

CHAPTER 6: ELECTROMAGNETIC INDUCTION

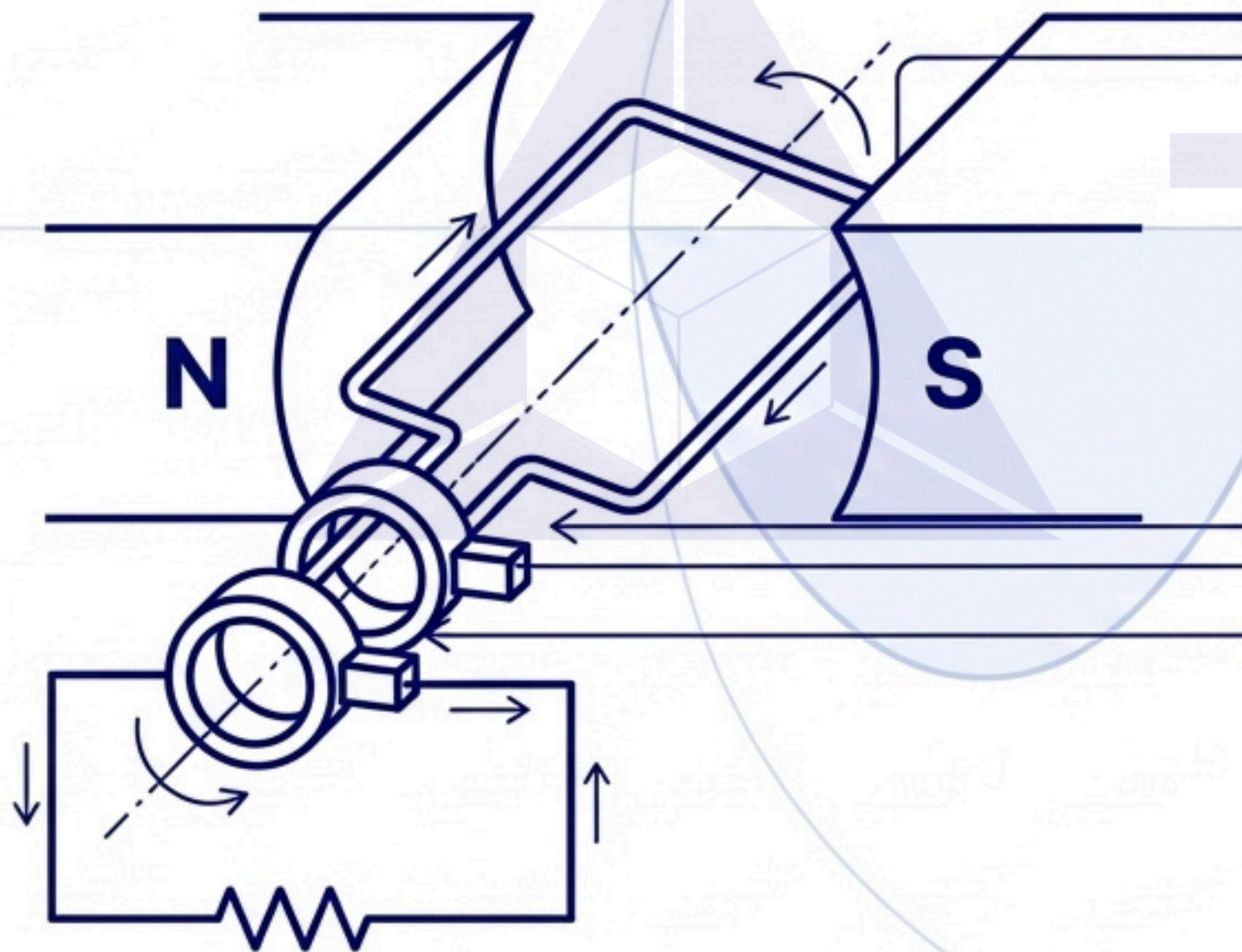
6.8 AC Generator

Mastering the principles, formulas, and alternating output of the AC Generator for NEET & JEE.



FIG 6.13: AC GENERATOR

Converting Mechanical to Electrical Energy



The Armature

A rotating coil of N turns placed in a uniform magnetic field created by stationary N-S poles.

Slip Rings

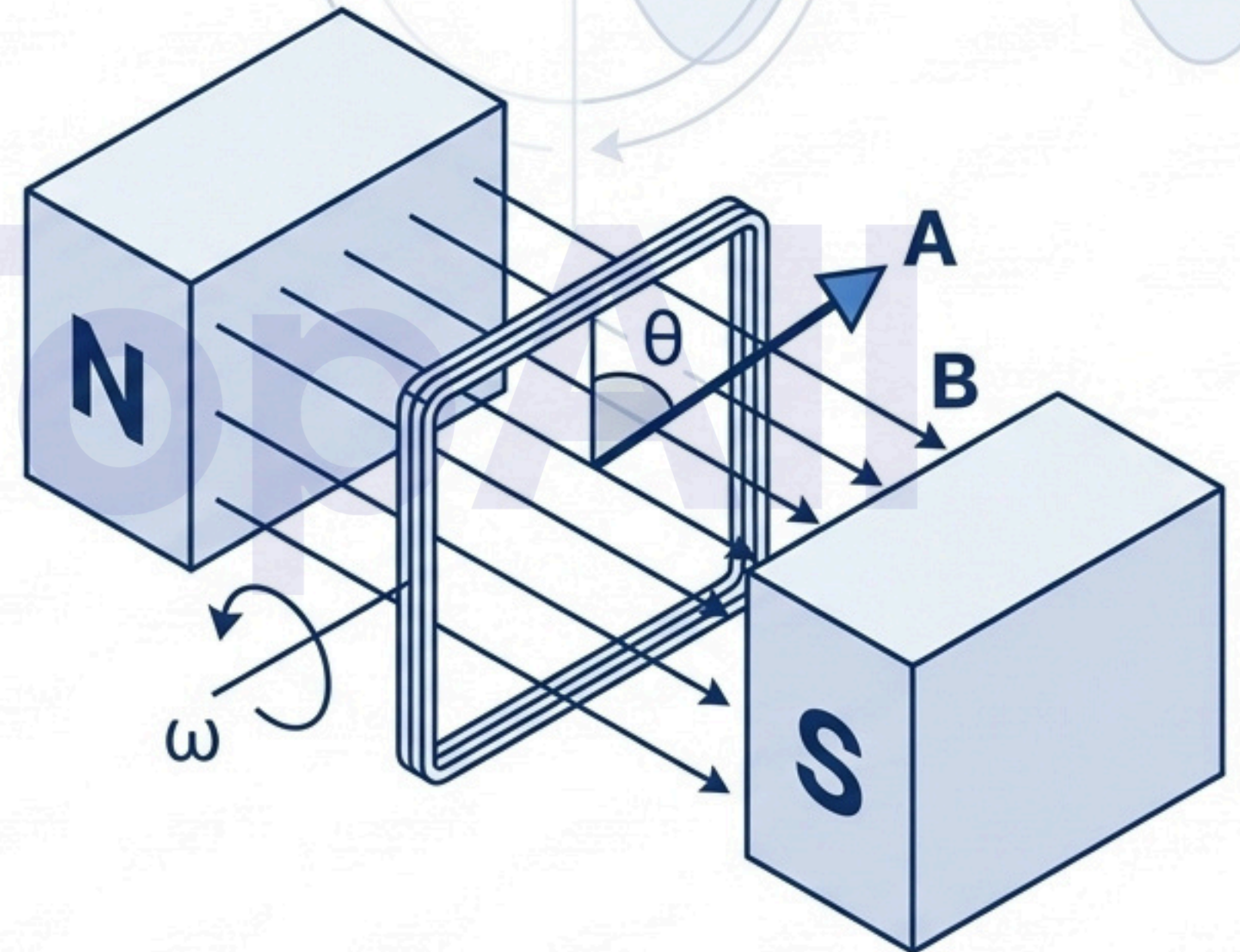
Crucial for AC. Two separate metal rings attached to the ends of the armature. They rotate with the coil to prevent wire tangling while transferring current.

Carbon Brushes

Stationary contacts that press against the rotating slip rings to pass the induced current to the external circuit.

The Physics of Rotation

- The coil is mechanically rotated with a constant angular speed ω .
- At any instant t , the angle θ between the magnetic field **B** and the coil's area vector **A** is given by $\theta = \omega t$.
- As the coil turns, the effective area exposed to the field lines ($A \cos \theta$) constantly changes.





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MATHEMATICAL MODELING

Flux Through a Rotating Coil

For a coil of N turns, the flux at any time t is:

$$\Phi_B = NBA \cos(\omega t)$$

N = Number of turns

A = Area of the coil

B = Uniform magnetic field

ω = Angular speed

EQ 6.19

Applying Faraday's Law

Step 1: Faraday's Law for a rotating coil

$$e = -N \frac{d\Phi_B}{dt}$$

Step 2: Differentiating the flux

$$e = -N \frac{d}{dt} (BA \cos \omega t)$$

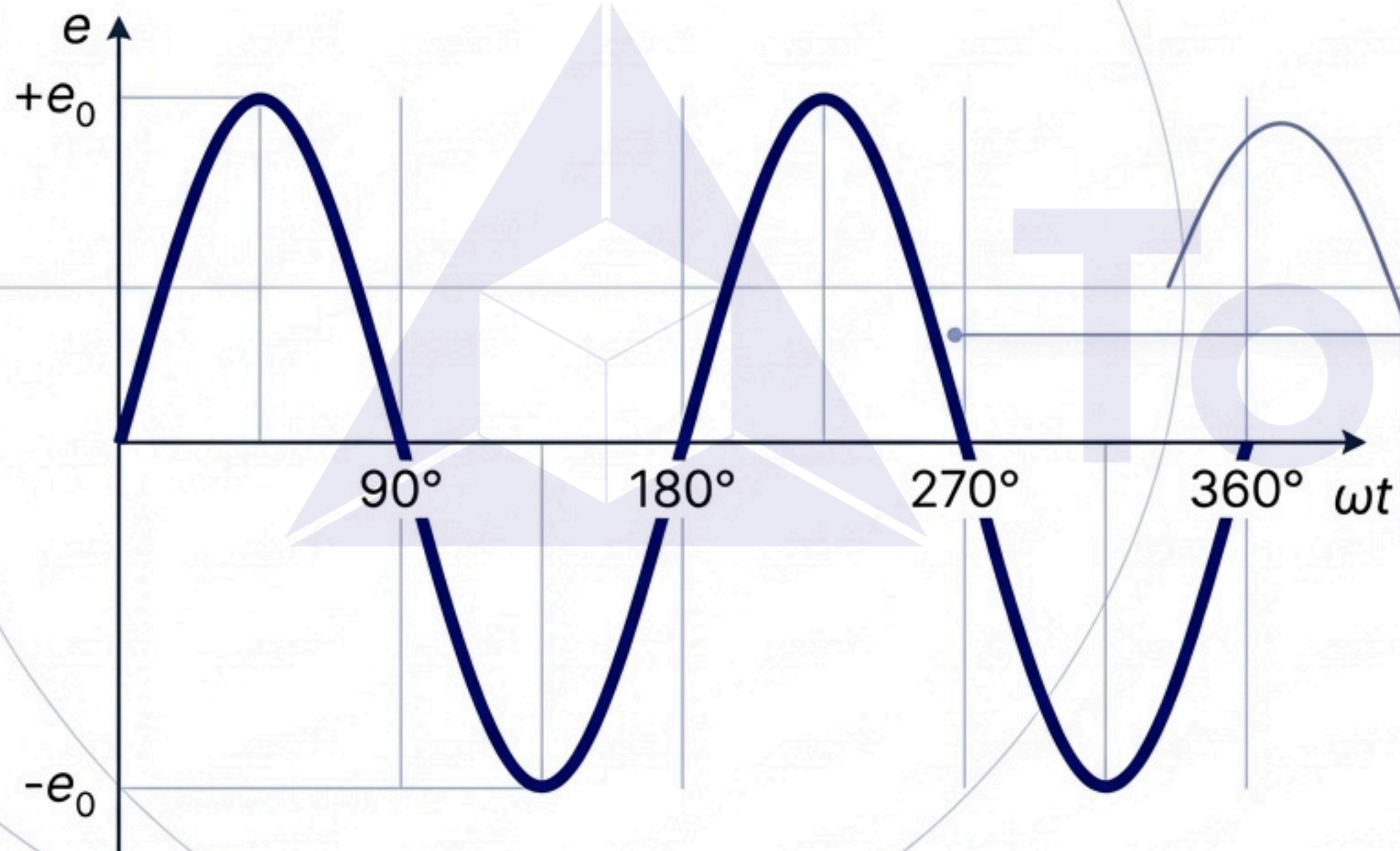
Step 3: The Induced EMF Formula

$$e = NBA\omega \sin(\omega t)$$

The mechanical rotation (ω) directly determines the amplitude of the induced voltage.

FIG 6.14: AC GRAPH

The Sinusoidal Nature of AC



Maximum EMF occurs when $\sin \omega t = \pm 1$.

$$e_0 = NBA\omega$$

EQ 6.20 & 6.21

$$e = e_0 \sin(\omega t)$$

$$e = e_0 \sin(2\pi vt)$$

(where v is the frequency)

Because the sine function varies between +1 and -1, the polarity of the EMF reverses periodically.

Key Takeaways

- **Energy Conversion:** AC Generators convert mechanical energy into electrical energy.
- **Core Principle:** Electromagnetic induction via a changing area vector angle ($\theta = \omega t$).
- **Key Hardware:** Slip rings are essential to transfer alternating current without tangling wires.
- **Peak EMF:** Depends on turns, field, area, and speed ($e_0 = NBA\omega$).

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