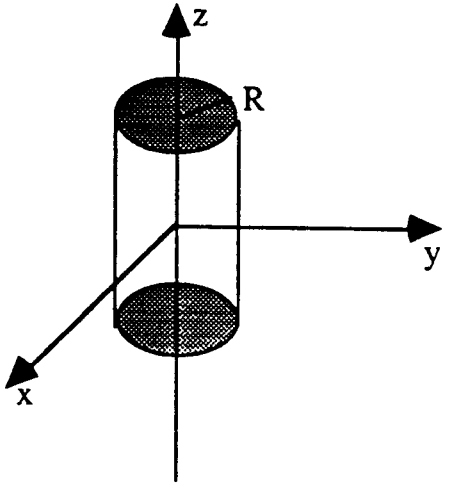
EMSpring95A

1. A very long nonconducting cylinder of radius R is wound with N turns per centimeter of wire carrying current I, which flows in a counter-clockwise (as seen from the top, i.e., from the z>0) direction. The cylinder is then charged with a uniform density ρ (charge/volume). You may assume the radius of the cylinder to be so much smaller than its length that the resulting magnetic field inside the cylinder is uniform.



a)

(i) What is the magnitude of the Poynting vector at a perpendicular distance r ($r < R$) from the axis of the cylinder? Express your answer in terms of r, R, ρ, N, I and constants, as needed.

(ii) What is the direction of the Poynting vector at (x,y) = (0,r)?

b) What is the angular momentum (per unit length) of the electromagnetic field about the axis of the cylinder?

c) The current is now turned off at a constant rate dI/dt, inducing an electric field which exerts a torque on the cylinder. Calculate the z-component of the torque τ_z in terms of dI/dt and the parameters given in the problem.

d) Use your result from part (c) to calculate the total change in the angular momentum (per unit length) of the cylinder. Comment briefly on the comparison of your result to your answer in part (b).