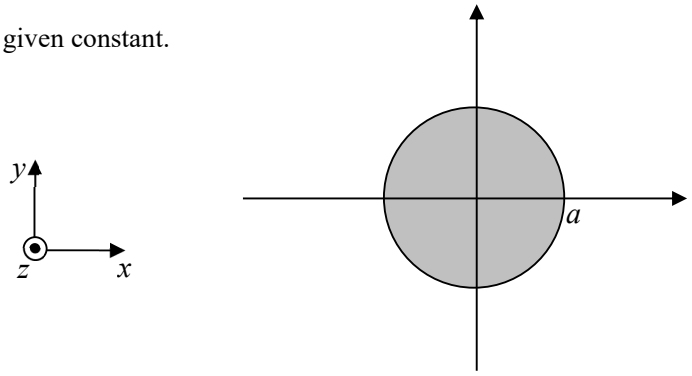
City University of Hong Kong
Electrical Engineering
EE2104 Introduction to Electromagnetics
Tutorial 09

The figure below shows a wire with a circular cross-section of radius *a.* The wire carries a current density towards the +z-direction with magnitude

$$J = J_0 \frac{\rho}{a}$$

where J_0 (A/m^2) is a given constant.



(a) Sketch the current density on the *xy*-plane. Present the variation of the current density by using streamlines.

(b) At $P(x, y) = (2a, 0)$, what is the direction of the magnetic field? Provide a reasoning based on the results for an infinitely long current.

(c) Does B depend on ρ, ϕ, or z? Simplify $\boldsymbol{B}(\rho, \phi, z)$ by symmetry arguments.

(d) Find the magnetic flux density $\boldsymbol{B}$ as a function of the radial distance ρ for $0 < \rho < \infty$.

(e) Sketch the magnitude $|\boldsymbol{B}|$ versus ρ for $0 < \rho < \infty$. What is the value of the maximum $|\boldsymbol{B}|$?

(f) By directly applying the curl-operation, find $\nabla \times \boldsymbol{B}$.