Homework # 01
Power Systems Analysis II
EE 457 – Iowa State University

Instructor: Prof. Hugo N. Villegas Pico

Due date: January 28, 2020

The objective of this assignment is to familiarize with modeling and simulation of electromechanical systems. Also, this homework is instrumental to apply good coding practices. Please, use the *publish* functionality of MATLAB to hand in any code related work. No screen captures of MATLAB code will be accepted. Code is expected to be commented as instructed in the classroom to earn credit.

Warning: This homework is to be individually completed; no collaboration is permitted. Cheating will not be tolerated and reported to the Dean of Students Office.

Problem 1 (25 pts) Derive from scratch using paper and pencil (or a pen) the dynamic model of the electromagnet of Fig. 1, i.e., repeat the derivations we did in the class. Recall that the dynamic model must be expressed as an ordinary differential equation.

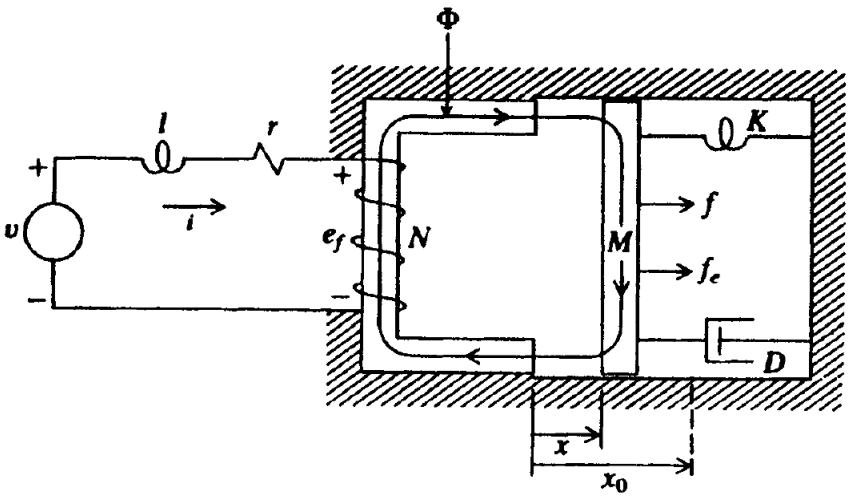

Figure 1: Elementary Electromagnet

Problem 2 (50 pts) Study the dynamic performance of the electromagnet model you derived in problem 1 for $t \in [0, 0.5]\,\text{s}$. Consider that $M = 0.055\,\text{kg}$, $r = 10\,\Omega$, $l = 0\,\text{H}$, $K = 2667\ \text{N/m}$, $k = 6.283 \times 10^{-5}\,\text{H·m}$, $D = 4\,\text{N·s/m}$. Assume the system is at rest at $t = 0^-$, hence $x(0) = x_0 = 3\,\text{mm}$, $v_x(0) = 0$, and $i(0) = 0$. The disturbance to the system is a step change in the source voltage at $t = 0.2\,\text{s}$ from $v(0 \leq t < 0.2) = 0\,\text{V}$ to $v(t \geq 0.2) = 5\,\text{V}$. The force component $f(t \geq 0) = 0\,\text{N}$. To earn credit, please, plot traces of x vs. t, v_x vs. t, λ vs. t, e_f vs. t, and f_e vs. t. Comment on the figures.

Problem 3 (25 pts) Repeat problem 2 but this time consider that the force component $f(0 \leq t < 0.25) = 0\,\text{N}$ and $f(0.25 \leq t \leq 0.5) = 4\,\text{N}$ as well as that $v(0 \leq t \leq 0.5) = 5\sin(120\pi t)\,\text{V}$. Comment on the figures.