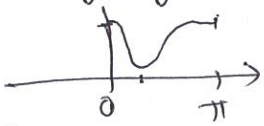
Tutorial sheet 6, EE 210 Signals & Systems, 30th Oct 2019.

Q-1 Convolve $(\frac{1}{2})^n u[n]$ and $3^{n-1} u[n+2]$. Relate this with series interconnection of systems.

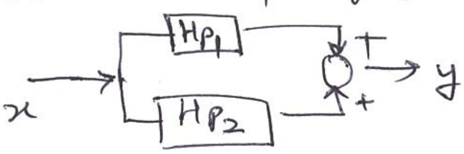
Q-2 We need ~~a~~ causal LTI system to have desired $H_d(z)$ to
- low attenuation at frequency $\frac{\pi}{4}$ rad/sample
- high gain at frequency (high) and (low)

Roughly



(a) Find $H_d(z)$

(b) $H_d(z)$ is to be obtained by designing $H_{p_2}(z)$ with $H_{p_1}(z)$ as shown



$x \xrightarrow{H_d(z)} y.$

and $H_{p_1}(z)$ has impulse response $(\frac{1}{2})^n u[n+3]$

Find $H_{p_2}(z)$

(c) Is H_{p_2} causal? why not/yes? Design causal H_{p_2} (if not causal)

Q-3: Describe time complexity of
(a) convolution of two finite duration discrete time signals, each of length N.
(b) product of two polynomials (each degree N)
(c) N-point DFT of periodic signal $x[n]$
(d) FFT implementation of N-point DFT (assume $N = 2^P$)
(e) FFT implementation for (b) above.

Q-4: A system is called "Finite Impulse Response" (FIR) if its impulse is zero outside a finite interval.
(a) Show that $H(z)$ filter is FIR iff poles (if any) of $H(z)$ are at $z = 0$.
(b) Check that series/parallel interconnection of LTI FIR systems yields FIR again

(c) Find ROC of FIR filters.
(non-causal included).

Q-5 Consider a region $R_1 \subset \mathbb{C}$ and consider set of all systems with $H(z)$ having ROC $= R_1$ (or ROC $\subseteq R_1$) ?

Show that this set is closed under following operations

(a) scaling by constants ($cH(z)$, $c \in \mathbb{R}$)

(b) addition (parallel interconnection)

(c) multiplication (series interconnection)

What about inverse ?
(Is the set closed under inverse operation?)

Q-6 (a) Relate ROC with stability of LTI system

$$\Leftrightarrow \sum_{n=-\infty}^{\infty} |h[n]| < \infty$$

(b) Relate ROC with stability of LTI causal system.

(pole location)
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