

# Unit 4 - Week 1-Basic tools for communication, Fourier Series/Transform, Properties, Parsevals Relation, Properties of Fourier Transform, LTI Systems

<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, Properties of Fourier Transform, LTI Systems
<ul style="list-style-type: none"> <li><span style="color: blue;">●</span> Lec 01-Principles of Communication Systems-I - Basics</li> <li><span style="color: blue;">●</span> Lec 02- Frequency Domain Representation of signals</li> <li><input type="radio"/> Lec 03-Discrete Fourier Series Example</li> <li><input type="radio"/> Lec 04 - Fourier and Inverse Fourier Transform</li> <li><input type="radio"/> Lec 05-Modulation Property of Fourier Transform</li> <li><input type="radio"/> Lec 06-Duality Property of Fourier Transform</li> <li><span style="color: blue;">●</span> Lec 07- Transmission of Signal through (LTI) systems</li> </ul>
<ul style="list-style-type: none"> <li><input type="radio"/> Quiz : Assignment-1</li> <li><input type="radio"/> Feedback For Week 1</li> <li><span style="color: blue;">●</span> Solution-1</li> </ul>
<b>Week 2- Cross- and Auto-correlation, (ESD), Introduction to Amplitude Modulation (AM), Spectrum of AM, Envelope Detection, Power Efficiency, (DSB-SC) Modulation and Demodulation</b>
Week-3- Power Efficiency, (DSB-SC) Modulation and Demodulation, Carrier Phase Offset Example for (DSB-SC), Costas Receiver
<b>Week-4 Quadrature Carrier Multiplexing (QCM) and Demodulation of QCM signals, Single Sideband Modulation (SSB), Hilbert Transform</b>
Week-5 Generation of SSB , Complex pre-envelope of QCM, VSB , Introduction to AM
<b>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</b>
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
<b>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</b>
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 Example
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-1

The due date for submitting this assignment has passed. **Due on 2020-02-12, 23:59 IST.**  
 As per our records you have not submitted this assignment.

1) The energy of a possibly complex signal  $x(t)$  is defined as 1 point

$\int_{-\infty}^{\infty} x^2(t)dt$   
  $\frac{1}{T} \int_{-T}^T |x(t)|^2 dt$   
  $\lim_{T \rightarrow \infty} \frac{1}{T} \int_{-T}^T |x(t)|^2 dt$   
  $\int_{-\infty}^{\infty} |x(t)|^2 dt$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\int_{-\infty}^{\infty} |x(t)|^2 dt$

2) The power of a possibly complex signal  $x(t)$  is defined as 1 point

$\int_{-\infty}^{\infty} x^2(t)dt$   
  $\frac{1}{T} \int_{-T}^T x^2(t)dt$   
  $\lim_{T \rightarrow \infty} \frac{1}{T} \int_{-T/2}^{T/2} |x(t)|^2 dt$   
  $\int_{-\infty}^{\infty} |x(t)|^2 dt$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\lim_{T \rightarrow \infty} \frac{1}{T} \int_{-T/2}^{T/2} |x(t)|^2 dt$

3) Consider the Fourier series of a signal  $x(t)$  with fundamental frequency  $f_0 = \frac{1}{T}$ . The coefficient  $c_l$  in the Fourier series corresponding to the term  $e^{j2\pi l f_0 t}$  is given as 1 point

$\frac{1}{T} \int_{-T/2}^{T/2} x(t)e^{j2\pi l f_0 t} dt$   
  $T \int_{-T/2}^{T/2} x(t)e^{-j2\pi l f_0 t} dt$   
  $\frac{1}{T} \int_{-T/2}^{T/2} x(t)e^{-j2\pi l f_0 t} dt$   
  $\int_{-T/2}^{T/2} x(t)e^{j2\pi l f_0 t} dt$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\frac{1}{T} \int_{-T/2}^{T/2} x(t)e^{-j2\pi l f_0 t} dt$

4) Power of the signal  $\sum_{k=0}^{\infty} c_k \sin(2\pi k f_0 t)$  with  $T = \frac{1}{f_0}$  is 1 point

$\frac{1}{2T} \sum_{k=0}^{\infty} c_k^2$   
  $\frac{1}{2} \sum_{k=1}^{\infty} c_k^2$   
  $\frac{1}{T} \sum_{k=0}^{\infty} c_k^2$   
  $\frac{1}{T} c_0^2 + \frac{1}{2T} \sum_{k=1}^{\infty} c_k^2$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\frac{1}{2} \sum_{k=1}^{\infty} c_k^2$

5) Consider the complex signal  $\frac{1}{a+jt}$ ,  $-\infty < t < \infty$ . Its energy is 1 point

$\frac{\pi}{a}$   
  $\frac{1}{2a}$   
  $\frac{a}{2\pi}$   
  $\sqrt{\frac{a}{\pi}}$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\frac{\pi}{a}$

6) If  $X(f)$  is the Fourier transform of  $x(t)$ , the Fourier transform of the signal  $X(t)$  is 1 point

$x(f)$   
  $x^*(-f)$   
  $x(-f)$   
  $x^*(f)$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $x(-f)$

7) Fourier transform is best suited for the analysis of 1 point

Continuous time aperiodic signals  
 Discrete time periodic signals  
 Continuous time periodic signals  
 Discrete time aperiodic signals

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
*Continuous time aperiodic signals*

8) Fourier transform of the signal  $\text{sinc}(2t)$  is 1 point

1 for  $|f| \leq 1$  and 0 otherwise  
  $\frac{1}{2}$  for  $|f| \leq 2$  and 0 otherwise  
  $\frac{1}{2}$  for  $|f| \leq 1$  and 0 otherwise  
 1 for  $|f| \leq \frac{1}{2}$  and 0 otherwise

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\frac{1}{2}$  for  $|f| \leq 1$  and 0 otherwise

9) Let  $x(t)$  have the Fourier transform  $X(f)$ . The Fourier transform of the signal  $t^2 x(t)$  is 1 point

$\frac{j}{2\pi} \frac{d}{df} X(f)$   
  $j2\pi f X(f)$   
  $\frac{d^2}{df^2} X(f)$   
  $-\frac{1}{4\pi^2} \frac{d^2}{df^2} X(f)$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $-\frac{1}{4\pi^2} \frac{d^2}{df^2} X(f)$

10) Let  $X(f) = \frac{1}{\pi f}$ . Let  $x(t)$  denote the inverse Fourier transform of  $X(f)$ . Then  $x(t)$  equals 1 point

$\text{sgn}(t)$   
  $j \text{sgn}(t)$   
  $\text{sgn}(t) + \frac{1}{2} \delta(t)$   
  $\delta(t)$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $j \text{sgn}(t)$