

CLTI Differential Equation

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Causal LTI Systems

$$a_N \frac{d^N y(t)}{dt^N} + a_{N-1} \frac{d^{N-1} y(t)}{dt^{N-1}} + \dots + a_1 \frac{dy(t)}{dt} + a_0 y(t) = b_M \frac{d^M x(t)}{dt^M} + b_{M-1} \frac{d^{M-1} x(t)}{dt^{M-1}} + \dots + b_1 \frac{dx(t)}{dt} + b_0 x(t)$$

$$\frac{d^N y(t)}{dt^N} + a_1 \frac{d^{N-1} y(t)}{dt^{N-1}} + \dots + a_{N-1} \frac{dy(t)}{dt} + a_N y(t) = b_{N-M} \frac{d^M x(t)}{dt^M} + b_{N-M+1} \frac{d^{M-1} x(t)}{dt^{M-1}} + \dots + b_{N-1} \frac{dx(t)}{dt} + b_N x(t)$$

$$(D^N + a_1 D^{N-1} + \dots + a_{N-1} D + a_N) y(t) = (D^M + b_{N-M+1} D^{M-1} + \dots + b_{N-1} D + b_N) x(t)$$

$$Q(D)y(t) = P(D)x(t)$$

- Zero Input Response
- Zero State Response (Convolution with $h(t)$)
- Natural Response (Homogeneous Solution)
- Forced Response (Particular Solution)

References

- [1] <http://en.wikipedia.org/>
- [2] J.H. McClellan, et al., Signal Processing First, Pearson Prentice Hall, 2003
- [3] B.P. Lathi, Linear Systems and Signals (2nd Ed)