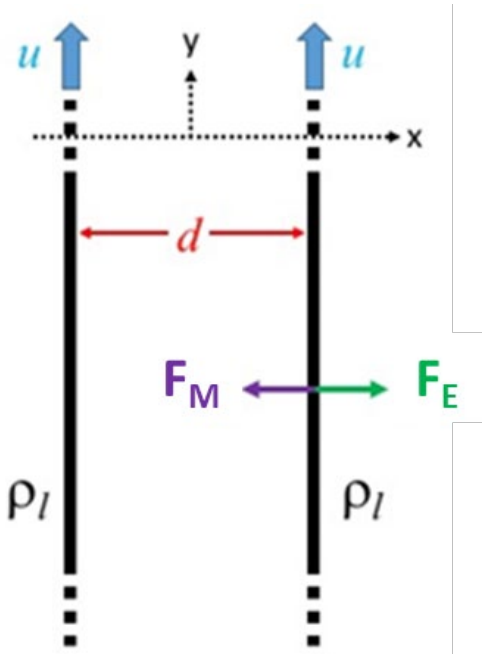
ELEN 3401 Electromagnetics
Problem Set #6

DUE: Friday April 4
Please include your name and UNI on the assignment

Problem 1: Lorentz Force

Consider two long straight conductors (wires consisting of magnetic material, with relative permeability of $\mu_r = 3$) with electric line charge densities ρ_l (Coulomb/m) as shown in the figure below. The conductors are a distance *d* apart and the line charges are moving at a constant speed *u* in the $+\hat{y}$ direction. Obtain the required speed, *u,* such that the magnetic attraction force ($\vec{F}_m$) and electric repulsion force ($\vec{F}_e$) on the two line charge densities are exactly in balance. (To solve for the required speed, begin by obtaining the electric field and magnetic field and their associated forces on each line charge.)



Problem 2: Ampere's Law

A coaxial system has a hollow inner conductive cylinder of inner radius a and outer radius b along with an outer conductor shell of radius c as shown in the figure below. The space outside the coaxial system, between the outer shell and the inner conductor, and inside the hollow conductor is filled with air (ϵ_0, μ_0) and the inner hollow conductor has magnetic permeability μ_1.

The outer conductor carries uniform surface current density $\vec{J}_S$ and the <u>total</u> current flowing in the outer conductor shell ($r = b$) is I and in the $-\hat{z}$ direction. The inner hollow cylinder ($a < r < b$) carries volume current density $\vec{J}$ and the <u>total</u> current flowing inside the inner cylinder is <u>uniform</u> current I in the $+\hat{z}$ direction. Find the magnetic field $\vec{H}$ in the four regions:

a. Region 1: $0 < r < a$
b. Region 2: $a \leq r \leq b$
c. Region 3: $b \leq r \leq c$
d. Region 4: $r > c$