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EE301 Homework #2

Problem 1 *Properties of the CT impulse function.*
Simplify the following expressions where $x(t)$ is a continuous function of t.

(a) $\int_{-\infty}^{\infty} x(t)\,\delta(t)\,dt$

(b) $\int_{-\infty}^{\infty} x(t)\,\delta(t-3)\,dt$

(c) $\int_{-\infty}^{\infty} x(t)\,\delta(2t)\,dt$ (Hint: Apply the substitution of variables $\tau = 2t$.)

Problem 2 *Properties of the DT impulse function.*
Simplify the following expressions where $x[n]$ is a discrete-time function.

(a) $\sum_{n=-\infty}^{\infty} x[n]\,\delta[n]$

(b) $\sum_{n=-\infty}^{\infty} x[n]\,\delta[n-k]$

(c) $\sum_{n=-\infty}^{\infty} x[n]\,x[k]\,\delta[n-k]$

Problem 3 *Working with integrals and sums.*
Evaluate the following expressions.

(a) $\sum_{k=0}^{\infty} a^k$ where $|a| < 1$.

(b) $\sum_{k=0}^{N-1} a^k$

(c) $\sum_{k=0}^{N-1} e^{j2\pi k/N}$

(d) $\int_{-\infty}^{\infty}(t-\tau)u(t-\tau)u(\tau)\,d\tau$

Problem 4

Consider a CT system with input $x(t)$ and output $y(t)$. For each of the following systems, i) prove that it is linear or give a counter example. ii) prove that it is time-invariant or give a counter example.

(a) $y(t) = \cos(t)x(t)$

(b) $y(t) = x(\cos(t))$

(c) $y(t) = \cos(x(t))$

(d) $y(t) = \frac{dx(t)}{dt}$

(e) $y(t) = \int_0^t x(\tau)d\tau$

Problem 5

Consider a CT system with input $x(t)$ and output $y(t)$. For each of the following systems, i) determine whether it is causal or noncausal, ii) determine if it is a memoryless or memory system.

(a) $y(t) = x(t)$

(b) $y(t) = x(t+1)$

(c) $y(t) = x(t-1)$

(d) $y(t) = x(0)$

(e) $y(t) = \int_0^t x(\tau)d\tau$

Problem 6 *DT System Properties.*

Consider a system with input $x[n]$ and output $y[n]$. For each of the following systems, i) prove that it is linear or give a counter example, ii) prove that it is time-invariant or give a counter example.

(a) $y[n] = x[n] + 2$

(b) $y[n] = x[2n]$ (This operation is known as *decimation*.)

(c) $y[n] = x[n-1] + x[n]$

(d) $y[n] = (x[n-1])(x[n])$

Problem 7 *MATLAB plot.*

On a single graph (use the *hold* command), plot the real and imaginary components of the DT complex exponential function

$$x[n] = e^{-j2\pi n/3}$$

on the interval $-20 \leq n \leq 20$. Use the MATLAB *stem* command to do the plots, and use the *xlabel*, *ylabel*, *title*, and *legend* commands to fully annotate your plot. Turn in your plot together with a print out of your MATLAB script. Make sure all axes are labeled and the graphs are titled. **Sign your plot and Matlab code to indicate authorship.**