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



## 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 $\alpha$ distributed uniformly in $\left[0, \frac{1}{2}\right]$. 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 $\alpha_k, \beta_k$ are independent zero-mean Gaussian random variables with variance of $\alpha_k, \beta_k$ 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 $\alpha_k, \beta_k$ are independent zero-mean Gaussian random variables with variance of $\alpha_k, \beta_k$ equal to $\frac{1}{2^k}$. What is the autocorrelation $R_{XX}(\tau)$ of this random process? ***1 point***

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

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

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

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

**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 $\alpha_k,\beta_k$ are independent zero-mean Gaussian random variables with variance of $\alpha_k,\beta_k$ equal to $\frac{1}{2^k}$. What is the power spectral density of this random process? ***1 point***

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

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

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

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

**No, the answer is incorrect.**
**Score: 0**

**Accepted Answers:**

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

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 $\alpha_k,\beta_k$ are independent zero-mean Gaussian random variables with variance of $\alpha_k,\beta_k$ equal to $\frac{1}{2^k}$. What is the minimum bandwidth $2W$ such that the band $[-W,W]$ contains 90% of the signal power? ***1 point***

$6f_c$

$4f_c$

$2f_c$

$0$

**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 $\alpha_k, \beta_k$ are independent zero-mean Gaussian random variables with variance of $\alpha_k, \beta_k$ equal to $\frac{1}{2^k}$. It is passed through an LTI system whose impulse response is $h(t) = 3f_c sinc(3f_c t)$. 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 $\alpha_k, \beta_k$ are **1 po**
independent zero-mean Gaussian random variables with variance of $\alpha_k, \beta_k$ equal to $\frac{1}{2^k}$. It is passed through an LTI system whose impulse response is $h(t) = 3f_c sinc(3f_c t)$. Wha 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 $\frac{\eta}{2}\delta(\tau)$. It is passed through an LTI system whose impulse response is $h(t) = 2Bsinc(2Bt)$. what is the mean of the output random process $Y(t)$? ***1 point***

- $\frac{5}{2\pi}$
- $5$
- $5\pi$
- $0$

**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 $h(t) = 2Bsinc(2Bt)$. what is the autocorrelation function of the output random process $Y(t)$? ***1 point***

- $\frac{\eta}{2}\delta(\tau)$
- $\eta Bsinc(2B\tau)$
- $\eta B^2 sinc^2(2B\tau)$
- $2\eta B^2 sinc(2B\tau)$

**No, the answer is incorrect.**
**Score: 0**

**Accepted Answers:**
$\eta Bsinc(2B\tau)$

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 $h(t) = 2Bsinc(2Bt)$. 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***

- $\frac{1}{2\pi\eta B}e^{-\frac{y_1^2+y_2^2}{2\eta B}}$
- $\frac{1}{\sqrt{2\pi\eta B}}e^{-\frac{y_1^2+y_2^2}{\eta B}}$
- $\frac{\eta}{2}, -\infty \leq f \leq \infty$
- $2B^2 sinc(2Bt)$

**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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