## PROBLEMS

**14.1.** Rework the example of Sec. 14.2.1 with the applied flux density in the $x_2$ direction. Assume that no current can flow in the $x_3$ direction. In particular obtain expressions for velocity profile (like Eq. 14.2.4), voltage (like Eq. 14.2.7), traction (like Eq. 14.2.10), and total power per unit area (like Eq. 14.2.12). Make plots of voltage and loss per unit area for the constants of Table 14.2.1 and compare the results with those plotted in Fig. 14.2.3.

**14.2.** A viscous liquid flows through a circular pipe, as shown in Fig. 14P.2. At the inlet the pressure is uniform and equal to $p_1$, and at the outlet it is still uniform, but $p_2$. The volume rate of flow is $Q\,m^3$/sec. Under the assumption that the flow is axisymmetric and steady and that the velocity is low enough that the fluid can be considered incompressible, find the velocity profile $v_z(r)$. *Hint.* Look for solutions where $\mathbf{v} = v_z(r)\mathbf{i}_z$ and $p = p(z)$.

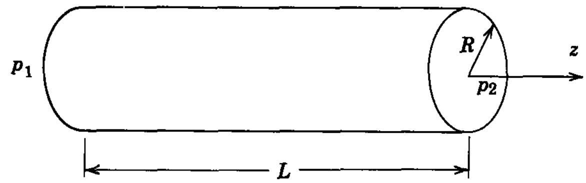


**Fig. 14P.2**

**14.3.** The channel shown in Fig. 14P.3 contains a viscous fluid of conductivity $\sigma$ moving in the $x_1$-direction. You are to analyze this problem using the Hartmann flow solutions (Section 14.2.2). The highly conducting electrodes are connected by a load resistance $R$.

(a) Given the pressure drop from inlet to outlet, the dimensions of the system, field $B_0$, and conductivity $\sigma$, what is the power dissipated in the resistance?

(b) What value of $R$ should be used to dissipate the largest possible power in the load?

(c) If the fluid is mercury, $B_0 = 20{,}000$ gauss, $d = 1$ cm, $l = 1$ m, and $w = 10$ cm, what is the Hartmann number? What is the value of the optimum resistance found in part (b)?

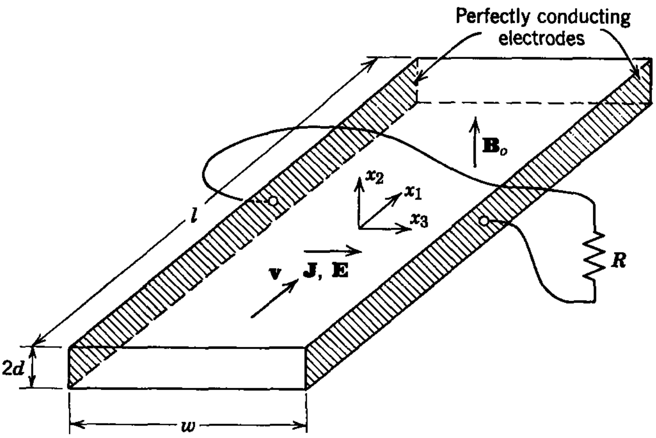


**Fig. 14P.3**