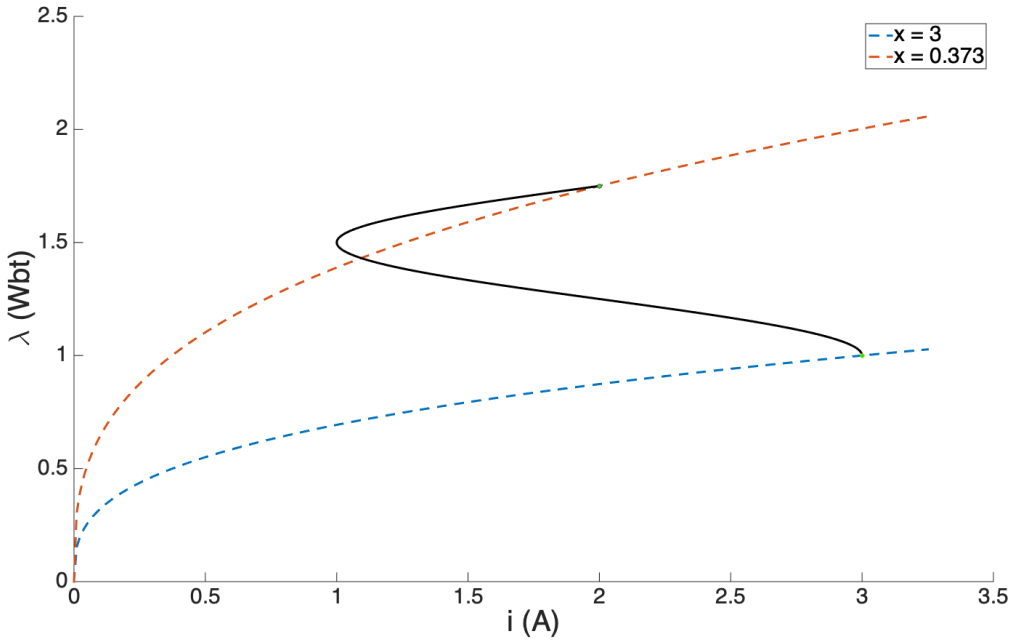
ECE 330 HW 9

IMPORTANT: Please treat HW9 as a homework assignment and please upload your solution by 10 A.M. on April 15$^{\text{th}}$ to Gradescope. We expect and trust that you will continue to show academic integrity. It is okay to discuss with fellow students, but you must submit your own solutions. Please continue to use Piazza to ask questions, but do not post solutions/answers on Piazza. Stay Safe!

Problem 1

Show graphically why the energy stored in the coupling field and the coenergy are equal for magnetically linear systems.

Problem 2



A system with nonlinear flux linkage given as

$$\lambda(i, x) = (i/x)^{1/3}$$

moves from point A ($i = 3$ A, $\lambda = 1$ Wbt) to point B ($i = 2$ A, $\lambda = 1.75$ Wbt) as shown in the figure above along a path parameterized as

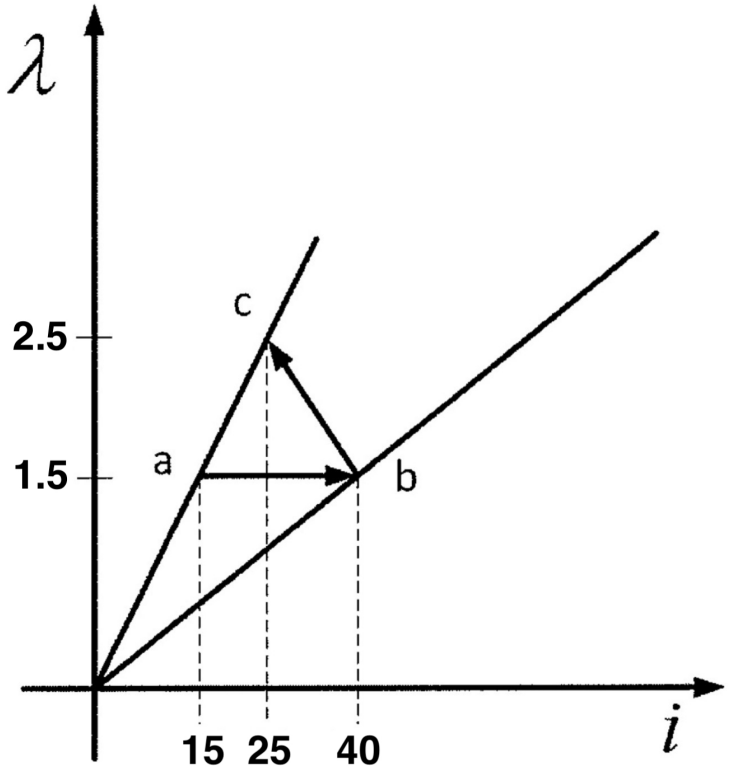
$$i(\lambda) = 2 + \cos(2\pi\lambda).$$

Lines of constant x are also shown. For this system, determine the following:

(a) The energy from the electrical (EFE) when going from point A to point B.
(b) The energy, W_m, at points A and B. (Hint: energy + co-energy = λi.)
(c) The energy from the mechanical (EFM) when going from point A to point B.

Problem 3

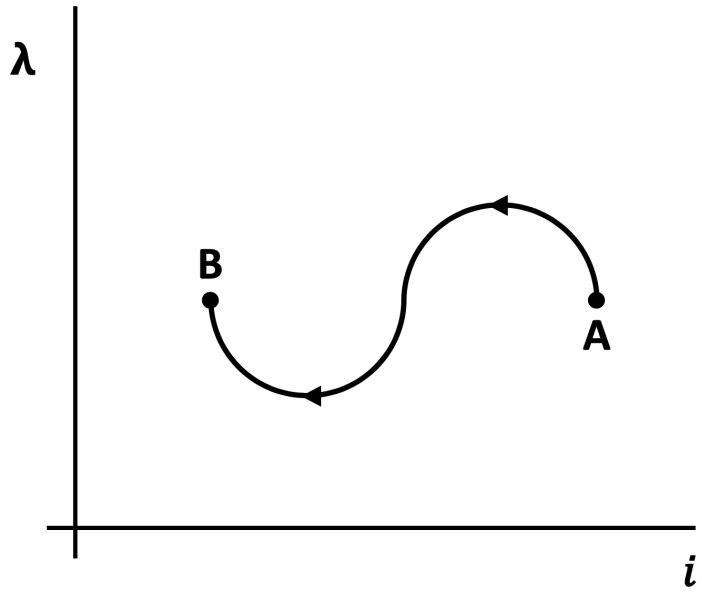
An electromechanical device with $\lambda = L(x)i$ is operated over the path $a \to b \to c$ shown in the figure below.



(a) Calculate the energy stored (in Joules) in the coupling field, W_m, at points a, b, and c.
(b) Calculate $\text{EFE}|_{a\to b\to c}$ in Joules.
(c) Calculate $\text{EFM}|_{a\to b\to c}$ in Joules.
(d) Suppose the system takes the path $a \to c$ directly. Is $\text{EFM}|_{a\to c} = \text{EFM}|_{a\to b\to c}$? Explain your answer. If $\text{EFM}|_{a\to c} \neq \text{EFM}|_{a\to b\to c}$, then state the value of $\text{EFM}|_{a\to c}$.

Problem 4

An electromechanical system with $\lambda = L(x)i$ is operated through the transition from point a to point b as shown below – note that the flux linkage at point a is equal to the flux linkage at point b.



Find the energy transferred from the electrical system into the coupling field as the sytem moves from point a to point b as shown (give a graphical answer).