Magnetic Energy and Force

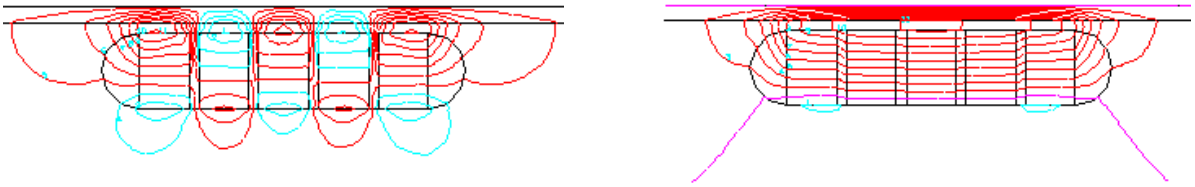
Reading assignment
Ulaby, 5-9
Connor and Salon, VIII-6 → VIII-12 and VIII-15 →VIII-20

Problem 1 - energy and inductance
The magnetic flux density in a coaxial cable is:

$$\mathbf{B} = \begin{cases} \mu_0 I r / 2\pi a^2 \, \mathbf{a}_\varphi & \text{for } 0 < r < a \\ \mu_0 I / 2\pi r \, \mathbf{a}_\varphi & \text{for } a < r < b \\ 0 & \text{for } b < r \end{cases}$$

a. Find the magnetic energy stored per unit length.
b. Determine the inductance per unit length of the cable.

Problem 2 - Force
The pictures below illustrate the flux lines of cow magnets.
a. First, examine the figures on the left. In this case, **M** alternately points in the left and right directions for the different sections. The force acting on the iron bar in the upper left figure is 23.8 Newtons. Estimate the difference in stored magnetic energy between the two figures on the left. Is the stored energy larger in the top or bottom figure?
b. The bar on the right has all **M** aligned. Is the force on the bar in the upper right figure greater or smaller than 23.8 Newtons?



For the top two figures, there is a gap of 4mm between the iron plate and the cow magnet.

For the bottom two figures, there is no gap between the iron plate and the cow magnet.

The iron plate is at the top. The cow magnets have 5 magnet regions separated by steel washers and they end in round steel caps.