



AL- MUSTAQBAL UNIVERSITY COLLEGE
DEPARTMENT OF BIOMEDICAL ENGINEERING

Signals and Systems for BME

BME 322

Lecture 6

- Infinite Impulse Response (IIR) Filters -

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Infinite Impulse Response (IIR) Filters



- IIR filters are recursive filters.
- Difference equation for IIR filters

$$y[n] = - \sum_{K=1}^N a_k y[n - k] + \sum_{K=0}^M b_k x[n - k]$$

a_k and b_k are the filter coefficients

Infinite Impulse Response (IIR) Filters



- IIR filters outputs depends on N past outputs and M past inputs.
- The impulse response samples getting smaller and smaller but they never settle to zero.



Determine the first three samples in the impulse response for the IIR filter.

$$y[n] - 0.2 y[n-1] = x[n] + x[n-1]$$

Sol:

Substituting $\delta[n]$ for $x[n]$ and $h[n]$ for $y[n]$.

$$h[n] - 0.2 h[n-1] = \delta[n] + \delta[n-1]$$

$$h[n] = 0.2 h[n-1] + \delta[n] + \delta[n-1]$$

Examples



$$h[0] = 0.2 h [0 - 1] + \delta [0] + \delta [0 - 1]$$

$$h[0] = 0.2 h [- 1] + \delta [0] + \delta [- 1]$$

$$= 0.0 + 1.0 + 0.0 = 1.0$$

$$h[1] = 0.2 h [1 - 1] + \delta [1] + \delta [1 - 1]$$

$$= 0.2 (1) + 0.0 + 1.0 = 1.2$$

Examples



$$h[2] = 0.2 h [2 - 1] + \delta [2] + \delta [2 - 1]$$

$$= 0.2 (1.2) + 0.0 + 0.0 = 0.24$$

$$h[3] = 0.2 h [3 - 1] + \delta [3] + \delta [3 - 1]$$

$$= 0.2 (0.24) + 0.0 + 0.0 = 0.048$$



Determine the first four samples in the impulse response for the IIR filter.

$$y[n] - 0.4 y[n-1] = x[n] - x[n-1]$$

Sol:

Substituting $\delta[n]$ for $x[n]$ and $h[n]$ for $y[n]$.

$$h[n] - 0.4 h[n-1] = \delta[n] - \delta[n-1]$$

$$h[n] = 0.4 h[n-1] + \delta[n] - \delta[n-1]$$

Examples



$$h [0] = 0.4h [-1] + \delta [0] - \delta [n - 1]$$

$$= 0.4 (0.0) + 1.0 - 0.0 = 1.0$$

$$h [1] = 0.4h [0] + \delta [1] - \delta [0]$$

$$= 0.4 (1.0) + 0.0 - 1.0 = -0.6$$

$$h [2] = 0.4h [1] + \delta [2] - \delta [1]$$

$$= 0.4 (-0.6) + 0.0 - 0.0 = -0.24$$

Examples



$$\begin{aligned}h[3] &= 0.4h[2] + \delta[3] - \delta[2] \\ &= 0.4(-0.24) + 0.0 - 0.0 = -0.096\end{aligned}$$

$$\begin{aligned}h[4] &= 0.4h[3] + \delta[4] - \delta[3] \\ &= 0.4(-0.96) + 0.0 - 0.0 = -0.0384\end{aligned}$$

$$\begin{aligned}h[5] &= 0.4h[4] + \delta[5] - \delta[4] \\ &= 0.4(-0.0384) + 0.0 - 0.0 = -0.01536\end{aligned}$$

