**EE1101 Signals and Systems JAN—MAY 2019**
**Tutorial 4: Extra Questions**

1. (Haykin Problem 2.49)
For each of the following impulse responses,determine whether the corresponding system is (i)memoryless, (ii) causal, and (iii)stable.
   (a) $h(t) = \cos(\pi t)$
   (b) $h(t) = e^{-2t}u(t-1)$
   (c) $h(t) = u(t+1)$
   (d) $h(t) = 3\delta(t)$
   (e) $h(t) = \cos(\pi t)u(t)$
   (f) $h[n] = (-1)^n u[-n]$
   (g) $h[n] = (1/2)^{|n|}$
   (h) $h[n] = \cos(\pi n/8)(u[n] - u[n-10])$
   (i) $h[n] = 2u[n] - 2u[n-5]$
   (j) $h[n] = \sin(\pi n/2)$
   (k) $h[n] = \sum_{p=-1}^{\infty} \delta[n-2p]$

2. (Oppenheim Advanced Problem 2.49)
If $h[n]$ is absolutely summable, then the LTI system with impulse response $h[n]$ is stable. This means that absolute summability is a sufficient condition for stability. Show that it is also a necessary condition. Consider an LTI system with impulse response $h[n]$ that is not absolutely summable, that is

$$\sum_{k=-\infty}^{+\infty} |h[k]| = \infty$$

   (a) Suppose that the input to the system is

$$x[n] = \begin{cases} 0 & if h[-n] = 0 \\ \frac{h[-n]}{|h[-n]|} & if h[-n] \neq 0 \end{cases}$$

   Does this input signal represent a bounded input ? If so, what is the smallest number $B$ such that

$$|x[n]| \leq B$$

   for all $n$ ?

   (b) Calculate the output at $n = 0$ for this particular choice of input. Does the result prove the contention that absolute summability is a necessary condition for stability ?

   (c) In a similar fashion, show that a continuous-time LTI system is stable if and only of its impulse response is absolutely integrable.

3. The step response to a system is given by $g(t) = (t+1)u(t)$. Find the response to $x(t) = \delta(-3t+1)$

4. (Oppenheim Advanced Problem 2.46)
Consider an LTI system S and a signal $x(t) = 2e^{-3t}u(t-1)$. If

$$x(t) \rightarrow y(t)$$

and

$$\frac{dx(t)}{dt} \rightarrow -3y(t) + e^{-2t}u(t)$$

determine the impulse response $h(t)$ of S

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