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Range of T-Expressions

Trigonometry

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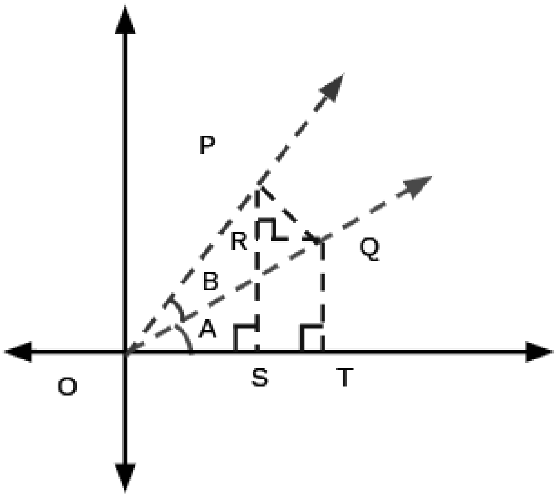

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B.Tech, M.Tech - IIT-Roorkee

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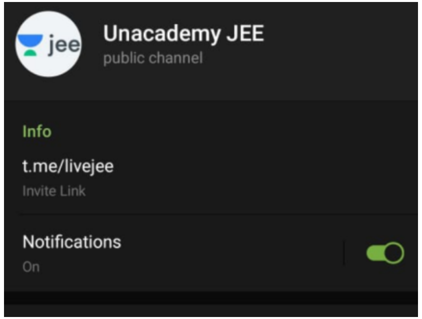

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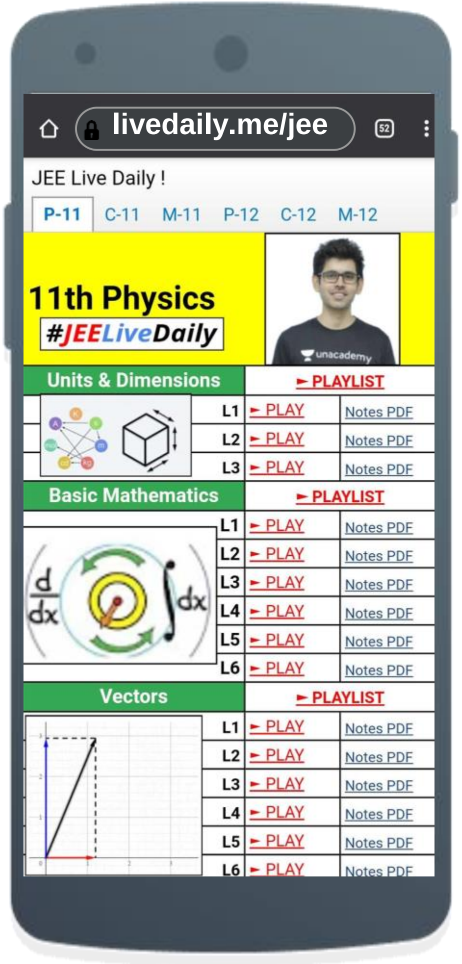

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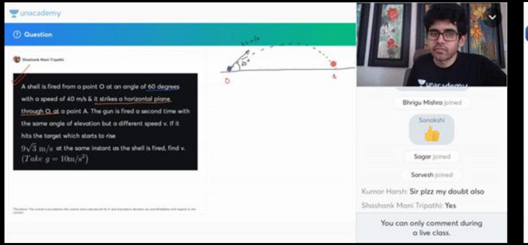

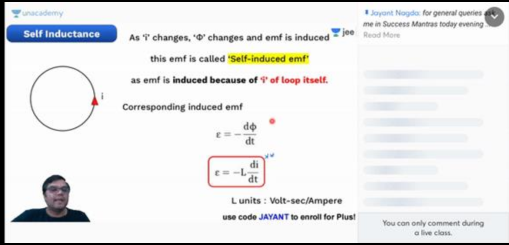

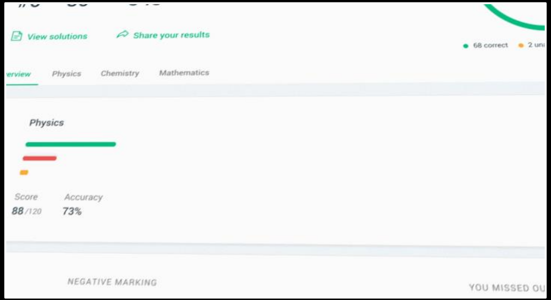

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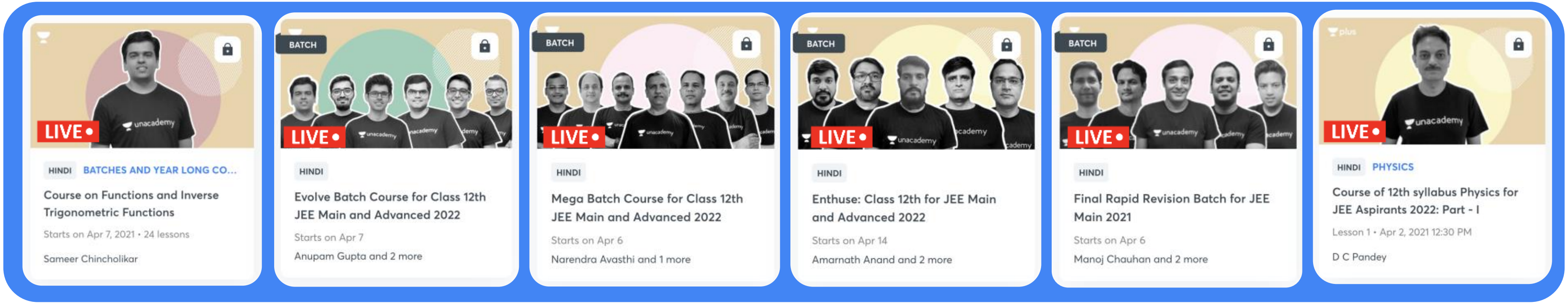

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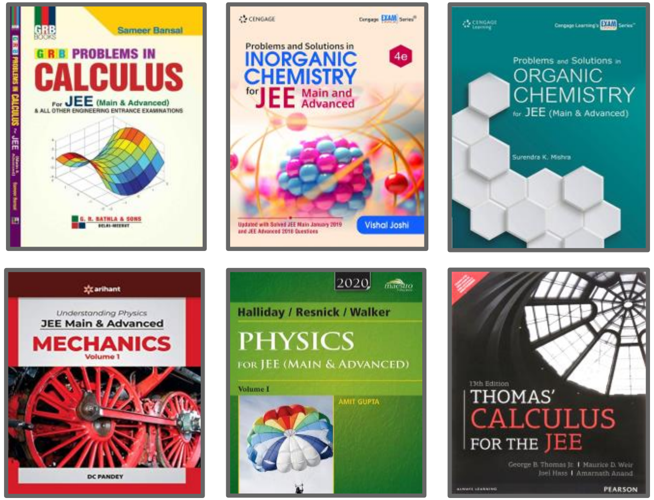


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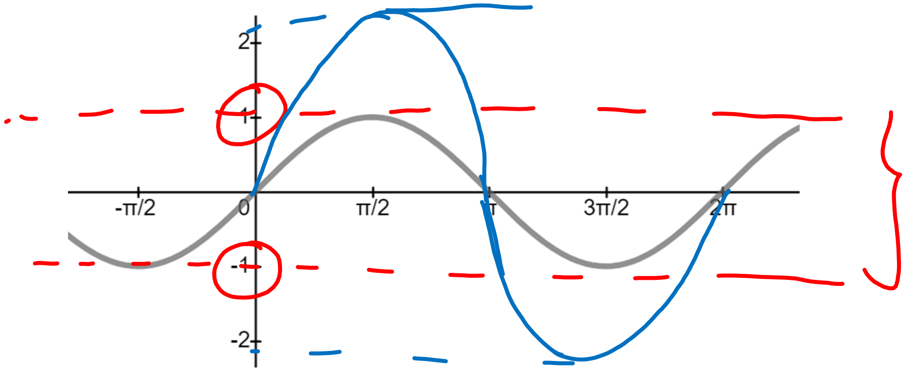
LET'S BEGIN!!

Simple T-Expressions

Find the range of:

1. $2\sin x$
2. $3\sin(x + \pi/6)$
3. $2\sin(5x) - 3$
4. $\sin^2 x$



(1) $2 \sin x$

$\sin x \in [-1, 1]$

$2\sin x \in [-2, 2]$

(2) $3 \sin\left(x + \frac{\pi}{6}\right)$

$\sin\left(x + \frac{\pi}{6}\right) \in [-1, 1]$

$3\sin\left(x + \frac{\pi}{6}\right) \in [-3, 3]$

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(3) $2\sin(5x) - 3$

$[-1, 1]$

$[-2, 2]$

$[-5, -1]$

(4) $\sin^2 x$

$\cos 2\theta = 1 - 2\sin^2\theta$

$\sin^2\theta = \left(\frac{1 - \cos 2\theta}{2}\right)$

$\frac{1}{2} - \frac{\cos 2x}{2}$ $\rightarrow [0, 1]$

$\left[-\frac{1}{2}, \frac{1}{2}\right]$

Minimum value of $\sin^6 x + \cos^6 x$ is equal to:

A. $\frac{1}{2}$ B. $\frac{3}{4}$ C. $\frac{1}{4}$ D. 1

$$\sin^6 x + \cos^6 x$$

$$(a+b)^3 = \boxed{a^3 + b^3} + 3ab(a+b)$$

$$(\sin^2 x)^3 + (\cos^2 x)^3$$

$$= (\underbrace{\sin^2 x + \cos^2 x}_{})^3$$

$$- 3(\sin^2 x)(\cos^2 x)(\underbrace{\sin^2 x + \cos^2 x}_{})$$

$$= 1 - 3\sin^2 x \cos^2 x$$

$$1 - \frac{3}{4}\left(\underbrace{4\sin^2 x\cos^2 x}\right)$$

$$= 1 - \frac{3}{4}(2\sin x\cos x)^2$$

$$= \boxed{1 - \frac{3}{4}\underbrace{\sin^2 2x}_{[0,1]}}$$

$$\left[\frac{1}{4}, 1\right]$$

T-Expressions of Quadratic form

Find the range of **$\sin^2 x - \sin x + 2$**

A. [0, 6]   **B.** [2, 4]   **C.** [7/4, 4]   **D.** [5/2, 4]

$\sin^2 x - \sin x + 2$

Let: $\sin x = t$

$\underbrace{t^2 - t} + 2$

$\underbrace{\left(t - \frac{1}{2}\right)^2 - \frac{1}{4}} + 2$

$= \left(t - \frac{1}{2}\right)^2 + \frac{7}{4}$

$$\underbrace{\left(\sin x - \frac{1}{2}\right)^2} + \frac{7}{4}$$

$$\underline{\underline{\text{min}}} : 0 + \frac{7}{4} = \frac{7}{4}$$

$$\underline{\underline{\text{Max}}} : \left(-1 - \frac{1}{2}\right)^2 + \frac{7}{4} = \frac{9}{4} + \frac{7}{4} = \frac{16}{4} = 4$$

T-Expressions of type - asinx ± bcosx

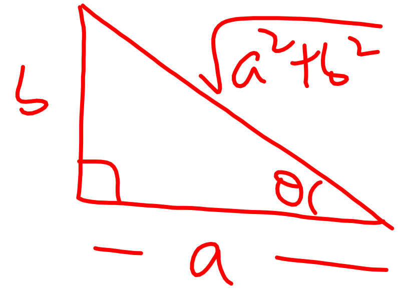
Range of asinx ± bcosx

$$a\sin x \pm b\cos x$$

$$\sqrt{a^2+b^2}\left(\underbrace{\boxed{\frac{a}{\sqrt{a^2+b^2}}}}_{\cos\theta}\sin x \pm \underbrace{\boxed{\frac{b}{\sqrt{a^2+b^2}}}}_{\sin\theta}\cos x\right)$$

let:

$$\cos\theta = \frac{a}{\sqrt{a^2+b^2}}$$



$$\sqrt{a^2+b^2}\left(\underbrace{\sin x \cos\theta \pm \sin\theta \cos x}\right)$$

$$\downarrow$$

$$\sqrt{a^2+b^2}\ \underbrace{\underbrace{\sin(x \pm \theta)}}$$

$$\downarrow$$

$$[-1,1]$$

$$\left[-\sqrt{a^2+b^2},\ \sqrt{a^2+b^2}\right]$$

The **maximum value** of : **(12 sin2x - 5 cos2x + 1)** is

A. 13 **B.** 14 **C.** 8 **D.** 18

$$\underbrace{\underset{a}{12}\,\sin(2x) - \underset{b}{5}\,\cos(2x)} + 1$$

$$[-13, 13] + 1$$

Find the **minimum value** of : **$4\sin 2\theta - 6\sin^2\theta$**

A. -5 **B.** -2 **C.** -8 **D.** 0

$$4\sin 2\theta - 6\sin^2\theta$$

$$4\sin 2\theta - 3(1-\cos 2\theta)$$

$$\underbrace{4\sin 2\theta + 3\cos 2\theta}_{[-5,\,5]} - 3$$

$$[-5,\,5] - 3$$

The **minimum value** of: $5\sin\theta + 3\sin\left(\theta - \frac{\pi}{3}\right) + 10$

A. 3 **B.** 5 **C.** -13 **D.** -8

$$5\sin\theta + 3\left((\sin\theta)\left(\frac{1}{2}\right) - (\cos\theta)\left(\frac{\sqrt{3}}{2}\right)\right) + 10$$

$$\left(\underbrace{\frac{13}{2}}_{a}\sin\theta - \underbrace{\frac{3\sqrt{3}}{2}}_{b}\cos\theta\right) + 10$$

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$$a^2+b^2=\frac{169}{4}+\frac{27}{4}$$

$$=\frac{196}{4}$$

$$=49$$

$$\therefore \left[-7,7\right]+10$$

Find the maximum value of the expression: $\dfrac{1}{(\sin^2\theta + 3\sin\theta\cos\theta + 5\cos^2\theta)}$

$$\sin^2\theta + 3\sin\theta\cos\theta + 5\cos^2\theta$$

$$= 1 + \frac{3}{2}(2\sin\theta\cos\theta) + 2(2\cos^2\theta)$$

$$= 1 + \frac{3}{2}(\sin 2\theta) + 2(1 + \cos 2\theta)$$

$$= 3 + \left(\frac{3}{2}\sin 2\theta + 2\cos 2\theta\right)$$

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$$= 3 + \left[-\sqrt{\frac{9}{4}+4}, \sqrt{\frac{9}{4}+4}\right]$$

$$\underbrace{3 + \left[-\frac{5}{2}, \frac{5}{2}\right]}$$

$$= \left[\frac{1}{2}, \frac{11}{2}\right]$$

max value of given expression

$$= \frac{1}{(1/2)}$$

$$= 2$$

The maximum value of the sum of the squares of the roots of the equation

$$x^2 + (\cos\theta - 1)x + \frac{1}{2}\cos^2\theta = 0 \text{ is.}$$

A. 1/2 **B.** 2 **C.** 3 **D.** 8

$$\alpha+\beta = -\frac{(\cos\theta - 1)}{1}$$

$$= (1-\cos\theta)$$

$$\alpha\beta = \left(\frac{1}{2}\cos^2\theta\right)$$

$$\alpha^2+\beta^2$$

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

$$= (1-\cos\theta)^2 - \cancel{2}\left(\frac{1}{\cancel{2}}\cos^2\theta\right)$$

$$= 1 + \cancel{\cos^2\theta} - 2\cos\theta - \cancel{\cos^2\theta}$$

$$= \underbrace{1 - \underbrace{2\underbrace{\cos\theta}_{[-1,1]}}_{[-2,2]}}_{[-1,3]}$$

If $a + b = 3 - \cos 4\theta$ & $a - b = 4 \sin 2\theta$, then ab is always less than or equal to

A. $\frac{1}{2}$ **B.** $\frac{3}{4}$ **C.** $\frac{2}{3}$ **D.** 1

$$\begin{cases} (a+b)^2 = (3 - \cos 4\theta)^2 \\ (a-b)^2 = (4 \sin 2\theta)^2 \end{cases}$$

$-$

$$4ab = (9 + \cos^2 4\theta - 6\cos 4\theta) - (16 \sin^2 2\theta)$$

$$4ab = \left(9 + \underline{\cos^2 4\theta} - 6\cos 4\theta\right)$$

$$- 8\left(1 - \cos 4\theta\right)$$

$$4ab = \left(1 + \cos^2 4\theta + 2\cos 4\theta\right)$$

$$4ab = \left(1 + \cos 4\theta\right)^2$$

$$\boxed{ab = \frac{1}{4}\left(1 + \cos 4\theta\right)^2} \Rightarrow (ab)_{max} = 1$$

If $u = \sqrt{a^2 \cos^2 \theta + b^2 \sin^2 \theta} + \sqrt{a^2 \sin^2 \theta + b^2 \cos^2 \theta}$

then the difference between the maximum & minimum values of u^2 is given by

A. $(a-b)^2$ B. $2\sqrt{a^2+b^2}$ C. $(a+b)^2$ D. $2(a^2+b^2)$

$$u^2 = (a^2\cos^2\theta + b^2\sin^2\theta) + (a^2\sin^2\theta + b^2\cos^2\theta)$$

$$+ 2\sqrt{(a^2\cos^2\theta + b^2\sin^2\theta)(a^2\sin^2\theta + b^2\cos^2\theta)}$$

$$u^2 = (a^2+b^2) + 2\sqrt{a^4\sin^2\theta\cos^2\theta + a^2b^2\cos^4\theta + a^2b^2\sin^4\theta + b^4\sin^2\theta\cos^2\theta}$$

$$= (a^2+b^2) + 2\sqrt{(a^4+b^4)\sin^2\theta\cos^2\theta + a^2b^2\left(\underbrace{\sin^4\theta+\cos^4\theta}\right)}$$

$$= (a^2+b^2) + 2\sqrt{(a^4+b^4)\sin^2\theta\cos^2\theta + a^2b^2\left(1-2\sin^2\theta\cos^2\theta\right)}$$

$$u^2 = (a^2+b^2) + 2\sqrt{a^2b^2 + \underline{\sin^2\theta}\,\underline{\cos^2\theta}\,(a^4+b^4-2a^2b^2)}$$

$$u^2 = (a^2+b^2) + 2\sqrt{a^2b^2 + \frac{1}{4}(\sin^2 2\theta)(a^2-b^2)^2}$$

$$u^2)_{max} = (a^2+b^2) + \cancel{2}\sqrt{\frac{4a^2b^2 + a^4 + b^4 - 2a^2b^2}{\cancel{4}}}$$

$$= (a^2+b^2) + \sqrt{(a^2+b^2)^2}$$

$$= \boxed{2(a^2+b^2)}$$

$$\& \quad \boxed{u^2_{min} = (a+b)^2}$$

Ans:

$$(2a^2+2b^2) - (a^2+b^2+2ab)$$

$$= a^2+b^2-2ab$$

$$= (a-b)^2$$

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Namo Sir | Physics

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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

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Nishant Sir | Maths

4:30 - 6:00 PM

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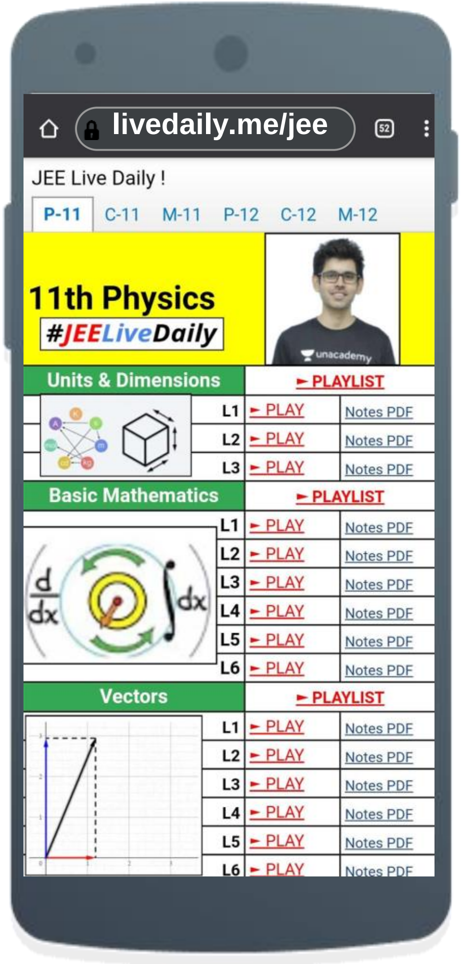

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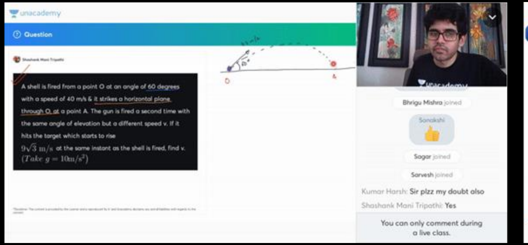

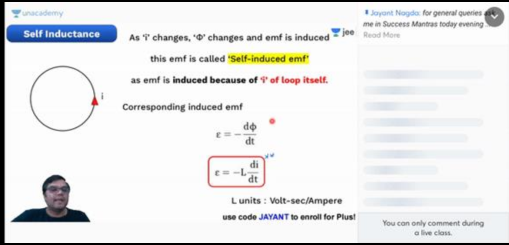

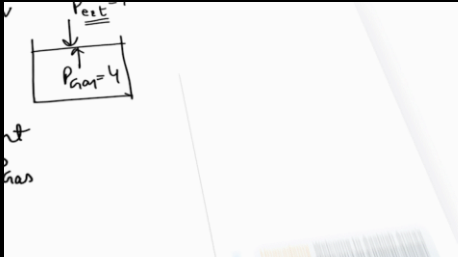

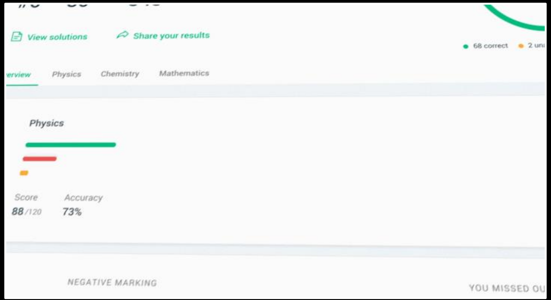

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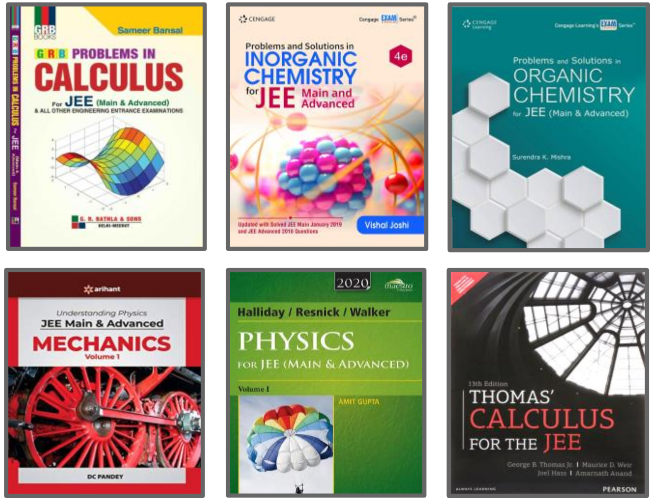


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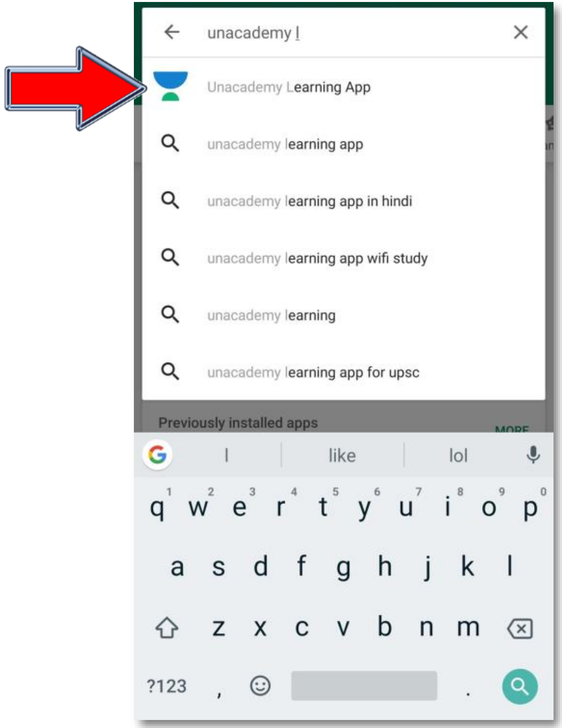
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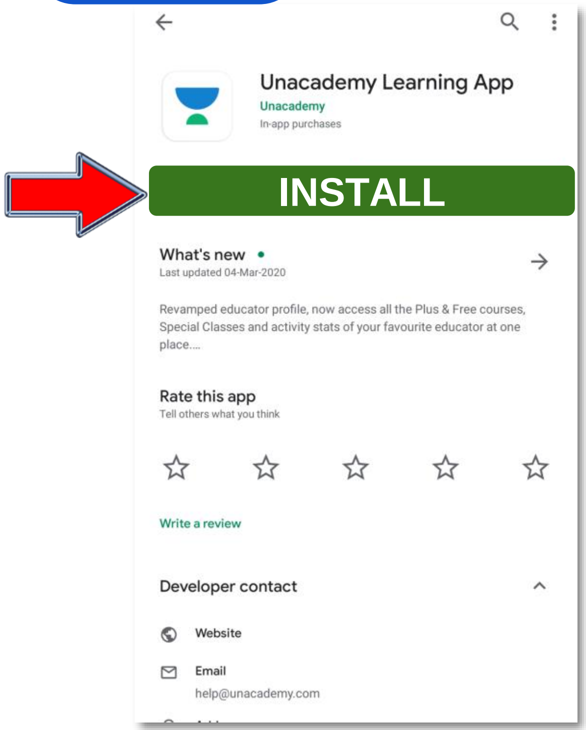
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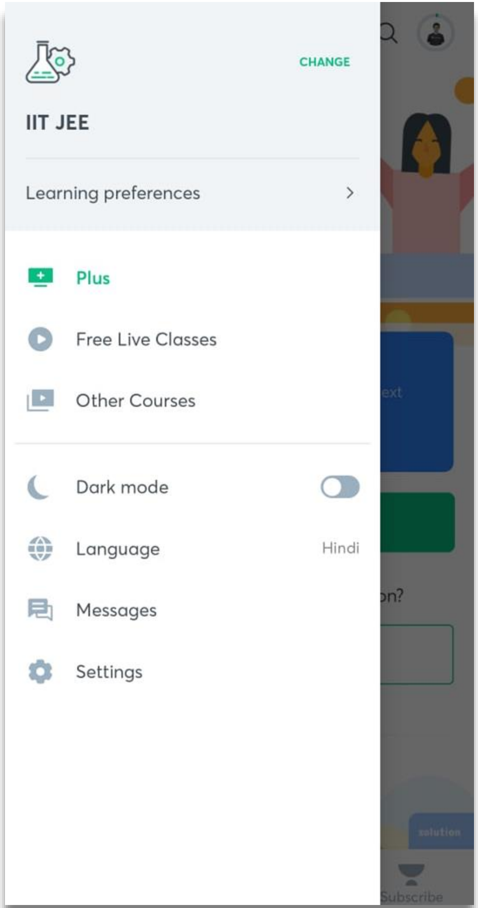
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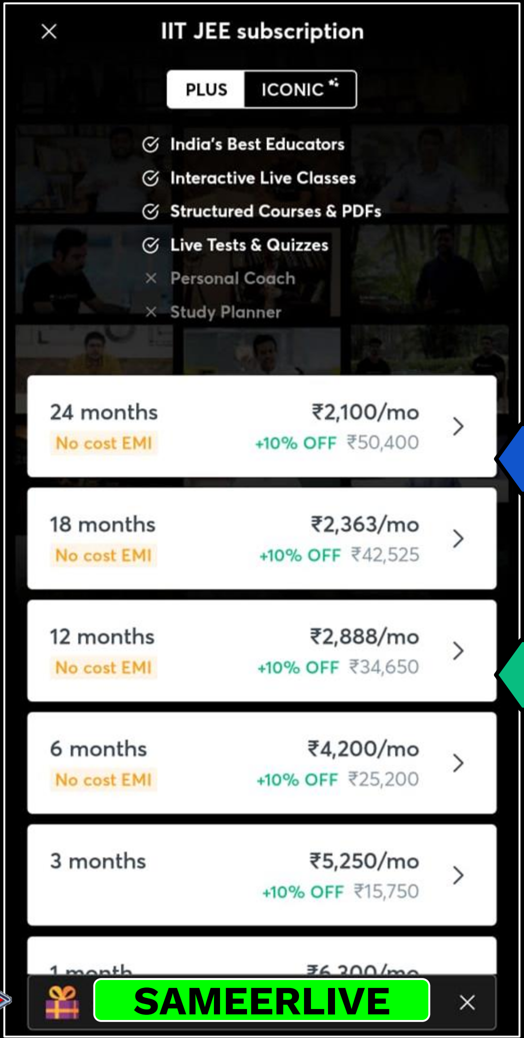

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