

Problem 4.7 If $\mathbf{J} = \hat{\mathbf{R}}5/R$ (A/m²), find I through the surface $R = 5$ m.

Solution: Using Eq. (4.12), we have

$$\begin{aligned} I &= \int_S \mathbf{J} \cdot d\mathbf{s} = \int_{\phi=0}^{2\pi} \int_{\theta=0}^{\pi} \left(\hat{\mathbf{R}} \frac{5}{R} \right) \cdot (\hat{\mathbf{R}} R^2 \sin \theta \, d\theta \, d\phi) \\ &= -5R\phi \cos \theta \bigg|_{R=5} \bigg|_{\theta=0}^{\pi} \bigg|_{\phi=0}^{2\pi} = 100\pi = 314.2 \quad (\text{A}). \end{aligned}$$
