A straight wire (along the z axis) of radius $R$ carries current density $\vec{J} = J_0 \hat{k}$. A cylindrical hole or radius $\alpha$ parallel to the axis of the wire is drilled at distance $b$ from it as shown in figure (viewed from the top). Show that the field anywhere inside the hole is uniform and given by $\vec{B} = \frac{2\pi J_0}{\alpha} \hat{k} \times \vec{b}$. If $I$ is the total current flowing through the hollow wire, express $B$ in terms of $I, b, R$ and $\alpha$.

A pair of parallel wires carries equal and opposite currents $I$. A closed rectangular wire loop of dimensions $h$ and $w$ is placed in the plane of them and as shown in the figure.

- Find the magnetic flux through the loop.
- Now allow $I$ to vary with time at a slow enough rate $dl/dt$. Find the induced Emf in the loop.
A uniform magnetic field $B$ fills a cylindrical volume of radius $R$. A metal rod of length $l$ is placed as shown. If $B$ is changing at the rate $\frac{dB}{dt}$ show that the emf that is produced by the changing magnetic field and that acts between the ends of the rod is given by $\frac{dB}{dt} \frac{l}{2e} \sqrt{R^2 - (l/2)^2}$.


Show that the self-inductance per unit length of a transmission line consisting of two concentric conducting tubes with radii $R_1$ and $R_2$ is $\frac{2}{\mu} ln \frac{R_2}{R_1}$. The current flows along one of the tubes and an equal and opposite current flows back along the other thus completing a circuit. The currents are uniformly distributed over the surfaces of each tube. Hint: calculate the magnetic flux coupling through a rectangle of length $l$ 'hanging' from the top of the outer conductor as shown in the figure.
Erotokritos Katsavounidis