Time: 03:00 Hrs. Max. Marks: 70

Note: 1) Attempt FIVE Questions only.
2) Question 1 is compulsory.
3) Attempt any FOUR out of the rest.

1. [a] i) Find the fourier transform of sgn(t) = u(t)-u(-t)
ii) Find inverse fourier transform of H(w) = -j sgn(w). (4)

[b] Determine the Hilbert transform of
$x(t) = m(t)[\sin(w_c t) + \cos(w_c t)]$. (3)

[c] The power of an un-modulated carrier signal is given as 10 KW. When the carrier is modulated by single sinusoidal message signal, the transmitted power becomes 13.5 KW. Find AM transmitter power if the carrier is simultaneously modulated by second message signal with 60% of modulation. (4)

[d] A carrier wave of frequency 91 MHz is frequency modulated by a sine wave of A_m = 10V and frequency f_m = 15KHz. The frequency sensitivity of the modulator is 3 KHz/V.
i) Determine the bandwidth of FM using Carson's rule.
ii) Repeat (i), if amplitude of modulating wave is doubled. (3)

2. [a] State and prove the sampling theorem. Explain the different types of sampling in detail. (7)

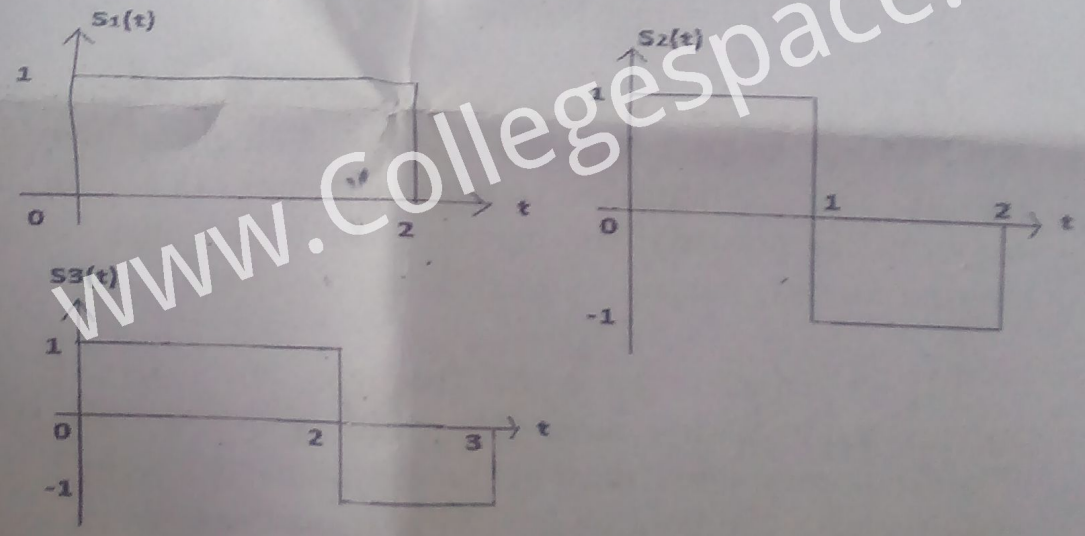
[b] A television signal with a bandwidth of 4.2 MHz is transmitted using binary PCM. The number of quantization levels is 512. Calculate the following:

i) Code word length
ii) Transmission bandwidth
iii) Final Bit Rate. (7)

X. [a] A random process is defined as X(t)=A Cos(2πft+θ), where f and θ are constants and A is uniformly distributed random variable between -1 and 1. Find out the autocorrelation function of X(t) and check the process for wide sense stationarity. (7)

[b]Explain power spectral density (PSD) and its properties. Obtain the PSD of a process whose autocorrelation function is given as $R_x(\tau) = e^{-a|\tau|}$, $a>0$. (7)

[a] Using the Gram-Schmit orthogonalization procedure, find a set of orthonormal basis functions to represent the following three finite energy signals $s_1(t)$, $s_2(t)$ and $s_3(t)$.



(7)

[b] Explain in detail i)Central Limit Theorem
ii)Ergodic random process. (7)

X. [a] If the density function of a continuous random variable X is given by

$$f_X(x) = \begin{cases} ax, & 0 \le x \le 1 \\ a, & 1 \le x \le 2 \\ 3a - ax, & 2 \le x \le 3 \end{cases}$$

i) Find the value of a.
ii) Find the CDF of x.
iii) Find $P(1 \leq x \leq 2)$ and $P(x > 1.5)$. (7)

[b] What is meant by matched filter? Show that the SNR at the output of a matched filter is always maximum. (7)

6. [a] Explain in detail PCM transmitter-receiver system. (7)

[b] Explain Q-PSK modulator and demodulator with the help of a block diagram. Also draw its constellation diagram. (7)

7. Write short note on any 2 of the following. (7 x 2)

[a] Uniform and Non-Uniform Quantization

[b] Costas loop for DSB-SC Demodulation

[c] Delta Modulation

[d] Direct method of FM generation.

Roll No. ..... No. of pages: 2

Date __/__/____

END SEMESTER EXAMINATION, May-2015
COE-215: Principles of communication Engineering

Time: 3:00 Hours **Max. Marks: 70**

Note: **Question 1 is compulsory.**
Attempt any 4 questions out of the rest.
All Question carry equal marks.
Assume suitable missing data, if any.

1. **[a]** Determine the Hilbert transform of (4)

$x(t)=m(t)[\sin(w_c t)+\cos(w_c t)]$,
where m(t) is bandlimited to the interval $-B \le w \ge B$ & $B < w_c$.

[b] A modulating signal $10\sin(2\pi \times 10^3 t)$ is used to amplitude modulate a carrier signal $20\sin(2\pi \times 10^4 t)$. Find modulation index percentage modulation, frequencies of the sideband components and their amplitudes. What is the bandwidth of modulated signal? (4)

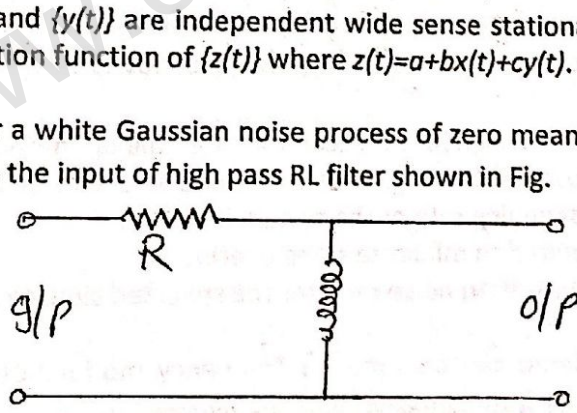
[c] If the nyquist rate for $x(t)$ is w_s. Find the Nyquist rate of: (3)
(i) $x(t)^* x(t)$, where * denotes the convolution operator.
(ii) $x(2t)$
(iii) $x(t/3)$

[d] The bandwidth of TV video plus audio signal is 4.5 MHz, if the signal is converted to PCM bi stream with 1024 quantization levels, determine the number of bits/sec generated by the PCM system. Assume that the signal is sampled at the rate of 20% above nyquist rate. (3)

2. **[a]** State and prove Sampling Theorem. (7)

[b] If $\{x(t)\}$ and $\{y(t)\}$ are independent wide sense stationary process with zero means, find th autocorrelation function of $\{z(t)\}$ where $z(t)=a+bx(t)+cy(t)$. Where a, b and c are constants.(7)

3. **[a]** Consider a white Gaussian noise process of zero mean and power spectral density $N_o/2$ tha is applied to the input of high pass RL filter shown in Fig.



(i)Find the autocorrelation function and power spectral density of the random process at th output of the filter.
(ii)Find the mean & variance of the output. (7

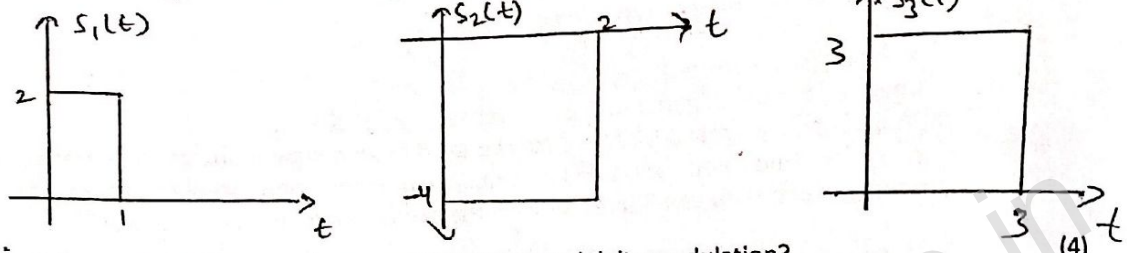
(86)

[b]If the density function of a continuous random variable x is given by

$$f_x(x) = \begin{cases} ax & 0 \le x \le 1 \\ a & 1 \le x \le 2, \\ 3a - ax & 2 \le x \le 3 \end{cases}$$ and 0 otherwise.

(I)Find the value of a.
(ii) Find the CDF of x.
(iii) Find $P(1 \le x \ge 2)$, $P(x > 1.5)$. (7)

4. [a] Using the Gram-Schmidt Orthogonalization procedure, find a set of orthonormal basis function to represent the three signals $S_1(t)$, $S_2(t)$, $S_3(t)$ and also give vector representation- (10)



[b] State the differences between PCM, DPCM and delta modulation? (4)

5. [a] In the On-Off keying version of an ASK system, symbol **1** is represented by transmitting a sinusoidal carrier of amplitude $\sqrt{2E_b/T_b}$, where E_b is the signal energy per bit and T_b is the bit duration and symbol **0** is represented by switching off the carrier. Assume that symbol **1** and **0** occur with equal probability. For an AWGN channel, determine the average probability of error for coherent reception. (7)
[b] State and prove central limit theorem. (7)

6. [a] In an FM system, the audio frequency is 1KHz and audio voltage is 2 volts. The deviation is 4KHz, if the AF voltage is now increased to 8 volts and its frequency is dropped to 500Hz. Find the modulation index in each case and the corresponding bandwidth? (7)

[b] Consider a DM system designed to accommodate analog message signals limited to bandwidth W=5KHz. A sinusoidal test signal of amplitude A=1 volt and frequency f_m=1KHz is applied to the system. The sampling rate of the system is 50KHz.
i) Calculate the step size required to minimize slope overload.
ii) Calculate the signal to quantization noise ratio for the specified sinusoidal test signal. (7)

7. [a] Explain how varactor diode can be used for frequency modulation. Also explain what is meant by narrowband FM and wideband FM using the expression. (7)
[b] If S(t), a rectangular pulse of amplitude A and duration T sec, is an input to a matched filter, then its maximum SNR is given by $\eta_{max} = \frac{2E}{N_o}$ where energy $E = A^2T$. Now if a simple RC filter is used in lieu of matched filter, determine the maximum SNR of RC filter and also determine by what factor the maximum output SNR of RC filter will get reduced compared to matched filter. (7)

(8 7)

Total No. of pages:3 Roll No. -----

FOURTH SEMESTER BE(COE)

END SEMESTER EXAMINATION May,2014

COE-215 : Principles Of Communication Engineering

Time: 3.00 Hours Max. Marks: 70

Note: Question 1 is compulsory, attempt any 4 questions among question no 2 to question no 7.

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1. [a] An antenna current of an AM transmitter is 8 A when only carrier is sent but increases to 8.93A when a carrier is modulated by a single sine wave.

   i. Find the percentage modulation
   ii. Find the antenna current when the depth of modulation is 0.8.

[b] An angle modulated signal $x(t) = 10\cos[10^8\pi t + 3\sin 2\pi 10^3 t]$ is present across a 50ohm resistive load. Find

   i. The total average power
   ii. Peak frequency deviation

[c] In $\mu-$law compander $\mu = 0$ and the step size is 8. Compute the signal to noise ratio for a sinusoidal signal with peak to peak amplitude of 4Volts,

[d] In a CD player, the sampling rate is 20 Kilosamples per second, and the samples are quantized using a 16bit quantizer. Determine the resulting number of bits for a piece of music with a duration of 10 minutes.

[e] A joint sample space of two random variables X and Y has four elements (1,1), (2,2), (3.3) and (4,4). Probabilities of these elements are 0.1, 0.35, 0.05 and 0.5. Find the probability of the event $\{X \leq 3\}$.

[4x5]

2 [a] A binary digital communication system employs the signals $s_0(t) = -A \quad 0 \leq t \leq T$ and $s_1(t) = A \quad 0 \leq t \leq T$ for transmitting the information. Find the probability of error.

[b] Explain the operation of differential pulse code modulator with help of proper diagram. What are its advantages compared to PCM system?

[7+6]

3. [a] A random process is given by X(t)=A+Bt, where A and B are independent random variables uniformly distributed in the interval [-1,1]. Find:

(i) The mean function $m_x(t)$.
(ii) The autocorrelation function $R_x(t_1,t_2)$.
(iii) Is X(t) a stationary process?

[b] Explain the operation of Foster Seeley demodulator used to demodulate FM signal? [6+6]

4.[a] Explain with help of block diagram the operation of QPSK generator and demodulator.

[b] The joint density function of two random variables X and Y are given as

$$f_{XY}(x,y)=\begin{cases}\frac{xy}{9} & 0<x<2 \text{ and } 0<y<3\\ 0 & \text{elsewhere}\end{cases}$$

i. Are X and Y uncorrelated? Give proper justification
ii. Comment with proper justification whether X and Y are statistically independent or not?

[5+8]

5. [a] A random process, $X(t)=K\cos(2\pi ft+\Phi)$ where K and f are constant and Φ is uniformaly distributed between 0 and 2π, is applied to an LTI system having impulse response h(t). Let the output of the filter be Y(t). Is Y(t) a WSS? Give proper justification.

[6+6]

[b] State and Prove Sampling theorem

6. Find the basis function for the signals shown in figure 1. [12]

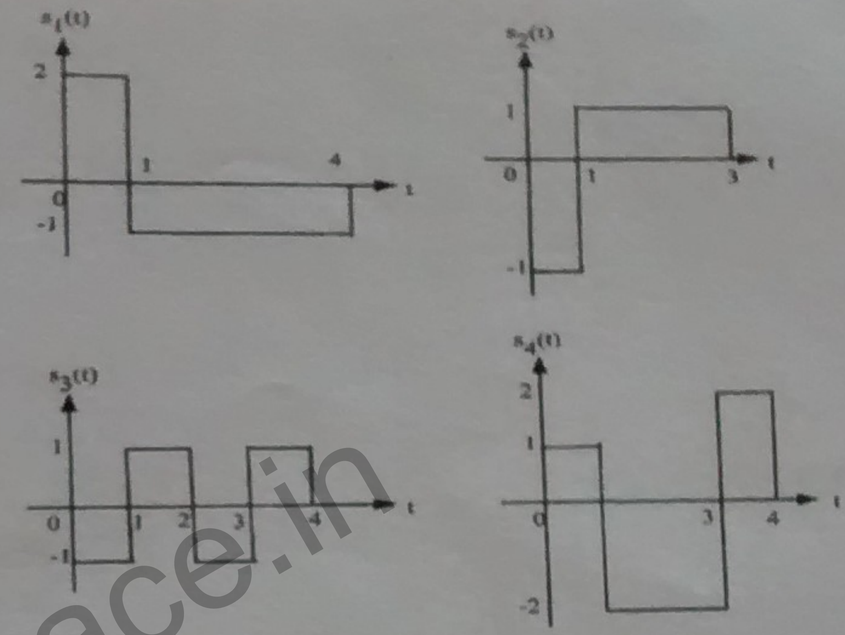


Figure 1

7. [a] Let X and Y be independent random variables with probability density function given as $f_X(x)=\alpha e^{-\alpha x}u(x)$ and $f_Y(y)=\beta e^{-\beta y}u(y)$ where α and β are assumed to be positive constants. Let Z=X+Y. Find the pdf of Z.

[b]With the help of suitable block diagram, explain the operation of Costas loop for DSBSC demodulation. [6+6]

END SEMESTER EXAMINATION May, 2013

COE-215: Principles of Communication Engineering

Time: 3 Hours **Max Marks: 70**

NOTE: Question ONE is compulsory. Attempt any FOUR from the rest.

[5, 3, 5, 5, 4]

Q1)

a) Two random variables X and Y have the joint density function

$$f_{XY}(x,y)=\begin{cases}\frac{5}{16}x^2y & 0<y<x<2\\ 0 & \text{elsewhere}\end{cases}$$

Find the marginal density function of X and Y?

b) A transmitter with a 10KW carrier transmits 11.2 KW when modulated with a single sine wave. Calculate the modulation index. If the carrier is simultaneously modulated with two other sine waves at 50% and 80% modulation indices, calculate the total transmitted power.

c) The diameter of cylinders coming out of production line are the values of a normal r.v. with μ=10 cm and σ= 0.05cm. If we set tolerance limit to 10% of the mean, find the percentage of rejected units.

d) What is Aliasing? A signal $x(t)=10\cos[1000t+\pi/3]+20\cos[1000t+\pi/6]$ is to be uniformly sampled for digital transmission. What is the maximum allowable time interval between two samples that will ensure perfect reconstruction?

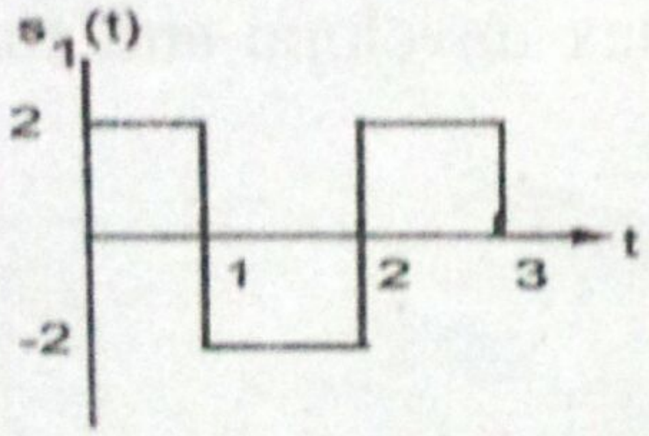
e) Given a function

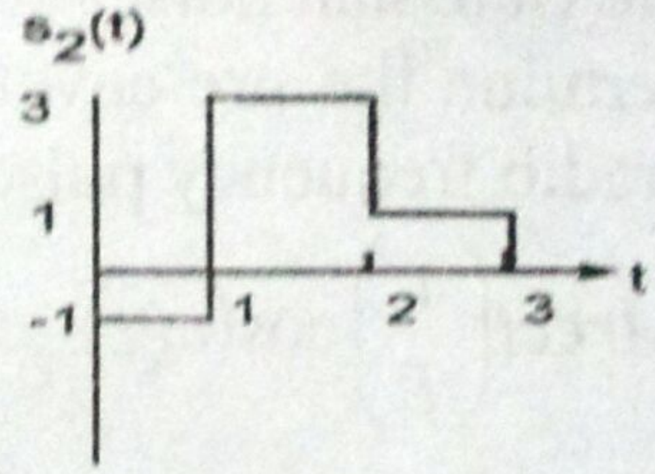
$$f_V(v)=\begin{cases}ke^{-|v|} & -4<v<4\\ 0 & \text{elsewhere}\end{cases}$$

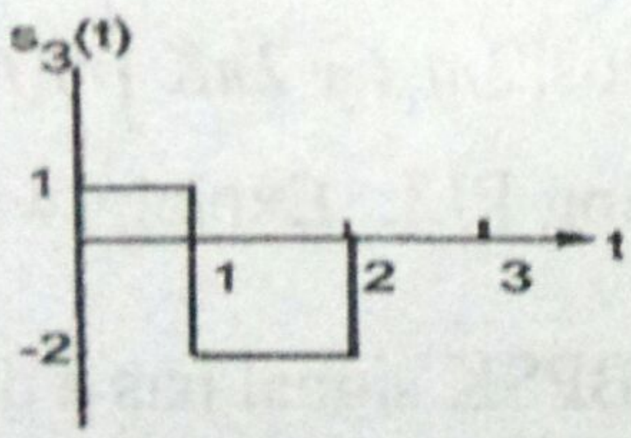
Find the value of k so that it becomes a valid density function.

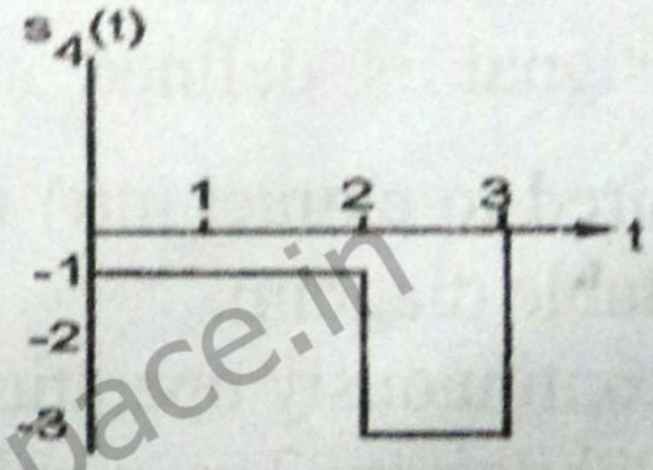
Q2) [9,3]

a) Determine the set of orthonormal functions for the four signals given below









b) Prove that mean square value of quantization noise error is $S^2/12$, where S is the step size.

Q3) [6, 6]

a) The signal $x(t) = \frac{1}{2}\cos 2\pi \times 70t + \frac{1}{8}\cos 2\pi \times 120t$ is applied to the input of square law AM modulator having output characteristic $v_{out} = a_1 v_{in} + a_2 v_{in}^{\ 2}$. If the carrier frequency is assumed to be 10KHz determine the values of constants a_1 and a_2 such that $A_c = 10$ and $\mu = \frac{1}{2}$. Plot the spectrum of AM signal.

b) In a delta modulated system, the voice signal is sampled at a rate of 64KHz. The maximum signal amplitude is $A_{max} = 1$.

i. Determine the minimum value of step size to avoid slope over load error.

ii. Determine the granular noise power if the voice signal bandwidth is 3.5 KHz.

Q4) [6, 6]

a) Evaluate the performance of QPSK signal in presence of additive white Gaussian noise.

b) Determine the pre-envelope, complex envelope and envelope of the radio frequency pulse defined by

$$g(t) = A\,rect\left(\frac{t}{T}\right)\cos(\omega_c t)$$

Q5) [8, 4]

a) A signal is defined as $s(t) = A\cos[2\pi f_c t + 2\pi K\int m(t)dt$. It is desired to extract m(t) from s(t) using PLL. Explain with help of suitable diagram.

b) A continuously operating coherent BPSK signal has a data rate of 1000bits/sec. The single sided noise PSD is 10^{-10}W/Hz. If the value of received average power is 10^{-10}W, calculate average bit error probability.

Q6) [6, 6]

a) A random variable **X** is uniformly distributed in the interval (5, 10), and $\mathbf{Y}=4\mathbf{X}^2$. Find the density of **Y**.

b) The signal $s(t) = e^{-t/\tau}$ is passed through high pass RC circuit having time constant τ. Find the energy spectral density at the output of circuit. Show that the total output energy is one half of the input energy.

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Total No. of Pages 3 *Roll No. .....*

FOURTH SEMESTER **B.E. (COE)**

END SEMESTER EXAMINATION ***MAY-2009***

COE-215 PRINCIPLES OF COMMUNICATION ENGINEERING

Time: 3 Hours *Max. Marks : 70*

Note : Answer any *FIVE* questions.
All questions carry equal marks.
Assume suitable missing data, if any.

1[a] Consider the sum of 4-identically distributed, independent random variables

$Z = X_1 + X_2 + X_3 + X_4$

Where the pdf of X_i is

$$P_{x_i}(x_i) = \begin{cases} 1; & |x_i| \le 1/2 \\ 0; & otherwise \end{cases}$$

Find the pdf of Z.

[b] Consider a random process :

$X(\theta; t) = A\cos(2\pi f_c t + \theta)$

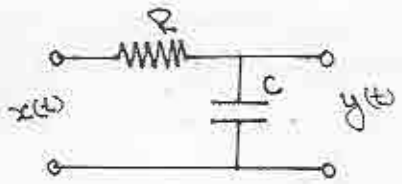
Where A and f_c are constants and θ is a random variable with pdf

$$f_\theta(\theta) = \begin{cases} \frac{2}{\pi}; & |\theta| \le \pi/4 \\ 0; & otherwise \end{cases}$$

Find whether the random process is a WSS process or not.

2[a] Suppose a Low Pass Filter shown in the figure below is excited by a random noise having Power Spectral Density defined as

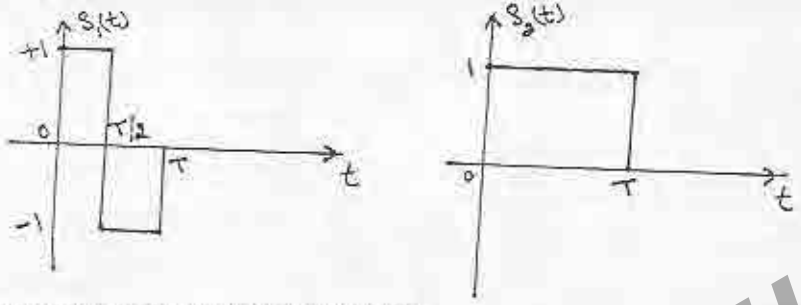
$$S_n(f) = \frac{1}{2}\eta;\ for\ all\ f.$$



Find the PSD of the output process and also find the auto-correlation of the output process.

[b] A Delta Modulator has a message signal $m(t) = 6\cos 2\pi(10t) + 4\cos 2\pi(20)t$. Determine the minimum sampling frequency required to prevent slope-overload assuming that the step size Δ of the modulator is 0.1π.

3[a] Figure below shows a pair of signals $s_1(t)$ and $s_2(t)$ which are orthogonal set of signals. Construct the signal constellation for $s_1(t)$ and $s_2(t)$.



[b] Consider a rectangular pulse defined

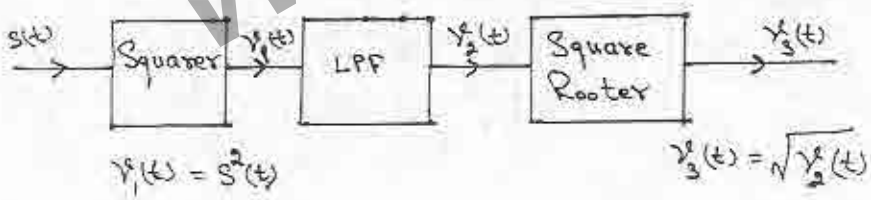
$$g(t) = \begin{cases} A; & 0 \le t \le T \\ 0; & otherwise \end{cases}$$

It is proposed to approximate the matched filter for g(t) by an ideal LPF of Band-width B(maximization of the peak pulse Signal to Noise ratio is the primary objective. Determine the optimum value of B for which the ideal LPF provides the best approximation to the MF.

4[a] Consider the AM signal

$$s(t) = A_c[1 + K_a m(t)]\cos(2\pi f_c t)$$

is applied to the system shown in figure given below.



Assume $|K_a \cdot m(t)| < 1$ for all t and $m(t)$ is limited to $(-W \le f \le W)$ and carrier frequency $f_c > 2W$. Show that $m(t)$ can be obtained from the output of the system.

[b] The local oscillator used for demodulation of an SSB signal s(t) has a frequency error Δf measured w.r.t. the carrier frequency (f_c) used to generate s(t). Evaluate the demodulated signal when the SSB signal s(t) consists of USB only.

5[a] Binary data bits are transmitted over a microwave link at the rate of 10^6 b/s 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 $(P_e) \le 10^{-4}$ for coherent BPSK.

[b] Discuss the similarities between MSK and QPSK along with features that distinguish.

6 A BFSK signal with discontinuous phase is defined by

$$S(t) = \begin{cases} \sqrt{\frac{2E}{T}}\cos\left[2\pi\left(f_c + \frac{\Delta f}{2}\right)t + \theta_1\right]; & for\ symbol\ 1 \\ \sqrt{\frac{2E}{T}}\cos\left[2\pi\left(f_c - \frac{\Delta f}{2}\right)t + \theta_2\right]; & for\ symbol\ 0 \end{cases}$$

Where E is signal energy per bit. T is bit duration and are sample values of uniformly distributed random variables over the interval 0 to 2π. In effect, the two oscillators supplying transmitted frequency $f_c \pm \Delta f/2$ operate independent of each other. Assume that $f_c >> \Delta f$.

(i) Evaluate PSD of FSK signal.
(ii) Draw the constellation diagram for the detection.
(iii) Calculate the probability of error.
(iv) Show that for frequencies far removed from the f_c, the PSD falls of as inverse square of frequency.

7 Write short notes on any TWO:

[a] Companding Techniques.
[b] MSK
[c] Properties of Matched filters.
[d] DPCM.

Total No. of Page(s): 3 *Roll No.....*

FOURTH SEMESTER **B.E. (COE)**

B.E. END SEM. EXAMINATION, May-2008

COE-215 : PRINCIPLES OF CUMMUNICATION ENGINEERING

Time: 3:00 Hrs. Max. Marks: 70

Note: *There are total 7 questions. Do any FIVE questions.*

1.

[a] 32 Voice communication channels are uniformly sampled and time division multiplexed. Assuming that the sampling technique is flat top sampling of pulses of 2μ second duration. If each pulse is being encoded by 8-bit code find

i) The spacing between pulses.

ii) The transmission rate. [7]

[b] Consider a random process $x(t)$ given by $x(t) = A\cos(wt + \theta)$, where w and θ are constants and A is a random variable between uniformly distributed between 0 and 1. Find the mean and auto-correlation function and comment whether the process is WSS or not. [7]

2.

[a] Find the distribution function of a random variable $y = g(x)$, in term of the distribution function of x. The density function of $g(x)$ is shown in Fig.-1. [7]

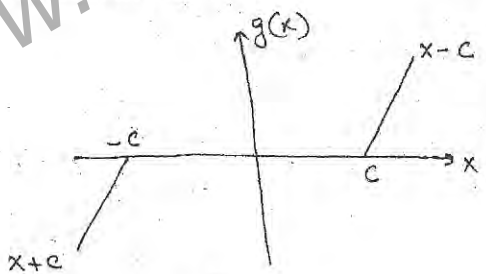


Fig.-1

[b] The mileage which car owners get with a certain kind of radial tire is a random variable having an exponential distribution with mean 40000 km. Find the probabilities that one of these tires will last

i) at least 20000 km.

ii) at most 30000 km. [7]

3. Evaluate the performance of AM system with receiver using envelope demodulator in the presence of white Gaussian Noise. [14]

4.

[a] A signal $m(t)=2\cos(200\pi t) + 4\cos 400\pi t$ is sampled with the sampling frequency 800 samples/second. If the sampled signal is passed through ideal LPF with cut-off frequency of 600 Hz. What frequency component will appear at the output [7]

[b] Let x and y be independent random variable with density functions:

$$f_x(x)=\begin{cases}2e^{-2x} & ; x\geq 0\\ 0 & ; x<0\end{cases}$$

and

$$f_y(y)=\begin{cases}3e^{-3y} & ; y\geq 0\\ 0 & ; y<0\end{cases}$$

Find the density function $z=x+y$. [7]

5.

[a] Find the optimum threshold and the probability of error, for detecting equally likely signals $S_1(t)=\sqrt{2E/T}\cos w_o t$ and $S_2(t)=\sqrt{\frac{1}{2}E/T}\cos(w_o t+\pi)$ in AWGN using a correlator receiver. [7]

[b] Find the basis functions using Gram. Schmidt procedure for the signals shown in Fig.-2. [7]

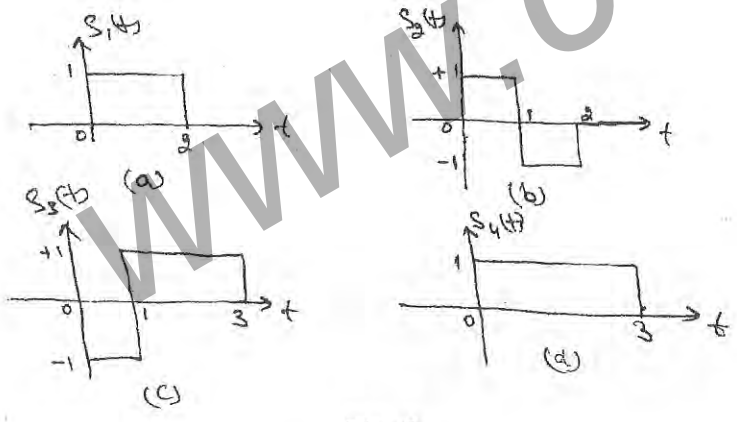


Fig.-2

6.

[a] The values of primary constants of an open wire line per loop km are R=10Ω, L=3.5mH, C=0.008μF and G=0.7μ mho, for signal frequency of 1000Hz. Calculate the following:

i) Characteristic Impedance.
ii) Phase Constant.
iii) Attenuation Constant.
iv) Phase Velocity. [7]

[b] An open-wire transmission line having $Z_0=650\angle -12^0\,\Omega$ is terminated by characteristic impedance at the receiving end. If this line is connected to a source of internal resistance of 300Ω, calculate the reflection factor and the reflection loss of the sending end terminal. [7]

7. Write short notes on the following:

[a] MSK. [5]
[b] Matched Filter. [5]
[c] PCM. [4]

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