

# Unit 16 - Week 11 - Transformation of Random Variables, Gaussian Random Variable ,Special Case: IID Gaussian Random Variables, Application: Uniform Linear Arrays, Random Processes and (WSS) and WSS Examplpe

<b>Course outline</b>
How does an NPTEL online course work?
<b>Week-0</b>
Week 1-Basic tools for communication, Fourier Series/Transform, Properties, Parsevals Relation, Power Efficiency, (DSB-SC) Modulation and Demodulation
Week 2- Cross- and Auto-correlation, (ESD), Introduction to Amplitude Modulation (AM), Spectrum of AM, Envelope Detection, Power Efficiency, (DSB-SC) Modulation and Demodulation
Week 3- Power Efficiency, (DSB-SC) Modulation and Demodulation, Carrier Phase Offset Example for (DSB-SC), Costas Receiver
Week 4 Quadrature Carrier Multiplexing (QCM) and Demodulation of QCM signals, Single Sideband Modulation (SSB), Hilbert Transform
Week 5 Generation of SSB , Complex pre-envelope of QCM, VSB , Introduction to AM
Week 6 Narrowband FM Generation, Spectrum of FM Signals, Carson's Rule for FM Bandwidth, Narrowband FM Generation, FM Demodulation, Introduction to Sampling, Spectrum of Sampled Signal, Aliasing, Nyquist Criterion
Week 7- Signal Reconstruction from Sampled Signal ,Introduction to Pulse Amplitude Modulation, Spectrum of PAM Signal and Reconstruction, Quantization, Uniform Quantizers – Midrise and Midtread, Quantization noise, Lloyd Max Quantization Algorithm, Non-uniform Quantizers
Week 8- Delta Modulation, Differential Pulse Code Modulation, Frequency Mixing and Translation in Communication Systems, Heterodyne and Super Heterodyne Receivers, Frequency Division Multiplexing, Time Division Multiplexing, T1 TDM System: Case Study
Week 9 - Basics of Probability, Conditional Probability, Independent Events - Mary-PAM Example, Independent Events-Block Transmission, Independent Events-Multiantenna Fading
<b>Text Transcripts</b>
<b>DOWNLOAD VIDEOS</b>
Week 10- Bayes Theorem, Maximum A posteriori Probability (MAP) Receiver, Random Variables and PDF, Power of Fading Wireless Channel, Mean & Variance of Random Variables and Application:Average & RMS Delay Spread
Week 11 - Transformation of Random Variables, Gaussian Random Variable ,Special Case: IID Gaussian Random Variables, Application: Uniform Linear Arrays, Random Processes and (WSS) and WSS Examplpe
<input type="radio"/> Lec 65- Transformation of Random Variables <input type="radio"/> Lec 66- Gaussian Random Variable <input type="radio"/> Lec 67- Special Case: IID Gaussian Random Variables <input checked="" type="radio"/> Lec 68- Application: Uniform Linear Arrays <input type="radio"/> Lec 69- Random Processes and (WSS) <input type="radio"/> Lec 70- WSS Examplpe <input type="radio"/> Quiz : Assignment-11 <input type="radio"/> Feedback For Week 11 <input type="radio"/> Solution-11
Week 12- Power Spectral Density(PSD) for WSS Random Process, PSD Application in Wireless, WSS Random Process Through LTI System, Special Random Processes and Gaussian Process Through LTI System

## Assignment-11

The due date for submitting this assignment has passed. **Due on 2020-04-15, 23:59 IST.**  
 As per our records you have not submitted this assignment.

1) Any PDF  $f_X(x)$  has to satisfy the properties **1 point**

i.  $\int_{-\infty}^{\infty} f_X(x)dx = 1$   
 ii.  $f_X(x) \geq 0$   
 iii.  $f_X(x) \leq 1$

Only i  
 Only i and ii  
 i, ii and iii  
 Only i and iii

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
*Only i and ii*

2) The probability density function of a Gaussian random variable  $X$  that has mean  $\mu$  and variance  $\sigma^2$  is **1 point**

$\frac{\sigma^2}{2\pi} e^{-2\sigma^2(x-\mu)^2}$   
  $\frac{1}{2\sigma} e^{-\frac{|x-\mu|}{2\sigma}}$   
  $\frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$   
  $\frac{1}{\sigma} e^{-\frac{(x-\mu)}{2\sigma}}$  for  $x \geq \mu$  and 0 otherwise

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$

3) Let  $X_1, X_2, \dots, X_L$  be independent identically distributed Gaussian random variables with mean 0 and variance  $\sigma^2$  each. Then, the variance of  $a_1X_1 + a_2X_2 + \dots + a_LX_L$  is **1 point**

$\sigma^2(a_1^2 + a_2^2 + \dots + a_L^2)$   
  $\sigma^2(a_1 + a_2 + \dots + a_L)^2$   
  $\sigma^2(|a_1| + |a_2| + \dots + |a_L|)$   
  $\sigma(a_1^2 + a_2^2 + \dots + a_L^2)$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\sigma^2(a_1^2 + a_2^2 + \dots + a_L^2)$

4) Consider the random variable  $X$  with the probability density function (PDF)  $f_X(x) = Ke^{-\lambda x}$  for  $0 \leq x < \infty$  and 0 for  $x < 0$ . Given  $\lambda > 0$ . The value of the constant  $K$  is **1 point**

$\frac{1}{\lambda}$   
  $\lambda$   
  $\lambda^2$   
  $\frac{2}{\lambda}$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\lambda$

5) Consider a random variable  $X$  with the probability density function  $f_X(x)$  and mean  $\mu$ . The variance  $\sigma^2$  of the random variable  $X$  is defined as **1 point**

$\int_{-\infty}^{\infty} x^2 f_X(x)dx$   
  $\int_{-\infty}^{\infty} x^2 f_X(x)dx - \mu$   
  $\int_{-\infty}^{\infty} (x - \mu)^2 f_X(x)dx$   
  $\int_{-\infty}^{\infty} x f_X(x)dx - \mu^2$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\int_{-\infty}^{\infty} (x - \mu)^2 f_X(x)dx$

6) Consider the random variable  $X$  with the probability density function (PDF)  $f_X(x) = Ke^{-\frac{x^2}{\lambda}}$  for  $-\infty < x < \infty$ . The value of the constant  $K$  is **1 point**

$\sqrt{\frac{\pi}{\lambda}}$   
  $\frac{1}{\lambda}$   
  $\sqrt{\frac{\lambda}{\pi}}$   
  $\frac{1}{\sqrt{\lambda}}$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\frac{1}{\sqrt{\lambda}}$

7) For the standard PDF of the power of the fading channel described in lectures, what is the approximate probability that the attenuation of the wireless channel is worse than 40 dB? **1 point**

0.1  
 0.01  
 0.001  
 0.0001

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 0.0001

8) For a wireless channel with the exponential power delay profile  $\beta e^{-\beta\tau}$  for  $\tau \geq 0$ . Its average delay and RMS delay spread are given as **1 point**

$\frac{1}{\beta}, \frac{1}{\beta^2}$   
  $\frac{1}{\beta}, \frac{1}{\beta}$   
  $1, \frac{1}{\beta}$   
  $\frac{1}{\beta}, \frac{2}{\beta}$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\frac{1}{\beta}, \frac{1}{\beta}$

9) Consider the random variable  $\theta$  uniformly distributed in  $[0, \frac{\pi}{2}]$ . The distribution of  $\phi = \sin \theta$  is **1 point**

$\frac{2}{\pi}$   
  $\frac{2}{\pi} \times \frac{1}{\sqrt{1-\phi^2}}$   
  $\frac{1}{\pi}$   
  $\frac{2}{\pi} \times \sin^{-1} \phi$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\frac{2}{\pi} \times \frac{1}{\sqrt{1-\phi^2}}$

10) The levels of a 4 - ary PAM constellation are  $S = \{-3\alpha, -\alpha, \alpha, 3\alpha\}$  with  $2P(\alpha) = 2P(-\alpha) = 3P(3\alpha) = 3P(-3\alpha)$ . Let  $x_1, x_2$  denote two symbols drawn independently from the constellation. The probability that at least one of  $x_1, x_2$  belongs to the set  $\{-\alpha, \alpha\}$  is **1 point**

$\frac{21}{25}$   
  $\frac{9}{100}$   
  $\frac{3}{5}$   
  $\frac{9}{25}$

**No, the answer is incorrect.**  
**Score: 0**  
**Accepted Answers:**  
 $\frac{21}{25}$