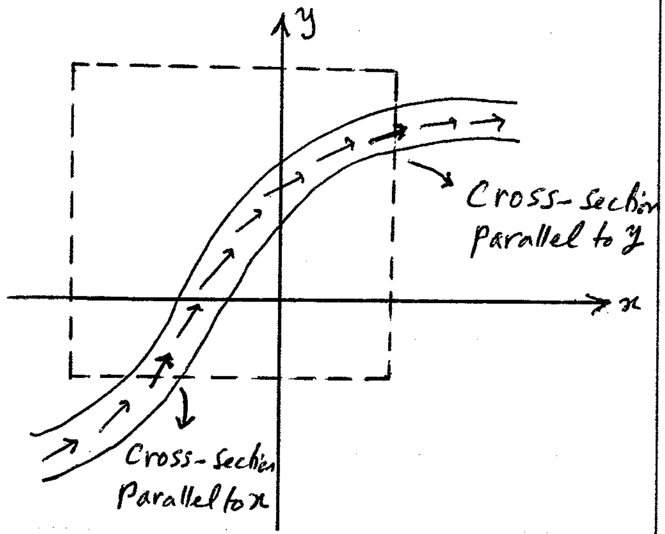
Problem 4)

Draw an arbitrary box in the xy-plane, so that it cuts the current-carrying strip at two different cross-sections. Then, from Gauss's theorem, we'll have:



$$\underset{\text{Cross-section 1}}{\int \vec{J}_s(x,y)\cdot d\vec{\ell}} + \underset{\text{Cross-section 2}}{\int \vec{J}_s(x,y)\cdot d\vec{\ell}} = 0$$

In both cases $d\vec{\ell}$ is $\perp$ to the cross-section and points <u>out</u> of the box. At the cross-section where the current flows into the box, reverse the sign of $d\vec{\ell}$. You'll have:

$$\underset{\text{Cross-section 1}}{\int \vec{J}_s(x,y)\cdot d\vec{\ell}} = \underset{\text{Cross-section 2}}{\int \vec{J}_s(x,y)\cdot d\vec{\ell}}$$ ← Same current passes through each and every cross-section of the strip.

In particular, let one cross-section be $\parallel$ to x and the other cross-section parallel to y. The above equation may then be written as follows:

$$\boxed{\underset{\text{Cross-section Parallel to } x}{\int J_{sy}(x,y)\,dx} = \underset{\text{Cross-section Parallel to } y}{\int J_{sx}\,dy}\,.}$$