

# Relation between Roots and Coefficients Quadratic Equations

1



$$\alpha + \beta = \frac{-b}{a}$$



$$\alpha\beta = \frac{c}{a}$$



$$|\alpha - \beta| = \frac{\sqrt{D}}{|a|}$$



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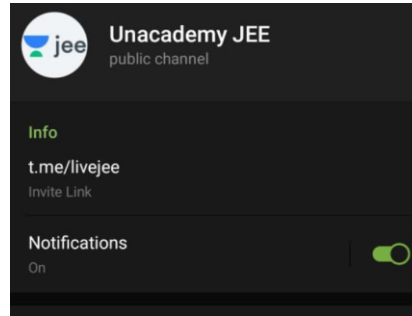
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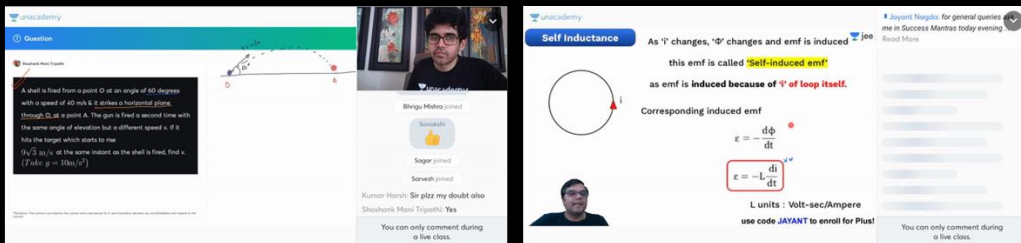
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Questions

A shell is fired from a point O at an angle of 60 degrees with a speed of 40 m/s. It strikes a horizontal plane through O at a point A. The gun is fired a second time with the same angle of elevation but a different speed  $v$ . If it hits the target which starts to rise  $(\sqrt{3}/2) \text{ m/s}^2$  at the same instant as the shell is fired, find  $v$ . (Take  $g = 10 \text{ m/s}^2$ )

Shruti Mishra joined

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Kumar Harsh: Sir plz my doubt also

Shashank Masi Tripathi: Yes

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**Self Inductance**

As  $\vec{I}$  changes,  $\vec{\Phi}$  changes and emf is induced

this emf is called **Self-induced emf**

as emf is induced because of  $\vec{I}$  of loop itself.

Corresponding induced emf

$$\mathcal{E} = -\frac{d\Phi}{dt}$$

$$\mathcal{E} = -L \frac{dI}{dt}$$

Units: Volt-sec/Ampere

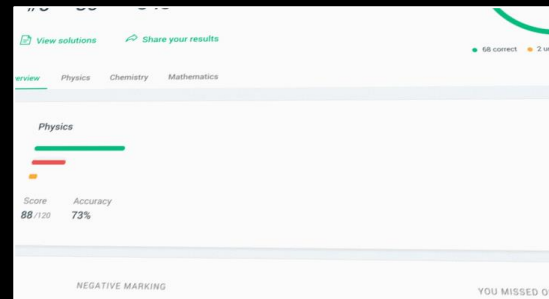
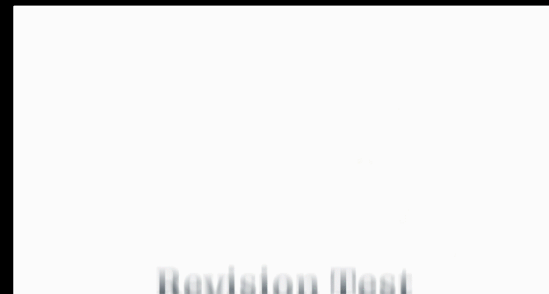
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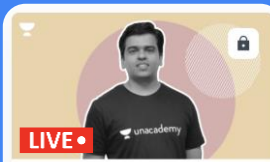


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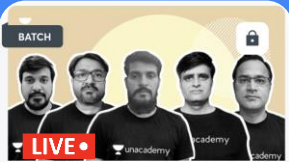
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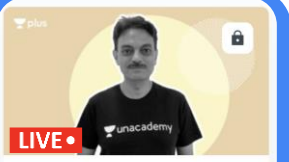
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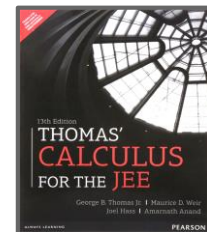
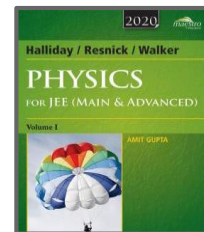
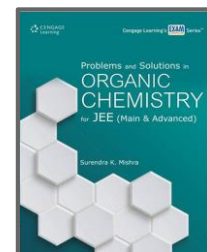
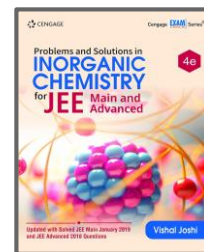
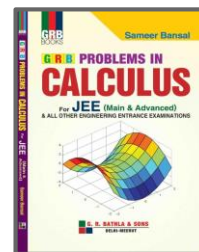
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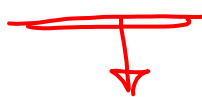
## Quadratic Equation

$$ax^2 + bx + c = 0 ; a \neq 0$$

NOTE: Quadratic Equation has 2 roots. Always.

eg:  $x^2 - 5x + 6 = 0$

$$(x-2)(x-3) = 0$$



$$x=2$$



$$x=3$$



## Roots of Quadratic Equation

The roots of the quadratic equation,  $ax^2 + bx + c = 0$  is given by

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

The expression  $D = b^2 - 4ac$  is called the discriminant of the quadratic equation.



## Equations convertible to Quadratic Form

Eg:  $x^4 - 5x^2 + 6 = 0$

Let.  $x^2 = t$

$$t^2 - 5t + 6 = 0$$

$$(t-2)(t-3) = 0$$

$$t = 2$$

$$x^2 = 2$$

$$x = \pm \sqrt{2}$$

$$t = 3$$

$$x^2 = 3$$

$$x = \pm \sqrt{3}$$



The roots of the equation  $4^x - 3 \cdot 2^{x+3} + 128 = 0$  are :

A. 4 and 5

✓ B. 3 and 4

C. 2 and 3

D. 1 and 2

$$4^x - 3(2)^{x+3} + 128 = 0$$

$$\Rightarrow (2^x)^2 - 3(2^x)(2^3) + 128 = 0$$

$$\text{let } 2^x = t$$

$$t^2 - 24t + 128 = 0$$

$$t^2 - 16t - 8t + 128 = 0$$

$$(t-16)(t-8) = 0$$

$$t = 16, 8$$



$$\Rightarrow 2^x = 16$$

$$2^x = 2^4$$

$$\boxed{x = 4}$$

$$2^x = 8$$

$$2^x = 2^3$$

$$\boxed{x = 3}$$



Find the real roots of the equation  $(x-1)(x-2)(x-3)(x-4) = 3$ .

$$(x-1)(x-2)(x-3)(x-4) = 3$$

$$(x^2 - 5x + 4)(x^2 - 5x + 6) = 3$$

let:  $x^2 - 5x + 4 = t$

$$(t)(t+2) = 3$$

$$t^2 + 2t - 3 = 0$$

$$(t+3)(t-1) = 0$$

$$\boxed{t = -3, 1}$$

Case-1:  $x^2 - 5x + 4 = -3$

$$x^2 - 5x + 7 = 0$$

$$x = \frac{5 \pm \sqrt{25-28}}{2}$$

Case-2

$$x^2 - 5x + 4 = 1$$

$$x^2 - 5x + 3 = 0$$

$$x = \frac{5 \pm \sqrt{25-12}}{2}$$

$$\boxed{x = \frac{5 \pm \sqrt{13}}{2}} \quad \checkmark$$

$\Rightarrow$  No real roots



Let  $-\frac{\pi}{6} < \theta < -\frac{\pi}{12}$  Suppose  $\alpha_1$  and  $\beta_1$  are the roots of the equation  $x^2 - 2x \sec \theta + 1 = 0$  and  $\alpha_2$  and  $\beta_2$  are the roots of the equation  $x^2 + 2x \tan \theta - 1 = 0$ . If  $\alpha_1 > \beta_1$  and  $\alpha_2 > \beta_2$  then  $\alpha_1 + \beta_2$  equals

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A.  $2(\sec \theta - \tan \theta)$ B.  $2 \sec \theta$ ✓ C.  $-2 \tan \theta$ 

D. 0

$$x^2 - 2x \sec \theta + 1 = 0$$

$$x = \frac{2 \sec \theta \pm \sqrt{4 \sec^2 \theta - 4}}{2}$$

$$x = \sec \theta \pm \sqrt{\sec^2 \theta - 1}$$

$$x = \sec \theta \pm |\tan \theta|$$

$$x = \sec \theta + \tan \theta$$

 $\beta_1$ 

$$x = \sec \theta - \tan \theta$$

 $\alpha_1$

$$x^2 + 2x \tan \theta - 1 = 0$$

$$x = \frac{-2 \tan \theta \pm \sqrt{4 \tan^2 \theta + 4}}{2}$$

$$x = -\tan \theta \pm \sqrt{\tan^2 \theta + 1}$$

$$x = -\tan \theta \pm \sec \theta$$

$$\underbrace{x = -\tan \theta + \sec \theta}_{\alpha_2}$$

$$\underbrace{x = -\tan \theta - \sec \theta}_{\beta_2}$$

$$\alpha_1 + \beta_2$$

$$(\sec \theta - \tan \theta)$$

$$+ (-\tan \theta - \sec \theta)$$

$$= \boxed{-2 \tan \theta}$$



## Equation v/s Identity

$ax^2 + bx + c = 0$   
If it has three distinct  
roots.  $\alpha, \beta$  &  $\gamma$

$$a\alpha^2 + b\alpha + c = 0 \quad \text{--- (1)}$$

$$a\beta^2 + b\beta + c = 0 \quad \text{--- (2)}$$

$$a\gamma^2 + b\gamma + c = 0 \quad \text{--- (3)}$$

$$\text{(1) - (2)} \Rightarrow a(\alpha^2 - \beta^2) + b(\alpha - \beta) = 0$$

$$(\alpha - \beta)[a(\alpha + \beta) + b] = 0$$

$$\Rightarrow a(\alpha + \beta) + b = 0 \quad \text{--- (4)}$$



$$\textcircled{2} - \textcircled{3} \Rightarrow a(\beta^2 - \gamma^2) + b(\beta - \gamma) = 0$$

$$(\beta - \gamma)[a(\beta + \gamma) + b] = 0$$

$$\Rightarrow a(\beta + \gamma) + b = 0 \quad \text{---} \textcircled{5}$$

$$\textcircled{4} - \textcircled{5} \Rightarrow a((\cancel{\alpha + \beta}) - (\cancel{\beta + \gamma})) = 0$$

$$a(\alpha - \gamma) = 0$$

$$\boxed{a = 0}$$

using eq<sup>n</sup> ⑤

$$\downarrow$$

$$\boxed{b = 0}$$

& using eq<sup>n</sup> ①

$$\downarrow$$

$$\boxed{c = 0}$$

$\Rightarrow$

$$0 \cdot x^2 + 0 \cdot x + 0 = 0$$



Find the value of “**a**” for which the following equation has more than **two roots**  $(a^2 - 5a + 6)x^2 - (a^2 - 3a + 2)x + 2a - a^2 = 0$

$$(a^2 - 5a + 6)x^2 - (a^2 - 3a + 2)x + (2a - a^2) = 0$$

$$\downarrow$$

$$(a-2)(a-3) = 0$$

$$\boxed{a=2; a=3}$$

$$\downarrow$$

$$(a-1)(a-2) = 0$$

$$a=1, \boxed{a=2}$$

$$\downarrow$$

$$a(2-a) = 0$$

$$a=0; \boxed{a=2}$$





Show that  $\frac{(x-a)(x-b)}{(c-a)(c-b)} + \frac{(x-b)(x-c)}{(a-b)(a-c)} + \frac{(x-c)(x-a)}{(b-c)(b-a)} = 1$  is an identity.

$$\left\{ \begin{array}{l} x=a: \quad 0 + \frac{(a-b)(a-c)}{(a-b)(a-c)} + 0 = 1 \\ x=b: \quad 0 + 0 + \frac{(b-c)(b-a)}{(b-c)(b-a)} = 1 \\ x=c: \quad \frac{(c-a)(c-b)}{(c-a)(c-b)} + 0 + 0 = 1 \end{array} \right.$$





## Relation Between Roots & Coefficients

If  $\alpha$  and  $\beta$ , are the **roots of the quadratic equation**  
 $ax^2 + bx + c = 0$ , then:

$$ax^2 + bx + c = a(x - \alpha)(x - \beta)$$

$$\Rightarrow x^2 + \left(\frac{b}{a}\right)x + \left(\frac{c}{a}\right) = x^2 - \underbrace{\beta x - \alpha x}_{(\alpha + \beta)x} + \alpha\beta$$

$$x^2 + \left(\frac{b}{a}\right)x + \left(\frac{c}{a}\right) = x^2 - (\alpha + \beta)x + (\alpha\beta)$$



$$\begin{cases} \alpha + \beta = -\frac{b}{a} \\ \alpha\beta = \frac{c}{a} \end{cases}$$

$$|\alpha - \beta|$$

$$(\alpha - \beta)^2 = (\alpha + \beta)^2 - 4(\alpha\beta)$$

$$\begin{aligned} (\alpha - \beta)^2 &= \left(-\frac{b}{a}\right)^2 - 4\left(\frac{c}{a}\right) \\ &= \frac{b^2}{a^2} - \frac{4c}{a} \end{aligned}$$

$$\boxed{(\alpha - \beta)^2 = \frac{b^2 - 4ac}{a^2}}$$



## Relation Between Roots & Coefficients

If  $\alpha$  and  $\beta$ , are the **roots of the quadratic equation**  
 **$ax^2 + bx + c = 0$** , then:

★  $\alpha + \beta = \frac{-b}{a}$

★  $\alpha\beta = \frac{c}{a}$

★  $|\alpha - \beta| = \frac{\sqrt{D}}{|a|}$





If  $\alpha$  and  $\beta$  are roots of  $ax^2 + bx + c = 0$ , find the value of following in terms of  $a$ ,  $b$  and  $c$ .

1.  $\frac{1}{\alpha^2} + \frac{1}{\beta^2}$



2.

$$(a\alpha + b)^{-2} + (a\beta + b)^{-2}$$

$$\textcircled{1} \quad \frac{\alpha^2 + \beta^2}{(\alpha\beta)^2}$$

$$= \frac{(\alpha + \beta)^2 - 2(\alpha\beta)}{(\alpha\beta)^2}$$

$$\frac{\left(-\frac{b}{a}\right)^2 - 2\left(\frac{c}{a}\right)}{\left(\frac{c}{a}\right)^2}$$

$$\left(\frac{b^2 - 2ac}{c^2}\right)$$

$$\textcircled{2} (a\alpha + b)^{-2} + (a\beta + b)^{-2}$$

$\cdot \begin{cases} \alpha \text{ \& } \beta \text{ are roots of} \\ ax^2 + bx + c = 0 \end{cases}$   
 $\Rightarrow \begin{cases} a\alpha^2 + b\alpha + c = 0 \\ a\beta^2 + b\beta + c = 0 \end{cases}$

$$= \left(-\frac{c}{\alpha}\right)^{-2} + \left(-\frac{c}{\beta}\right)^{-2}$$

$$= \frac{\alpha^2}{c^2} + \frac{\beta^2}{c^2}$$

$$= \frac{\alpha^2 + \beta^2}{c^2}$$

$$= \frac{(\alpha + \beta)^2 - 2(\alpha\beta)}{c^2}$$



If one root of the equation  $px^2 - 14x + 8 = 0$  is six times the other, then p is equal to :

A. 2

☒ B. 3

C. 1

D. None of these

$(\alpha, 6\alpha)$

$$\begin{aligned} & \text{(*) } px^2 - 14x + 8 = 0 \\ & \text{(*) } \alpha + 6\alpha = \frac{14}{p} \\ & 7\alpha = \frac{14}{p} \\ & \alpha = \frac{2}{p} \\ & \text{(*) } (\alpha)(6\alpha) = \frac{8}{p} \\ & 6\alpha^2 = \frac{8}{p} \\ & 6\left(\frac{4}{p^2}\right) = \frac{8}{p} \\ & \Rightarrow \boxed{p=3} \end{aligned}$$







Let  $\alpha$  and  $\beta$  be the roots of the  $x^2 - 6x - 2 = 0$  with  $\alpha > \beta$ .

If  $a_n = \alpha^n - \beta^n$  for  $n \geq 1$  then the value of

$$\frac{a_{10} - 2a_8}{2a_9}$$

A. 1

B. 2

C. 3

D. 4

$$a_n = \alpha^n - \beta^n$$

$$a_{10} = \alpha^{10} - \beta^{10}$$

$$a_9 = \alpha^9 - \beta^9$$

$$a_8 = \alpha^8 - \beta^8$$

$$\begin{aligned} & \frac{a_{10} - 2a_8}{2a_9} \\ &= \frac{(\alpha^{10} - \beta^{10}) - 2(\alpha^8 - \beta^8)}{2(\alpha^9 - \beta^9)} \end{aligned}$$

$$\begin{aligned} & \begin{cases} \alpha^2 - 6\alpha - 2 = 0 \\ \beta^2 - 6\beta - 2 = 0 \end{cases} \\ & (\alpha^2 - 2) = 6\alpha \\ & (\beta^2 - 2) = 6\beta \end{aligned}$$

$$\frac{(\alpha^{10} - 2\alpha^8) - (\beta^{10} - 2\beta^8)}{2(\alpha^9 - \beta^9)}$$

$$\frac{\alpha^8(\alpha^2 - 2) - \beta^8(\beta^2 - 2)}{2(\alpha^9 - \beta^9)}$$

$$= \frac{\alpha^8(6\alpha) - \beta^8(6\beta)}{2(\alpha^9 - \beta^9)}$$

$$\frac{6(\cancel{\alpha^9} - \cancel{\beta^9})}{2(\cancel{\alpha^9} - \cancel{\beta^9})}$$

$$= 3$$



Find  $k$  in the equation  $5x^2 - kx + 1 = 0$  such that the **difference between the roots** of the equation is unity.

one

$$|\alpha - \beta| = 1$$

$$(\alpha - \beta)^2 = 1$$

$$(\alpha + \beta)^2 - 4(\alpha\beta) = 1 = \overset{K}{\pm 3\sqrt{5}}$$

$$\left(\frac{K}{5}\right)^2 - 4\left(\frac{1}{5}\right) = 1$$

$$\frac{K^2}{25} = \frac{9}{5} \Rightarrow K^2 = 45$$





If c, d are the **roots of the equation**  $(x - a)(x - b) - k = 0$ ,  
Then a, b are the roots of the equation:

A.  $(x - c)(x - d) - k = 0$

✓ B.  $(x - c)(x - d) + k = 0$

C.  $(x - c)(x - d) + 2k = 0$

D. None of these

$$(x - a)(x - b) - k = (x - c)(x - d)$$

$$\Rightarrow (x - c)(x - d) + k = (x - a)(x - b)$$





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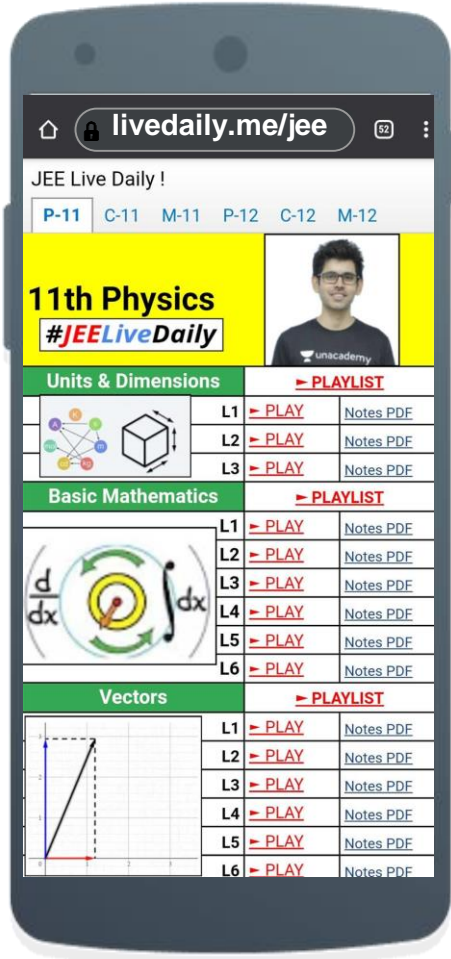


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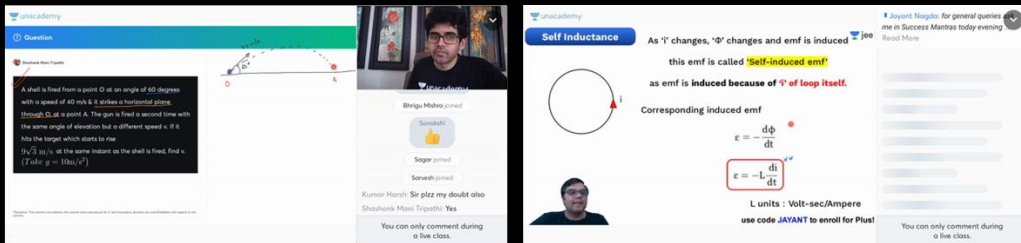
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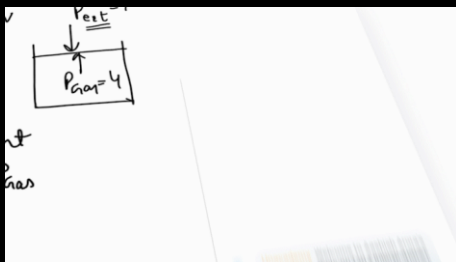
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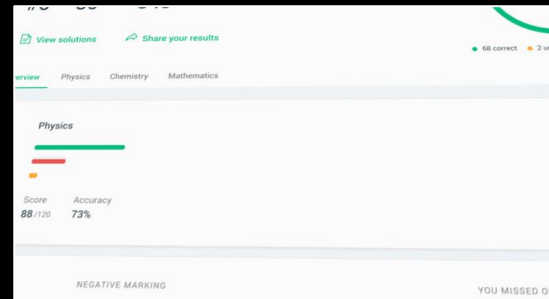
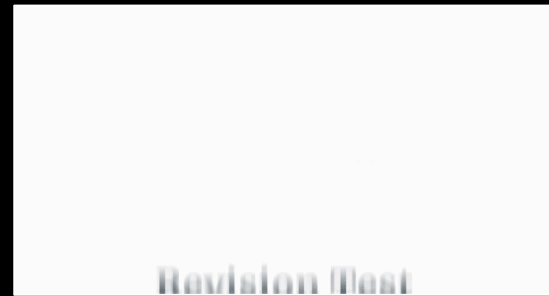


The image shows two screenshots from the Unacademy live class interface. The left screenshot displays a physics problem: "A shell is fired from a point O at an angle of 60 degrees with a speed of 40 m/s. It strikes a horizontal plane through O at a point A. The gun is fired a second time with the same angle of elevation but a different speed  $v$ . If it hits the target which starts to rise  $(\sqrt{3}/2) \text{ m/s}^2$  at the same instant as the shell is fired, find  $v$ . (Take  $g = 10 \text{ m/s}^2$ )". The right screenshot shows a lecture on "Self Inductance" with the text: "As  $\vec{I}$  changes,  $\vec{\Phi}$  changes and emf is induced. This emf is called **Self-induced emf** as emf is induced because of  $\vec{I}$  of loop itself." It also includes the formula for induced emf:  $\mathcal{E} = -\frac{d\Phi}{dt}$  and  $\mathcal{E} = -L \frac{di}{dt}$ , and mentions "L units: Volt-sec/Ampere" and "use code JAYANT to enroll for Plus!".



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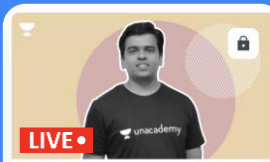


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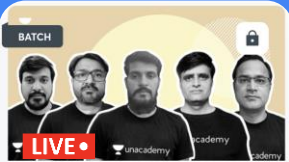
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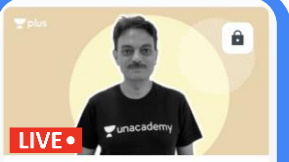
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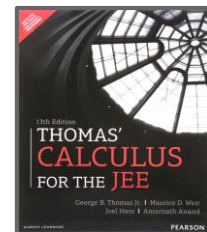
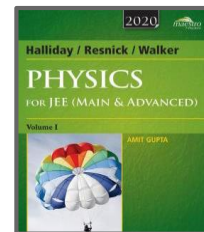
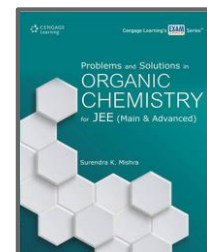
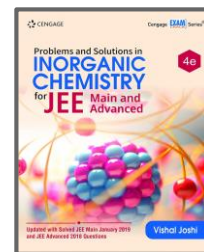
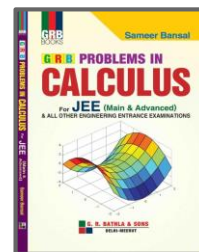
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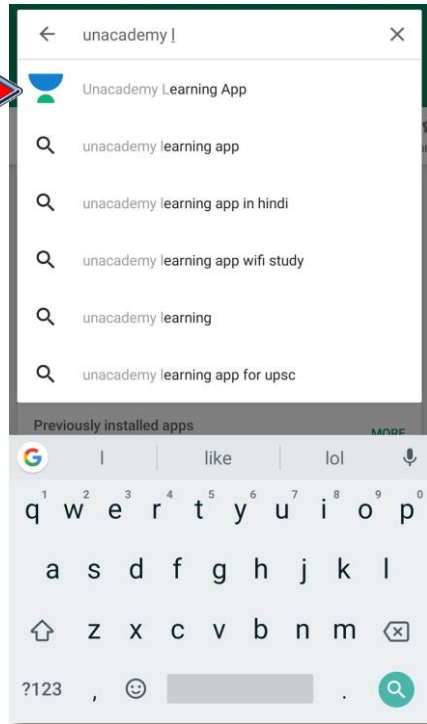


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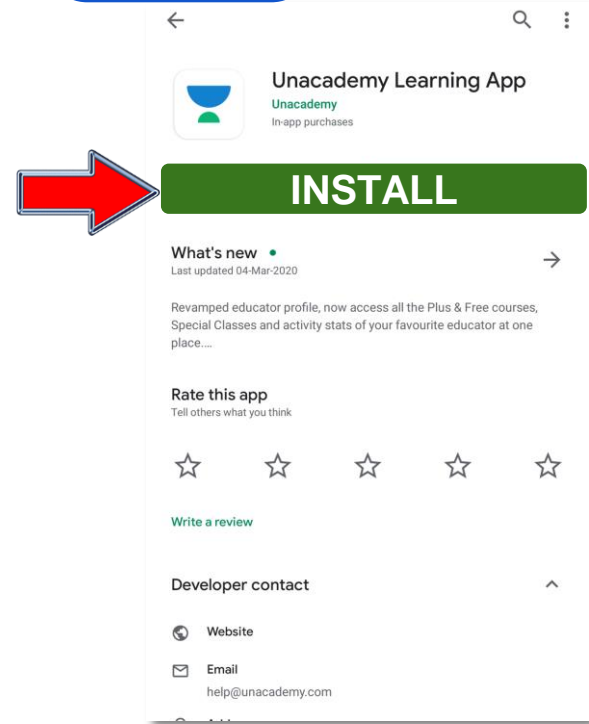


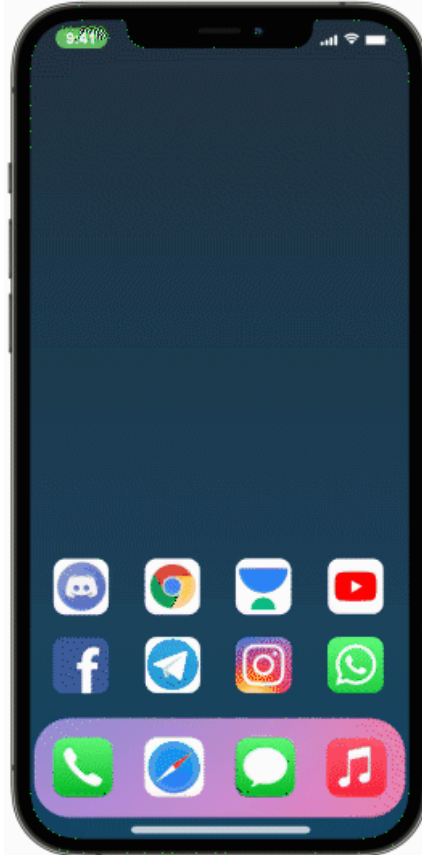
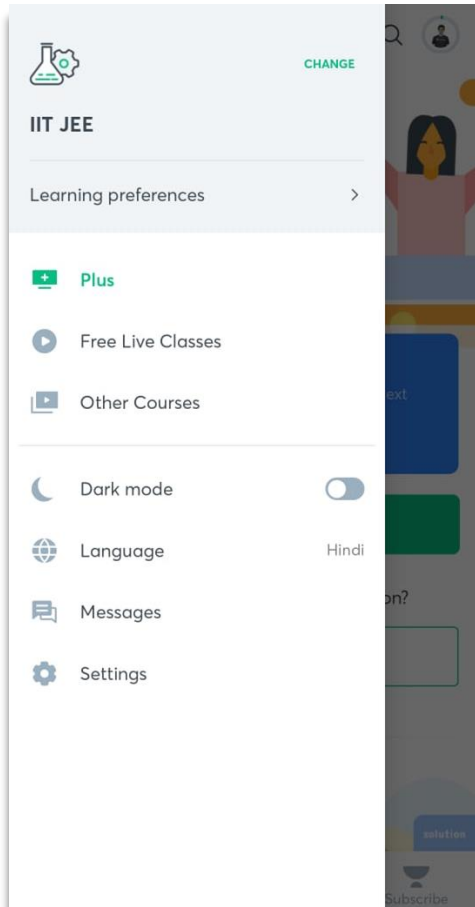
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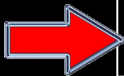
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**Emerge Batch (Class 11th) : JEE Main & Advanced 2023**  Starts on **8th June 2021**

**Evolve Batch (Class 12th) : JEE Main & Advanced 2022**  Starts on **9th June 2021**

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