

演習問題 2

(1)

$$\begin{aligned}
 \Phi &= \int_0^l \int_0^l B_z dx dy \\
 &= B \int_0^l \sin(\pi x) dx \int_0^l \sin(\pi y) dy \cdot \sin \omega t \\
 &= B \frac{1}{\pi^2} (\cos \pi l - 1)^2 \sin \omega t.
 \end{aligned}$$

(2)

$$\begin{aligned}
 \phi_{em} &= -N \frac{d\Phi}{dt} \\
 &= -BN \frac{\omega}{\pi^2} (\cos \pi l - 1)^2 \cos \omega t.
 \end{aligned}$$

(3)

$$\begin{aligned}
 I &= \frac{\phi_{em}}{R} \\
 &= -\frac{NB\omega}{R\pi^2} (\cos \pi l - 1)^2 \cos \omega t.
 \end{aligned}$$

演習問題 3

(1)

$$\Phi = B \cdot n = Bl^2 \cos \theta.$$

(2)

$$\phi_{em} = -\frac{d\Phi}{dt} = Bl^2 \omega \sin \theta \left(\because \frac{d\theta}{dt} = \omega \right).$$

(3)

$$\begin{aligned}
 I &= \frac{\phi_{em}}{R} = \frac{Bl^2 \omega}{R} \sin \theta \\
 J &= RI^2 = \frac{B^2 l^4}{R} \omega^2 \sin^2 \theta.
 \end{aligned}$$

(4)

$N = I \mathbf{S} \mathbf{n} \times \mathbf{B}$ より力のモーメントの大きさは

$$N = Il^2 B \sin \theta = \frac{B^2 l^4}{R} \omega \sin^2 \theta.$$

(5)

$$W = \int_0^\theta N d\theta = \frac{B^2 l^4 \omega}{R} \frac{1}{2} \left(\theta - \frac{1}{2} \sin 2\theta \right).$$

(6)

$$\begin{aligned} \frac{dW}{dt} &= \frac{B^2 l^4 \omega^2}{R} \frac{1}{2} (1 - \cos 2\theta) \\ &= \frac{B^2 l^4 \omega^2}{R} \sin^2 \theta \end{aligned}$$

となり，これは(3)の結果と同じになる