Magnetic Induction: Application (14)

Consider a conducting frame moving in the magnetic field of a straight current-carrying wire.

- magnetic field: $B = \dfrac{\mu_0 I}{2\pi r}$
- magnetic flux: $\Phi_B = \int \vec{B} \cdot \vec{A}, \quad dA = a dr$

$$\Phi_B = \frac{\mu_0 I a}{2\pi} \int_x^{x+b} \frac{dr}{r} = \frac{\mu_0 I a}{2\pi} \Big[\ln(x+b) - \ln x \Big] = \frac{\mu_0 I a}{2\pi} \ln \frac{x+b}{x}$$

- induced EMF: $\mathcal{E} = -\dfrac{d\Phi_B}{dt} = -\dfrac{d\Phi_B}{dx}\dfrac{dx}{dt} = -\dfrac{d\Phi_B}{dx} v$

$$\mathcal{E} = -\frac{\mu_0 I a v}{2\pi} \left[\frac{1}{x+b} - \frac{1}{x} \right] = \frac{\mu_0 I a b v}{2\pi x(x+b)}$$

- induced current: $I_{ind} = \dfrac{\mathcal{E}}{R}$ clockwise