GEORGIA INSTITUTE OF TECHNOLOGY
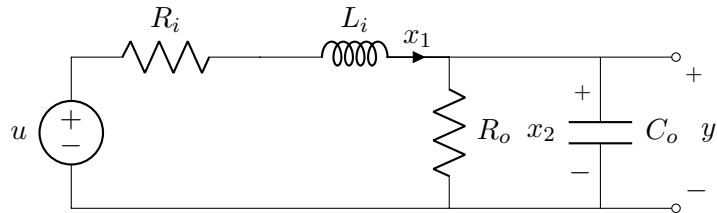SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 4550 — Control System Design — Summer 2020

Problem Set #2: Dynamic System Response

The objective of this problem set is to reinforce lecture material relating to various methods for evaluating the response of physical systems. Submit your solution online by 5/26.

1. Consider the electric circuit shown below
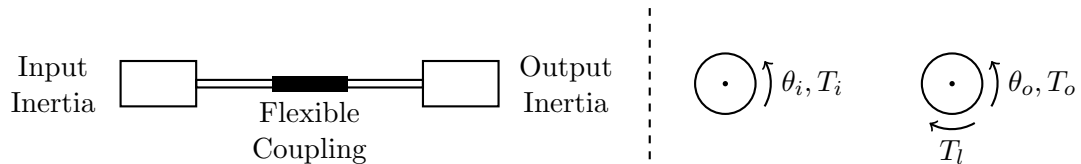

and its corresponding state-space model

$$\dot{x}(t) = \begin{bmatrix} -1 & -1 \\ 1 & -1 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 0 & 1 \end{bmatrix} x(t).$$

Use the Laplace transform method to find $y(t)$ for $t \geq 0$, given

$$x(0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad u(t) = 1, \quad t \geq 0.$$

2. Consider the mechanical system shown below

and its corresponding state-space model

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 & 0 & 0 \\ -1 & -1 & 1 & 1 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & -1 & -1 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 0 & 0 & 1 & 0 \end{bmatrix} x(t)$$

as developed in posted class notes. Use numerical integration (forward Euler method with time increment $h = 0.01$) to approximate $y(t)$ over time interval $0 \leq t \leq 10$, given

$$x(0) = \begin{bmatrix} 1 \\ 0 \\ 1 \\ 0 \end{bmatrix}, \quad u(t) = \begin{cases} \sin(\pi t) & , \ 0 \leq t < 2 \\ 0 & , \ t \geq 2. \end{cases}$$

Implement the iteration using a `for` loop in Matlab and use `subplot` to display the approximated response of $y(t)$ in the top plot and the specified excitation $u(t)$ in the bottom plot. Submit a source code listing and the pair of labeled plots.