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Courses » Probability and Random Variables / Processes for Wireless Communications

Announcements Course Ask a Question Progress

Unit 5 - Gaussian Random Process, Noise, Bit-Error and Impact on Wireless Systems



Course outline

How to access the portal

Basics of Probability, Conditional Probability, MAP Principle

Random Variables, Probability Density Functions, Applications in Wireless Channels

Basics of Random Processes, Wireless Fading Channel Modeling

Gaussian Random Process, Noise, Bit-Error and Impact on Wireless Systems

- Power Spectral Density (PSD) for WSS Random Process
- PSD Application in Wireless – Bandwidth Required for Signal Transmission
- Transmission of WSS Random Process

Assignment 4

The due date for submitting this assignment has passed. **Due on 2017-02-21, 23:59 IST.**
As per our records you have not submitted this assignment.

1) Consider the random process $X(t) = \alpha \cos(2\pi f_c t)$, with f_c constant and α distributed uniformly in $[0, \frac{1}{2}]$. What is the autocorrelation corresponding to time instants t_1, t_2 ? 1 point

- $(1/6) \times (\cos(2\pi f_c t_1) + \cos(2\pi f_c t_2))$
- $(1/3) \times \cos(2\pi f_c t_1) \cos(2\pi f_c t_2)$
- $(1/12) \times \cos(2\pi f_c (t_2 - t_1))$
- $(1/12) \times \cos(2\pi f_c t_1) \cos(2\pi f_c t_2)$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$(1/12) \times \cos(2\pi f_c t_1) \cos(2\pi f_c t_2)$$

2) Consider $X(t) = \alpha_0 + \sum_{k=1}^{\infty} \alpha_k \cos(2\pi k f_c t) + \beta_k \sin(2\pi k f_c t)$, where all α_k, β_k are independent zero-mean Gaussian random variables with variance of α_k, β_k equal to $\frac{1}{2^k}$. What is the nature of this random process? 1 point

- White
- Gaussian
- Both of the above
- None of the above

No, the answer is incorrect.

Score: 0

Accepted Answers:

Gaussian

3) Consider $X(t) = \alpha_0 + \sum_{k=1}^{\infty} \alpha_k \cos(2\pi k f_c t) + \beta_k \sin(2\pi k f_c t)$, where all α_k, β_k are independent zero-mean Gaussian random variables with variance of α_k, β_k equal to $\frac{1}{2^k}$. What is the autocorrelation $R_{XX}(\tau)$ of this random process?

- $0.5 \cos(2\pi f_c \tau)$

Through LTI System

Special Random Processes – Gaussian Process and White Noise – AWGN Communication Channel

Gaussian Process Through LTI System – Example: WGN Through RC Low Pass Filter

Quiz : Assignment 4

Assignment-4 Solutions

$$0.5 \sin(2\pi f_c \tau)$$

$$1 + \sum_{k=1}^{\infty} \frac{1}{2^k} \cos(2\pi k f_c \tau)$$

$$1 + \sum_{k=1}^{\infty} \frac{1}{2^k} \sin(2\pi k f_c \tau)$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$1 + \sum_{k=1}^{\infty} \frac{1}{2^k} \cos(2\pi k f_c \tau)$$

4) Consider $X(t) = \alpha_0 + \sum_{k=1}^{\infty} \alpha_k \cos(2\pi k f_c t) + \beta_k \sin(2\pi k f_c t)$, where all α_k, β_k are **1 point** independent zero-mean Gaussian random variables with variance of α_k, β_k equal to $\frac{1}{2^k}$. What is the power spectral density of this random process?

$$\frac{1}{4} \delta(f - f_c) + \frac{1}{4} \delta(f + f_c)$$

$$\frac{1}{4} \delta(f - f_c) - \frac{1}{4} \delta(f + f_c)$$

$$\delta(f) + \sum_{k=1}^{\infty} \frac{1}{2^{k+1}} (\delta(f - k f_c) - \delta(f + k f_c))$$

$$\delta(f) + \sum_{k=1}^{\infty} \frac{1}{2^{k+1}} (\delta(f - k f_c) + \delta(f + k f_c))$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\delta(f) + \sum_{k=1}^{\infty} \frac{1}{2^{k+1}} (\delta(f - k f_c) + \delta(f + k f_c))$$

5) Consider $X(t) = \alpha_0 + \sum_{k=1}^{\infty} \alpha_k \cos(2\pi k f_c t) + \beta_k \sin(2\pi k f_c t)$, where all α_k, β_k are **1 point** independent zero-mean Gaussian random variables with variance of α_k, β_k equal to $\frac{1}{2^k}$. What is the minimum bandwidth $2W$ such that the band $[-W, W]$ contains 90% of the signal power?

$$6f_c$$

$$4f_c$$

$$2f_c$$

$$0$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$6f_c$$

6)

1 point

Consider $X(t) = \alpha_0 + \sum_{k=1}^{\infty} \alpha_k \cos(2\pi k f_c t) + \beta_k \sin(2\pi k f_c t)$, where all α_k, β_k are independent zero-mean Gaussian random variables with variance of α_k, β_k equal to $\frac{1}{2^k}$. It is passed through an LTI system whose impulse response is $h(t) = 3f_c \text{sinc}(3f_c t)$. What is the power of the output random process $Y(t)$?

- 1.76 dB
 3 dB
 4.77 dB
 6 dB

No, the answer is incorrect.

Score: 0

Accepted Answers:

1.76 dB

7) Consider $X(t) = \alpha_0 + \sum_{k=1}^{\infty} \alpha_k \cos(2\pi k f_c t) + \beta_k \sin(2\pi k f_c t)$, where all α_k, β_k are independent zero-mean Gaussian random variables with variance of α_k, β_k equal to $\frac{1}{2^k}$. It is passed through an LTI system whose impulse response is $h(t) = 3f_c \text{sinc}(3f_c t)$. What is distribution $f_{Y(t)}(y)$ of the output random process $Y(t)$?

- $\frac{1}{\sqrt{4\pi}} e^{-y^2/4}$
 $2\delta(y)$
 $\frac{1}{\sqrt{3\pi}} e^{-y^2/3}$
 $\sum_{k=1}^{\infty} \cos(2\pi k f_c y)$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\frac{1}{\sqrt{3\pi}} e^{-y^2/3}$

8) Consider $X(t)$ to be white Gaussian noise with zero mean and autocorrelation function $\frac{1}{2} \delta(\tau)$. It is passed through an LTI system whose impulse response is $h(t) = 2B \text{sinc}(2Bt)$. What is the mean of the output random process $Y(t)$?

- $\frac{5}{2\pi}$
 5
 5π
 0

No, the answer is incorrect.

Score: 0

Accepted Answers:

0



9) Consider $X(t)$ to be white Gaussian noise with zero mean and autocorrelation function $\frac{\eta}{2} \delta(\tau)$. It is passed through an LTI system whose impulse response is $h(t) = 2B \text{sinc}(2Bt)$. what is the autocorrelation function of the output random process $Y(t)$? **1 point**



$$\frac{\eta}{2} \delta(\tau)$$



$$\eta B \text{sinc}(2B\tau)$$



$$\eta B^2 \text{sinc}^2(2B\tau)$$



$$2\eta B^2 \text{sinc}(2B\tau)$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\eta B \text{sinc}(2B\tau)$$

10) Consider $X(t)$ to be white Gaussian noise with zero mean and autocorrelation function $\frac{\eta}{2} \delta(\tau)$. It is passed through an LTI system whose impulse response is $h(t) = 2B \text{sinc}(2Bt)$. Consider two time instants t_1 and $t_2 = t_1 + 1/B$. What is the joint distribution $f_{Y(t_1)Y(t_2)}(y_1, y_2)$ of the output random process $Y(t)$? **1 point**



$$\frac{1}{2\pi\eta B} e^{-\frac{y_1^2 + y_2^2}{2\eta B}}$$



$$\frac{1}{\sqrt{2\pi\eta B}} e^{-\frac{y_1^2 + y_2^2}{\eta B}}$$



$$\frac{\eta}{2}, -\infty \leq f \leq \infty$$



$$2B^2 \text{sinc}(2Bt)$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{1}{2\pi\eta B} e^{-\frac{y_1^2 + y_2^2}{2\eta B}}$$



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