Lab 2

Method of images in magnetostatics

Matlab assignment

- Derive an images solution for an infinite (unit) line current situated (a unit distance) above and parallel to a hyper-ferromagnetic infinite plane bounding an infinite hyper-ferromagnetic half space.
- Write a program to simulate the magnetic flux lines (directional curves) in this configuration (projected to a plane orthogonal to the current).
- Your solution should include sample *Matlab* code and 2-dimensional plots of the field lines generated therefrom.

Hint: consider the analogy with the electric case.

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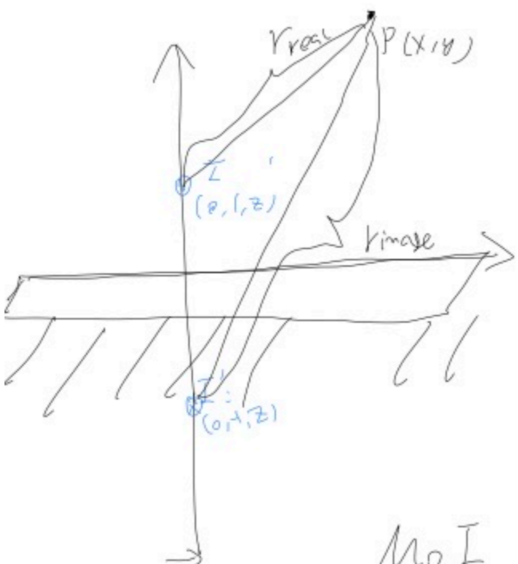

Assume the wire position I: (0,1,z) (parallel with XY-plane)

Current I: [0,0,I]

image wire position [0,-1,z] current [0,0,-I]

Test point P: [x,y,z]

$$\because \oint_L \vec{B} \cdot \vec{dL} = \mu_0 \sum I$$

(Ampere's law)

$$\therefore \vec{B} \cdot 2\pi r = \mu_0 I$$

$$\therefore \vec{B}_{up}(r) = \frac{\mu_0 I}{2\pi r} \qquad \vec{B}_{down} = -\frac{\mu_0 I}{2\pi r}$$

$$\because r_{real} = \sqrt{(x-0)^2 + (y-1)^2} \ ; \ r_{image} = \sqrt{(x-0)^2 + (y+1)^2}$$

$$\therefore r = \sqrt{x^2 + (y-1)^2} \ ; \ r = \sqrt{x^2 + (y+1)^2}$$

$$\therefore \vec{B} = \vec{B}_{real} + \vec{B}_{image} = \frac{\mu_0 I \times [x, y-1, 0]}{2\pi \left(\sqrt{x^2+(y-1)^2}\right)^2} - \frac{\mu_0 I \times [x, y+1, 0]}{2\pi \left(\sqrt{x^2+(y+1)^2}\right)^2}$$

$$= \frac{\mu_0 I}{2\pi} \left(\frac{2}{2x^2 + (y+1)^2 + (y-1)^2} \right) a_x$$

$$+ \frac{\mu_0 I}{2\pi} \left(\frac{2x}{2x^2 + (y-1)^2 + (y+1)^2} \right) a_y$$

(for $y > 0$)