Indian Institute of Technology Bombay
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Question 1) Consider a discrete-time system with the impulse response $h[n], n \in \mathbb{Z}$. It is given that $\sum_{n \in \mathbb{Z}} |h[n]| < \infty$. Explain whether the system is BIBO stable.

Question 2) Consider the system $h[n] = \text{sinc}(2n), n \in \mathbb{Z}$. Is this system BIBO stable?

Question 3) Consider the input-output relation given by

$$y[n] - 1.3y[n-1] + 1.04y[n-2] - 0.222y[n-3] = x[n-1] - 1.2x[n-2] + x[n-3].$$

Find the transfer function in the $z-$ domain and argue whether the system is stable or not.

Question 4) Determine the $Z-$transform and the corresponding region of convergence (ROC) for the following sequences.
(a) $x[n] = (0.8)^n u[n+1]$.
(b) $x[n] = (0.9)^n u[n-2] + (0.95)^n u[-n-1]$.
(c) $x[n] = (0.9)^n u[n+2] + (0.95)^n u[-n-1]$.
(d) $x[n] = n^2 (0.8)^n u[n]$.
(e) $x[n] = \frac{1}{2}(n+1)(n+2)(0.9)^n u[n]$.

Question 5) Which discrete time sequence will have an $Z-$ transform given by

$$H(z) = \frac{1}{1 - 2r \cos\theta z^{-1} + r^2 z^{-2}} , \ |z| > r > 0, \ r < 1.$$

Question 6) Consider a low pass filter with the following specifications.

$$\text{pass band} : 0 \le |f| \le 0.125 , \ 0.8 \le |H(f)| \le 1 \quad \text{stop band} : 0.375 \le |f| \le \frac{1}{2}, \ |H(f)| \le 0.2. \quad (1)$$

(a) Design an IIR filter with the above specifications.
(b) Use GNURadio to plot its magnitude and phase response (draw the observed plots in the paper).