20EI402

Hall Ticket Number:

II/IV B.Tech (Regular\Supplementary) DEGREE EXAMINATION

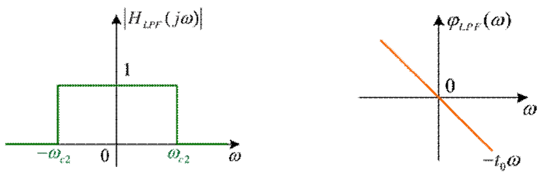
July/August, 2023 — **Electronics and Instrumentation Engineering**

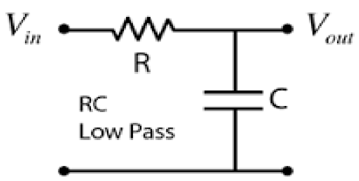
Fourth Semester — **Signals & Systems**

Time: Three Hours — **Maximum:** 70 Marks

Answer question 1 compulsory. **(14X1 = 14Marks)**

Answer one question from each unit. **(4X14=56 Marks)**

			CO	BL	M
1	a)	Differentiate Energy and Power signals Signal with finite energy is known as “Energy Signal” and Signal with finite Avg. Power is known as “Power Signal”.	CO1	L2	1M
	b)	Sketch the signal x(t) = u(-t+3)	CO1	L2	1M
	c)	What is the fundamental period of the signal $x(t) = 1+ e^{-\pi t} + e^{-3\pi t}$	CO1	L2	1M
	d)	Evaluate the integral $\int_{-\infty}^{\infty} t^2 . \delta(t-5)\, dt$	CO1	L3	1M
	e)	Write the relationship between input, output and Impulse response of a continuous-time LTI system. y(t)=x(t)*h(t)	CO2	L1	1M
	f)	What are the basic elements of block diagram representation of a system? Show their symbols. Multiplier, Adder, Differentiators or Integrators.	CO2	L3	1M
	g)	State Dirichlet's conditions for Fourier series. i. The signal should have a finite number of maxima and finite number of minima over the range of time period. ii. The signal should have a finite number of discontinuities over the range of time period. iii. Signal should be absolutely integrable over the range of time period	CO2	L2	1M
	h)	State the differentiation property of Fourier Series. If $x(t)$ is a periodic function with time period T and with Fourier series coefficient C_n. If $x(t) \overset{FS}{\leftrightarrow} C_n$ Then, the time differentiation property of continuous-time Fourier series states that $\frac{dx(t)}{dt} \overset{FS}{\leftrightarrow} jn\omega_0 C_n$	CO2	L2	1M
	i)	What is the inverse Fourier transform of the function $X(j\omega) = \delta(\omega)$? Ans: $1/2\pi$	CO3	L2	1M
	j)	State the symmetry properties of Fourier transform. $X(-j\omega) = X^*(j\omega)$	CO3	L2	1M
	k)	Draw the frequency response of an Ideal Low Pass Filter.  (a) Amplitude-frequency. (b) Phase-frequency.	CO3	L3	1M
	l)	What is under sampling? Fs<2Fm	CO4	L3	1M

	m)	Compare convolution and correlation. • Convolution is the calculation of the area under the product of two signals in LTI systems where as correlation is measurement of similarity between two signals. • Correlation is measurement of the similarity between two signals/sequences. Convolution is measurement of effect of one signal on the other signal.	CO5	L2	1M
	n)	What is the energy spectral density of $x(t) = \delta(t-1)$	CO5	L2	1M
		Unit-I			
2	a)	Explain about classification of systems with examples. • Linear and Non-linear Systems • Time Variant and Time Invariant Systems • Static and Dynamic Systems • Causal and Non-causal Systems • Invertible and Non-Invertible Systems • Stable and Unstable Systems	CO1	L2	7M
	b)	Determine whether the following signals are energy signals or power signals i) $x(t) = e^{2t} u(-t+3)$ ii) $x(t) = 1 + \sin(\pi t)$	CO1	L3	7M
		(OR)			
3	a)	Given $x(t) = u(t+3) - u(t-4)$. Sketch the following signals i) $y(t) = x(t+2)$ ii) $y(t) = x(t-3)$ iii) $y(t) = x(2t-1)$ iv) $y(t) = x(-3t+1)$	CO1	L2	7M
	b)	Test whether the following system is linear, causal, time-invariant and stable with appropriate test conditions. $y(t) = x(t+2).\cos(\omega_0 t)$	CO1	L4	7M
		Unit-II			
4	a)	Compute and Sketch the convolution of the following signals $x(t) = e^{-2t} u(t)$ and $h(t) = e^{-t} u(t+2)$	CO2	L4	7M
	b)	Determine the trigonometric Fourier Series coefficients of the signal $x(t) = t;\ 0 < t < 2$ with fundamental period T = 2 sec.	CO2	L3	7M
		(OR)			
5	a)	Consider a continuous-time LTI system with impulse response $h(t) = u(t+3)$. Determine the response of the system to the input $x(t) = e^{t} u(-t+3)$	CO2	L4	7M
	b)	Find the exponential Fourier series representation of a periodic signal $x(t) = \cos(\pi t);\ -1 < t < 1$ with fundamental period T = 2 sec.	CO2	L3	7M
		Unit-III			
6	a)	Compute the Fourier transform of a signal $x(t) = \sin(\pi t).u(t-1)$	CO3	L3	7M
	b)	 $\lvert V_{out}\rvert = \lvert V_{in}\rvert \frac{1}{\sqrt{1+\omega^2 R^2 C^2}}$ Determine the frequency response of RC low Pass Filter and draw the magnitude and phase response plots.	CO3	L4	7M
		(OR)			
7	a)	State and prove time scaling and modulation properties of Fourier Transform. Scaling Property:	CO3	L3	7M

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$x(t) \overset{\mathfrak{F}}{\longleftrightarrow} X(j\omega),$

$$\boxed{x(at) \overset{\mathfrak{F}}{\longleftrightarrow} \frac{1}{\lvert a\rvert}X\left(\frac{j\omega}{a}\right),}$$

Modulation Property:

Modulation property: $s(t)\cdot\cos(2\pi f_c t) \overset{F\{\ \}}{\Leftrightarrow} \frac{1}{2}\left[S(f-f_c)+S(f+f_c)\right].$

(a) $v(t)=A\cdot \mathrm{tri}\left(\frac{t}{a}\right)\cos(\omega_c t)=\left\{\begin{array}{c} A\left(1-\frac{\lvert t\rvert}{a}\right)\cos(\omega_c t),\ \lvert t\rvert<a \\ 0,\ elsewhere\end{array}\right\}$

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<tr><td></td><td>b)</td><td>

Consider the continuous time LTI system described by

$$\frac{dy(t)}{dt} + 5y(t) = x(t)$$

Determine the output y(t) of the system to the input $x(t) = e^{-2t}\,u(t-3)$.

</td><td>CO3</td><td>L4</td><td>7M</td></tr>
<tr><td colspan="6"><u>Unit-IV</u></td></tr>
<tr><td>8</td><td>a)</td><td>

State and Prove Sampling theorem for bandlimited signals.

$$x_p(t) = \sum_{n=-\infty}^{+\infty} x(nT)\delta(t-nT).$$

From the multiplication property (Section 4.5), we know that

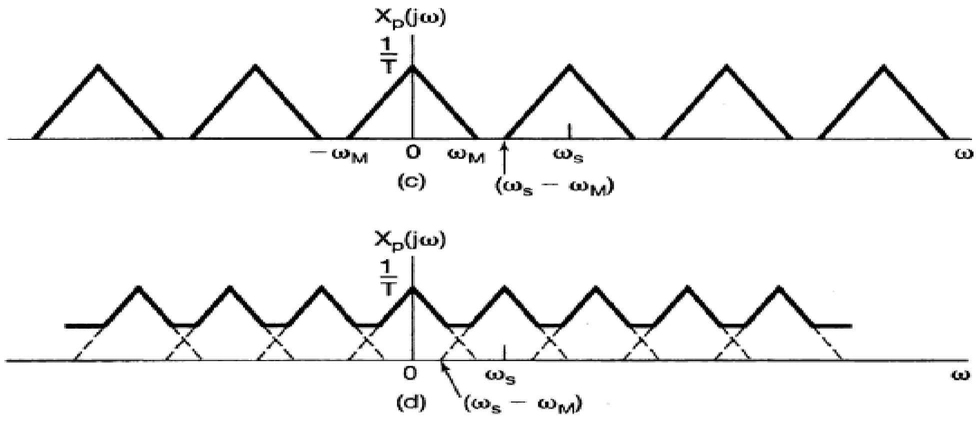
$$X_p(j\omega) = \frac{1}{2\pi}\int_{-\infty}^{+\infty} X(j\theta)P(j(\omega-\theta))d\theta.$$

and from Example 4.8,

$$P(j\omega) = \frac{2\pi}{T}\sum_{k=-\infty}^{+\infty}\delta(\omega-k\omega_s).$$

Since convolution with an impulse simply shifts a signal [i.e., $X(j\omega) * \delta(\omega-\omega$ $X(j(\omega-\omega_0))$], it follows that

$$X_p(j\omega) = \frac{1}{T}\sum_{k=-\infty}^{+\infty} X(j(\omega-k\omega_s)).$$



</td><td>CO4</td><td>L3</td><td>7M</td></tr>
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		• That is, Xp(jw) is a periodic function of w consisting of a superposition of shifted replicas of X(jw), scaled by 1/T. • In Figure (c) $\omega_M < (\omega_s - \omega_M)$ or equivalently, $\omega_s > 2\omega_M$ and thus there is no overlap between the shifted replicas of X(jw), whereas in Figure (d), with $\omega_s < 2\omega_M$, there is overlap. • In Figure (c) X(jw) is faithfully reproduced at integer multiples of the sampling frequency. • Consequently, if $\omega_s > 2\omega_M$, x(t) can be recovered exactly from xp(t) by means of a lowpass filter with gain T and a cutoff frequency greater than ω_M and less than $(\omega_s - \omega_M)$.			
	b)	Compute the Energy Spectral Density of the signal $x(t) = e^{-\lvert t \rvert}$	CO4	L3	7M
(OR)					
9	a)	State and prove the properties of cross correlation. The properties of cross correlation function for energy signals are given as follows – **Property 1** The cross correlation functions of energy signals exhibit conjugate symmetry property, that is, $R_{12}(\tau) = R_{21}^{*}(-\tau)$ **Property 2** The cross correlation functions of energy signals are not in general commutative, i.e., $R_{12}(\tau)\ eq\ R_{21}(-\tau)$ **Property 3** If, $R_{12}(0) = \int_{-\infty}^{\infty} x_1(t) x_2^{*}(t) dt = 0$ Then, the two energy signals $x_1(t)$ and $x_2(t)$ are said to be *orthogonal signals* over the entire time interval. The cross correlation of orthogonal signals is zero.	CO4	L3	7M
	b)	Compute the Power Spectral Density of the signal $x(t) = \sin(3\pi t)$	CO4	L3	7M