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NPTEL

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Courses » Mathematical Methods and Techniques in Signal Processing

Announcements **Course** Ask a Question Progress FAQ

Week 4 - Probability and Random Processes

Register for Certification exam

Course outline

- How to access the portal
- Week 0 - Background and Prerequisites
- Week 1 - Introduction to Signal Processing, State Space Representation and Vector Spaces - I
- Week 2 - Vector Spaces - II
- Week 3 - Vector Spaces - III and Signal Geometry
- Week 4 - Probability and Random Processes
  - Basics of probability and random variables
  - Mean and variance of a

Assignment 4

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment. **Due on 2019-02-27, 23:59 IST.**

Instructions:

1. **Attempt all questions.**
2. **Submission deadline**: 27th February 2019 23:59 IST
3. **Solutions to be posted**: 28th February 2019
4. Older browsers might show **unnecessary vertical bars** at the end of math equations.

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1) Let $X(t)$ and $Y(t)$ be two random processes, ***1 point***
then $|R_{XX}(\tau)| + |R_{YY}(\tau)| \leq \left(\sqrt{R_{XX}(0)} + \sqrt{R_{YY}(0)}\right)^2 - 2|R_{XY}(\tau)|$.

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

2) Three people randomly choose a 4-digit ATM pin using the numbers ***1 point***
1,2,3,4,5,6,7,8,9,0,A,B,C,D,E,F. What is the probability that all three choose the same ATM pin?

- $\frac{1}{16^4}$
- $\frac{1}{16^8}$
- $\frac{1}{16^{12}}$

3) Consider the data given in the previous question. What is the probability that all 3 people choose different pins? ***1.5 points***

- $\frac{1}{16^8}$
- $\frac{1}{16^{12}}$
- $\frac{(16^4-2)(16^4-1)}{16^8}$
- $\frac{(16^4-3)(16^4-2)(16^4-1)}{16^{12}}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{(16^4-2)(16^4-1)}{16^8}$

4) Consider the power spectral density function $S_{xx}(\omega) = \frac{26+4\omega^2}{\omega^4+13\omega^2+36}$. The corresponding autocorrelation function is ***1.5 points***

- $\frac{1}{9}e^{-3|\tau|} + \frac{1}{4}e^{-2|\tau|}$
- $\frac{1}{2}e^{-2|\tau|} + \frac{1}{3}e^{-3|\tau|}$
- $2e^{-2|\tau|} + 2e^{-3|\tau|}$
- $\frac{1}{4}e^{2|\tau|} + \frac{1}{9}e^{3|\tau|}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{1}{2}e^{-2|\tau|} + \frac{1}{3}e^{-3|\tau|}$

5) Which of the following can be CDF of a random variable? ***2 points***

- $F_X(x) = \begin{cases} 0 & \text{for } -\infty < x < -1 \\ 0.5 & \text{for } -1 \le x < 0 \\ 0.75 & \text{for } 0 \le x < 2 \\ 1 & \text{for } 2 \le x < \infty \end{cases}$
- $F_X(x) = \begin{cases} 0 & \text{for } -\infty < x < -1 \\ 0.5 & \text{for } -1 \le x < 0 \\ 0.75 & \text{for } 0 \le x < 2 \\ x & \text{for } 2 \le x < \infty \end{cases}$
- $F_X(x) = \begin{cases} \frac{1}{2|x|+4} & \text{for } -\infty < x \le -1 \\ 0.5 & \text{for } -1 \le x < 0 \\ 0.75 & \text{for } 0 \le x < 2 \\ 1 & \text{for } 2 \le x < \infty \end{cases}$

$$F_X(x) = \begin{cases} \frac{1}{|x|+2} & \text{for } -\infty < x < 0 \\ 1-(0.5)\mathrm{e}^{-x} & \text{for } 0 \le x \le \infty \end{cases}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$F_X(x) = \begin{cases} 0 & \text{for } -\infty < x < -1 \\ 0.5 & \text{for } -1 \le x < 0 \\ 0.75 & \text{for } 0 \le x < 2 \\ 1 & \text{for } 2 \le x < \infty \end{cases}$$

$$F_X(x) = \begin{cases} \frac{1}{|x|+2} & \text{for } -\infty < x < 0 \\ 1-(0.5)\mathrm{e}^{-x} & \text{for } 0 \le x \le \infty \end{cases}$$

6) Consider $X(t) = A\cos(\omega t + \phi)$ where $\phi \sim \mathrm{U}[-\pi, \pi]$, A is a random variable and A and ϕ are statistically independent. Consider a system with impulse response $H(t)$ that satisfies $Y(t) = H(t) * X(t)$, where $*$ represents linear convolution. Which of the following properties does $Y(t)$ possess: ***2 points***

- Autocorrelation $R_{YY}(t_1, t_2)$ does not change by shifts in time.
- Mean $\mathrm{E}[Y(t)]$ is time varying.
- $Y(t)$ is a WSS random process.
- None of the above.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Autocorrelation $R_{YY}(t_1, t_2)$ does not change by shifts in time.
$Y(t)$ is a WSS random process.

7) Consider random processes $X[n]$ and $Y[n]$ which are uniformly distributed over the shaded rectangle in the figure below. ***2.5 points***

Which of the following statements are true about the random processes?

- The two random processes are uncorrelated but not independent.
- The two random processes are independent, uncorrelated and orthogonal.
- The two random processes are independent but non orthogonal.
- The two random processes are correlated.

No, the answer is incorrect.
Score: 0

Accepted Answers:
The two random processes are independent, uncorrelated and orthogonal.

8) Let $f(t)$ be a zero mean white random process with $\sigma_f^2 = 1$. Let $y(t) = 3f(t) - 4f(t-2)$. What is the value of $a+b+c$ when the autocorrelation matrix is $R_{YY} = \begin{bmatrix} a & b & c \\ b & a & b \\ c & b & a \end{bmatrix}$.

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Numeric) 13

2.5 points

9) Consider a fair die with 8 faces. What is the expected number of times you need to roll the die to so that all possible numbers appear at least once? Give your answer to 2 decimal places.

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Range) 21.72,21.76

3 points

10)X and Y are random variables on a probability space with joint probability mass function given by, ***3 points***

Let the random variable Z be defined as $Z = X + Y$. Find the variances of each of the random variables X, Y and Z?

- $\text{Var}(X)=3.23, \text{Var}(Y)=2.2, \text{Var}(Z)=8.87$
- $Var(X) = 1.1275, Var(Y) = 0.76, Var(Z) = 1.8475$
- $Var(X) = 1.45, Var(Y) = 1.2, Var(Z) = 2.65$
- None of the above

No, the answer is incorrect.
Score: 0

Accepted Answers:
$Var(X) = 1.1275, Var(Y) = 0.76, Var(Z) = 1.8475$

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