Course Code: 20EC0404 **R20**

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:: PUTTUR
(AUTONOMOUS)
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QUESTION BANK (DESCRIPTIVE)

Subject with Code: Signals, Systems and Random Processes (20EC0404) **Course & Branch**: B.Tech - ECE
Year & Sem: II-B.Tech & I-Sem **Regulation:** R20

UNIT –I

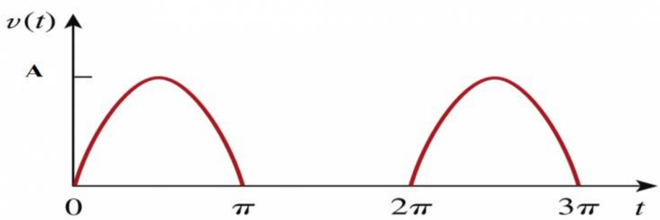
INTRODUCTION TO SIGNALS AND SYSTEMS

1.	**a)**	Define signal. Explain various elementary signals and indicate them graphically.	[L2] [CO1]	**[6M]**
	b)	Sketch the following signals. (i) x(t)=2 u(t+2)- 2 u(t-3) (ii) x(t)=r(t)-r(t-1)-r(t-3)+r(t-4)	[L3] [CO1]	**[6M]**
2.	**a)**	Classify the signals with respect to continuous time and discrete time.	[L2] [CO1]	**[6M]**
	b)	Sketch the different signals.	[L3] [CO1]	**[6M]**
3.		Define and Explain the Following with an example. (i) Continuous time and Discrete time signals (ii) Energy and Power Signal. (iii) Periodic and Aperiodic Signal (iv) Deterministic and Non-Deterministic Signal.	[L2] [CO1]	**[12M]**
4.	**a)**	Define the Energy and Power of continues and discrete time signals with necessary equations.	[L3] [CO1]	**[6M]**
	b)	Identify whether the following signals are energy signals or power signals. (i) x(t)=8 cos4t cos6t (ii) $x(t)= e^{j[3t+(\pi/2)]}$ (iii) $x(n)=(1/2)^n u(n)$	[L3] [CO1]	**[6M]**
5.		Find whether the following signals are periodic or not? If periodic determine the fundamental Period. (i) sin (12πt) (ii) sin (10t+1)- 2cos (5t-2) (iii) $e^{j4\pi t}$	[L3] [CO1]	**[12M]**
6.		What are the basic operations on signals? Explain with an example.	[L2] [CO1]	**[12M]**
7.		Define a System. Classify the Systems with an example for each.	[L2] [CO1]	**[12M]**
8.	**a)**	Define the following Systems (i) Linear and Non- Linear (ii) Time invariant and time variant. (iii) Static and dynamic (iv) Causal and Non-causal	[L1] [CO2]	**[8M]**
	b)	Find whether the following system is (i) Linear or Non- Linear (ii) Static and dynamic. $d^3y(t)/dt^3+2d^2y(t)/dt^2+4dy(t)/dt+3y^2(t)=x(t+1)$	[L3] [CO2]	**[4M]**
9.		Interpret whether the following systems are Linear or Non- Linear, Time Invariant or Time Variant and Stable or Unstable. (i) $y(n) =\log_{10} \lvert x(n) \rvert$ (ii) $y(t)=at^2 x(t)+bt\, x(t-4)$	[L3] [CO3]	**[12M]**
10.	**a)**	Define Stable and Unstable systems with an example.	[L2] [CO3]	**[6M]**
	b)	Determine whether the following systems are stable or not. (i) y(t)= (t+5) u(t) (ii) $h(n)=a^n$ for $0<n<11$	[L3] [CO3]	**[6M]**

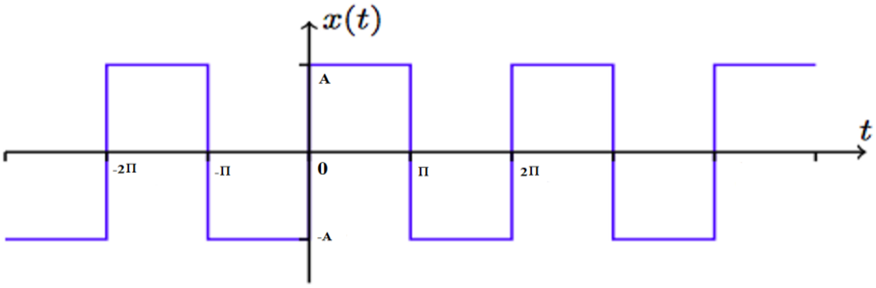
UNIT –II

FOURIER SERIES AND FOURIER TRANSFORM

1.	**a)**	Give the representation of Fourier series.	[L2] [CO2]	**[2M]**
	b)	List the Properties of Fourier series.	[L1] [CO2]	**[2M]**
	c)	State and Prove the Linearity, Time Shifting, Time Reversal and Time Convolution Properties of Fourier series.	[L3] [CO2]	**[8M]**
2.	**a)**	Discuss the Dirichlet's Conditions.	[L2] [CO2]	**[2M]**
	b)	Explain the representation of a signal in Trigonometric Fourier series.	[L2] [CO2]	**[2M]**
	c)	Derive the Trigonometric Fourier series coefficients.	[L3] [CO2]	**[8M]**
3.	**a)**	Explain the representation of a signal in exponential Fourier series.	[L2] [CO2]	**[3M]**
	b)	Derive the Exponential Fourier series coefficient.	[L3] [CO2]	**[9M]**
4.		Construct the Trigonometric Fourier series expansion of the half wave rectified sine wave shown in figure.	[L3] [CO2]	**[12M]**



5.		Develop the Exponential Fourier Series for the given signal below	[L3] [CO2]	**[12M]**



6.	**a)**	Demonstrate how Fourier Transform derived from Fourier series.	[L2] [CO2]	**[4M]**
	b)	Define Fourier transform and find the Fourier transform of any one standard signal.	[L3] [CO2]	**[4M]**
	b)	Define magnitude and phase response.	[L1] [CO2]	**[4M]**
7.		Find the Fourier transform of the following. (i) $x(t)=\delta(t)$ (ii) $x(t)=u(t)$ (iii) $x(t)=sgn(t)$ (iv) $\sin\omega_0 t$ (v) $\cos\omega_0 t$ (vi) $x(t)=e^{-at}u(t)$	[L3] [CO2]	**[12M]**
8.	**a)**	List the properties of Continuous time Fourier transform.	[L1] [CO2]	**[2M]**
	b)	State and prove the Linearity and Time Shifting properties of Continuous time Fourier transform.	[L3] [CO2]	**[6M]**
	c)	Find the Fourier transform, magnitude and phase response of the given signal. $x(t) = e^{-t}\cos 5t\, u(t)$	[L3] [CO2]	**[4M]**
9.		Find the inverse Fourier transform of the following signals. (i) $X(\omega) = \frac{4(j\omega)+6}{(j\omega)^2+6(j\omega)+8}$ (ii) $X(\omega) = \frac{1+3(j\omega)}{(j\omega+3)^2}$	[L3] [CO2]	**[12M]**
10.	**a)**	Explain about Fourier Transform of Periodic Signals.	[L2] [CO2]	**[6M]**
	b)	Find the Fourier Transform of the following signals using Properties. (i) $e^{-at}u(t)$ (ii) $\delta(t+2)+\delta(t+1)+\delta(t-1+\delta(t-2)$	[L3] [CO2]	**[6M]**

UNIT –III
SIGNAL TRANSMISSION THROUGH LINEAR SYSTEMS

1.	**a)**	Describe the following responses of Systems. (i) Impulse Response. (ii) Step Response. (iii) Response of the System.	[L2] [CO2]	**[6M]**
	b)	Define linear time invariant and linear time variant system with necessary equations.	[L1] [CO2]	**[6M]**
2.	**a)**	List the properties of linear time invariant system.	[L1] [CO2]	**[2M]**
	b)	State and prove the following properties of linear time invariant system. (i) Cumulative Property (ii) Invertability Property (iii) Stability Property (iv) Causality Property	[L3] [CO2]	**[10M]**
3.	**a)**	State and Prove the Following Properties of LTI System. (i) Distributive Property (ii) Associative Property	[L3] [CO2]	**[6M]**
	b)	Derive the Transfer function of LTI system.	[L3] [CO2]	**[6M]**
4.		Consider a causal LTI system with frequency response H(ω)=1/4+jω, for a input x(t), the system is observed to produce the output $y(t)=e^{-2t}u(t)- e^{-4t}u(t)$. Find the input x(t).	[L3] [CO2]	**[12M]**
5.		Consider a stable LTI system that is characterized by the differential equation $d^2y(t)/dt^2+4dy(t)/dt+3y(t)= dx(t)/dt+2x(t)$ find the response for an input $x(t)=e^{-t}\, u(t)$.	[L3] [CO2]	**[12M]**
6.	**a)**	The impulse response of a continuous-time system is expressed as $h(t)=e^{-2t}\, u(t)$. Find the Frequency response of the system.	[L3] [CO2]	**[6M]**
	b)	Explain the Filter characteristics of linear systems with neat diagrams.	[L2] [CO2]	**[6M]**
7.	**a)**	Define Convolution. State and prove the time convolution theorem with Fourier transforms.	[L3] [CO4]	**[4M]**
	b)	State and prove the frequency convolution theorem with Fourier transforms.	[L3] [CO4]	**[4M]**
	c)	Find the convolution of the following signal $x_1(t)=\boldsymbol{e^{-2t}\, u(t)}$, $x_2(t)=\boldsymbol{e^{-4t}\, u(t)}$.	[L3] [CO4]	**[4M]**
8.	**a)**	Demonstrate the Procedure to perform convolution graphically.	[L2] [CO4]	**[6M]**
	b)	Examine the convolution of the following signals by graphical method. **$x(t)=e^{-3t}\, u(t)$ and $h(t)=u(t+3)$**	[L3] [CO4]	**[6M]**
9.	**a)**	Define Cross correlation.	[L2] [CO4]	**[4M]**
	b)	List the properties of Cross correlation function.	[L1] [CO4]	**[2M]**
	c)	State and prove following properties of Cross correlation function. (i) Conjugate Symmetry (ii) $\lvert R_{XY}(\tau)\rvert \leq \sqrt{R_{XX}(0).R_{YY}(0)}$	[L3] [CO4]	**[6M]**
10.	**a)**	Define Auto correlation.	[L2] [CO4]	**[4M]**
	b)	List the properties of Auto correlation function.	[L1] [CO4]	**[2M]**
	c)	State and prove the following properties of Auto correlation function. (i) $R_{XX}(-\tau) = R_{XX}(\tau)$ (ii) $R_{XX}(0) = E[X^2(t)]$	[L3] [CO4]	**[6M]**

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UNIT –IV

LAPLACE TRANSFORMS AND INTRODUCTION TO PROBABILITY

<table>
<tr><td>1.</td><td>a)</td><td>Define Laplace Transformation. Explain the ROC and its constraints.</td><td>[L2] [CO5]</td><td>[4M]</td></tr>
<tr><td></td><td>b)</td><td>Determine the Laplace transform of the signal $x(t)= e^{-at} u(t) - e^{-bt} u(-t)$ and also find its ROC.</td><td>[L3] [CO5]</td><td>[4M]</td></tr>
<tr><td></td><td>c)</td><td>Find the Laplace transforms and ROC for the following signals.
(i) $x(t)=e^{-5t} u(t-1)$
(ii) $x(t)=e^{-a|t|}$</td><td>[L3] [CO5]</td><td>[4M]</td></tr>
<tr><td>2.</td><td>a)</td><td>Describe the Laplace domain analysis.</td><td>[L2] [CO5]</td><td>[5M]</td></tr>
<tr><td></td><td>b)</td><td>List the Properties of Laplace Transform.</td><td>[L1] [CO2]</td><td>[1M]</td></tr>
<tr><td></td><td>c)</td><td>State and prove the Linearity and Time Shifting Properties of Laplace Transform.</td><td>[L3] [CO2]</td><td>[6M]</td></tr>
<tr><td>3.</td><td>a)</td><td>State and prove the Time Reversal Property of Laplace transform.</td><td>[L2] [CO2]</td><td>[3M]</td></tr>
<tr><td></td><td>b)</td><td>Derive the Laplace transform of any three standard signals.</td><td>[L3] [CO3]</td><td>[9M]</td></tr>
<tr><td>4.</td><td></td><td>Illustrate the inverse Laplace transform of the following.
(i) $X(s) = 1/ s(s+1) (s+2) (s+3)$
(ii) $X(s)=s/(s+3)(s2+6s+5)$</td><td>[L3] [CO5]</td><td>[12M]</td></tr>
<tr><td>5.</td><td>a)</td><td>Determine the Laplace transform of the following signals using properties
(i) $x(t)=t\, e^{-t} u(t)$
(ii) $x(t)=t\, e^{-2t} \sin 2t\, u(t)$</td><td>[L3] [CO5]</td><td>[8M]</td></tr>
<tr><td></td><td>b)</td><td>Derive the relation between Laplace Transform and Fourier Transform of a signal.</td><td>[L3] [CO5]</td><td>[4M]</td></tr>
<tr><td>6.</td><td>a)</td><td>Define Probability.</td><td>[L1] [CO6]</td><td>[2M]</td></tr>
<tr><td></td><td>b)</td><td>Define the following with examples.
(i) Sample space
(ii) Event
(iii) Mutually exclusive events.
(iv) Independent events</td><td>[L1] [CO6]</td><td>[10M]</td></tr>
<tr><td>7.</td><td>a)</td><td>Explain the concept of Joint probability.</td><td>[L2] [CO6]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>Explain the concept of Conditional probability.</td><td>[L2] [CO6]</td><td>[6M]</td></tr>
<tr><td>8.</td><td>a)</td><td>Define Random variable and explain briefly.</td><td>[L2] [CO6]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>Define probability distribution and density functions.</td><td>[L1] [CO6]</td><td>[4M]</td></tr>
<tr><td></td><td>c)</td><td>List the properties of probability distribution and density functions.</td><td>[L1] [CO6]</td><td>[2M]</td></tr>
<tr><td>9.</td><td>a)</td><td>Examine the distribution function $F_{xx}(x,y)$
<table><tr><td>(X,Y)</td><td>(0,0)</td><td>(1,2)</td><td>(2,3)</td><td>(3,2)</td></tr><tr><td>P(x,y)</td><td>0.2</td><td>0.3</td><td>0.4</td><td>0.1</td></tr></table></td><td>[L3] [CO6]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>A random variable X has a probability density function
$f_x(x) = \begin{cases} C(1-x^4) & -1<x<1 \\ 0 & \text{Otherwise} \end{cases}$
Determine the constant ‘C’.</td><td>[L3] [CO6]</td><td>[6M]</td></tr>
<tr><td>10.</td><td></td><td>Let X is a continuous random variable with density function
$f_X(x) = \begin{cases} x/9+k & 0<x<6 \\ 0 & \text{Otherwise} \end{cases}$
(i) Find ‘k’
(ii) Find $p[2<x<5]$</td><td>[L3] [CO6]</td><td>[12M]</td></tr>
</table>

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UNIT –V
RANDOM PROCESSES

1.	**a)**	Explain the concept of Random process.	[L2] [CO6]	**[6M]**
	b)	Classify the Random Processes and explain briefly.	[L2] [CO6]	**[6M]**
2.	**a)**	Define and Differentiate the Distribution and Density functions of a Random Process.	[L2] [CO6]	**[6M]**
	b)	Define and explain Stationary and Statistical Independence of Random process.	[L2] [CO6]	**[6M]**
3.	**a)**	Describe the first order, second order, wide-sense and strict sense stationary process.	[L2] [CO6]	**[6M]**
	b)	Illustrate about Time averages of Random process.	[L3] [CO6]	**[6M]**
4.	**a)**	Define Auto Correlation Function.	[L1] [CO6]	**[4M]**
	b)	List the properties of Auto Correlation Function. State and prove following property. (i) If E[X(t)]=$\overline{X} \neq 0$ and X(t) is ergodic with no period components then $\lim_{\lvert\tau\rvert\to\infty} R_{XX}(\tau)=\overline{X}^2$.	[L3] [CO6]	**[8M]**
5.		Prove the following properties of Auto Correlation function. (i) $\lvert R_{xx}(\tau)\rvert \leq R_{xx}(0)$ (ii) $R_{xx}(-\tau)= R_{xx}(\tau)$ (iii) $R_{xx}(0) = E[X^2(t)]$	[L3] [CO6]	**[12M]**
6.	**a)**	Define Cross Correlation Function.	[L1] [CO6]	**[4M]**
	b)	List the properties of Cross Correlation Function.	[L1] [CO6]	**[2M]**
	c)	State and prove the following properties. (i) $R_{XY}(-\tau) = R_{YX}(\tau)$ (ii) If tow random processes X(t) and Y(t) are statistically independent and wide sense stationary, $R_{XY}(\tau) = \overline{X}.\overline{Y}$	[L3] [CO6]	**[6M]**
7.	**a)**	Describe the concept of power spectral density. List the properties of power spectral density.	[L2] [CO6]	**[6M]**
	b)	State and prove the following properties of power spectral density. (i) $S_{XX}(\omega) \geq 0$ (ii) $S_{XX}(-\omega) = S_{XX}(\omega)$	[L3] [CO6]	**[6M]**
8.	**a)**	Prove that the Power Spectral Density of the derivative X(t) is equal to ω^2 times the Power Spectral Density of Sxx(ω).	[L5] [CO6]	**[6M]**
	b)	Show that the autocorrelation function of a stationary random process is an even function of τ.	[L2] [CO6]	[6M]
9.	**a)**	Explain the concept of cross power density spectrum. List the properties of cross power spectral density.	[L2] [CO6]	**[6M]**
	b)	State and prove the following properties of cross power density spectrum. (i) $S_{XY}(-\omega) = S_{YX}(-\omega) = S_{YX^*}(\omega)$ (ii) Imaginary part of cross power density spectrum is an odd function.	[L3] [CO6]	**[6M]**
10.	**a)**	If the Power Spectral Density of x(t) is Sxx(ω) then find the Power Spectral Density of dx(t)/dt.	[L3] [CO6]	**[6M]**
	b)	The power spectral density of a stationary random process is given by $S_{xx}(\omega) = \begin{cases} A ; & -k < \omega < k \\ 0 ; & \text{otherwise} \end{cases}$ Find the auto correlation function.	[L3] [CO6]	**[6M]**

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