# ECE 330 HW 7

IMPORTANT:

Please treat HW7 as a homework assignment and please upload your solution by 1st April, 10 am to Gradescope. We expect and trust that you will continue of show your academic integrity. It is okay to discuss with fellow students, but you have to submit your own solution. Please continue to use Piazza to ask questions but do not post solutions/answers on Piazza.
Stay Safe!

## Problem 1
An electromechanical system has two electrical and one mechanical ports. The $\lambda - \theta$ relations are:

$$\begin{bmatrix} \lambda_1 \\ \lambda_2 \end{bmatrix} = \begin{bmatrix} (5 + cos(2\theta)) * 10^3 & 0.1cos(\theta) \\ 0.1cos(\theta) & 50 + 10cos(2\theta) \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$$

(a) Determine the expression for terminal voltages at both terminals.
(b) Find the torque of electrical origin.
(c) Evaluate the torque at $i_1 = 1A$ and $i_2 = 0.01A$.
(d) Find the maximum torque possible and the angle at which it occurs.

## Problem 2
A Machine has the following $\lambda - \theta$ relation:

$$\lambda_{as} = (L_0 + L_1 cos(2\theta))i_{as} + Mcos(\theta)i_r$$
$$\lambda_{bs} = (L_0 - L_1 cos(2\theta))i_{bs} + Msin(\theta)i_r$$
$$\lambda_r = Mcos(\theta)i_{as} + Msin(\theta)i_{bs} + L_2 cos(4\theta)i_r$$

Find the terminal voltages for all terminals, co-energy and the torque of electrical origin.

## Problem 3
A two-electrical and one-mechanical rotational port system has the following $\lambda - i$ relations.

$$\lambda_1 = (L_0 + Mcos(2\theta))i_1 + Msin(2\theta)i_2$$
$$\lambda_2 = Msin(2\theta)i_1 + (L_0 - Mcos(2\theta))i_2$$

(a) Determine the expression for terminal voltages at both terminals.
(b) Determine the torque $T^e(i_1, i_2, \theta)$ of electric origin.
(c) If $i_1 = Icos(\omega_s t)$, $i_2 = Isin(\omega_s t)$, and the rotor has a constant angular velocity $\omega_m$ such that $\theta = \omega_m t + \delta$ (where $\delta$ = constant), evaluate the instantaneous torque.

## Problem 4
Suppose an electromechanical system with equation $\lambda = \frac{0.04i^2}{x - 0.01}$.
Find the voltage and force evaluated at $i = 2$ A and $x = 0.02$ m.