Halil Temurtaş
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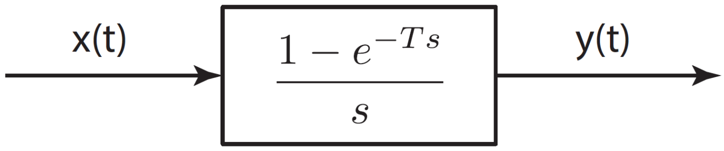
EE402 Discrete Time Control Systems
Mini-Project 1

1. For each of the following systems with input u and output y, t ≥ 0, determine whether the system is memoryless, linear, time-invariant, causal, finite-dimensional ?

   (a) $y(t) = (sin(t))^3$
   (b) $y(t) = \int_0^t \tau u(\tau) d\tau$
   (c) $y(t) = 2u(t) + 10$
   (d) $y(t) = cos(t)u(t)$
   (e) $y(t) = u(t - T)$
   (f) $y(t) = u[k - n]$
   (g)



2. Review of the basic properties of the convolution operation, denoted by *, as well as those of the Laplace transform, denoted by $\mathcal{L}$. Consider $f : \mathbb{R} \to \mathbb{R}$, and $g : \mathbb{R} \to \mathbb{R}$, and $h : \mathbb{R} \to \mathbb{R}$.

   (a) * is associative, that is, $(f * g) * h = f * (g * h)$
   (b) $f(t - \tau) = f(t) * \delta(t - \tau), \tau \geq 0$, sifting property of the dirac delta function $\delta(t)$
   (c) $\mathcal{L}(f * g) = \mathcal{L}(f)\mathcal{L}(g)$
   (d) $\mathcal{L}(f + g) = \mathcal{L}(f) + \mathcal{L}(g)$

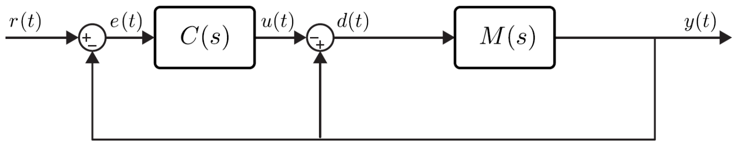
3. Finding $Y(s) = U(s)$ for the following system

$$y(t) = \int_{t_T}^{t} h(t - \tau) u(\tau) d\tau$$

$$h(t) = \begin{cases} t \quad if \quad t > 10 \\ 0 \quad if \quad t \leq 0 \end{cases}$$

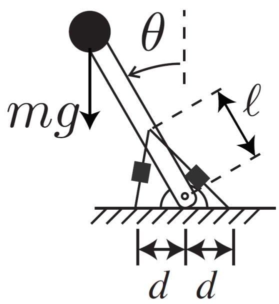
4. Analysis of the the control system that is illustrated with the block diagram topology given below. Let's assume that $M(s) = \frac{1}{s-a}, a > 0$ and $C(s) = \frac{K}{s+1}$.

   Finding the range of K such that the closed-loop system is stable.



5. Inverted pendulum of length L, with mass m, that is actuated by an agonist/antagonist linear actuator pair that attach a distance l from the joint / pivot point. One can show

$$h(t) = \begin{cases} t \;\; if \;\; t > 10 \\ 0 \;\; if \;\; t \leq 0 \end{cases}$$



Appendix

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