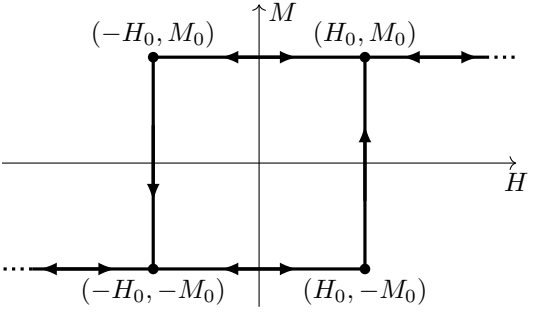
T2: Hysteresis (10 pts)

Consider a solenoid with $N \gg 1$ turns, radius R and length $\ell \gg R$. The solenoid has a ferromagnetic core with hysteresis curve as shown in the picture. M denotes the magnetization of the core and would be zero without core material. It is related to H, the magnetic field strength generated by the current in the solenoid coil, and B by $B = \mu_0 (H + M)$. M_0 and H_0 are of the same order of magnitude. Assume that M can only change if $|H| \geq H_0$.



An ideal capacitor with capacitance C is now connected to the solenoid forming a closed circuit. Assume that all wires have negligible resistance.

a) **(3.0 pts)** Initially there is a current I_i flowing through the circuit and the capacitor is uncharged. I_i is large enough that $H(I_\mathrm{i}) \gg H_0$. After one oscillation the current again reaches a maximum value. Determine the difference between I_i and this value.

b) **(2.3 pts)** Find the maximum current that can be attained after many oscillations.

c) **(4.7 pts)** The current $I(t)$ exhibits two qualitatively distinct phases of behaviour, A and B. The system can remain in phase A indefinitely, whereas any single interval spent in phase B has bounded duration. Find the maximal possible duration of a phase-B interval, if I_i is chosen optimally.