[Cheng P.7-7] A conducting sliding bar oscillates over two parallel conducting rails in a sinusoidally varying magnetic field

$$\mathbf{B} = \mathbf{a}_z 5\cos\omega t \text{ (mT)},$$

as shown in Fig. 7-13. The position of the sliding bar is given by $x = 0.35(1 - \cos\omega t)$ (m), and the rails are terminated in a resistance $R = 0.2$ (Ω). Find i in Fig.7-13.

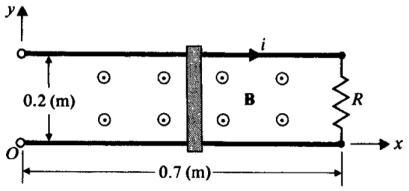

FIGURE 7–13
A conducting bar sliding over parallel rails in a time-varying magnetic field (Problem P.7–7).

Solution: The flux through the surface composed of the rails, resistor, and bar as a function of time is given by

$$\begin{aligned}\Phi(t) &= \mathbf{B}(t)\cdot\mathbf{S}(t)\\ &= -(5\cos\omega t)\cdot 0.2(0.7 - x)\\ &= -0.35\cos\omega t(1 + \cos\omega t) \text{ (mT)}.\end{aligned}$$

We can now find the current i

$$\begin{aligned}i &= \frac{v}{R} = \frac{1}{R}\cdot -\frac{d\Phi}{dt}\\ &= -\frac{1}{R}0.35\omega(\sin\omega t + \sin 2\omega t)\\ &= -1.75\omega\sin\omega t(1 + 2\cos\omega t) \text{ (mA)}.\end{aligned}$$

Answer:

$$i = -1.75\omega\sin\omega t(1 + 2\cos\omega t) \text{ (mA)}.$$