9. SOLENOIDS (8 points) *(by S. Ainsaar).* A tightly-wound rigid solenoid coil has been partly inserted into another. They are connected to a constant current source so that the same current I flows through them; both generate a magnetic field in the same direction. The solenoids have N turns both, their length is l, their cross-sectional areas are A_1 and A_2. It may be assumed that $A_1, A_2 \ll l^2$. You may find it useful to know that the magnetic field at the centre of one solenoid taken separately is $B = \mu_0 IN/l$, where μ_0 is the permeability of vacuum.

i) *(2 points)* The centres of the coils are at a distance $x < l$ along their common axis $[A_1, A_2 \ll (x-l)^2, x^2]$. Find the total energy E_m of the magnetic field in the system.

ii) *(4 points)* Find the electromotive forces $\mathcal{E}_1$ and $\mathcal{E}_2$ generated on the coils when one is pulled out with a speed v.

iii) *(2 points)* Find the force F needed to pull one coil outwards.