

**Problem 1 (10 Points)**

An infinite-long line charge in a free space is along the  $z$  axis and has a uniform density  $\rho_l$ . Find the electric potential in the whole space.

**Problem 2 (10 Points)**

A point charge  $Q$  is located at the origin of a rectangular coordinate system. Find the total flux pass through the triangular area defined by  $(1, 0, 0)$ ,  $(0, 2, 0)$  and  $(0, 0, 3)$ .

**Problem 3 (10 Points)**

Given a region of free space in which the electrostatic field is everywhere directed parallel to the  $x$ -axis, prove that the field is independent of the  $y$ - and  $z$ -coordinates. If there is no charge in this region, prove that the field is also independent of  $x$ .

**Problem 4 (20 Points)**

A long straight conductor carries uniform current density  $J$ . It is in the form of a cylinder of radius  $a$  with an off-axis cylindrical hole of radius  $b$ . The distance between the axis of the cylinder and the axis of the hole is  $d$ . Prove that the magnetic field intensity at any point in the hole is given by  $\vec{J} \times \vec{d} / 2$ , where  $\vec{d}$  is the position vector of the cavity axis with respect to the axis of the conductor.

**Problem 5 (20 Points)**

A section of an electromagnet with a plate below it carrying a load is shown in the figure. The electromagnet has a contact area of  $200 \text{ cm}^2$  per pole with the middle pole having a winding of 1000 turns and current  $I$ . Calculate the required current to lift a mass of 50 kg. Assume that the reluctance of the electromagnet and plate is negligible.

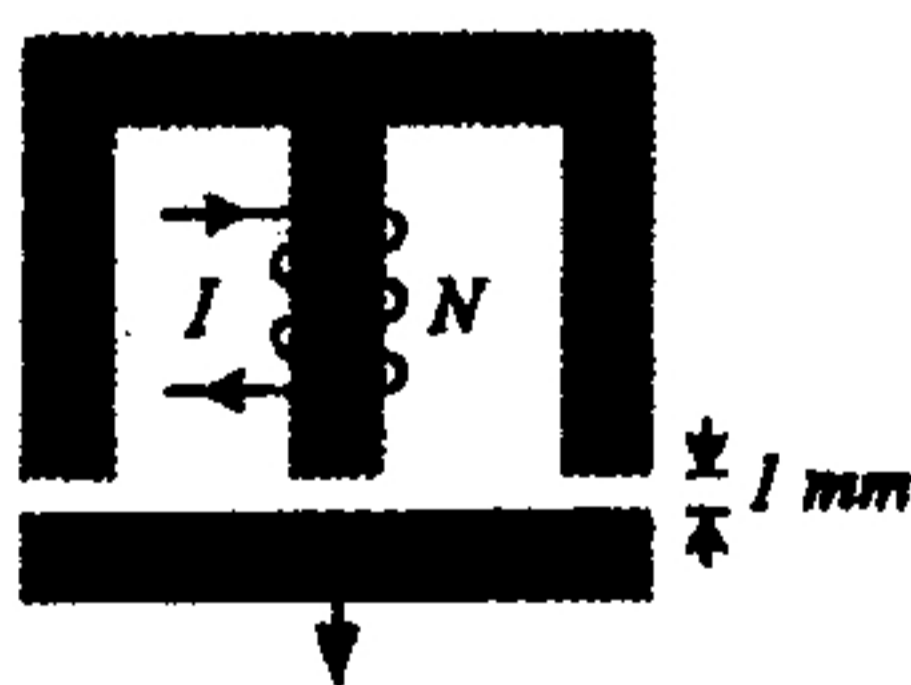


Figure for Problem 5

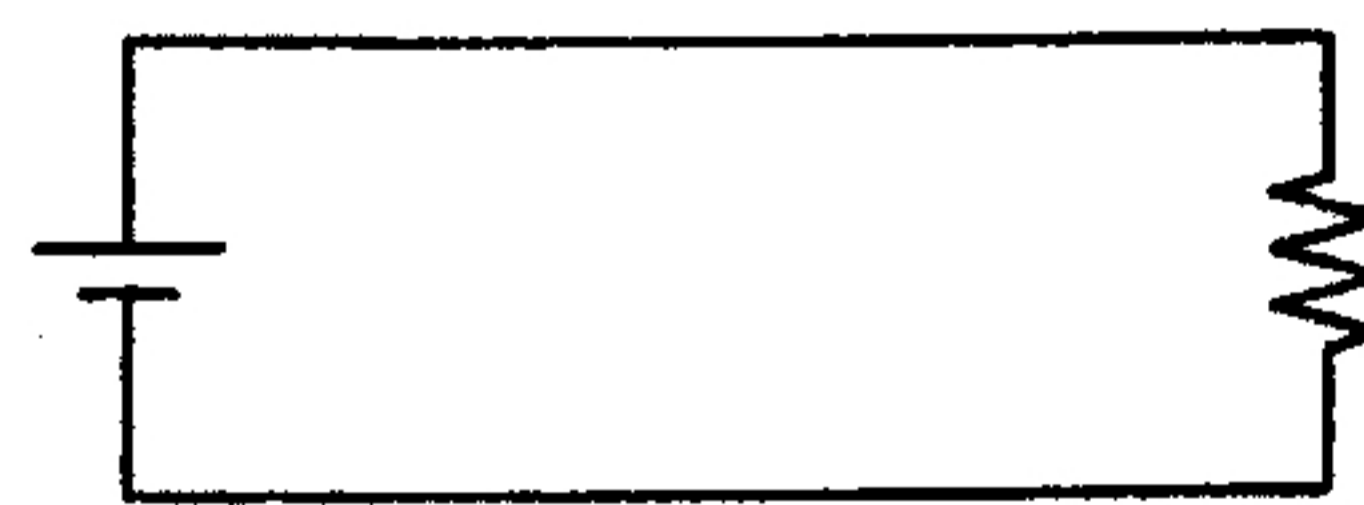


Figure for Problem 6

**Problem 6 (10 Points)**

Draw the electric fields, magnetic fields, and Poynting vectors around the simple circuit as shown in the figure.

**Problem 7 (20 Points)**

Write down the complete Maxwell's equations in differential form and all the boundary conditions.