COLLEGE OF ENGINEERING & TECHNOLOGY

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Course : Spectral Analysis
Course Code : EC321

Sheet 9

1. Let *x(t)* be the unit impulse train expressed as $x(t) = \sum_{m=-\infty}^{\infty} \delta(t - mT_o)$ and $h(t) = tri(\frac{t}{2})$, determine and sketch $y(t) = x(t) \otimes h(t)$, at:
   a. $T_o = 5$
   b. $T_o = 4$
   c. $T_o = 2$

2. A signal *x(t)* of finite energy is applied to a square-law device whose output is defined by
   $$y(t) = x^2(t)$$
   If the spectrum of *x(t)* is limited to the frequency interval $-W < f < W$. Hence, show that the spectrum of *y(t)* is limited to $-2W < f < 2W$. Hint: Express *y(t)* as *x(t)* multiplied by itself.

3. A signal $x(t) = e^{j2\pi ft}$ has been transmitted through a linear time-invariant system of impulse response *h(t)*, evaluate the response of the system in terms of the system frequency response.

4. Suppose that, for a given signal *x(t)*, the integrated value of the signal over an interval *T* is required, as shown by
   $$y(t) = \int_{t-T}^{T} x(\tau)\, d\tau$$
   show that *y(t)* can be obtained by transmitting the input signal through a filter with its transfer function given by
   $$H(f) = T\, sinc(Tf)\, e^{-j\pi fT}$$

5. Check if the following systems are linear or nonlinear systems:
   a. $y(t) = a[x(t) - x(t-5)]$
   b. $y(t) = (t+1)[x(t) - x(t-3)]$
   c. $y(t) = e^{-atx(t)}$
   d. $y(n) = 2x^2(n)$
   e. $y(n) = nx(n) + x(n-1)$
   f. $y(n) = a_0 x(n) + a_1 x(n-1) + \ldots + a_m x(n-m)$

6. Check if the above listed systems are time-invariant or time varying systems, identify which of them is linear time-invariant LTI system.