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Formation of Quadratic and Theory of Equations

Quadratic Equations

2

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

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

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

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B.Tech, M.Tech - IIT-Roorkee

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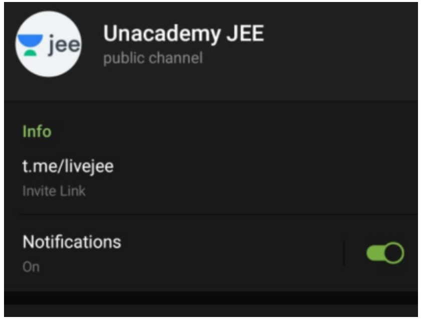

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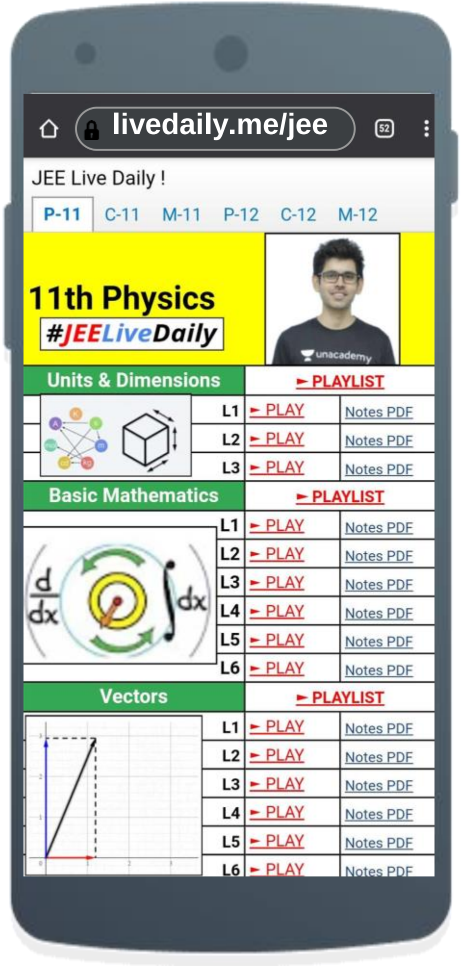

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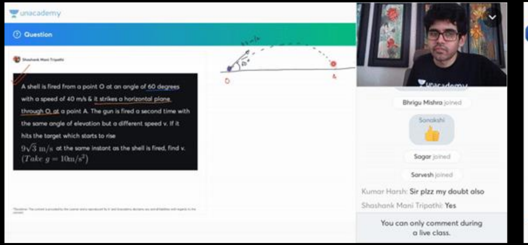

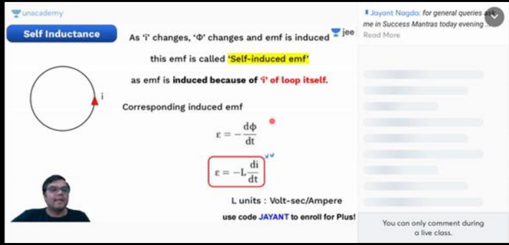

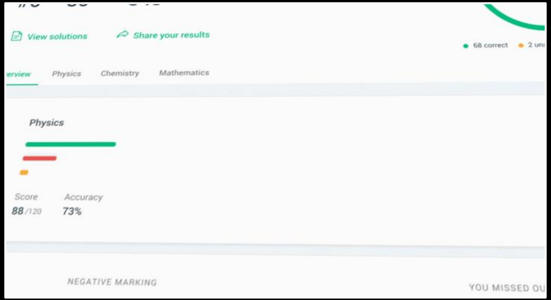

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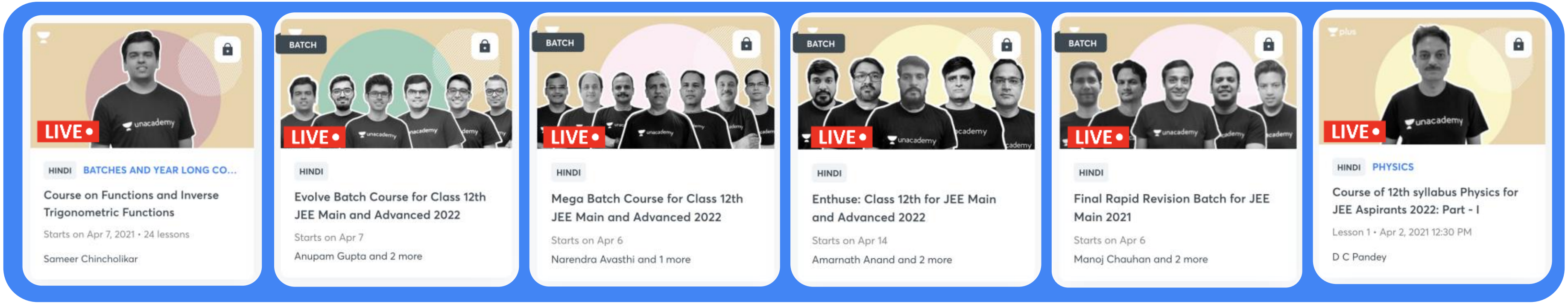

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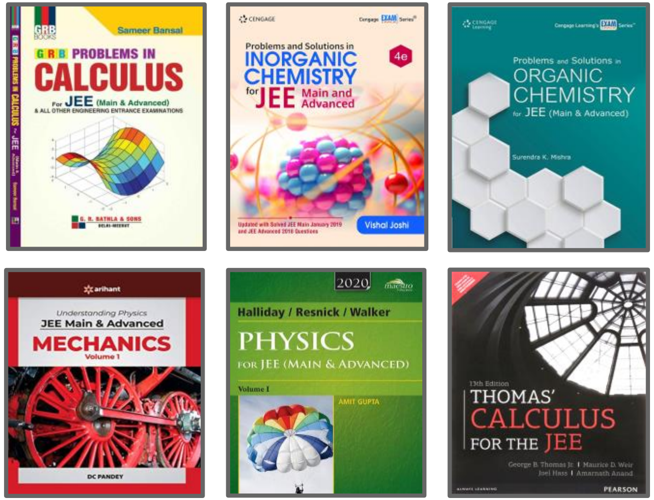


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LET'S BEGIN!!

Formation of Quadratic Equation

Formation of Quadratic Equation

A quadratic equation whose roots are α and β, is $(x - \alpha)(x - \beta) = 0$

i.e. $x^2 -$ (sum of roots) $x +$ (product of roots) $= 0$

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

If **(α, β)** are the roots of the quadratic equation **$ax^2 + bx + c = 0$** then find the **quadratic equation** whose roots are **$(2\alpha, 2\beta)$**

$$ax^2+bx+c=0 \; ; \; (\alpha,\beta) \Rightarrow \begin{cases} \alpha+\beta = \dfrac{-b}{a} \\ \alpha\beta = \dfrac{c}{a} \end{cases}$$

New Eqⁿ:

$$\left(\text{Sum of roots}\right) = 2\alpha+2\beta = 2(\alpha+\beta) = \left(-\frac{2b}{a}\right)$$

$$\left(\text{Prod. of roots}\right) = (2\alpha)(2\beta) = 4(\alpha\beta) = \left(\frac{4c}{a}\right)$$

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The new Eq^n is:

$$x^2 - \left(\frac{-2b}{a}\right)x + \frac{4c}{a} = 0$$

$$\boxed{ax^2 + 2bx + 4c = 0}$$

M-2: (α, β) are roots of

$$ax^2 + bx + c = 0$$

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

Now:

$$x = 2\alpha$$

$$\Rightarrow \alpha = \frac{x}{2}$$

$$\Rightarrow a\left(\frac{x}{2}\right)^2 + b\left(\frac{x}{2}\right) + c = 0$$

$$\Rightarrow \boxed{ax^2 + 2bx + 4c = 0}$$

Let α **and** β, be the roots of the quadratic equation $ax^2 + bx + c = 0$, $c \neq 0$. Find the **quadratic equation** whose roots are

$$\frac{1-\alpha}{\alpha} \text{ and } \frac{1-\beta}{\beta}$$

M-2

$\because$ α & β are roots of $ax^2+bx+c=0$

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

Now:

$$x = \frac{1-\alpha}{\alpha}$$

$$x = \frac{1}{\alpha} - 1$$

$$\frac{1}{\alpha} = x+1$$

$$\boxed{\alpha = \frac{1}{x+1}}$$

use in Eqⁿ ①.

$$a\left(\frac{1}{x+1}\right)^2 + b\left(\frac{1}{x+1}\right) + c = 0$$

$$a + b(x+1) + c(x+1)^2 = 0$$

$$\boxed{cx^2 + (b+2c)x + (a+b+c) = 0}$$

If (α, β) are the roots of the quadratic equation $ax^2 + bx + c = 0$ then find the **quadratic equation** whose roots are $\left(\frac{\alpha}{\beta}, \frac{\beta}{\alpha}\right)$

M-1

$$\text{Sum} = \frac{\alpha}{\beta} + \frac{\beta}{\alpha}$$

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

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

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

$$= \boxed{\frac{b^2 - 2ac}{ac}}$$

Product

$$= \left(\frac{\alpha}{\beta}\right)\left(\frac{\beta}{\alpha}\right)$$

$$= 1$$

$\therefore$ Req. Eq^n:

$$x^2 - \left(\frac{b^2-2ac}{ac}\right)x + 1 = 0$$

$$\boxed{acx^2 - (b^2-2ac)x + ac = 0}$$

M-2:

$$\left(\frac{\alpha}{\beta}, \frac{\beta}{\alpha}\right) = \left(\frac{\alpha^2}{\alpha\beta}, \frac{\beta^2}{\alpha\beta}\right)$$

$$= \left(\frac{\alpha^2}{(c/a)}, \frac{\beta^2}{(c/a)}\right)$$

Now:

$$x = \frac{\alpha^2}{(c/a)}$$

$$\alpha^2 = \frac{cx}{a}$$

$$\boxed{\alpha = \sqrt{\frac{cx}{a}}}$$

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Now,

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

$$a\left(\sqrt{\frac{cx}{a}}\right)^2+b\left(\sqrt{\frac{cx}{a}}\right)+c=0$$

$$\frac{\cancel{a}cx}{\cancel{a}}+c=-b\sqrt{\frac{cx}{a}}$$

$$c^{\cancel{2}}(x+1)^2=\frac{b^2\cancel{c}x}{a}$$

$$ac(x^2+2x+1)=b^2x$$

$$\boxed{acx^2+(2ac-b^2)x+(ac)=0}$$

If $\alpha \neq \beta$, but $\alpha^2 = 5\alpha - 3$, $\beta^2 = 5\beta - 3$, then the equation whose roots are α / β and β / α is :

A. $x^2 - 5x - 3 = 0$

B. $3x^2 - 19x + 3 = 0$

C. $3x^2 - 12x - 3 = 0$

D. None of these

$$\begin{cases} \alpha^2 - 5\alpha + 3 = 0 \\ \beta^2 - 5\beta + 3 = 0 \end{cases}$$

$\Rightarrow$ α & β are roots of

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

Now.

$\boxed{\alpha + \beta = 5 \; ; \; \alpha\beta = 3}$

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

$\frac{19}{3}$

$$\text{Prod} = \left(\frac{\alpha}{\beta}\right)\left(\frac{\beta}{\alpha}\right) = 1$$

The quadratic equation $x^2 + mx + n = 0$ has roots which are twice those of $x^2 + px + m = 0$ and m, n and $p \neq 0$. Find the value of $\boxed{n/p}$.

$\rightarrow x^2 + mx + n = 0$, $(2\alpha, 2\beta)$

$\boxed{x^2 + px + m = 0}$, (α, β)

New Eqn $(2\alpha, 2\beta)$

$x = 2\alpha \Rightarrow \alpha = \frac{x}{2}$

$\boxed{\alpha^2 + p\alpha + m = 0}$

$\left(\frac{x}{2}\right)^2 + p\left(\frac{x}{2}\right) + m = 0$

$\boxed{x^2 + (2p)x + (4m) = 0}$ —— (1)

But Eqn with roots $(2\alpha, 2\beta)$

is $\boxed{x^2 + mx + n = 0}$ — (2)

On comparing Eqn (1) & (2).

$m = 2p \Rightarrow p = m/2$

$n = 4m \Rightarrow n = 4m$

$\Rightarrow \dfrac{n}{p} = \dfrac{4m}{m/2} = 8$

If α, β are the roots of equation, $x^2 - 2x + 3 = 0$, find the **equation whose roots** are $\alpha^3 - 3\alpha^2 + 5\alpha - 2$ and $\beta^3 - \beta^2 + \beta + 5$

$x^2 - 2x + 3 = 0$; (α, β)

$$\begin{cases} \alpha^2 - 2\alpha + 3 = 0 \\ \beta^2 - 2\beta + 3 = 0 \end{cases}$$

$\boxed{\alpha^3} - 2\alpha^2 + 3\alpha = 0$

Now.

$\alpha^3 - 3\alpha^2 + 5\alpha - 2$

$(2\alpha^2 - 3\alpha) - 3\alpha^2 + 5\alpha - 2$

$\underbrace{-\alpha^2 + 2\alpha}_{3} - 2$

$3 - 2 = 1$

Now.

$$\underbrace{\beta^3}_{\downarrow} - \beta^2 + \beta + 5$$

$$(2\beta^2 - 3\beta) - \beta^2 + \beta + 5$$

$$\underbrace{\beta^2 - 2\beta}_{\downarrow} + 5$$

$$-3 + 5 = 2$$

New Eqⁿ is.

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

Theory of Equations (Relation between roots and coefficients)

1. Quadratic Equation

$\sum \alpha = \alpha + \beta = -\frac{b}{a}$ — 1

$\sum \alpha\beta = \alpha\beta = \frac{c}{a}$ — 2

$ax^2 + bx + c = 0$

$\downarrow$

(α, β)

2. Cubic Equation

For: $ax^3+bx^2+cx+d=0$

has three roots: (α, β, γ)

$$ax^3+bx^2+cx+d = a\left[(x-\alpha)(x-\beta)(x-\gamma)\right]$$

$$x^3+\left(\frac{b}{a}\right)x^2+\left(\frac{c}{a}\right)x+\left(\frac{d}{a}\right) = x^3-(\alpha+\beta+\gamma)x^2 + (\alpha\beta+\beta\gamma+\gamma\alpha)x-\alpha\beta\gamma$$

$\alpha+\beta+\gamma=-\frac{b}{a}$ —— (1)

$\alpha\beta+\beta\gamma+\gamma\alpha=\frac{c}{a}$ — (2)

$\alpha\beta\gamma=-\frac{d}{a}$ —— (3)

$\sum\alpha=-\frac{b}{a}$

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

$\sum\alpha\beta\gamma=-\frac{d}{a}$

If $2x^3 + mx^2 - 13x + n = 0$ has roots **2 and 3,** then the **value of m and n** are:

A. -10, 50 **B.** -5, 30 ✓ **C.** 5, 30 **D.** None of these

$(\alpha, 2, 3)$

$2x^3 + mx^2 - 13x + n = 0$

$\alpha + 2 + 3 = -\frac{m}{2}$

$2\alpha + 6 + 3\alpha = -\frac{13}{2} \rightarrow 5\alpha = -\frac{25}{2} \Rightarrow \boxed{\alpha = -\frac{5}{2}}$

$(\alpha)(2)(3) = -\frac{n}{2}$

$$\begin{cases} -\dfrac{5}{2}+5=-\dfrac{m}{2} \\ \dfrac{5}{2}=-\dfrac{m}{2} \\ \boxed{m=-5} \end{cases}$$

&

$$-\dfrac{5}{\cancel{2}}\times 6=-\dfrac{n}{\cancel{2}}$$

$$\boxed{n=30}$$

M-2

$$\begin{cases} 2(2)^3+m(2)^2-13(2)+n=0 \\ 2(3)^3+m(3)^2-13(3)+n=0 \end{cases}$$

solve: $\begin{cases} m=? \\ n=? \end{cases}$

3. Equation of degree 'n'

If $\alpha_1, \alpha_2, \alpha_3, \ldots\ldots\ldots \alpha_n$ are the roots of the equation;

$$f(x) = a_0x^n + a_1x^{n-1} + a_2x^{n-2} + \ldots.. + a_{n-1}x + a_n = 0$$

where $a_0, a_1, \ldots.\ a_n$ are all real & $a_0 \neq 0$ then,

$$a_0x^n + a_1x^{n-1} + a_2x^{n-2} + \cdots + a_n = 0$$

has roots, $\alpha_1, \alpha_2, \alpha_3 \cdots \alpha_n$

$$a_0x^n + a_1x^{n-1} + a_2x^{n-2} + \cdots + a_n$$

$$= a_0(x-\alpha_1)(x-\alpha_2)(x-\alpha_3)\cdots(x-\alpha_n)$$

$$x^n + \left(\frac{a_1}{a_0}\right)x^{n-1} + \left(\frac{a_2}{a_0}\right)x^{n-2} + \cdots + \left(\frac{a_n}{a_0}\right)$$

$$= x^n - (\alpha_1+\alpha_2\cdots+\alpha_n)x^{n-1} + \left(\sum \alpha_1\alpha_2\right)x^{n-2}$$

2. Equation of degree 'n'

If $\alpha_1, \alpha_2, \alpha_3, \ldots\ldots\ldots \alpha_n$ are the roots of the equation;

$$f(x) = a_0x^n + a_1x^{n-1} + a_2x^{n-2} + \ldots\ldots + a_{n-1}x + a_n = 0$$

where $a_0, a_1, \ldots\ldots a_n$ are all real & $a_0 \neq 0$ then,

$$\sum \alpha_1 = -\frac{a_1}{a_0}$$

$$\sum \alpha_1 \alpha_2 = +\frac{a_2}{a_0}$$

$$\sum \alpha_1 \alpha_2 \alpha_3 = -\frac{a_3}{a_0}$$

$$\vdots$$

$$\alpha_1 \alpha_2 \alpha_3 \ldots\ldots\ldots \alpha_n = (-1)^n \frac{a_n}{a_0}$$

If α, β, γ are the roots of the cubic $x^3 + qx + r = 0$ then find the **equation** whose roots are $\alpha + \beta, \beta + \gamma, \gamma + \alpha$.

$$x^3 + qx + r = 0 \; ; \; (\alpha, \beta, \gamma)$$

$$(-\gamma, -\alpha, -\beta)$$

$$\boxed{\alpha^3 + q\alpha + r = 0}$$

$$\begin{cases} \alpha + \beta + \gamma = 0 \\ \alpha\beta + \beta\gamma + \gamma\alpha = q \\ \alpha\beta\gamma = -r \end{cases}$$

$$x = -\alpha$$

$$\boxed{\alpha = -x}$$

$$(-x)^3 + q(-x) + r = 0$$

$$-x^3 - qx + r = 0$$

$$\boxed{x^3 + qx - r = 0}$$

If α, β, γ are the roots of the cubic $x^3 + qx + r = 0$ then find the **equation** whose roots are $\alpha\beta, \beta\gamma, \gamma\alpha$.

H.W - 1

If $x^2 - 3x + 2$ is one of the **factors** of the expression $x^4 - px^2 + q$, then:

A. $p = 4, q = 5$

B. $p = 5, q = 4$

C. $p = -5, q = -4$

D. None of these

HW. 2

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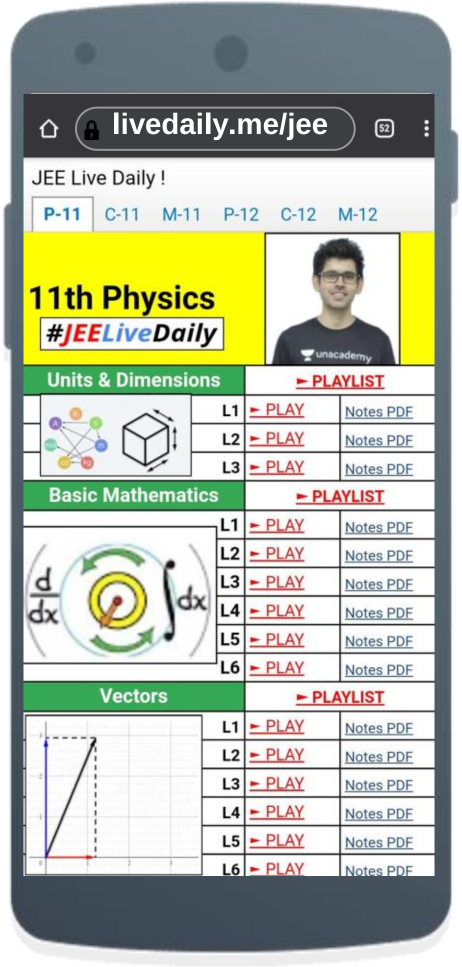

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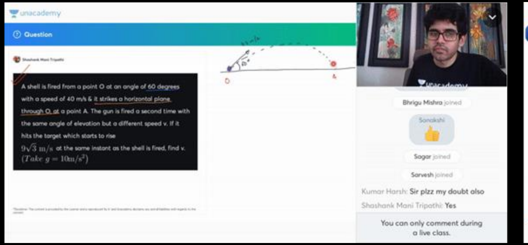

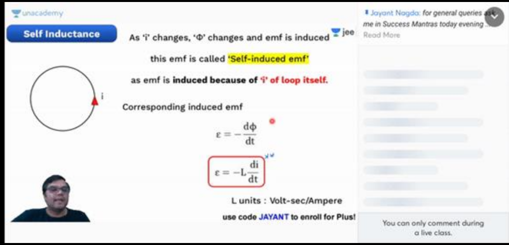

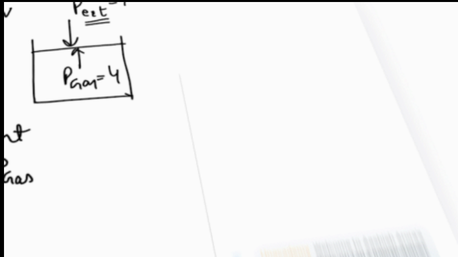

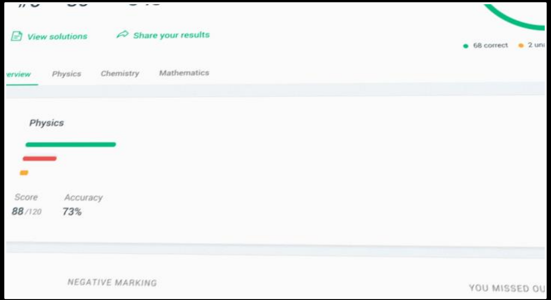

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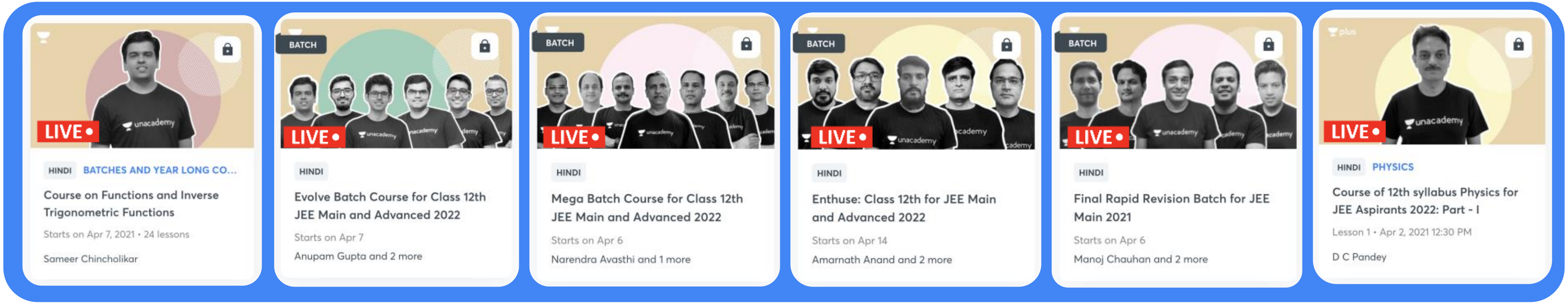

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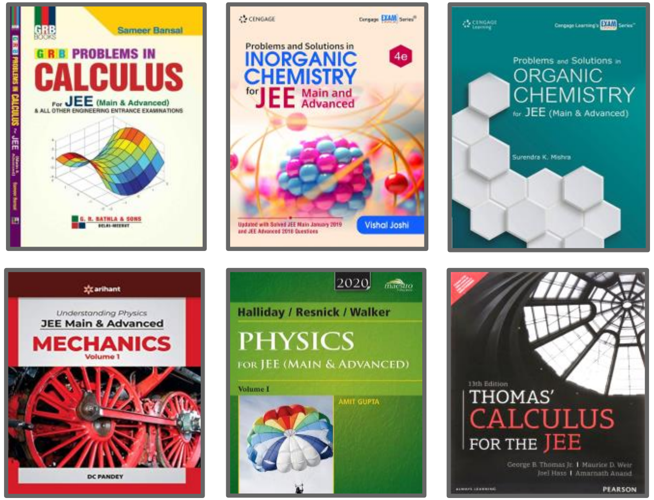


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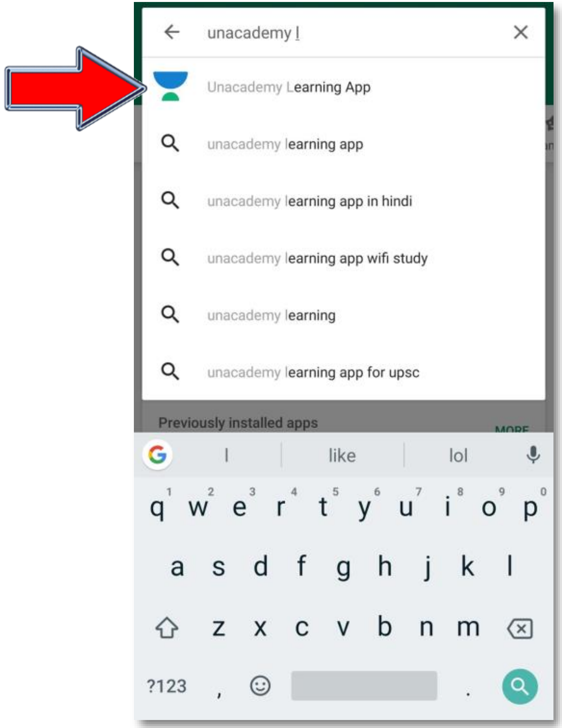
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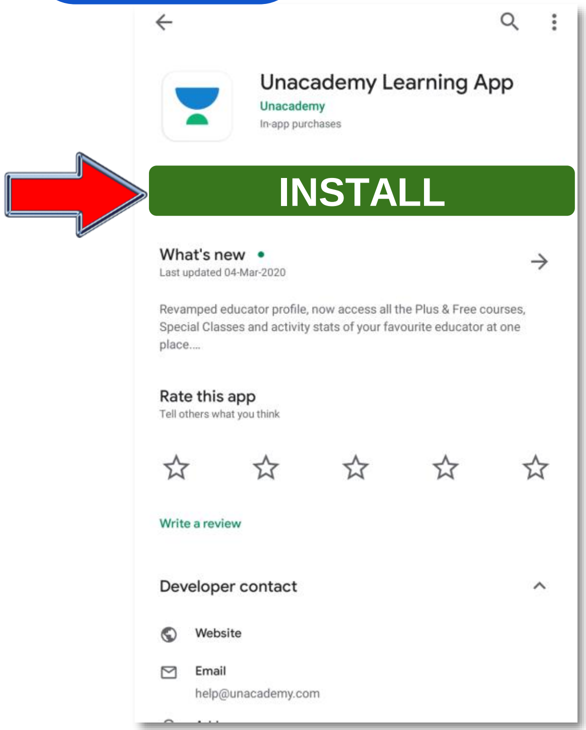
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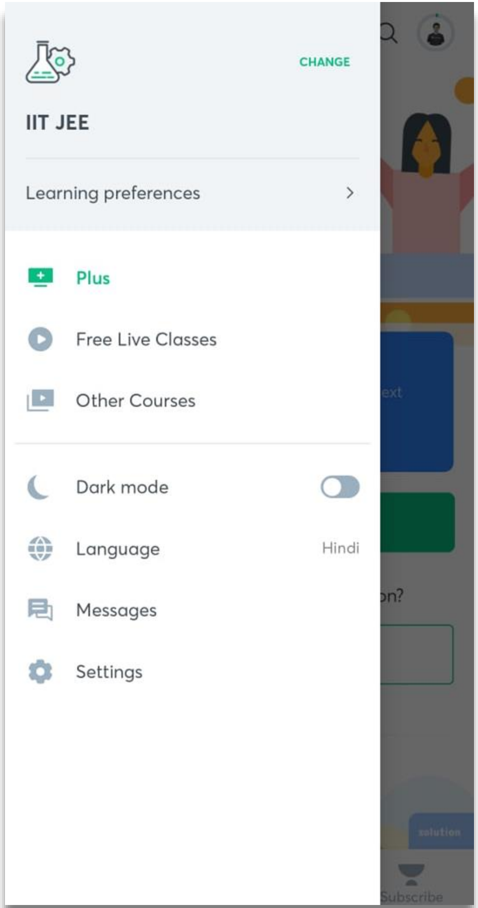
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JEE Main & Advanced 2023
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Upcoming Batches in June

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Evolve Batch (Class 12th) : JEE Main & Advanced 2022 — Starts on 2nd June 2021

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

All Stars Batch : JEE Main 2021 — Starts on 9th June 2021

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