ECEN220 Tutorial Questions

Block 2: Linear Time Invariant (LTI) Systems

Q1. What three properties must an LTI system have?

Q2. Does the system $y(t) = x^2(t)$ have the scaling property?

Q3. Which of the following systems is linear?

$$\text{(a) } y_1(t) = |\sin(3t)|\, x(t), \text{ (b) } y_2(t) = a\,\frac{dx}{dt}$$
$$\text{(c) } y_3(t) = |x(t)|, \text{ (d) } y_4(t) = \sin[x(t)]$$

Q4. Which systems are time-invariant?

$$\text{(a) } y(t) = \frac{dx}{dt} + \sin[x(t-1)]$$

$$\text{(b) } \frac{dy}{dt} = 2\sin[x(t-1)] + 3\cos[x(t-1)]$$

Q5. How can you measure the impulse response of a system?

Q6. How can you compute the impulse response of a system from its response?

Q7. Determine the impulse response of a system whose step response is

$$y_{\text{step}}(t) = \begin{cases} 0, & t \le 0 \\ t, & 0 \le t \le 1 \\ 1, & t \ge 1. \end{cases}$$

Q8. Describe the process involved in the application of the graphical convolution techniques.

Q9. Describe the time-shift property of convolution.

Q10. What is the outcome of convolving a signal with a step function? With an impulse function?

Q11. What is the area property of convolution?

Q12. Evaluate $$u(t) * \delta(t-3) - u(t-4) * \delta(t+1)$$

Q13. Evaluate $$\lim_{t\to\infty} [e^{-3t}\, u(t) * u(t)]$$

Q14. A system's impulse response is $h(t) = u(t-1)/t^2$. Is the system BIBO stable?

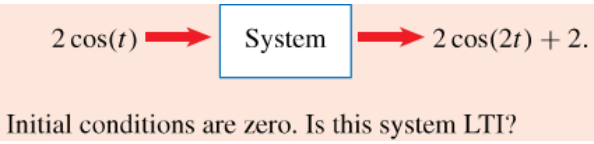
Q15. A system's impulse response is $h(t) = u(t-1)/t$. Is the system BIBO stable?

Q16. If the input to an LTI system is a sinusoid, which of the following attributes can change between the input and output: amplitude, frequency or phase?

Q17. Derive the output.

$$\cos(t) \rightarrow \boxed{h(t) = e^{-t}\, u(t)} \rightarrow \; ?$$

Q18.



Initial conditions are zero. Is this system LTI?

Q19. The input x(t) and the impulse response h(t) of a continuous time LTI system are given by

$$x(t) = u(t) \qquad h(t) = e^{-\alpha t}u(t), \alpha > 0$$

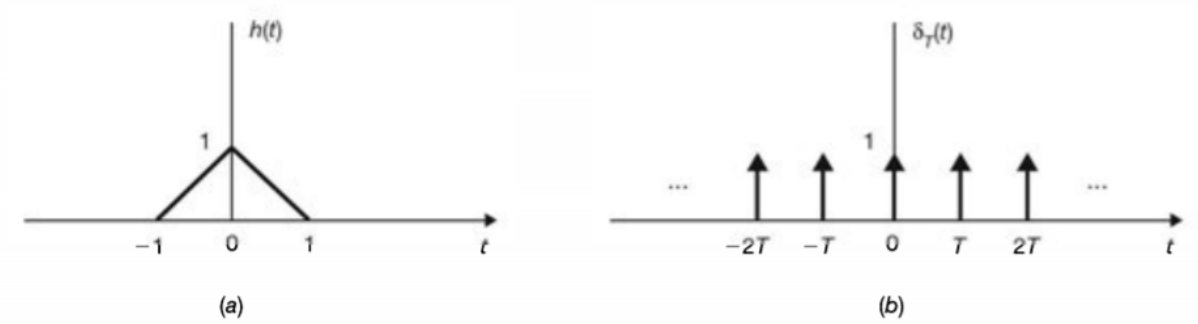
(a) Compute y(t) by using $y(t) = x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)\,d\tau$

(b) Compute y(t) by using $y(t) = h(t) * x(t) = \int_{-\infty}^{\infty} h(\tau)x(t-\tau)\,d\tau$

Q20. Let h(t) be the triangular pulse shown in figure (a) and let x(t) be the unit impulse train (as shown in figure b) expressed as

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

Determine and sketch y(t) = h(t) * x(t) for the following values of T: (a) T = 3, (b) T = 2, (c) T = 1.5.



Q21. Is the system with impulse response BIBO stable?

$$h[n] = \frac{1}{(n+1)^2}\,u[n]$$

Q22. Is the system with impulse response BIBO stable?

$$h[n] = \left(\tfrac{1}{2}\right)^n u[n]$$

Q23. A system has an impulse response h[n] = 0 for n < 0 but h[0] $\neq$ 0. Is the system causal?

Q24. Compute y[n] = {1,2} $*$ {0,0,3,4}.