BITS Pilani
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Department of Electrical Engineering

EEE/ECE F311
Communication Systems
Tutorial-11

Date : 30/10/2025
Date : 04/11/2025

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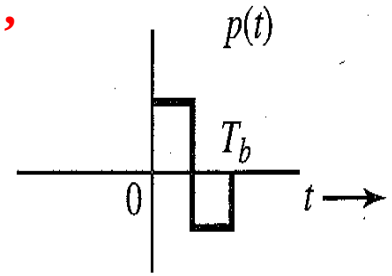
1. Derive $S_y(w)$, the PSD of the manchester (split phase) signal , assuming 1 and 0 are equally likely. Sketch the PSD



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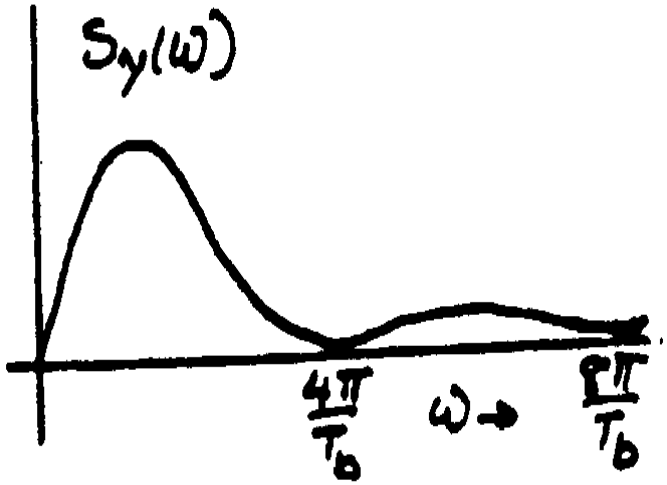
Solution 1

$$S_y(\omega) = \frac{|P(\omega)|^2}{T_b} = T_b \operatorname{sinc}^2\left(\frac{\omega T_b}{4}\right) \sin^2\left(\frac{\omega T_b}{4}\right)$$



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2. A leased telephone of bandwidth 3 kHz is used to transmit binary data. Calculate the data rate (in bits per second) that can be transmitted if we use:

(a) Polar signal with rectangular half-width pulses.

(b) Polar signal with rectangular full-width pulses.

(c) Polar signal using Nyquist criterion pulses of $r = 0.25$.

(d) Bipolar signal with rectangular half-width pulses.

(e) Bipolar signal with rectangular full-width pulses.

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Solution 2

(a) For Polar Signal:

$R_b = B_T / 2 = 1.5$ *kbits / sec*

(b) $p(t) = rect(t/T_b)$;

$\Rightarrow$ *Essential BW* $(B_T) = R_b$ *: Hence, transmission bit rate = 3Kbits/sec*

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Solution 2

c) BT = 4800 bits/sec

d) Essential BW = R_b : Bit rate possible is 3 kbits/s

e)

Again for Bipolar Signal:

$\Rightarrow$ *Essential BW = R_b : BT ; Hence, transmission bit rate = 3Kbits/sec*

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3. A 64 Kbps binary PCM Bipolar NRZ signal is passed through a communication system with a raised cosine filter with roll off factor 0.25. Determine the bandwidth of the PCM signal and the bandwidth of the filtered PCM signal.

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Solution 3

Nyquist BW= 32 KHz

BW of filtered PCM signal = 40 KHz

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4. For the Gaussian random variable, X with mean and standard deviation values are given as μ=5 and σ=2, respectively. Find the probability values such as (a) P(X>8), (b) P(X<8) and (c) P(3<X<8).

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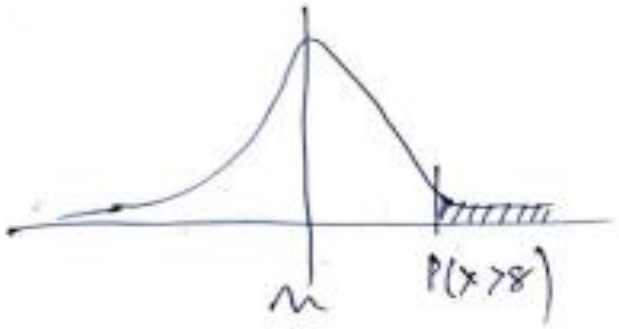
Solution 4

$P(x>8) = Q((x-\mu)/\sigma) = 0.066807$



$P(x<8) = 1 - P(x>8) = 1 - Q(1.5) = 0.933193$

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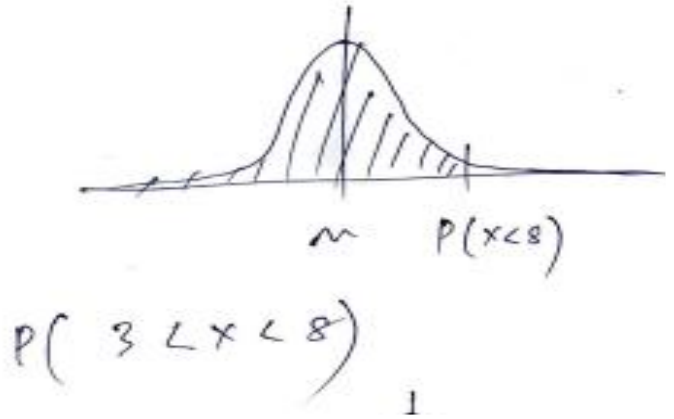
Solution 4



P(3<x<8) = 1- Q (1.5) – Q(1)

= 1-0.066807-0.15866=0.774533

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5. For the Gaussian random variable, X with mean and standard deviation values are given as μ=5 and σ=3, respectively. Find the factor a such that P(X<a)=0.9

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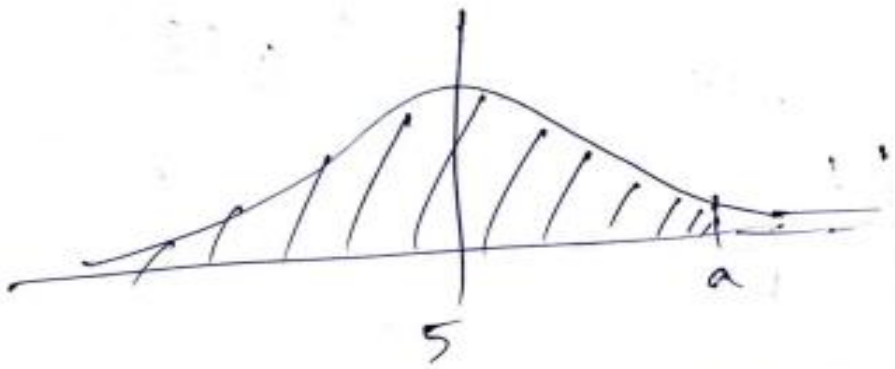
Solution 5

Ans



$P(X<a) = 0.9$ $\Rightarrow P(X>a) = 0.1$

$\Rightarrow Q\left(\frac{a-5}{3}\right) = 0.1$

Thus $\frac{a-5}{3} \simeq 1.25$

$\Rightarrow a = (1.25 \times 3) + 5$

$= 3.75 + 5 = 8.75$

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6. For the Gaussian random variable, X with mean and standard deviation values are given as μ=5 and σ=3, respectively. Find the factor a such that P(3<X<a)=0.7

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Solution 6

$$\Rightarrow P(X > a) = 1 - 0.95 = 0.05$$

$$\Rightarrow Q\left(\frac{a-5}{3}\right) = 0.05$$

$$\Rightarrow \frac{a-5}{3} = 1.60$$

$$\Rightarrow a = 4.8 + 5 = 9.8$$