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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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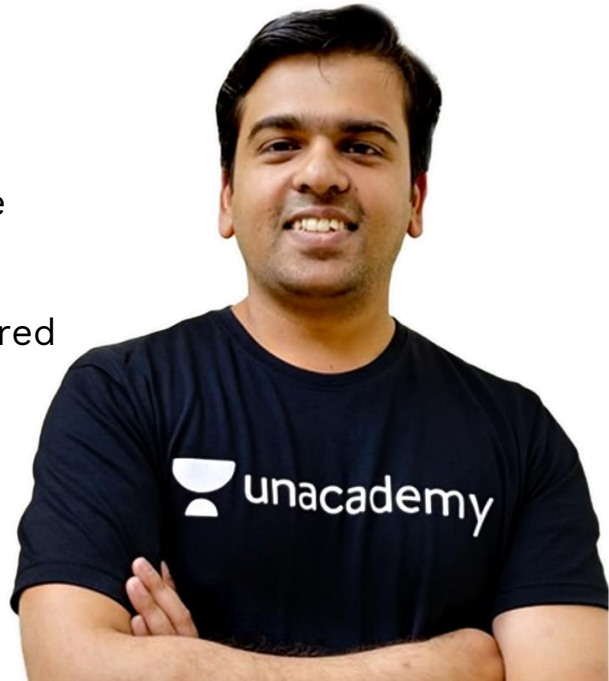
Sameer Chincholikar

B.Tech, M.Tech - IIT-Roorkee

- **10+** years Teaching experience
- Taught **1 Million+** Students
- **100+** Aspiring Teachers Mentored



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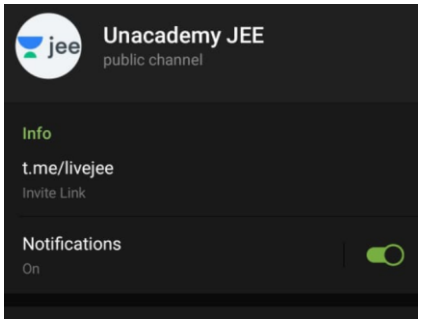

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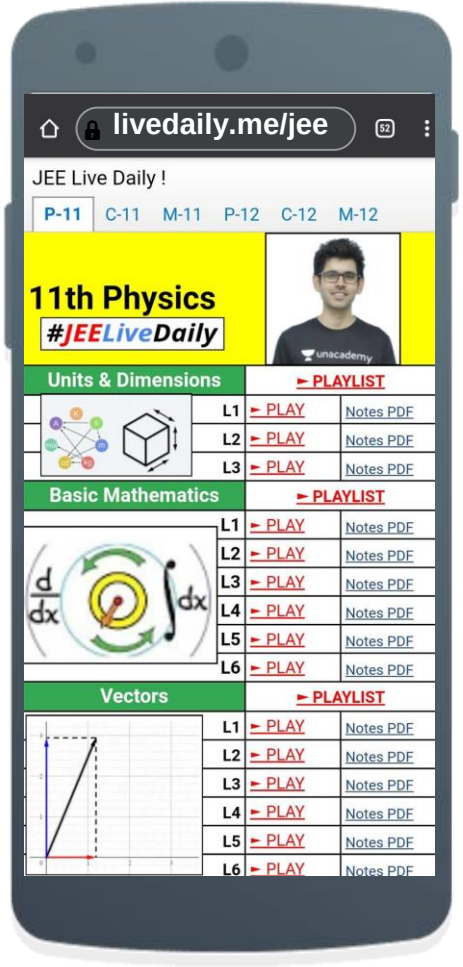

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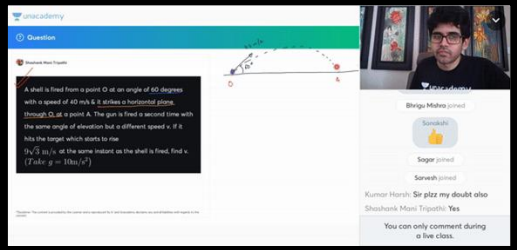

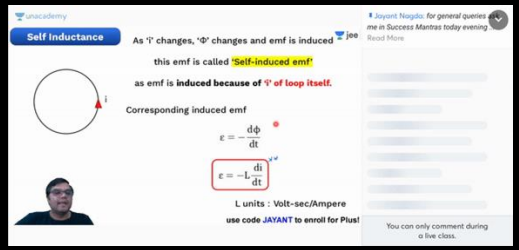

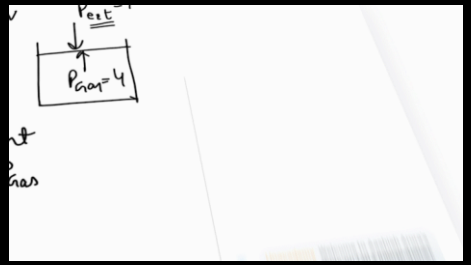

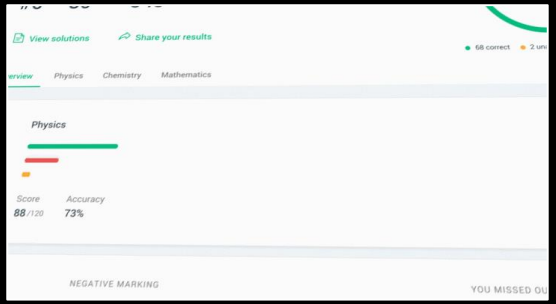

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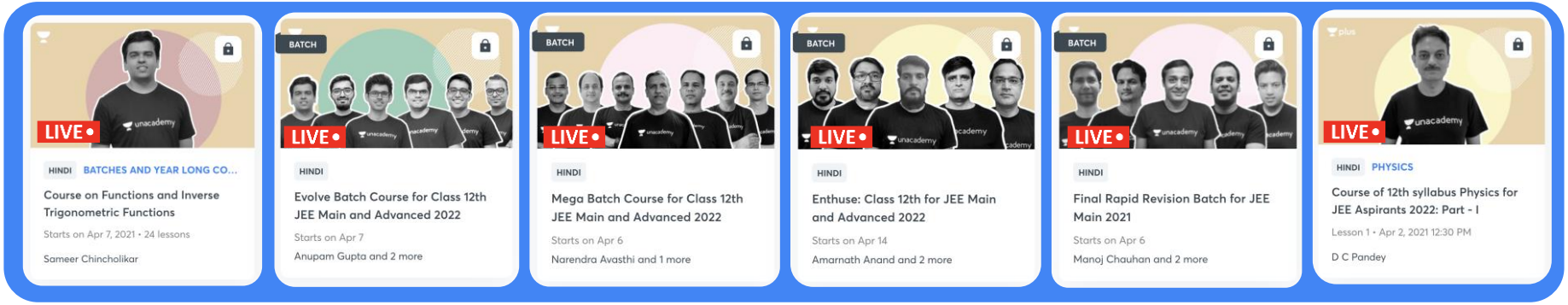

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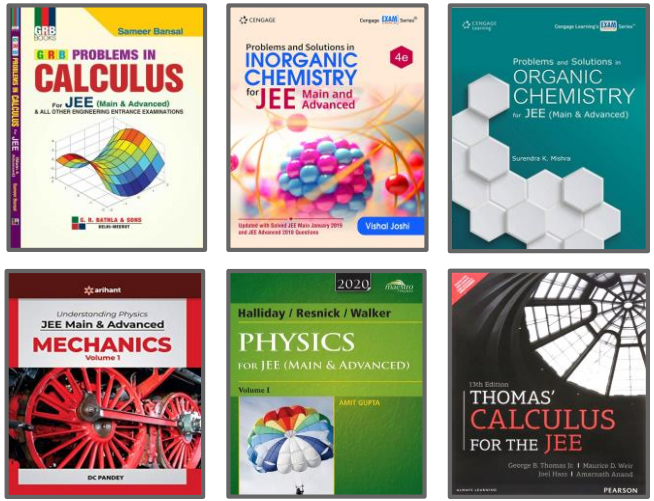

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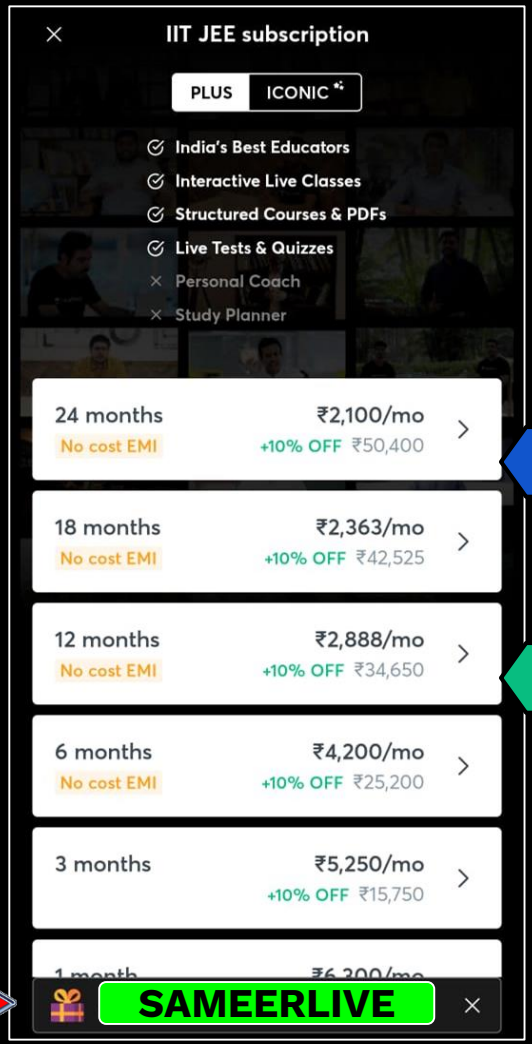

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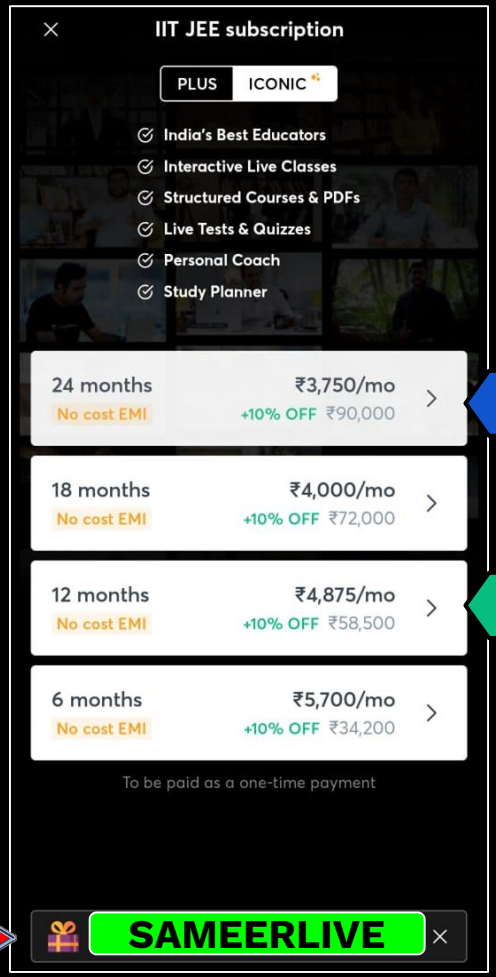

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LET'S BEGIN!!

Quadratic Equation

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

NOTE: Quadratic Equation has 2 roots. Always.

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

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

$x = 2$ $\quad$ $x = 3$

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 $4^x - 3.2^{x+3} + 128 = 0$ are :

A. 4 and 5

B. 3 and 4

C. 2 and 3

D. 1 and 2

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

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

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

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

$x = \frac{5 \pm \sqrt{25-28}}{2} \Rightarrow$ No real roots

Case-2

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

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

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

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

Let $-\frac{\pi}{6} < \theta < -\frac{\pi}{12}$ Suppose α_1 and β_1 are the roots of the equation $x^2 - 2x \sec\theta + 1 = 0$ and α_2 and β_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

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

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

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

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

$x = \sec\theta + \tan\theta$ (β_1)

$x = \sec\theta - \tan\theta$ (α_1)

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

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

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

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

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

α_2 $\quad$ β_2

$$\alpha_1 + \beta_2$$

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

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

Equation v/s Identity

$$\begin{cases} ax^2+bx+c=0 \\ \text{If it has three distinct} \\ \text{roots. } \alpha, \beta \& \gamma \end{cases}$$

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

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

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

$$(1)-(2): a(\alpha^2-\beta^2)+b(\alpha-\beta)=0$$

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

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

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② − ③ : $a(\beta^2-\gamma^2)+b(\beta-\gamma)=0$

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

$\Rightarrow a(\beta+\gamma)+b=0$ — ⑤

④ − ⑤ : $a((\alpha+\beta)-(\beta+\gamma))=0$

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

$\boxed{a=0}$

using eqn ⑤ ↓ $\boxed{b=0}$

& using eqn ① ↓ $\boxed{c=0}$

$\Rightarrow$

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

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

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

$(a-2)(a-3)=0$ $\quad$ $(a-1)(a-2)=0$ $\quad$ $a(2-a)=0$

$a=2, a=3$ $\quad$ $a=1, a=2$ $\quad$ $a=0, a=2$

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.

$x = a$: $0 + \frac{(a-b)(a-c)}{(a-b)(a-c)} + 0 = 1$

$x = b$: $0 + 0 + \frac{(b-c)(b-a)}{(b-c)(b-a)} = 1$

$x = c$: $\frac{(c-a)(c-b)}{(c-a)(c-b)} + 0 + 0 = 1$

Relation Between Roots & Coefficients

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

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

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

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

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

$|\alpha-\beta|$

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

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

$$= \frac{b^2}{a^2} - \frac{4c}{a}$$

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

Relation Between Roots & Coefficients

If **α and β**, 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 α and β 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. $(a\alpha + b)^{-2} + (a\beta + b)^{-2}$

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

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

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

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

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

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

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

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

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

- α & β are roots of $ax^2+bx+c=0$

$a\alpha^2+b\alpha+c=0$

$a\beta^2+b\beta+c=0$

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

$(\alpha, 6\alpha)$

$px^2 - 14x + 8 = 0$

(*)

$\alpha + 6\alpha = \frac{14}{p}$

$7\alpha = \frac{14}{p}$

$\alpha = \frac{2}{p}$

(*)

$(\alpha)(6\alpha) = \frac{8}{p}$

$6\alpha^2 = \frac{8}{p}$

$6\left(\frac{4}{p^2}\right) = \frac{8}{p}$

$\Rightarrow p = 3$

Let α and β 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 $\dfrac{a_{10} - 2a_8}{2a_9}$

A. 1 **B.** 2 **C.** 3 **D.** 4

$$\alpha^2 - 6\alpha - 2 = 0$$
$$\beta^2 - 6\beta - 2 = 0$$
$$(\alpha^2 - 2) = 6\alpha$$
$$(\beta^2 - 2) = 6\beta$$

$$a_n = \alpha^n - \beta^n$$
$$a_{10} = \alpha^{10} - \beta^{10}$$
$$a_9 = \alpha^9 - \beta^9$$
$$a_8 = \alpha^8 - \beta^8$$

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

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

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

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

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

$$= 3$$

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

one

$|\alpha - \beta| = 1$

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

$(\alpha+\beta)^2 - 4(\alpha\beta) = 1$

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

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

$k = \pm 3\sqrt{5}$

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

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

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

#JEELiveDaily Schedule

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11th

Namo Sir | Physics

6:00 - 7:30 PM

Ashwani Sir | Chemistry

7:30 - 9:00 PM

Sameer Sir | Maths

9:00 - 10:30 PM

12th

Jayant Sir | Physics

1:30 - 3:00 PM

Anupam Sir | Chemistry

3:00 - 4:30 PM

Nishant Sir | Maths

4:30 - 6:00 PM

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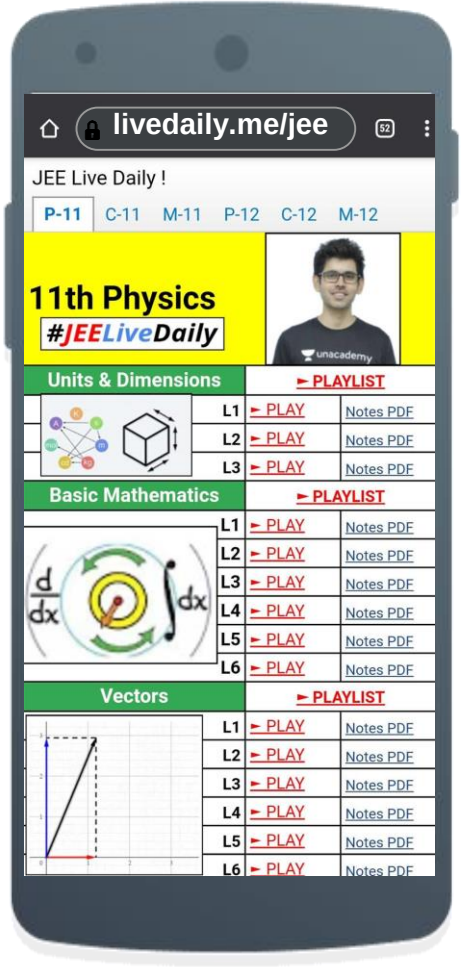

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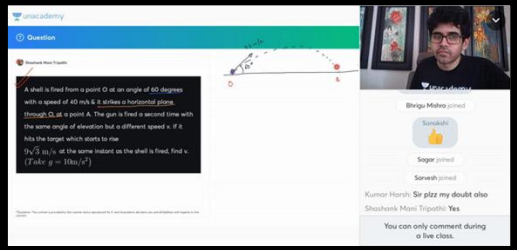

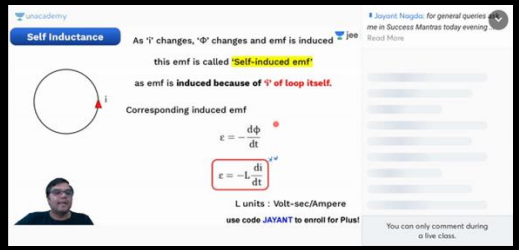

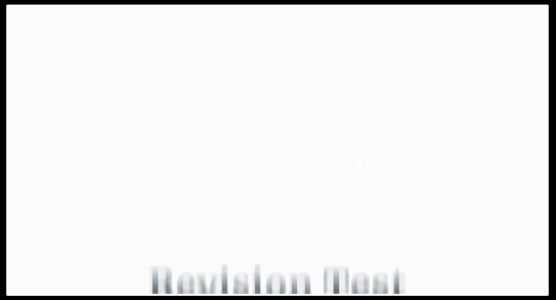

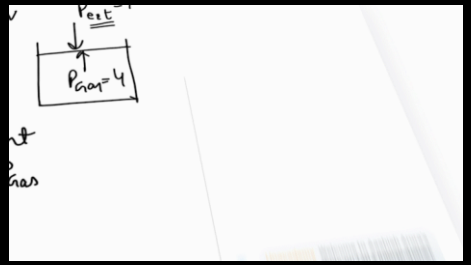

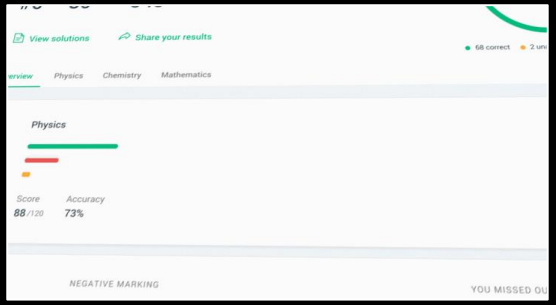

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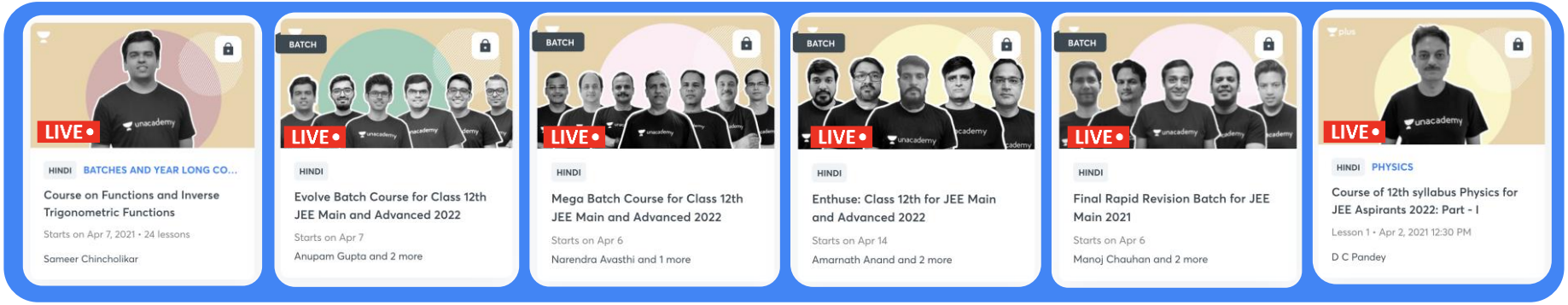

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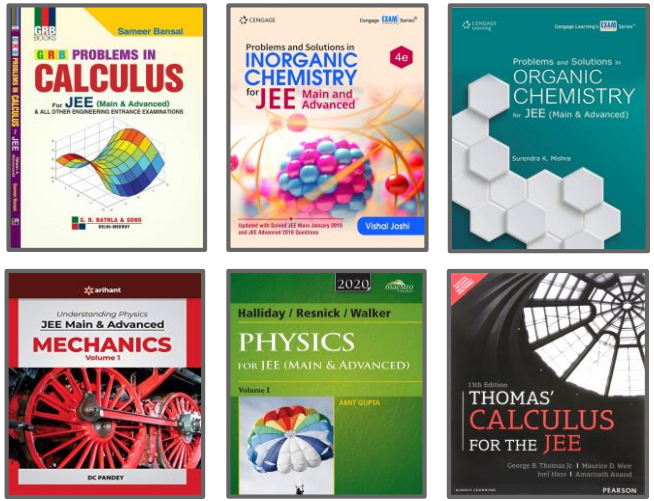

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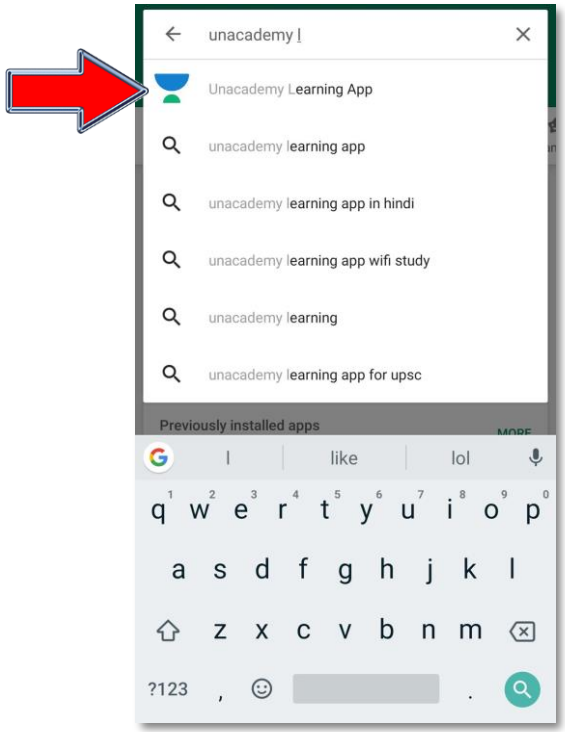
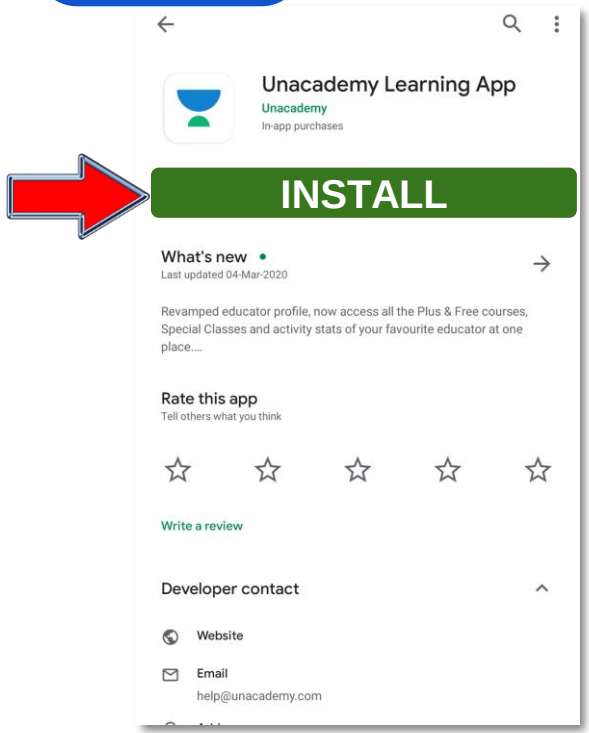
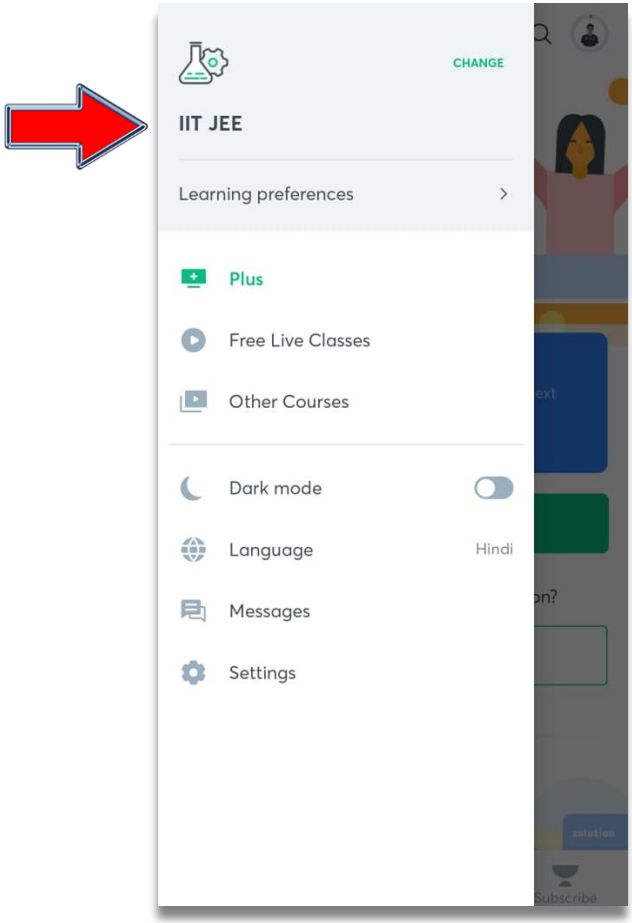
Step 1



Step 2

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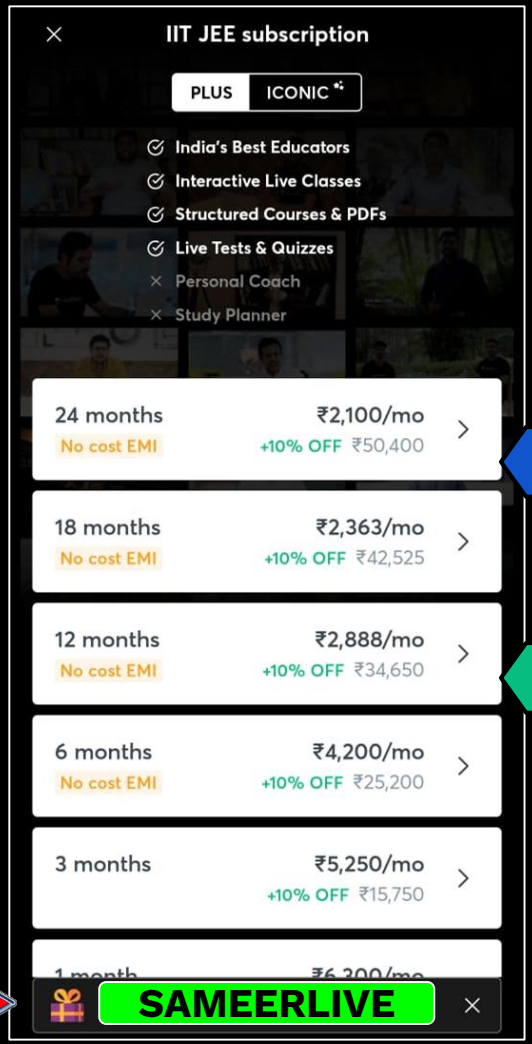

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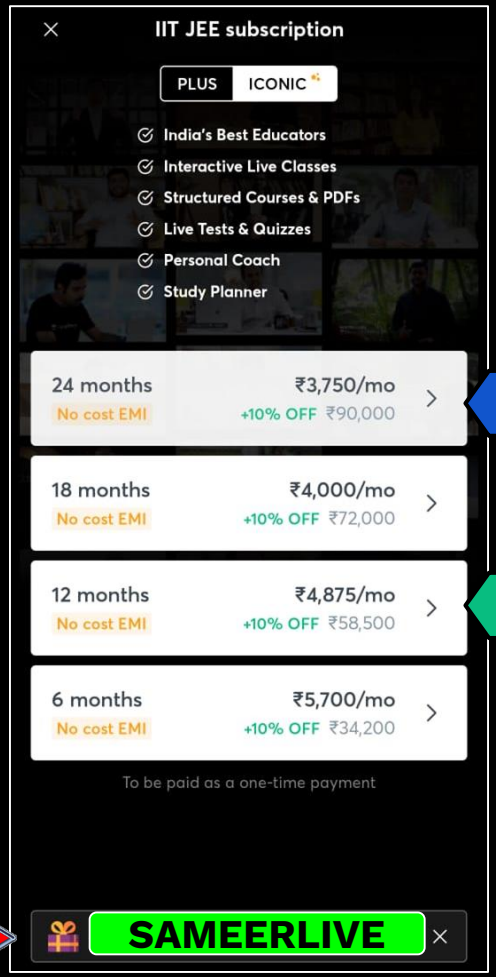

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