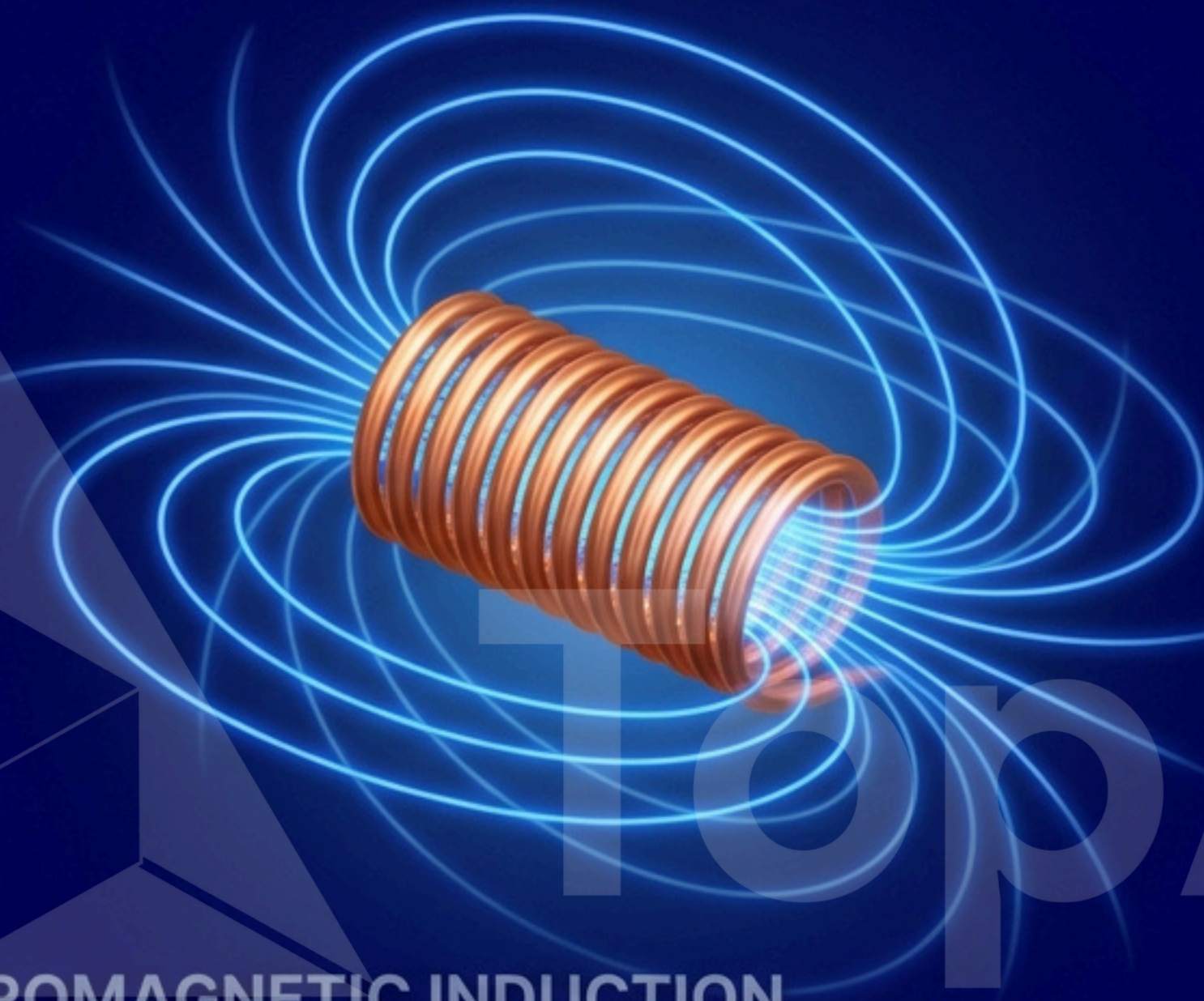


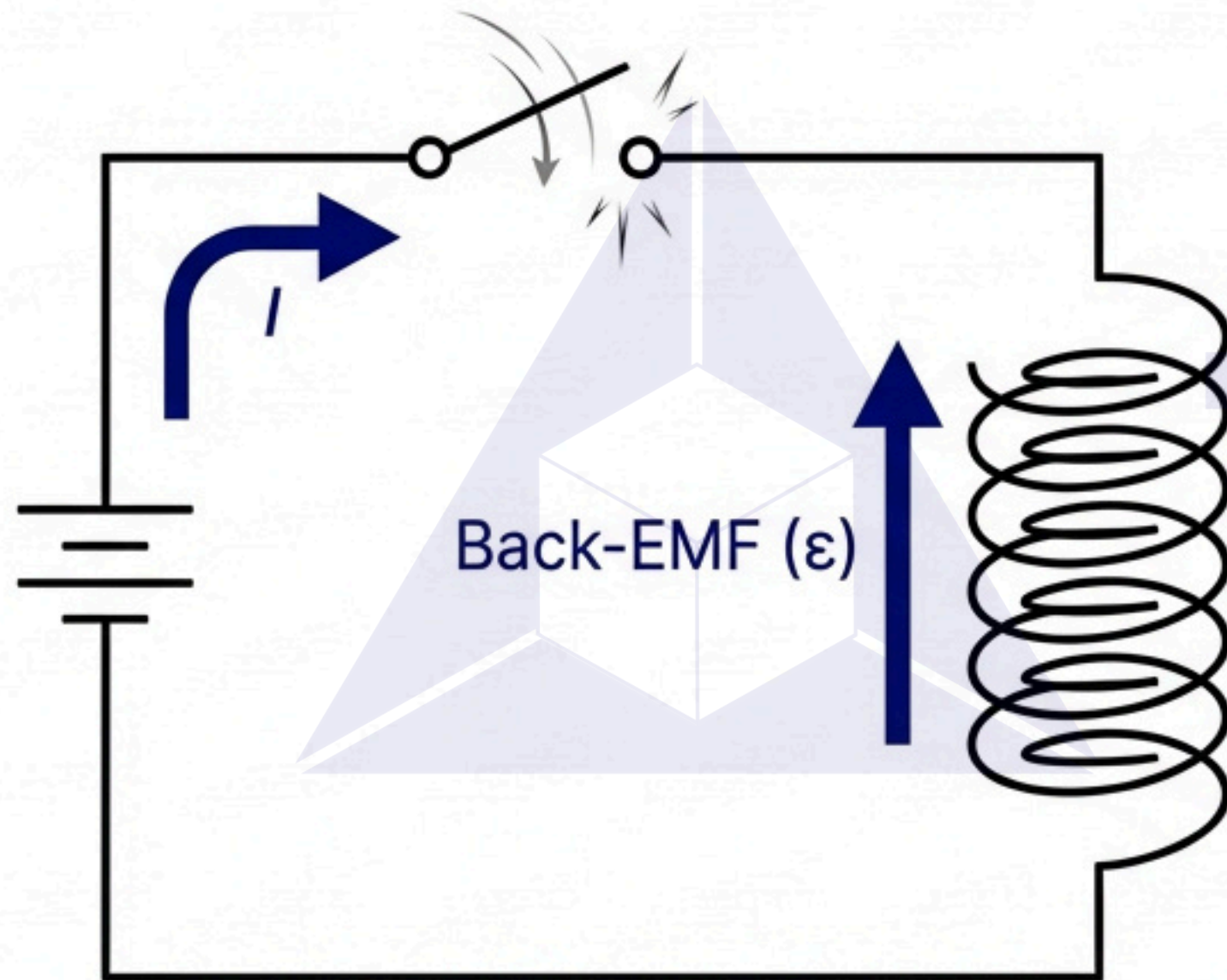


CHAPTER 6.7.3 • ELECTROMAGNETIC INDUCTION

Energy Stored In An Inductor

Understanding magnetic potential energy, work done against back-emf, and magnetic energy density.

Work Done Against Back-EMF



Self-induced emf ($\varepsilon = -L \, di/dt$) always opposes the growth of current in the circuit.

It acts as electrical inertia—just as mechanical mass resists a sudden change in velocity.

To establish the current I , the external voltage source must actively do work against this back-emf.

POWER EQUATION:
$$dW/dt = |\varepsilon| I$$

Deriving Magnetic Potential Energy

Rate of Work

$$\frac{dW}{dt} = |\epsilon| I = L I \frac{dI}{dt}$$

Total Work

$$W = \int dW = \int_0^I L I dI$$

Integration

$$W = L \left[\frac{I^2}{2} \right]_0^I$$

Magnetic Energy (U)

$$U = \frac{1}{2} L I^2$$

The total work done is entirely stored as magnetic potential energy within the inductor.



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



Mechanical vs. Electrical Systems

Classical Mechanics



Inertia Property: Mass (m) resists changes in velocity.

$$\text{Kinetic Energy: } K = \frac{1}{2}mv^2$$

Electromagnetism



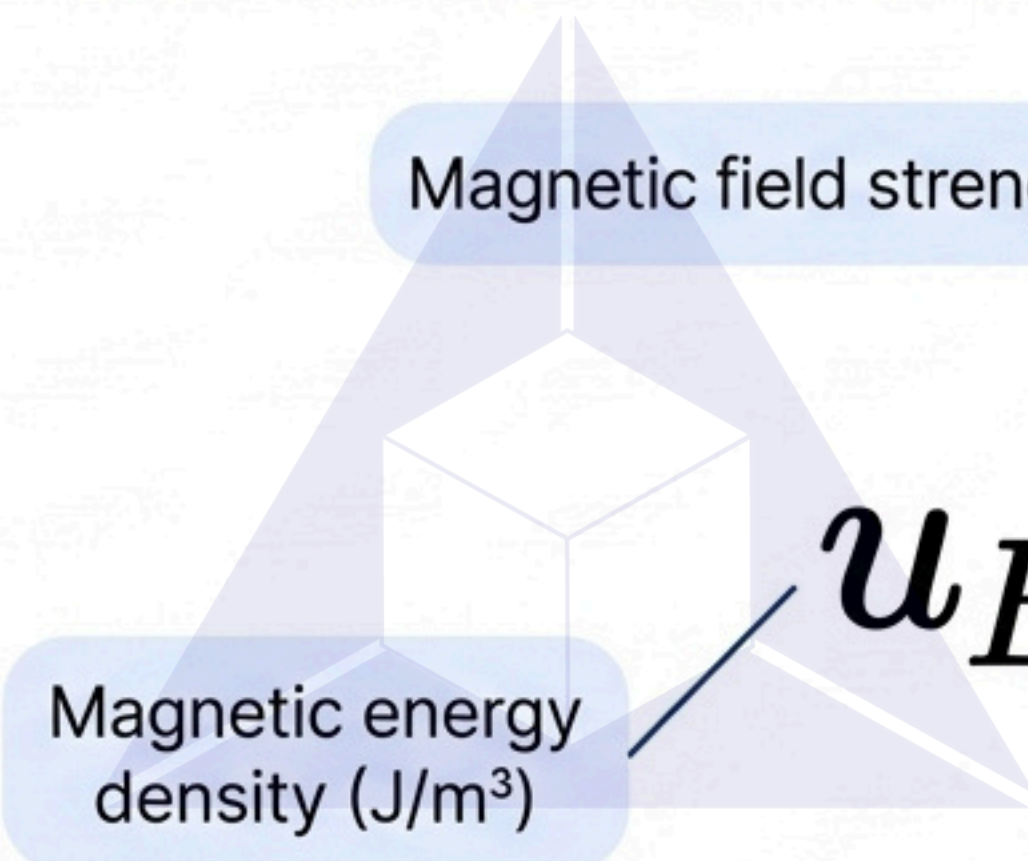
Inertia Property: Inductance (L) resists changes in current.

$$\text{Magnetic Energy: } U = \frac{1}{2}LI^2$$

Both equations follow the exact same universal pattern of energy stored by overcoming inertia.

ESSENTIAL FORMULA • EQ (6.18)

Energy Stored Per Unit Volume (u_B)


$$u_B = \frac{B^2}{2\mu_0}$$

Magnetic field strength (Tesla) points to B^2

Magnetic energy density (J/m^3) points to u_B

Permeability of free space points to $2\mu_0$

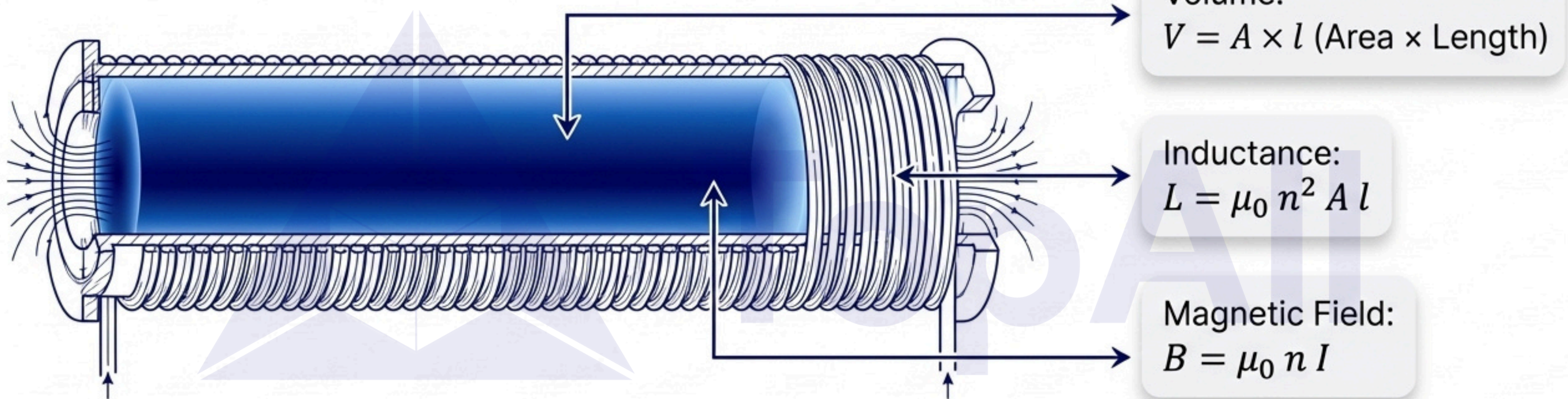


EXAM TIP

Universally valid for any region of space containing a magnetic field, not just solenoids!

Visualizing Energy in Space

Where exactly is the energy stored? In the magnetic field itself.



Substituting L and I into $U = \frac{1}{2}LI^2$ yields the total energy $U = \frac{B^2}{2\mu_0} (A_0) (Al)$.
Dividing by the volume (Al) gives our energy density u_B .

Key Takeaways

- ✓ Inductors act as electrical inertia, continually opposing any change in current via back-emf.
- ✓ The work done to establish a current is stored as magnetic potential energy: $U = \frac{1}{2}LI^2$.
- ✓ This magnetic energy physically resides in the field itself, possessing an energy density of $u_B = \frac{B^2}{2\mu_0}$.

Start Practice →



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