SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY (AUTONOMOUS):: PUTTUR

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QUESTION BANK (DESCRIPTIVE)

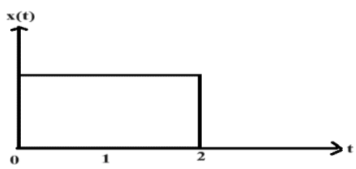
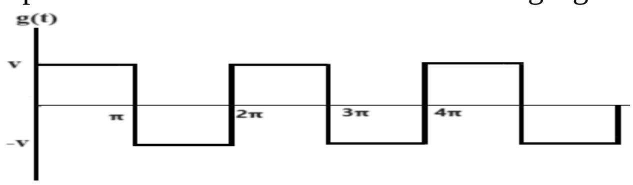
Subject with Code : Signals, Systems and Stochastic Processes (23EC0401)
Course & Branch: B. Tech –ECE
Year & Semester: II- B. Tech. & I-Semester **Regulation:** R23

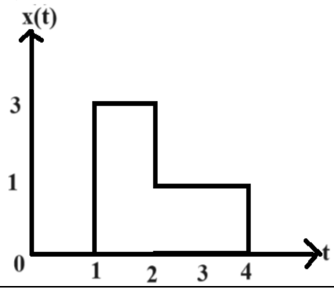
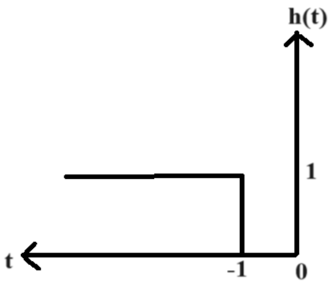
UNIT I
Signals and Systems, Fourier Series

PART-A (2 MARKS)

1.	**(a)**	Define signal and system.	**[L1][CO1]**	**[2M]**
	(b)	Test whether the signal $y(t) = 3x(t) + 2$ is linear or nonlinear.	**[L4][CO1]**	**[2M]**
	(c)	Discuss about causal and non-causal, Time invariant and time variant systems.	**[L2][CO1]**	**[2M]**
	(d)	Define convolution and correlation.	**[L1][CO1]**	**[2M]**
	(e)	List any two properties of Fourier Series.	**[L1][CO2]**	**[2M]**

PART-B (10 MARKS)

2.	**(a)**	Define energy and power signals. Interpret whether the signal $x(t)= e^{-2t} u(t)$ is a power signal or energy signal.	**[L3][CO1]**	**[5M]**
	(b)	Discuss the following. (i) Even and Odd signals (ii) Periodic and Non-Periodic Signals.	**[L2][CO1]**	**[5M]**
3.		Chart the following signals for given x(t). (i) x(t-4) (ii) x(2t-4) (iii)2x(2-t) 	**[L3][CO1]**	**[10M]**
4.	**(a)**	Articulate whether the following system is linear system or non linear system. $Y(t)=x(t).x(t-5)$	**[L3][CO1]**	**[5M]**
	(b)	Define stability of the system. Compute the stability for the following system. $y(t)=x^2(t)$.	**[L3][CO1]**	**[5M]**
5.		Examine the linearity, time-invariance, causality, stability and invertibility of the following system. $Y(t)=x(t+1) + x(t-1)$	**[L3][CO1]**	**[10M]**
6.		Develop the exponential Fourier Series of the following signal. 	**[L3][CO2]**	**[10M]**

7.	**(a)**	Chart the signals of impulse, unit step and unit ramp function.	**[L3][CO1]**	**[5M]**
	(b)	Compute the convolution of following two signals at time t=0.5 sec.  	**[L3][CO1]**	**[5M]**
8.		A Rectangular function defined as x(t)={A for $0<t<\pi/2$ -A for $\pi/2<t<3\pi/2$ A for $3\pi/2<t<2\pi$ Compute the above function by A cos t between the intervals $(0,2\pi)$ such that mean square error is minimum	**[L3][CO1]**	**[10M]**
9.	**(a)**	State and Prove Linearity and Time reversal properties of Fourier series	**[L1][CO2]**	**[5M]**
	(b)	Illustrate how exponential Fourier series is obtained from trigonometric series.	**[L3][CO2]**	**[5M]**
10.		Discuss about orthogonality in signals and derive the expression of selecting c_{12} to minimize the error between the actual function and the approximated function over the time interval $t_1<t<t_2$.	**[L2][CO1]**	**[10M]**
11.	**(a)**	Calculate the odd and even components of the signal $x(t)= \cos t + \sin t + \cos t \sin t$.	**[L3][CO1]**	**[5M]**
	(b)	Discuss about Dirichlet's conditions for Fourier Series.	**[L2][CO2]**	**[5M]**

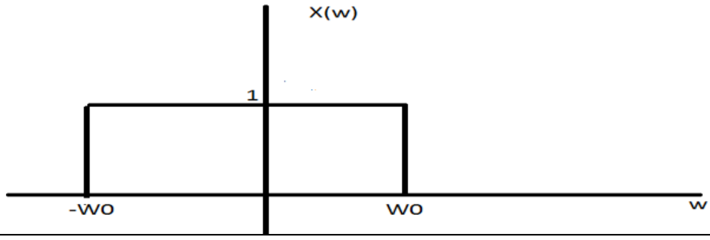
UNIT II
Fourier Transform and Laplace Transform

PART-A (2 MARKS)

1.	**(a)**	Define sampling theorem.	**[L3][CO2]**	**[2M]**
	(b)	Find the Fourier Transform of e^{-at} u(t)	**[L3][CO2]**	**[2M]**
	(c)	Explain the time shifting property of Fourier transform.	**[L1][CO3]**	**[2M]**
	(d)	State the properties of ROC of Laplace Transform	**[L1][CO2]**	**[2M]**
	(e)	Find the Laplace transform impulse signal.	**[L2][CO2]**	**[2M]**

PART-B (10 MARKS)

2.		State and articulate sampling theorem.	**[L3][CO3]**	**[10M]**
3.	**(a)**	Explain modulation property of Fourier transform	**[L2][CO2]**	**[5M]**
	(b)	Compute the Fourier transform of the function e^{at} u(-t)	**[L3][CO2]**	**[5M]**
4.		Calculate the Nyquist rate of the following signals. (a) $x(t)=2 \sin 10\pi t. \sin 50\pi t$ (b) $x(t)=\cos^2 10\pi t$	**[L3][CO3]**	**[10M]**

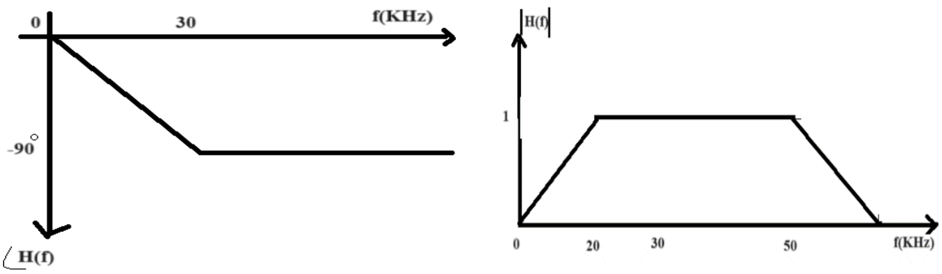
5.	**(a)**	Construct the inverse Fourier transform of the following signal. 	**[L3][CO4]**	**[5M]**
	(b)	State and prove Differentiation in time and time shifting property of Fourier transform	**[L1][CO2]**	**[5M]**
6.	**(a)**	State any six properties of Fourier Transform	**[L1][CO4]**	**[5M]**
	(b)	Compute the Inverse Fourier Transform of the following signals $X(w)=\frac{(4jw+6)}{(jw)^2+6jw+8)}$ (ii) $X(w)=\frac{1+3jw}{(jw+3)^2}$	**[L3][CO4]**	**[5M]**
7.	**(a)**	State initial and final value theorem of Laplace Transform.	**[L1][CO2]**	**[5M]**
	(b)	Calculate the initial and final values of $X(s)=\frac{2s+5}{s^2+5s+6}$	**[L3][CO4]**	**[5M]**
8.	**(a)**	Calculate the transfer function of following system. $\frac{d^2y(t)}{dt^2}+2\frac{dy(t)}{dt}=3x(t)$	**[L3][CO4]**	**[5M]**
	(b)	Illustrate how Fourier transform is derived from Laplace transform in s-plane.	**[L3][CO2]**	**[5M]**
9.	**(a)**	Explain convolution property of Laplace transform	**[L2][CO2]**	**[5M]**
	(b)	Calculate the Laplace transform of $x(t)=e^{-t}\,u(-t)+e^{5t}\,u(t)$	**[L3][CO4]**	**[5M]**
10.	**(a)**	Calculate the Laplace transform of $x(t)=e^{-at}\,u(t)$	**[L3][CO4]**	**[5M]**
	(b)	Consider the signal $x(t)=\text{Cos}6\pi t+\sin 8\pi t$, where t is in seconds. Calculate the Nyquist rate for $y(t)=x(2t+5)$	**[L3][CO3]**	**[5M]**
11.	**(a)**	Calculate the Laplace transform of the function $f(t)=t^2-3t+5$	**[L3][CO4]**	**[3M]**
	(b)	If $L\{f(t)\}=s^2\,e^x$ then chart $L\{f(4t)\}$	**[L3][CO4]**	**[3M]**
	(c)	Define Inverse Laplace transform and Calculate $L^{-1}\{\frac{s}{s^2+4s+3}\}$	**[L3][CO4]**	**[4M]**

UNIT III
Signal Transmission through Linear Systems

PART-A (2 MARKS)

1.	**(a)**	Define LTI system.	**[L1][CO1]**	**[2M]**
	(b)	Describe what is impulse response.	**[L1][CO4]**	**[2M]**
	(c)	Define system bandwidth and signal bandwidth.	**[L1][CO4]**	**[2M]**
	(d)	Explain about Paley-Wiener criterion.	**[L2][CO4]**	**[2M]**
	(e)	Define Energy and Power spectral densities.	**[L1][CO2]**	**[2M]**

PART-B (10 MARKS)

2.	**(a)**	Chart the magnitude and phase response for a distortion less transmission system.	**[L3][CO4]**	**[5M]**
	(b)	Suppose a transmission system has the frequency response as shown below.  Deduce the range of frequency there is no distortion and explain the reason.	**[L4][CO2]**	**[5M]**
3.		Compute the output response of linear time invariant system.	**[L3[CO4]**	**[10M]**
4.	**(a)**	Define linear time variant system.	**[L1][CO1]**	**[5M]**
	(b)	For a discrete system having x[n]={1,2,3,4} and h[n]={1,2,1,-1} compute the output response y[n].	**[L3][CO4]**	**[5M]**
5.	**(a)**	Compute the output of LTI system for input of impulse	**[L3][CO1]**	**[3M]**
	(b)	Articulate the condition for LTI system to be causal and stable.	**[L3][CO1]**	**[4M]**
	(c)	Explain the properties of convolution integral.	**[L3][CO1]**	**[3M]**
6.		Let x(t)= e^{-at}u(t), where a>0 ,be the input to an LTI system with impulse response h(t)= u(t). Calculate the response of the system.	**[L3][CO4]**	**[10M]**
7.		Find the conditions for the distortion less transmission through a system. What do you understand by the term signal bandwidth? Articulate.	**[L3][CO4]**	**[10M]**
8.	**(a)**	Explain the ideal filter characteristics.	**[L2][CO3]**	**[5M]**
	(b)	Explain causality and physical reliability of a system and hence develop Paley- Wiener criterion.	**[L3][CO4]**	**[5M]**
9.		Develop the relationship between the bandwidth and rise time of ideal Low Pass Filter.	**[L3][CO4]**	**[10M]**
10.	**(a)**	Define the Energy Spectral Density Function and list the properties of ESD.	**[L1][CO2]**	**[5M]**
	(b)	Compute the relation between ESD and Auto Correlation Function.	**[L3][CO2]**	**[5M]**
11.	**(a)**	Define the Power Spectral Density Function and list the properties of PSD.	**[L1][CO2]**	**[5M]**

	(b)	Compute the relation between PSD and Auto Correlation Function.	**[L3][CO2]**	**[5M]**

UNIT IV
Random Processes – Temporal Characteristics

PART-A (2 MARKS)

1.	**(a)**	Differentiate between Random Processes and Random variables with example.	**[L4][CO5]**	**[2M]**
	(b)	Define wide sense stationary random processes.	**[L1][CO6]**	**[2M]**
	(c)	Describe the statement of ergodic theorem.	**[L2][CO6]**	**[2M]**
	(d)	How two random processes X(t)& Y(t) are said to be independent.	**[L2][CO5]**	**[2M]**
	(e)	Define the cross correlation function between two random processes X(t) & Y(t).	**[L1][CO6]**	**[2M]**

PART-B (10 MARKS)

2.	**(a)**	Define Wide Sense Stationary Process and write it's conditions.	**[L1][CO6]**	**[5M]**
	(b)	A random process is given as X(t) = At, where A is a uniformly distributed random variable on (0,2). Interpret whether X(t) is wide sense stationary or not.	**[L3][CO5]**	**[5M]**
3.		X(t) is a stationary random process with a mean of 3 and an auto correlation function of 6+5 exp (-0.2 $\lvert\tau\rvert$). Calculate the second central Moment of the random variable Y=Z-W, where Z and W are the samples of the random process at t=4 sec and t=8 sec respectively.	**[L3][CO5]**	**[10M]**
4.		Explain the following i. Stationarity ii. Ergodicity iii. Statistical independence with respect to random processes	**[L2][CO6]**	**[10M]**
5.	**(a)**	Given the Random Process X(t) = A cos(w_0t) + B sin (w_0t) where ω_0 is a constant, and A and B are uncorrelated Zero mean random variables having different density functions but the same variance σ 2 . Illustrate that X(t) is wide sense stationary.	**[L2][CO5]**	**[5M]**
	(b)	Define Covariance of the Random processes with any two properties.	**[L1][CO6]**	**[5M]**
6.	**(a)**	A Gaussian RP has an auto correlation function $R_{XX}(\tau)$=6 sin $(\pi\tau)/\pi\tau$. Compute a covariance matrix for the Random variable X(t) .	**[L3][CO6]**	**[5M]**
	(b)	Compute the expression for cross correlation function between the input and output of a LTI system.	**[L3][CO3]**	**[5M]**
7.		Explain about Poisson Random process and also find its mean and variance.	**[L2][CO6]**	**[10M]**
8.		Briefly explain the distribution and density functions in the context of stationary and independent random processes.	**[L2][CO6]**	**[10M]**
9.		Explain about the following random process (i) Mean ergodic process (ii) Correlation ergodic process (iii) Gaussian random process	**[L2][CO6]**	**[10M]**
10.		State and prove the auto correlation and cross correlation function properties.	**[L1][CO3]**	**[10M]**
11.		The function of time Z(t) = $X_1\cos\omega_0 t$- $X_2\sin\omega_0 t$ is a random process. If X_1 and X_2 are independent Gaussian random variables, each with zero mean and variance σ2 , Calculate E[Z], E[Z^2] and var(z).	**[L3][CO5]**	**[10M]**

UNIT V
Random Processes – Spectral Characteristics

PART-A (2 MARKS)

1.	**(a)**	Define Power Spectrum Density.	**[L1][CO2]**	**[2M]**
	(b)	Discuss the statement of Wiener-Khinchin relation.	**[L2][CO6]**	**[2M]**
	(c)	Define spectrum Band width and RMS bandwidth.	**[L1][CO2]**	**[2M]**
	(d)	List any two properties of Power Spectrum Density.	**[L1][CO2]**	**[2M]**
	(e)	If X(t) & Y(t)are uncorrelated and have constant mean values X &Y then show that $S_{XX}(\omega)= 2\Pi X\ Y\ \delta(\omega)$.	**[L1][CO5]**	**[2M]**

PART-B (10 MARKS)

2.	**(a)**	Analyze whether the following power spectral density functions are valid or not $i)\ cos^8(\omega)/(\ 2 + \omega^4\ )\ ii)\ e^{-(\omega-1)^2}$	**[L4][CO2]**	**[5M]**
	(b)	Compute the relation between input PSD and output PSD of an LTI system.	**[L3][CO2]**	**[5M]**
3.		Compute the relationship between cross-power spectral density and cross correlation function.	**[L3][CO2]**	**[10M]**
4.		A stationery random process X(t) has spectral density $S_{XX}(\omega)$=25/ (ω^2+25) and an independent stationary process Y(t) has the spectral density $S_{YY}(\omega)= \omega^2 / (\omega^2+25)$. If X(t) and Y(t) are of zero mean, calculate the: a) PSD of Z(t)=X(t) + Y(t) b) Cross spectral density of X(t) and Z(t)	**[L3][CO6]**	**[10M]**
5.	**(a)**	The input to an LTI system with impulse response h(t)= $\delta(t) + t^2 e^{-at}$. U(t) is a WSS process with mean of 3. Calculate the mean of the output of the system.	**[L3][CO3]**	**[5M]**
	(b)	Define Power Spectral density with three properties.	**[L1][CO2]**	**[5M]**
6.	**(a)**	A random process Y(t) has the power spectral density $S_{YY}(\omega)= 9/(\omega^2+64)$. Calculate i. The average power of the process ii. The Auto correlation function	**[L3][CO6]**	**[5M]**
	(b)	A random process has the power density spectrum $S_{YY}(\omega)= 6\omega^2 /(1+\omega^4)$. Calculate the average power in the process.	**[L3][CO6]**	**[5M]**
7.	**(a)**	Analyze the cross correlation function corresponding to the cross power spectrum $S_{XY}(\omega)= 6 /[(9+\omega^2)(3+j\omega)^2]$.	**[L4][CO2]**	**[5M]**
	(b)	Explain briefly about cross power density spectrum.	**[L2][CO2]**	**[5M]**
8.	**(a)**	Consider a random process X(t)=cos($\omega t + \theta$)where ω is a real constant and $\theta$is a uniform random variable in (0, π/2). Calculate the average power in the process.	**[L3][CO6]**	**[5M]**
	(b)	Define and derive the expression for average power of Random process.	**[L1][CO6]**	**[5M]**
9.		The power spectrum density function of a stationary random process is given by $S_{XX}(\omega)$= A, -K< ω< K 0, other wise Calculate the auto correlation function.	**[L3][CO6]**	**[10M]**
10.	**(a)**	Define and compute the expression for average cross power between two random process X(t) and Y(t).	**[L3][CO6]**	**[5M]**
	(b)	Calculate the power spectral density for $R_{XX}(\tau)=A^2 /2 \sin(\omega 0\tau)$.	**[L3][CO2]**	**[5M]**
11.	**(a)**	Show that $S_{XX}(-\omega) = S_{XX}(\omega)$. i.e., Power spectrum density is even function of ω.	**[L2][CO2]**	**[5M]**
	(b)	If the Power spectrum density of x(t) is $S_{XX}(\omega)$, compute the PSD of $dx(t)/dt$.	**[L3][CO2]**	**[5M]**

Prepared by:

Dr. B. T. Madhav, Associate Professor, Dept. of ECE, SIETK
S.V.Rajesh Kumar, Assistant Professor, Dept. of ECE, SIETK.
G.Priyanka, Assistant Professor, Dept. of ECE, SIETK.