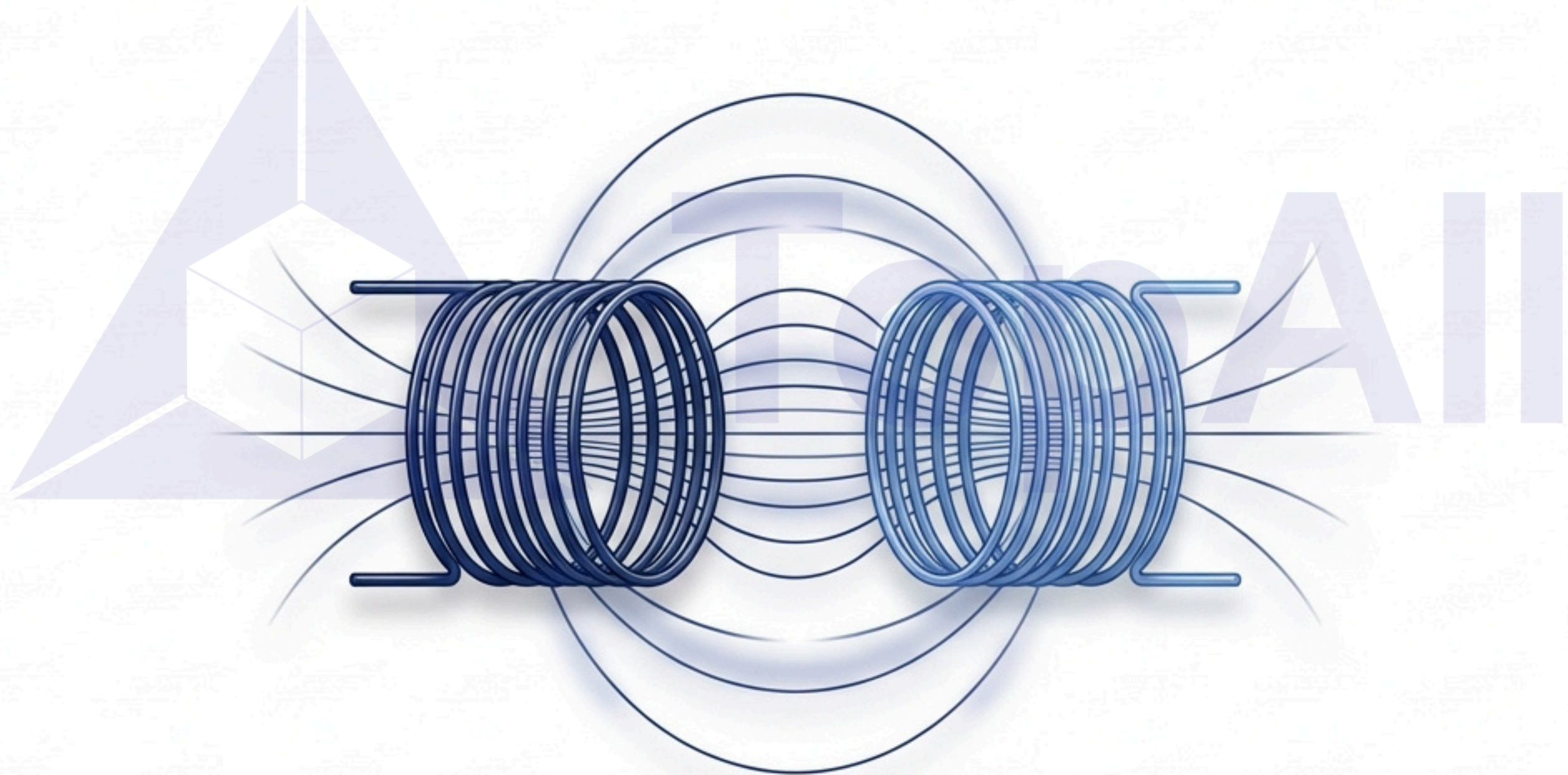


Mutual Inductance

Understanding how nearby coils influence each other magnetically.



The Invisible Magnetic Link

When an electric current varies in one coil, it induces an electromotive force (EMF) in a neighboring coil.

- A changing current in Coil 1 creates a changing magnetic flux.
- This magnetic flux links with Coil 2.
- The changing flux through Coil 2 induces a current in it (Faraday's Law).

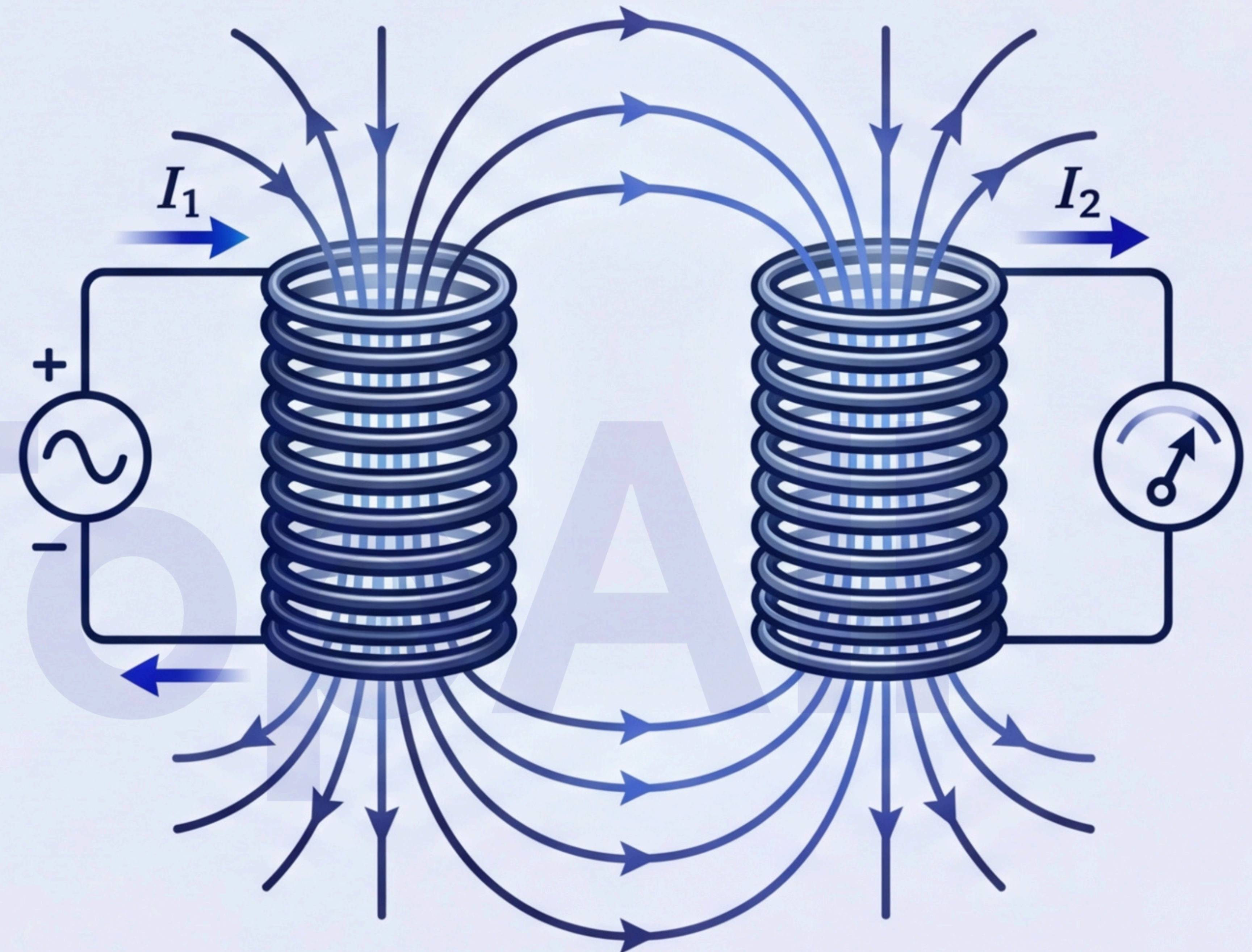
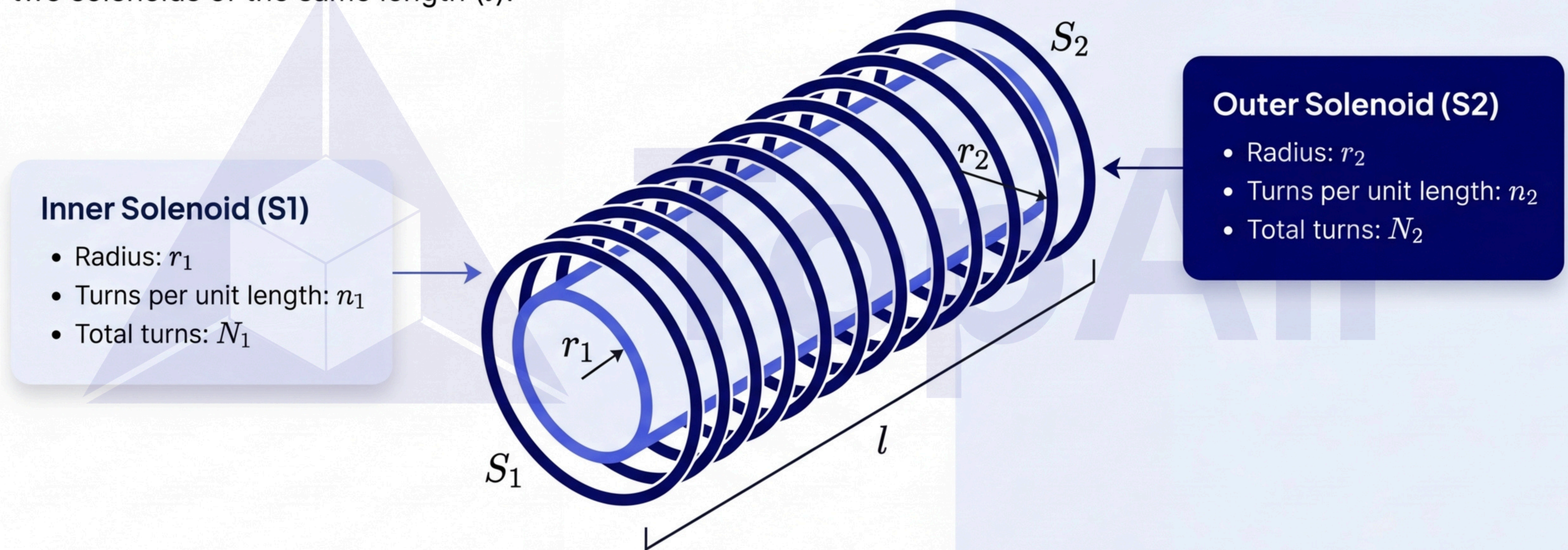


FIG. 6.12 REDRAW

Two Long Coaxial Solenoids

To calculate mutual inductance, we use a system of two solenoids of the same length (l).





You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

Practice Now



At prep.topall.app

Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



Calculating Mutual Inductance (M)

General Rule

Flux linkage in Coil 1 is directly proportional to the current in Coil 2.

$$N_1 \Phi_1 = M_{12} I_2$$

Where M_{12} is the Coefficient of Mutual Induction.

For Coaxial Solenoids

Derived from $B_2 = \mu_0 n_2 l_2$

$$M = \mu_0 n_1 n_2 \pi r_1^2 l$$

Note: Depends on the inner radius (r_1) and total length (l).

FARADAY'S LAW APPLIED

Induced EMF & The Symmetry Principle

Induced EMF Relation

By applying Faraday's Law ($\varepsilon = -d\Phi/dt$) to the flux linkage equation:

$$\varepsilon_1 = -M \frac{dI_2}{dt}$$

The negative sign indicates opposition to the change in current (Lenz's Law).

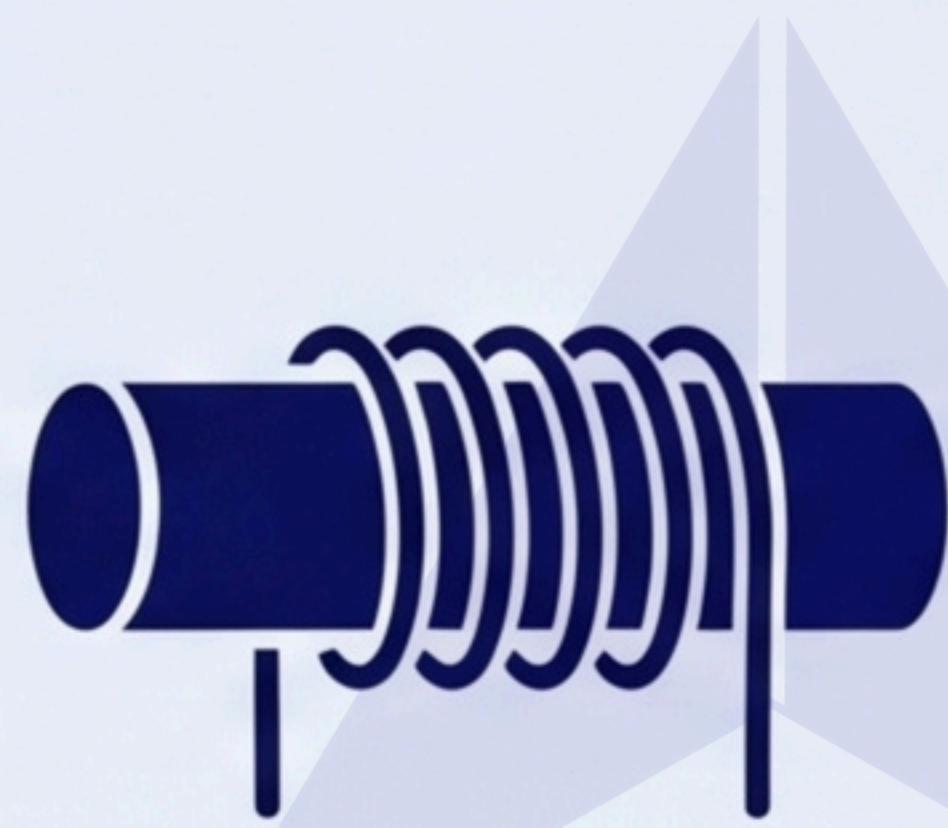
EXAM TIP | RECIPROCITY THEOREM

$$M_{12} = M_{21} = M$$

The mutual inductance of coil 1 with respect to coil 2 is exactly equal to the mutual inductance of coil 2 with respect to coil 1, **regardless of their shapes or sizes!**

DEPENDENCIES

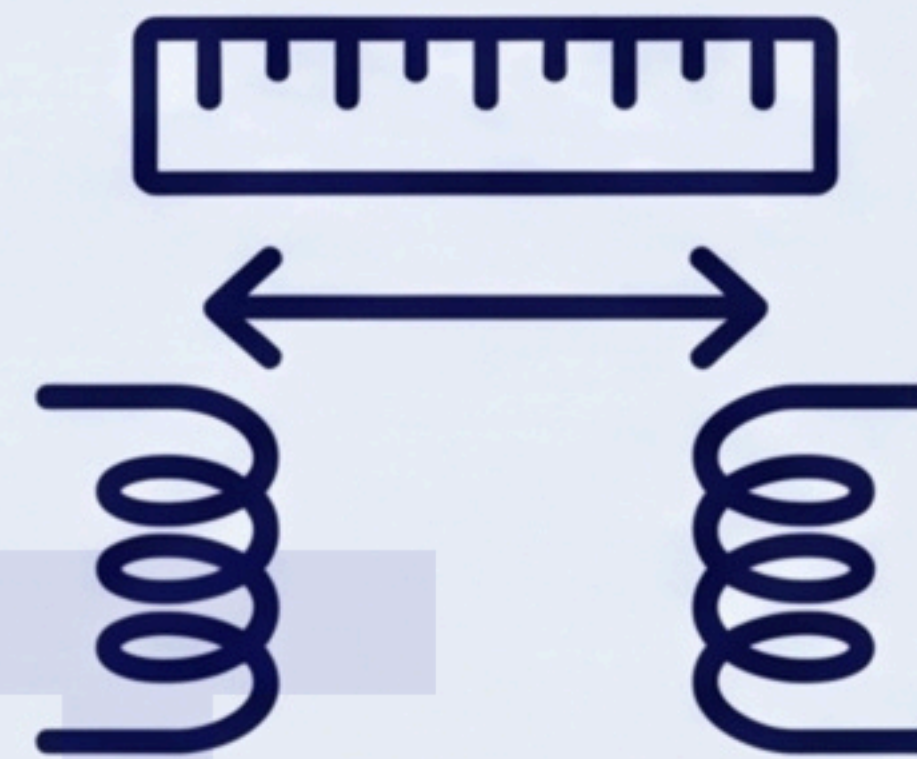
Factors Affecting Mutual Inductance



Core Medium

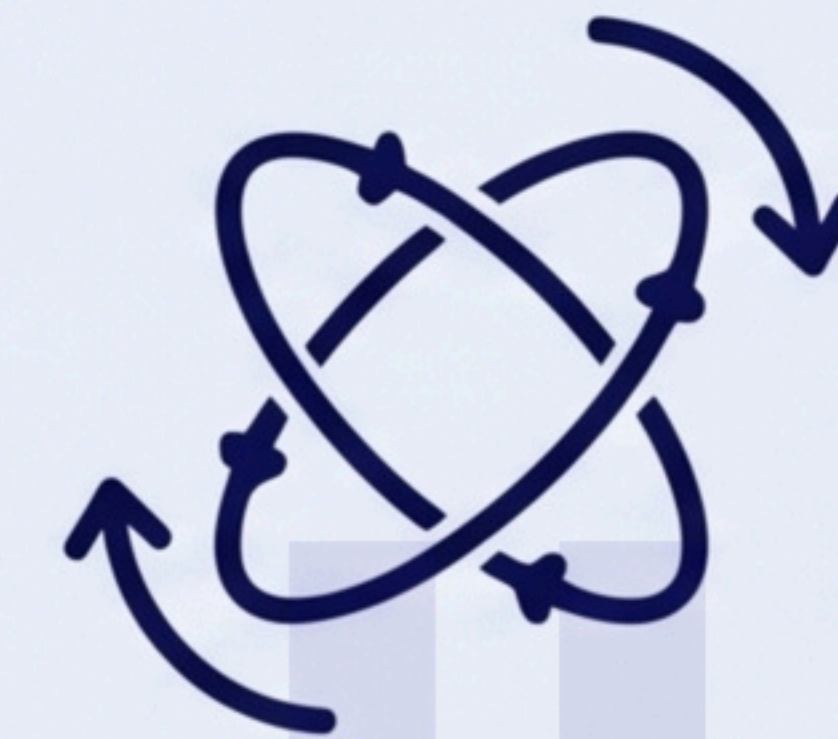
If a medium with relative permeability (μ_r) is inserted, M increases.

$$M = \mu_r \mu_0 n_1 n_2 \pi r_1^2 l$$



Separation Distance

As the distance between the two coils increases, the magnetic flux linkage decreases, reducing M .



Relative Orientation

M is maximum when coils are parallel (coaxial) and zero when they are perpendicular to each other.

QUICK REVISION

Wrap-Up

Key Takeaways

- ✓ Mutual inductance (M) links the changing current in one coil to the induced EMF in a nearby coil.
- ✓ General Formula: $\mathcal{E}_1 = -M \frac{dI_2}{dt}$
- ✓ For long coaxial solenoids: $M = \mu_0 n_1 n_2 \pi r_1^2 l$
- ✓ Always remember the symmetry rule: $M_{12} = M_{21}$.

Start Practice: Try Chapter MCQs Next →



You've Learned the Theory.

Now Let's Test It.

Reading notes gets you knowledge.

Practicing MCQs gets you marks.

That's exactly what TopAll Pro is built for.

Try TopAll Pro Now

What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**
AI Recommendation Analysis your Tests and tell you where you need to improve.



Practice the moment you finish studying
Jump in while the concept is still fresh in your head

4.5L+
MCQs

1.5L+
Students

AI Powered
In-Depth Analysis