ENEE 322

Sections 0201 & 0202 Spring 2018

Homework #2

All plots should be done by hand, not by computer (a calculator, if needed, is OK).

1) Consider the continuous signals $x(s) = \max\left(\sin(2\pi s), 0\right)$ and $y(s) = \min\left(\sin(2\pi s), 0\right)$

where $\max(a,b) = \begin{cases} a & a \geq b \\ b & a < b \end{cases}$ and $\min(a,b) = \begin{cases} b & a \geq b \\ a & a < b \end{cases}$.

a) Is $x(s)$ periodic? If so, compute the fundamental period.

b) Is $y(s)$ periodic? If so, compute the fundamental period.

c) Consider the signal $\left(x(s) - y(s)\right)$. Is it periodic? If so, compute the fundamental period, and reconcile your answer with the answers to (a) and (b).

2) Consider the discrete signals $x[n] = \begin{cases} 0 \text{ for } n \text{ even} \\ 1 \text{ for } n \text{ odd} \end{cases}$ and $y[n] = \sin(n)$.

a) Is $x[n]$ periodic? If so, compute the fundamental period.

b) Is $y[n]$ periodic? If so, compute the fundamental period.

3) For each of the following continuous signals $x(t)$, compute, $\text{Ev}\{x(t)\}$ i.e. the even part of $x(t)$, and $\text{Od}\{x(t)\}$, i.e. the odd part of $x(t)$.

a) $x(t) = C\,\text{e}^{j\omega_o t}$, where $C = \text{e}^{j\frac{\pi}{2}}$.

b) $x(t) = \dfrac{1}{1+2t}$.

c) $x(t) = 2$.

4) Consider the continuous signal $x(t) = C\,\text{e}^{j\omega_o t}$

a) For $C = \dfrac{1+j}{\sqrt{2}} = \text{e}^{+j\frac{\pi}{4}}$, $\omega_o = \frac{4}{3}\pi$, on separate graphs, plot $\text{Re}\left(x(t)\right)$ and $\text{Im}\left(x(t)\right)$ in the range [–3, +3], and compute the fundamental period of $x(t)$.

b) For $C = 1.5\,\text{Volts}$, $\omega_o = 2\pi f_0$, $f_0 = 2\,\text{kHz}$, on separate graphs, plot $\text{Re}\left(x(t)\right)$ and $\text{Im}\left(x(t)\right)$ in the range [–1 ms, +1 ms], and compute the fundamental period of $x(t)$ (with the correct units).

5) Consider the continuous signal $x(t) = C\,\text{e}^{\alpha t}$, where $C = \sqrt{2}\left(1+j\right) = 2\,\text{e}^{+j\frac{\pi}{4}}$, $\alpha = 1 + 2\pi j$.

a) Plot $|x(t)|$ and $-|x(t)|$ and $\text{Re}\left(x(t)\right)$, on the same graph, in the range [–2, +2] .

b) Plot $|x(t)|$ and $-|x(t)|$ and $\mathrm{Im}(x(t))$, on the same graph, in the range [–2, +2] .

6) Consider the discrete signal: $x[n] = C\alpha^n$.

a) Plot $x[n]$ in the range [–2, +2], for $C = 3$, $\alpha = 2$.

b) Plot $x[n]$ in the range [–2, +2], for $C = 3$, $\alpha = 2^{-1}$.

c) Plot $x[n]$ in the range [–2, +2], for $C = 3$, $\alpha = -2$.

d) Plot $x[n]$ in the range [–2, +2], for $C = -3$, $\alpha = 2$.

7) Consider a discrete signal $x[n] = Ce^{j\omega_0 n}$ which is periodic with $N = 6$.

a) List the allowed values of ω_0 in the range $[0, 2\pi]$.

b) List the allowed values of ω_0 in the range $[-\pi, +\pi]$.

8) Consider the following systems, where $x \rightarrow [\text{System}] \rightarrow y$

a) $y(t) = \cosh(x(t)) = \frac{1}{2}\left(e^{x(t)} + e^{-x(t)}\right)$

b) $y[n] = \mathrm{Run}_{-\infty}(x[n]) = \sum_{n'=-\infty}^{n} x[n']$

c) $y[n] = \left| x[n+1] - x[n] \right|$

d) $\frac{d}{dt}y(t) + \omega y(t) = \omega^2 t x(t)$

i) Which of the systems (a-c) are instantaneous/ultralocal/memoryless?

ii) Which of the systems (a-d) are invertible?

iii) Which of the systems (a-c) are causal?

iv) In a few words and/or equations, explain why system (a) is or isn't instantaneous/ultralocal/memoryless

v) In a few words and/or equations, explain why system (b) is or isn't instantaneous/ultralocal/memoryless

~~vi) In a few words and/or equations, explain why system (a) is or isn't instantaneous/ultralocal/memoryless~~

~~vii) In a few words and/or equations, explain why system (b) is or isn't instantaneous/ultralocal/memoryless~~

viii) In a few words and/or equations, explain why system (a) is or isn't invertible

ix) In a few words and/or equations, explain why system (b) is or isn't invertible

x) In a few words and/or equations, explain why system (c) is or isn't invertible

xi) In a few words and/or equations, explain why system (d) is or isn't invertible

xii) In a few words and/or equations, explain why system (b) is or isn't causal

xiii) In a few words and/or equations, explain why system (c) is or isn't causal