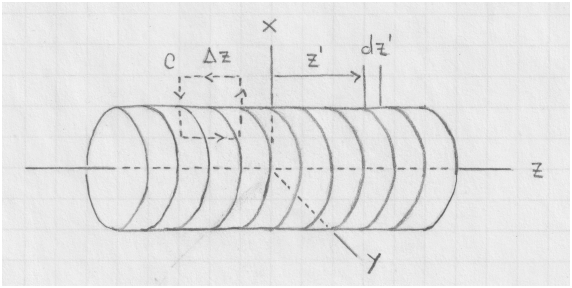
[lex65] Magnetic field along the axis of a solenoid

Consider a solenoid of cross-sectional radius R and length L. The winding of the current-carrying wire has n turns per unit length. The solenoid is placed along the z-axis with its center at $z = 0$.
(a) Use the result of [lex59] for the magnetic field of a current-carrying ring to set up a differential for the magnetic field dB_z generated by slice of solenoid of length dz containing ndz turns that are near circular.
(b) Integrate this differential to produce an analytic expression for the function $B_z(z)$ representing the magnetic field along the axis of the solenoid.
(c) Plot B_z versus z over the range $-(R + L) < z < +(R + L)$ for solenoids with different values of R/L.
(d) Show that in the limit $L/R \to \infty$ the expression $B_z(z)$ becomes independent of z and show how that expression can be reproduced by invoking Ampère's law (e.g. for the rectangular loop shown dashed).



Solution: