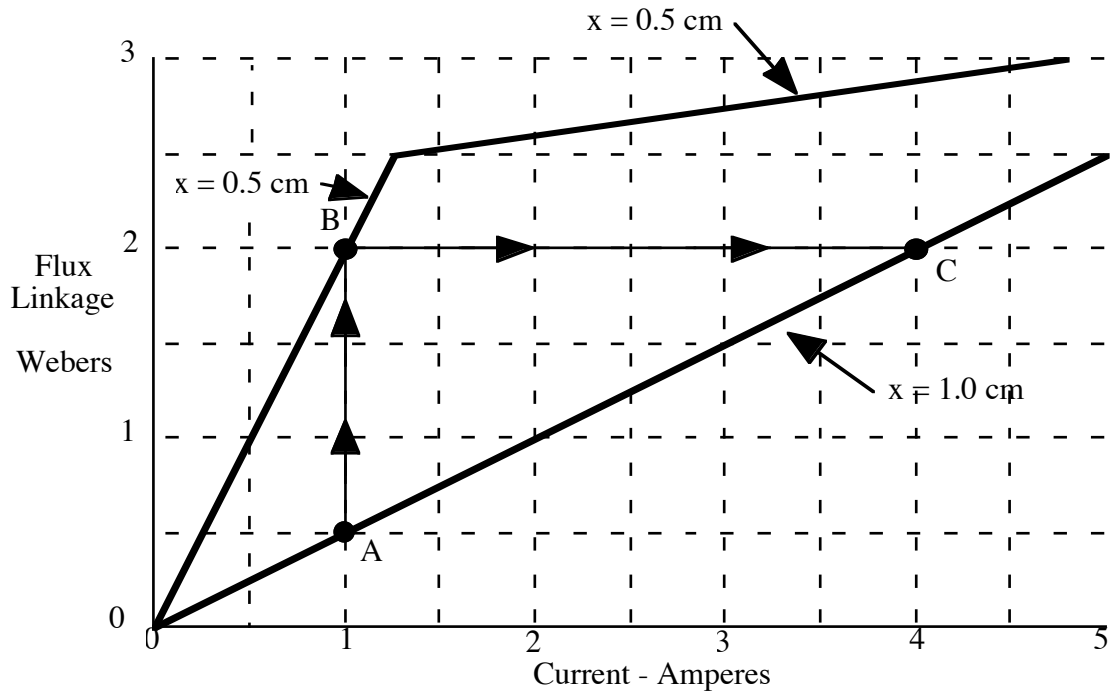


**Required Homework Problem 6**  
**Singly Excited Electromechanical Systems**



1) A singly excited electromechanical system has the two magnetization curves for  $x = 1.0$  cm and  $x = 0.5$  cm shown in the figure. Find the quantities requested below:

a) The field energy at points A, B and point C

$$W_A = \text{_____ j}$$

$$W_B = \text{_____ j}$$

$$W_C = \text{_____ j}$$

b) The electrical energy input and the mechanical energy output for a transition along a constant current curve from point A to point B as shown in the figure.

$$W_{\text{elec}} = \text{_____ j}$$

$$W_{\text{Mout}} = \text{_____ J}$$

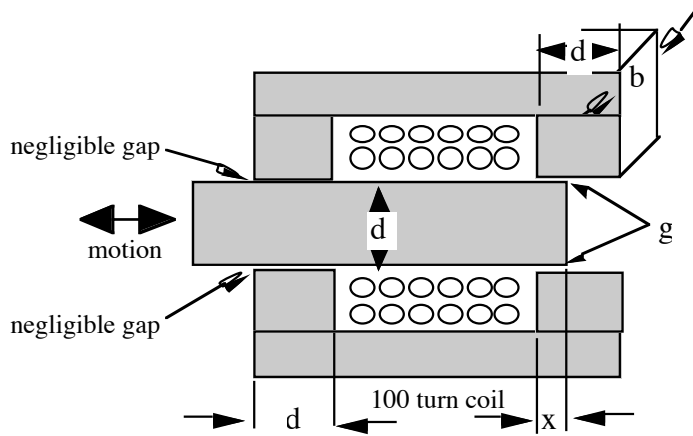
c) Repeat 'b' for the transition from B to C along the constant flux path as shown in the figure.

$$W_{\text{elec}} = \text{_____ j}$$

$$W_{\text{Mout}} = \text{_____ j}$$

ECE 355 - Electromechanical Energy Conversion

2) A singly excited magnetic device with a moving iron element in which the force density expression  $B^2/2\mu_0$  does not apply is illustrated in the figure below.



$$g = 0.10 \text{ mm}$$

$$d = 2.0 \text{ cm}$$

$$b = 3.0 \text{ cm}$$

Assume the mmf in the iron and the effects of fringing and leakage flux are negligible.

a) Find the coil current required to create  $B = 1.0 \text{ T}$  in the right hand gap when  $x = 1.0 \text{ cm}$

$$I = \text{_____ A}$$

b) Find the inductance of the device as a function of the overlap distance  $x$ .

$$L(x) = \text{_____ h}$$

c) Find the force as a function of the overlap distance  $x$  if the current is equal to  $1.0 \text{ A}$ .

$$f(x) = \text{_____ lbs}$$

d) Find peak current as a function of the overlap distance  $x$  if the excitation is  $16 \text{ volts peak}$  at  $60 \text{ hz}$ . Use this result to find the average force as a function of the overlap distance  $x$  with this excitation.

$$I_{pk}(x) = \text{_____ A}$$

$$f_{avg}(x) = \text{_____ lbs}$$