Assignment - 2

Yash Rajput
BM20BTECH11018

Abstract—This document contains the solution to Exercise 2.23 (a) of Oppenheim.

Problem 1. Using the definition of linearity, show that the moving average system is linear.
Solution: The ideal delay system:

$$y[n] = T\{x[n]\} = x[n - k] \qquad (1)$$

Using the definition of linearity:

$$T\{ax_1[n] + bx_2[n]\} = ax_1[n - k] + bx_2[n - k] \qquad (2)$$
$$= ay_1[n] + by_2[n] \qquad (3)$$

So, the ideal delay system is LINEAR.
The moving average system is given by

$$y[n] = Tx[n] = \frac{1}{M_1 + M_2 + 1} \sum_{k=-M_1}^{M_2} x[n - k] \qquad (4)$$

by linearity:

$$T\{ax_1[n] + bx_2[n]\} = \frac{1}{M_1 + M_2 + 1} \sum_{k=-M_1}^{M_2} (ax_1[n] + bx_2[n]) \qquad (5)$$

$$= \frac{1}{M_1 + M_2 + 1} \sum_{k=-M_1}^{M_2} ax_1[n] + \frac{1}{M_1 + M_2 + 1} \sum_{k=-M_1}^{M_2} bx_2[n] \qquad (6)$$

$$= ay_1[n] + by_2[n] \qquad (7)$$

Conclude, the moving average system is linear.