DEPARTMENT OF ELECTRICAL ENGG. IIT DELHI

ELL311 Comm. ENGG. MINOR-I, AUG. 30, 2016 M.M. 25

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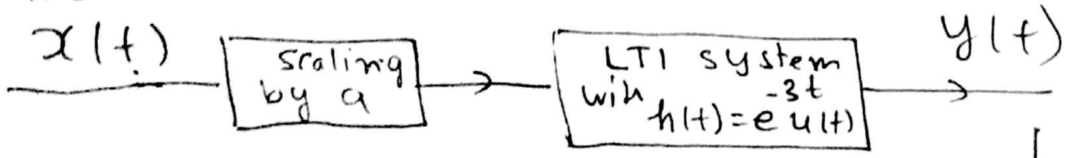
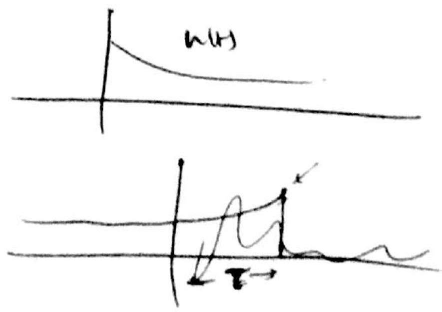
MAKE ASSUMPTIONS, IF REQUIRED. Total 3

Prob. 1 Evaluate the integral $\int_{-\infty}^{\infty} \left(\frac{\sin t}{\pi t}\right)^2 \cos(t/2)\, dt$ (3)

Prob. 2 Consider the system given below. Find the output in terms of input & comment on Time invariance of the system: (3)





$y(t) = a x(t) * e^{-3t} u(t)$

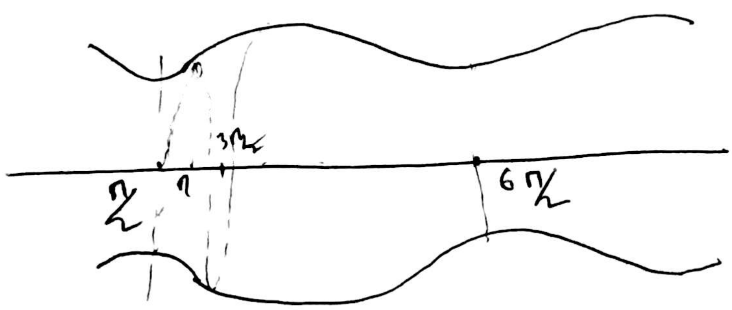
$Y(\omega) = 2\pi a X(\omega)\, \delta(\omega \pm 3)$

Prob. 3 For an Amplitude modulated signal let $m(t) = 2\cos(\omega_m t)$ & $\omega_c = 5\omega_m$. Plot the modulated signal for (a) modulation index $\mu = \frac{1}{2}$ (b) Modulation Index $\mu = \frac{3}{2}$. (4)

(a) modulated signal index $= \frac{K_a^2 P_m}{1 + K_a^2 P_m} =$

$\mu = \frac{1}{2} \rightarrow K_a = 1/\sqrt{2}$ $\quad A(1 + k_a m(t)) \cos \omega_c t$ $\rightarrow 2\cos \omega_m t$

1



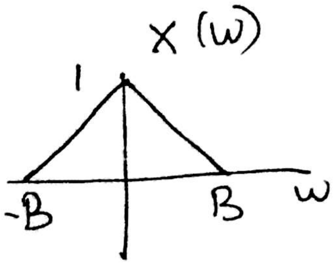
(b) $\mu = 3/2 \rightarrow K_a =$ this is not possible modulation index cannot be greater than one

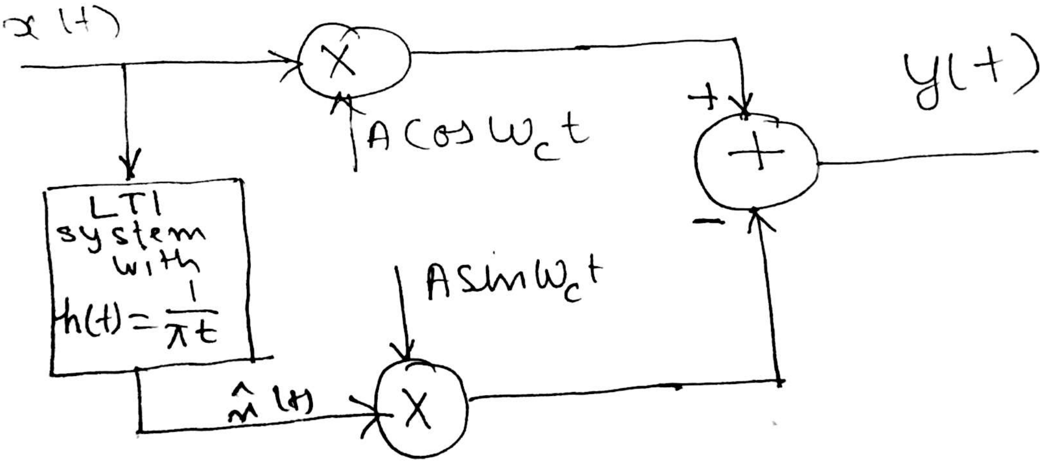
4

Prob. 4 Let $x(t) = \frac{1}{1+t^2}$. Find & plot its Pre-envelope. (whatever that makes sense)

$\frac{1}{1+\omega^2} \leftrightarrow$

Prob. 5





Find & plot $Y(w)$.

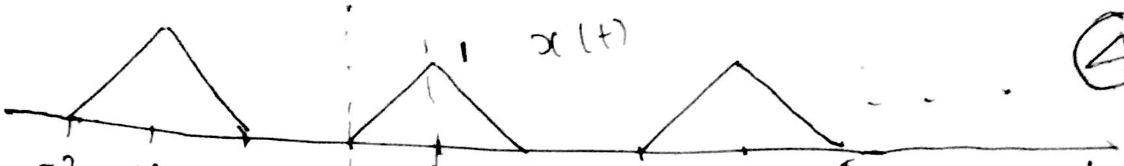
$$y(t) = x(t)\, A\cos w_c t - \hat{x}\, A\sin w_c t$$

when $\hat{x} = x(t) * \frac{1}{\pi t}$

$$\hat{x}(t) = -x(t)\, j\, \mathrm{sgn}(t)$$

$$y(t) = x(t)\, A\cos w_c t + x(t)\, j\, \mathrm{sgn}(t)\, \sin w_c t$$

Prob. 6



(4)

A periodic signal $x(t)$ is passed through an LTI system having $H(\omega) = \dfrac{j\omega}{6-\omega^2+5j\omega}$. Find & plot the spectrum of the output.

$x^+(n)$

$x^+(\omega)$

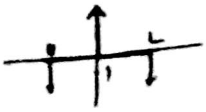
$-\omega^2 x^+(\omega) \cdot H(\omega) = \dfrac{-j\omega^3 x^+(\omega)}{6-\omega^2+5j\omega}$

$\dfrac{d x^+(t)}{dt}$

$+j\omega x^+(\omega)$

$= \dfrac{-j\omega^3 x(\omega)}{\omega^2-5j\omega-6} = \dfrac{-j\omega^3 X(\omega)}{(\omega-3j)(\omega-2j)}$

$\dfrac{d^2 x^+(t)}{dt^2}$



$-\omega^2 x^+(\omega)$

$= -2\pi\delta(\omega)$
$+ 4\pi e^{\omega}\delta(\omega)$
$- 2\pi e^{-2\omega}\delta(\omega)$

1/2

$x^+(\omega) = \dfrac{(-2\pi\delta + 4\pi e^{\omega} - 2\pi e^{2\omega})}{-\omega^2}\,\delta(\omega)$

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(4)

Prob. 7 Find the mean Power of the signal

$x(t) = m(t)\cos\omega_c t - \hat{m}(t)\sin\omega_c t$.

where $\hat{m}(t)$ is the Hilbert Transform of $m(t)$ & mean Power in $m(t)$ is P_m.