

[SECTION 4.8] MOVING CHARGES AND MAGNETISM

Force Between Two Parallel Currents

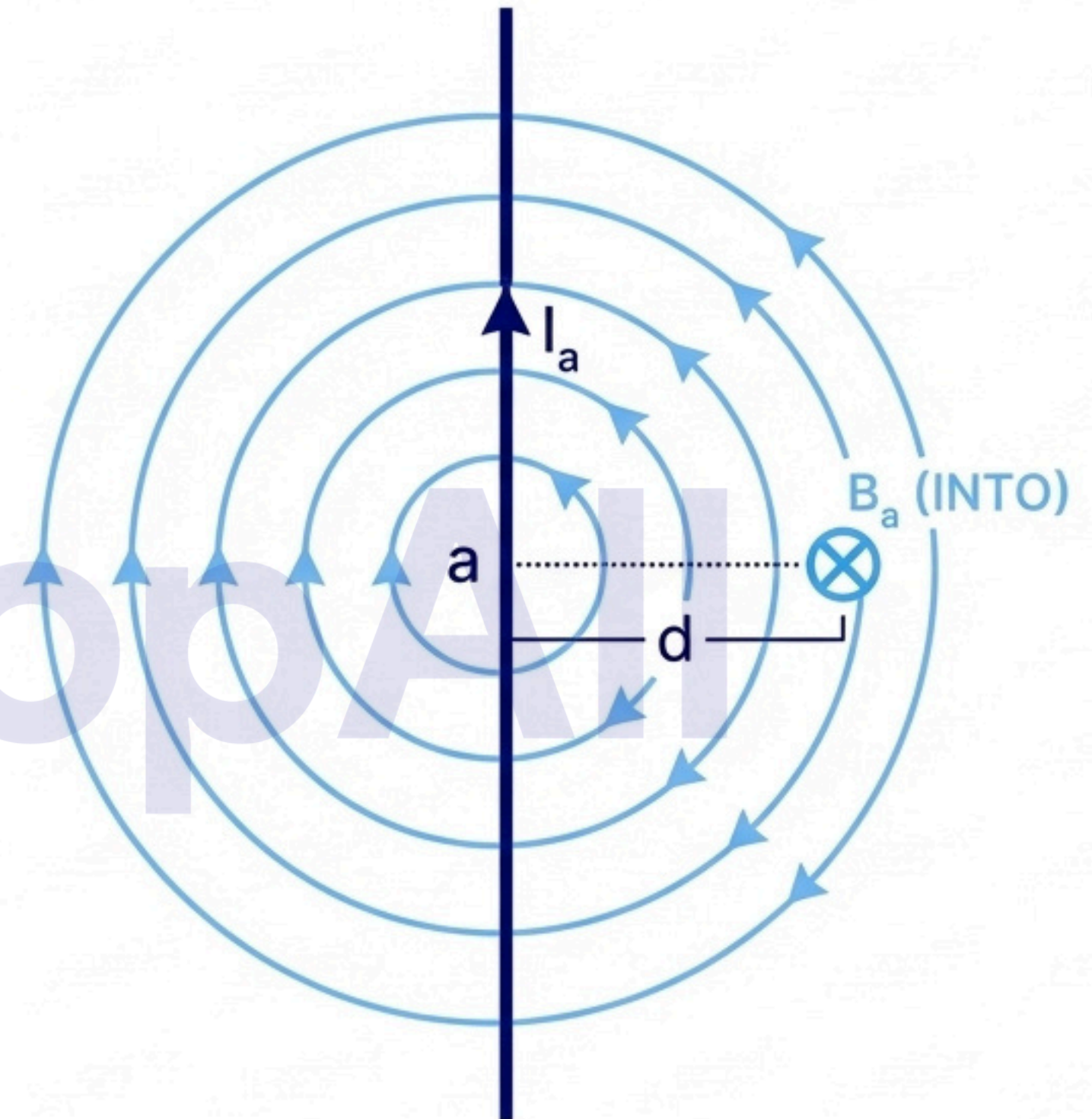
Understanding magnetic interactions, deriving force per unit length, and defining the Ampere.

[STEP 01] THE MAGNETIC SETUP

Conductor 'a' creates a field at Conductor 'b'

Before they can interact, the first wire generates a magnetic field that engulfs the surrounding space. Using Ampere's Circuital Law, the magnetic field (B_a) at a perpendicular distance d is uniform along the entire length of where the second wire will be placed.

$$B_a = \frac{\mu_0 I_a}{2\pi d}$$



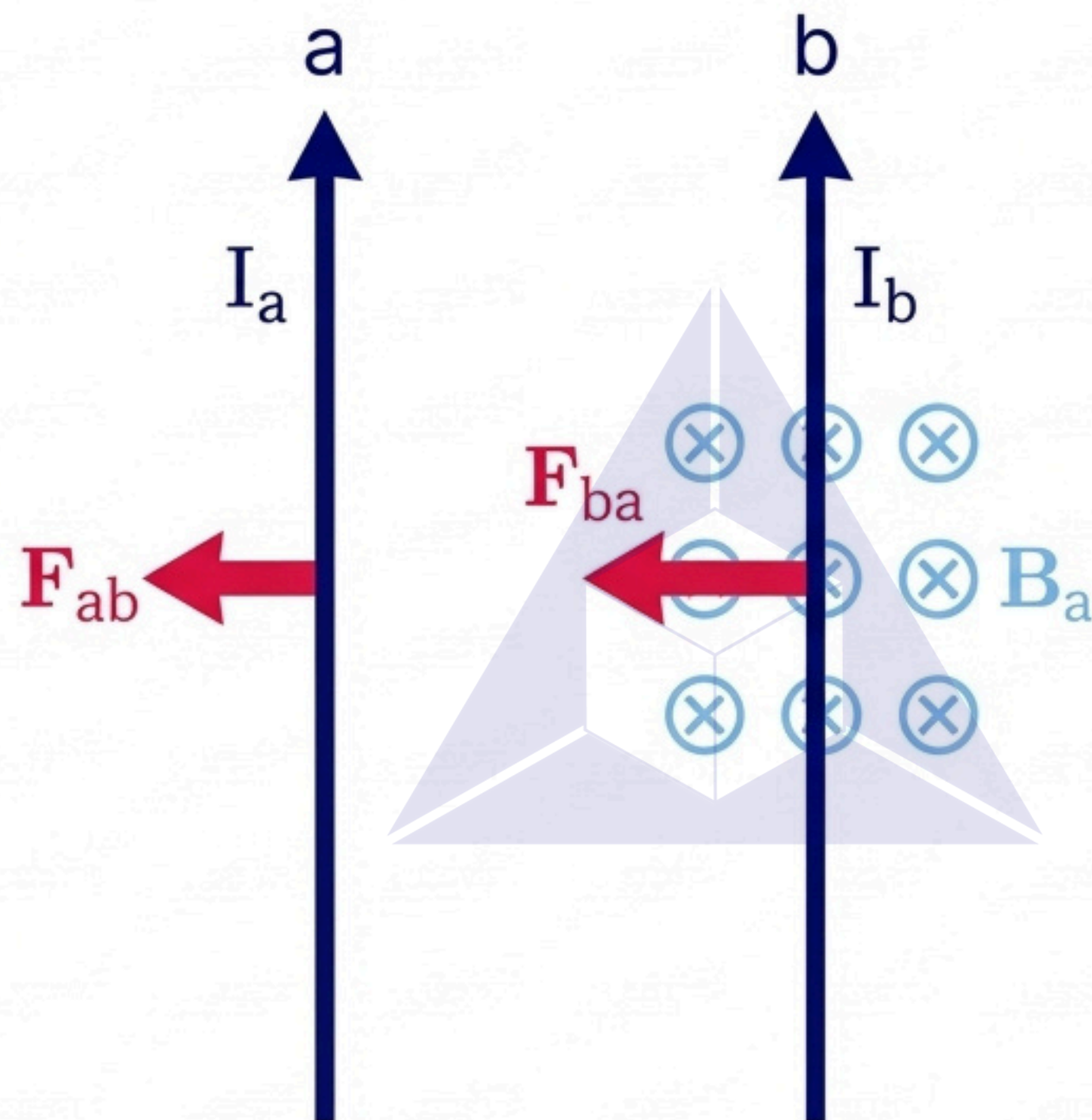
[STEP 02] PARALLEL CURRENTS

Currents in the Same Direction Attract

Conductor 'b' carries current I_b through field B_a . Using the cross-product rule ($F = I L \times B$), the resulting magnetic force pulls wire 'b' toward wire 'a'.

$$F_{ba} = I_b L B_a = \frac{\mu_0 I_a I_b L}{2\pi d}$$

Newton's Third Law: $F_{ab} = -F_{ba}$





**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

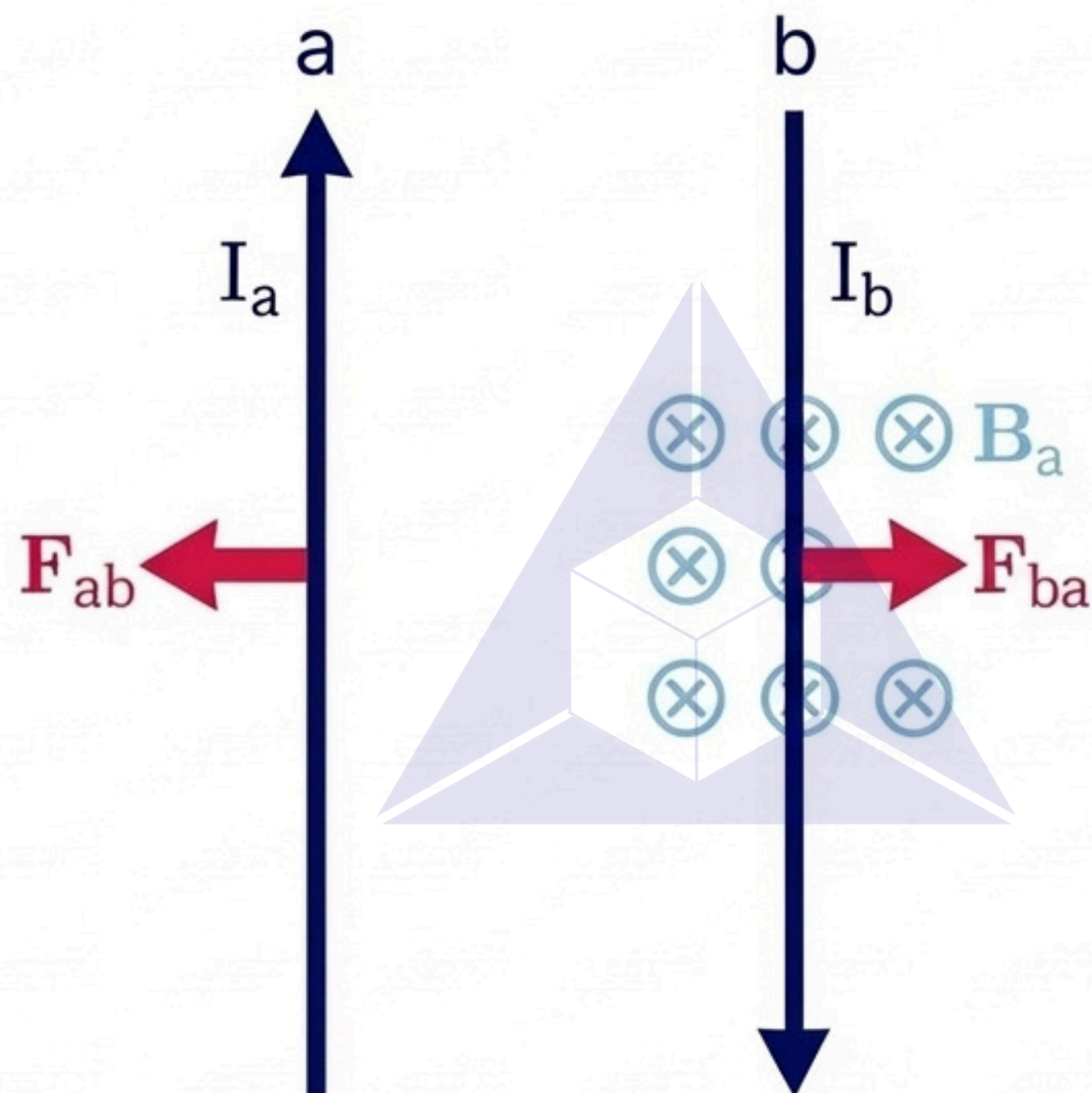


[STEP 03] ANTI-PARALLEL CURRENTS

Currents in Opposite Directions Repel

Reversing the current in Conductor 'b' flips the direction of the vector product. The wires now exert an outward, repulsive force on each other.

Unlike electrostatics where “like charges repel,” in magnetism, “like (parallel) currents attract.”

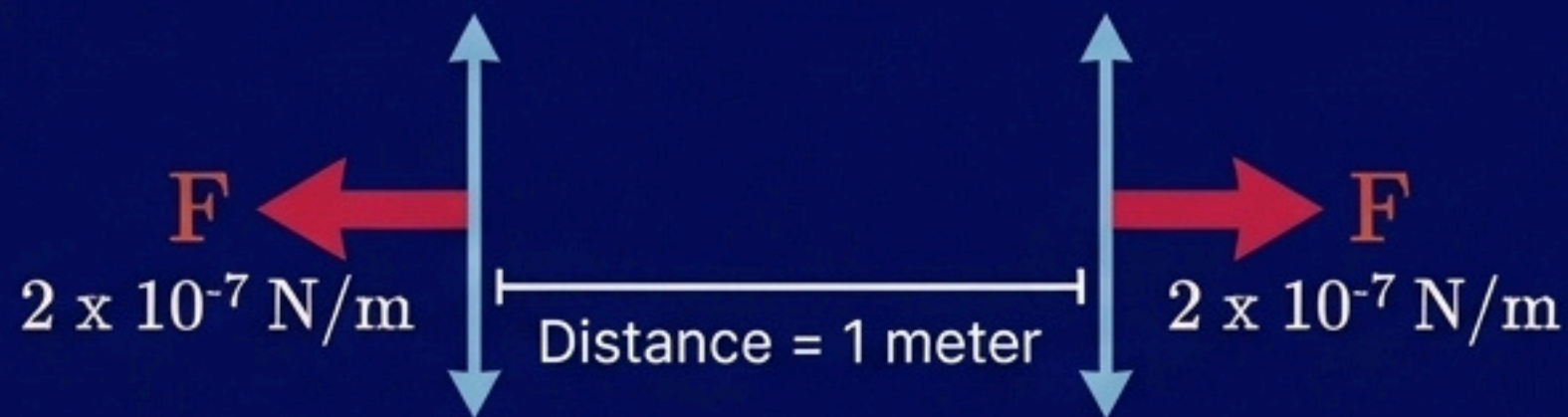


Force per Unit Length

To make the force equation universal regardless of wire length, we divide by length (L) to find the force per unit length (f_{ba}).

$$f = \frac{F}{L} = \frac{\mu_0 I_a I_b}{2\pi d}$$

Defining The Ampere (SI Base Unit)



1 Ampere is the steady current that, when flowing in two infinitely long, parallel wires 1 meter apart in a vacuum, produces a force of exactly 2×10^{-7} Newtons per meter of length.

[CHAPTER SUMMARY]

Exam Insights & Key Takeaways



Parallel = Attract, Anti-parallel = Repel. (Note: This is directly opposite to electrostatic rules where like charges repel).



Newton's Third Law Holds. The force exerted by wire 'a' on 'b' is always equal and opposite to 'b' on 'a' ($F_{ab} = -F_{ba}$), even if the current magnitudes (I_a, I_b) are different.



The Master Formula. Force per unit length is directly proportional to the product of both currents and inversely proportional to their separation distance ($f \propto (I_a I_b) / d$).



The Ampere Definition. The SI unit of current is fundamentally defined by this exact magnetic force interaction (2×10^{-7} N/m), not by counting electrons.



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