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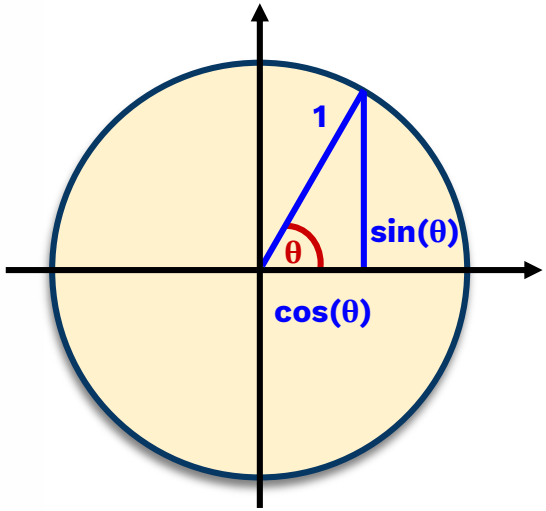
Trigonometric Series & Product of Cosines -1

Trigonometry 10



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Sameer Chincholikar

B.Tech, M.Tech - IIT-Roorkee

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

sameer_iitr

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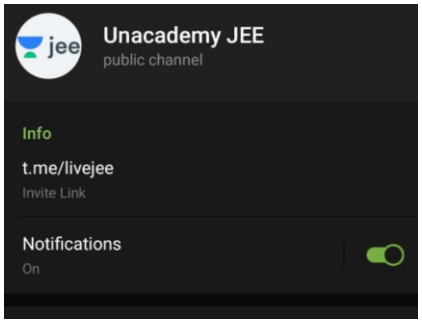

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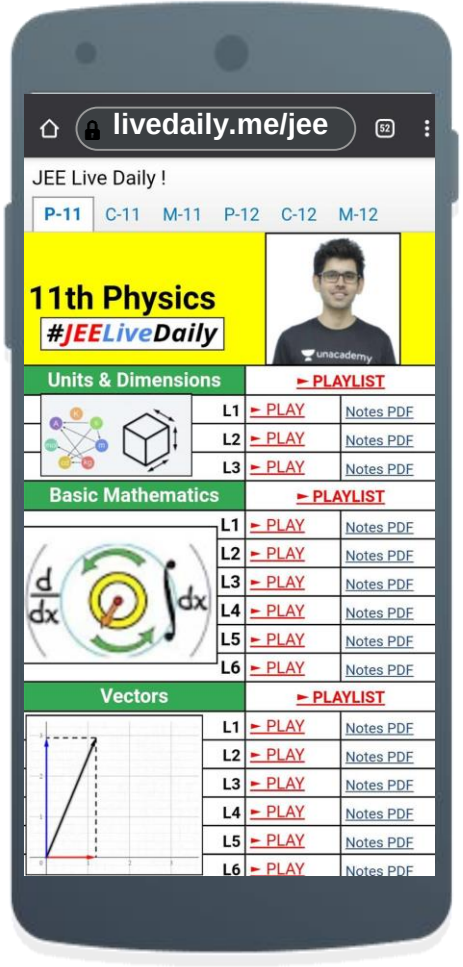

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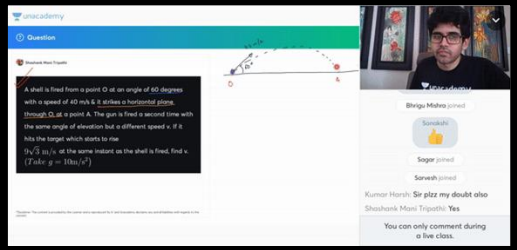

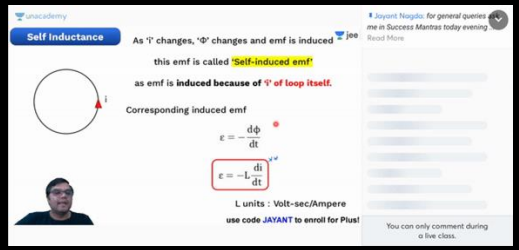

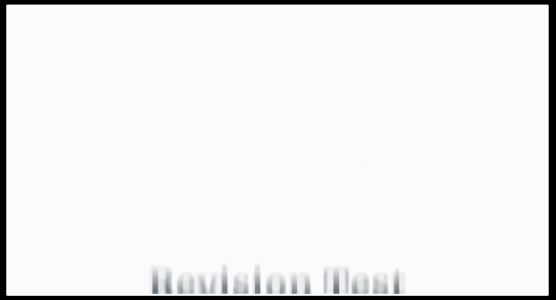

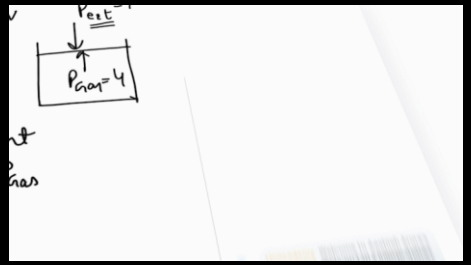

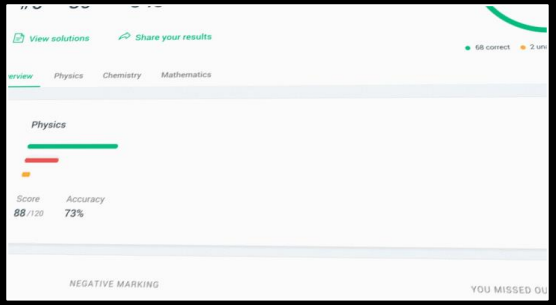

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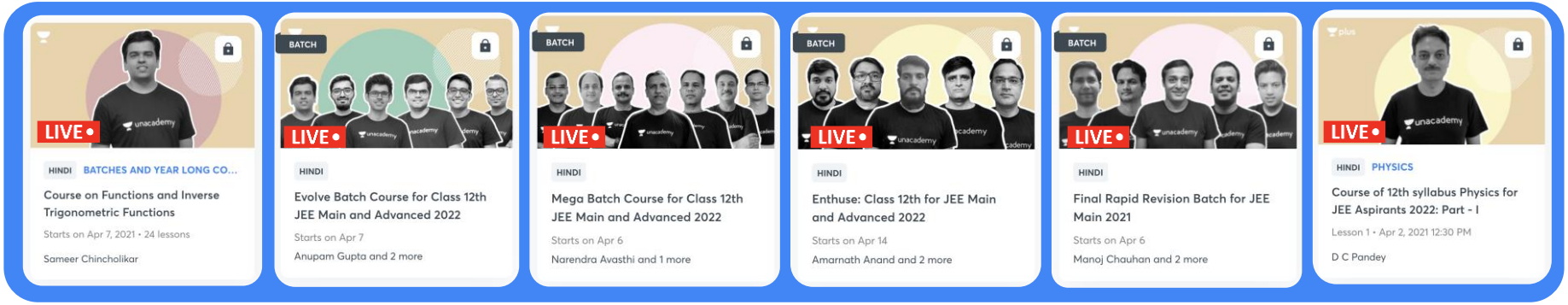

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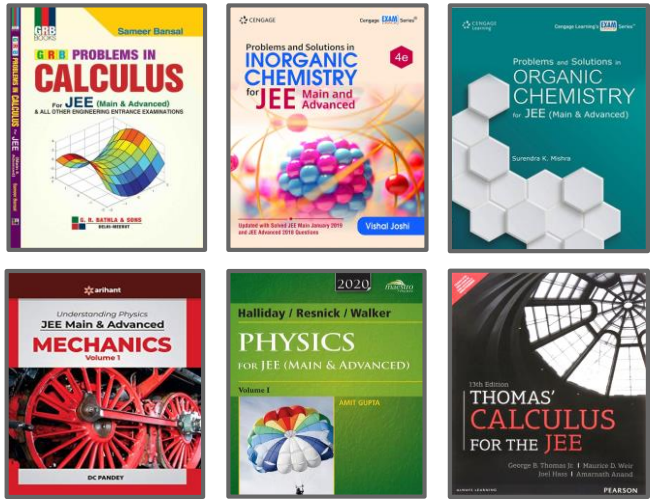

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Top Results

Bratin Mondal

100 %ile

Amaiya Singhal
99.97

Adnan
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Ashwin Prasanth
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Tanmay Jain
99.86

Kunal Lalwani
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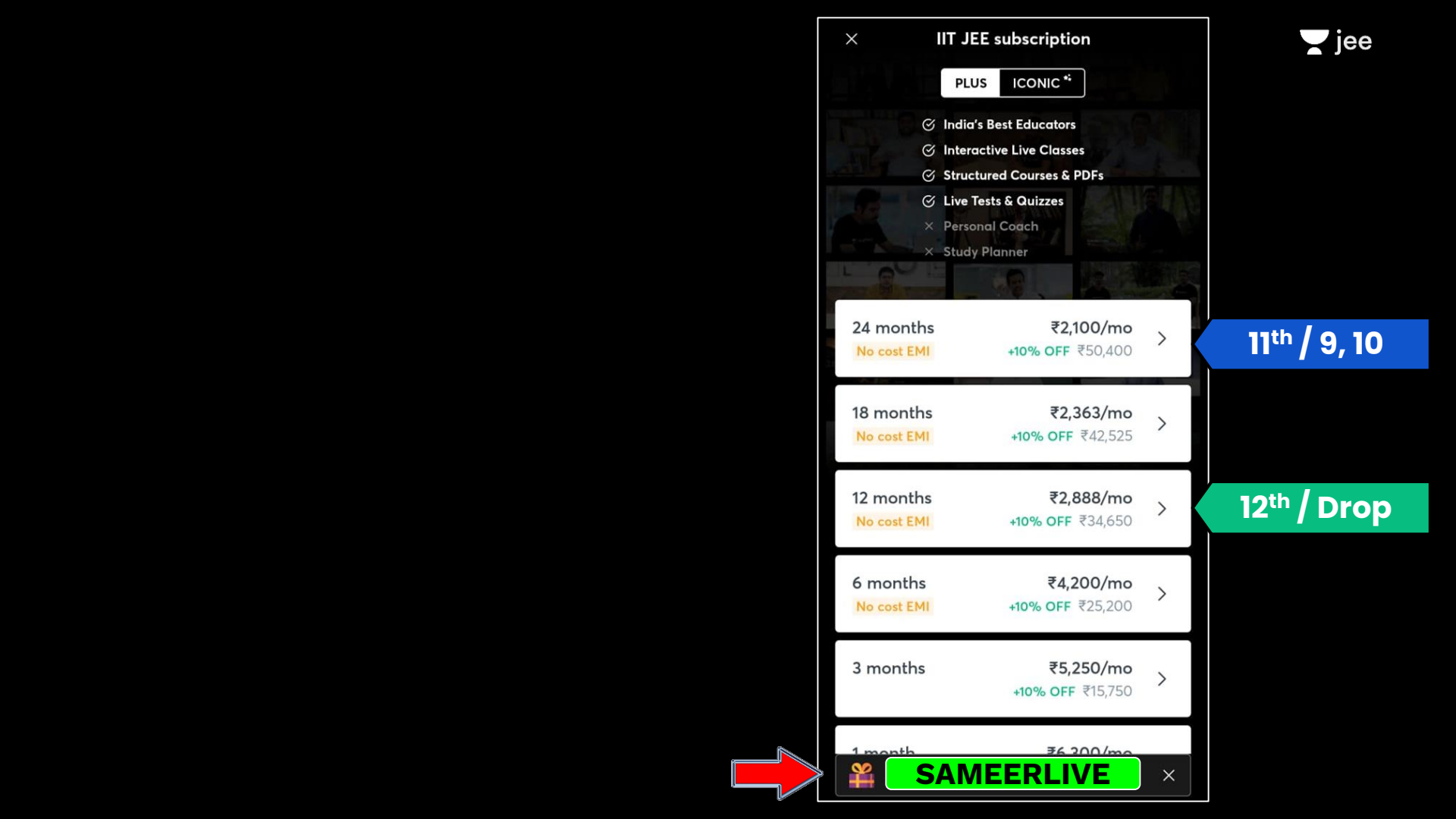
98.59

Naman Goyal
98.48

MIHIR PRAJAPATI
98.16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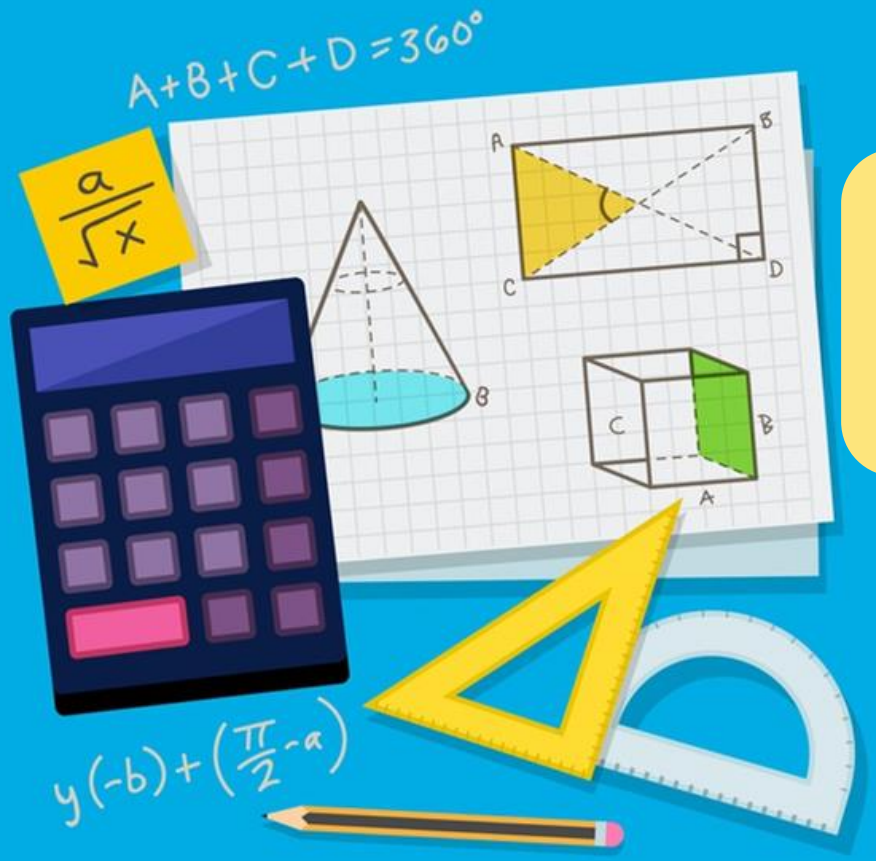
18 months
No cost EMI
₹2,363/mo
+10% OFF ₹42,525
12 months
No cost EMI
₹2,888/mo
+10% OFF ₹34,650
6 months
No cost EMI
₹4,200/mo
+10% OFF ₹25,200
3 months
₹5,250/mo
+10% OFF ₹15,750
SAMEERLIVE
jee
11th / 9, 10
12th / Drop

LET'S BEGIN!!



Homework Question

If $\cos^3 x \sin 2x = \sum_{r=0}^{n} a_r \sin(rx)$, $\forall x \in R$ then find a_3/a_1 :

$= a_0 \sin 0 + a_1 \sin x + a_2 \sin 2x + a_3 \sin 3x$

$+ a_4 \sin 4x + a_5 \sin 5x + \cdots$

$\left(\frac{\cos 3x + 3\cos x}{4}\right) \sin 2x$

$= \frac{1}{4}\left(\sin 2x \cos 3x + 3 \sin 2x \cos x\right)$

$\because \cos 3\theta = 4\cos^3\theta - 3\cos\theta$

$\Rightarrow \cos^3\theta = \left(\frac{\cos 3\theta + 3\cos\theta}{4}\right)$

$$= \frac{1}{8}\left(2\sin 2x\cos 3x + 3(2\sin 2x\cos x)\right)$$

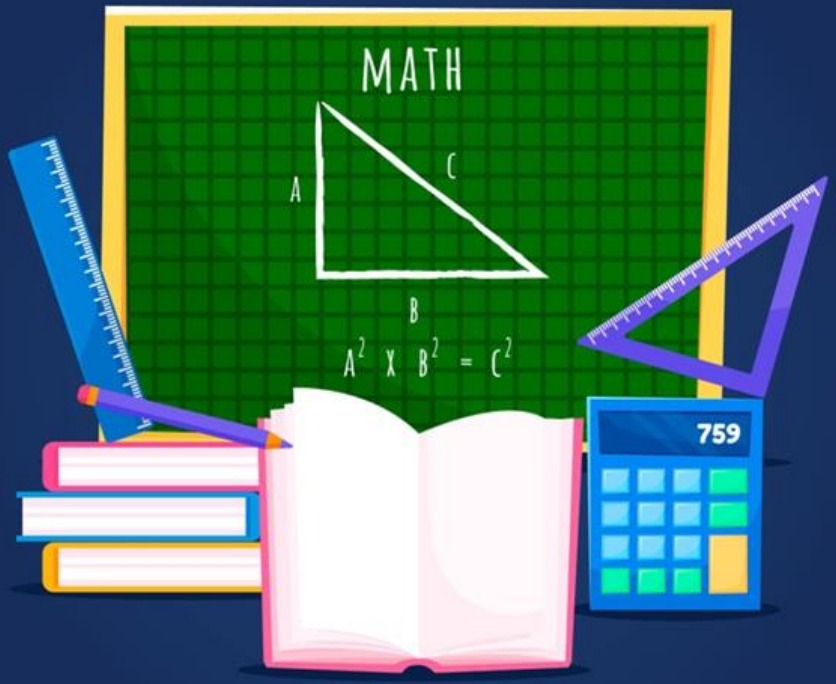
$$= \frac{1}{8}\left((\sin(5x)+\sin(-x)) + 3(\sin 3x + \sin x)\right)$$

$$= \frac{1}{8}\left(\sin 5x + 3\sin 3x + 2\sin x\right)$$

$$= \frac{1}{8}\sin 5x + \frac{3}{8}\sin 3x + \frac{1}{4}\sin x$$

$a_1 = 1/4$, $a_2 = 0$, $a_3 = 3/8$, $a_4 = 0$, $a_5 = 1/8$

Trigonometric Series of Sine & Cosine



Trigonometric Series of Sine and Cosine

1

$$\sin\alpha + \sin(\alpha+\beta) + \sin(\alpha+2\beta) + \ldots\ldots + \sin\{\alpha+(n-1)\beta\} = \frac{\sin\frac{n\beta}{2}}{\sin\frac{\beta}{2}}\sin\left(\alpha+\frac{n-1}{2}\beta\right)$$

* angles are in A.P.
* total n-terms
* first term: α
* Common diff: β

$2\sin A\sin B =$

$\cos(A-B) - \cos(A+B)$

$$= \frac{2\sin\beta/2}{2\sin\beta/2}\left[\sin\alpha + \sin(\alpha+\beta) + \sin(\alpha+2\beta) + \cdots + \sin(\alpha+(n-1)\beta)\right]$$

$$= \left(\frac{1}{2\sin\frac{\beta}{2}}\right)\left[2\sin\alpha\sin\frac{\beta}{2} + 2\sin(\alpha+\beta)\sin\frac{\beta}{2} + 2\sin(\alpha+2\beta)\sin\frac{\beta}{2} + \cdots + 2\sin(\alpha+(n-1)\beta)\sin\frac{\beta}{2}\right]$$

$$= \left(\frac{1}{2\sin\frac{\beta}{2}}\right)\left[\left(\cos\left(\alpha-\frac{\beta}{2}\right) - \cos\left(\alpha+\frac{\beta}{2}\right)\right) + \left(\cos\left(\alpha+\frac{\beta}{2}\right) - \cos\left(\alpha+\frac{3\beta}{2}\right)\right)\right.$$

$$+\left(\cos\left(\alpha+\frac{3\beta}{2}\right)-\cos\left(\alpha+\frac{5\beta}{2}\right)\right)$$

$$+\cdots+\left(\cos\left(\alpha+\left(n-1-\frac{1}{2}\right)\beta\right)-\cos\left(\alpha+\left(n-1+\frac{1}{2}\right)\beta\right)\right)\Bigg]$$

$$=\left(\frac{1}{2\sin\frac{\beta}{2}}\right)\left(\cos\left(\alpha-\frac{\beta}{2}\right)-\cos\left(\alpha+\left(n-\frac{1}{2}\right)\beta\right)\right)$$

$$=\frac{1}{\left(2\sin\frac{\beta}{2}\right)}\left(2\sin\left(\frac{2\alpha+\left(n-\frac{1}{2}-\frac{1}{2}\right)\beta}{2}\right)\sin\left(\frac{\left(n-\frac{1}{2}+\frac{1}{2}\right)\beta}{2}\right)\right)$$

$$= \frac{\sin\left(n\frac{\beta}{2}\right)}{\sin\left(\frac{\beta}{2}\right)} \sin\left(\alpha + (n-1)\frac{\beta}{2}\right)$$

Trigonometric Series of Sine and Cosine

2

$$\cos\alpha + \cos(\alpha + \beta) + \cos(\alpha + 2\beta) + \ldots + \cos\{\alpha + (n-1)\beta\} = \frac{\sin\frac{n\beta}{2}}{\sin\frac{\beta}{2}} \cos\left(\alpha + \frac{n-1}{2}\beta\right)$$

The **value of** $\sin\frac{\pi}{18}+\sin\frac{2\pi}{18}+\sin\frac{3\pi}{18}+\ldots\ldots\ldots\ldots\ldots+\sin\frac{35\pi}{18}=$

A. 1 **B.** 2 **C.** 0 **D.** 4

$n = 35$

$\alpha = \frac{\pi}{18}$

$\beta = \frac{\pi}{18}$

$\frac{\beta}{2} = \frac{\pi}{36}$

$= \frac{\sin\left(n\frac{\beta}{2}\right)}{\sin\left(\frac{\beta}{2}\right)} \cdot \sin\left(\alpha+(n-1)\frac{\beta}{2}\right)$

$= \frac{\sin\left(35\ \frac{\pi}{36}\right)}{\sin\left(\frac{\pi}{36}\right)}$

$\sin\left(\frac{\pi}{18}+34\times\frac{\pi}{36}\right)$

$= \pi$

zero

The **value of** $\cos\frac{\pi}{7}+\cos\frac{2\pi}{7}+\cos\frac{3\pi}{7}+\cdots\ldots\ldots+\cos\frac{7\pi}{7}=$

A. -1 **B.** -2 **C.** 0 **D.** 2

$\alpha=\frac{\pi}{7}$

$\beta=\frac{\pi}{7}$

$\frac{\beta}{2}=\frac{\pi}{14}$

$n=7$

$$\frac{\sin\left(7\cdot\frac{\pi}{14}\right)}{\sin\left(\frac{\pi}{14}\right)}\cos\left(\frac{\pi}{7}+3\cdot\frac{\pi}{14}\right)$$

$$\frac{1}{\sin\left(\frac{\pi}{14}\right)}\cdot\cos\left(\frac{4\pi}{7}\right)$$

$\frac{\pi}{14}, \frac{8\pi}{14}$

$\frac{8\pi}{14} - \frac{\pi}{14} = \frac{7\pi}{14} = \frac{\pi}{2}$

$\frac{8\pi}{14} = \left(\frac{\pi}{2} + \frac{\pi}{14}\right)$

$$\frac{\cos\left(\frac{8\pi}{14}\right)}{\sin\left(\frac{\pi}{14}\right)}$$

$$= \frac{\cos\left(\frac{\pi}{2} + \frac{\pi}{14}\right)}{\sin\left(\frac{\pi}{14}\right)}$$

$$= -\frac{\cancel{\sin\left(\frac{\pi}{14}\right)}}{\cancel{\sin\left(\frac{\pi}{14}\right)}} = -1$$

The **value of** $\cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{8\pi}{7}$ is

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

$\cos\left(\pi-\frac{5\pi}{7}\right)+\cos\left(\pi-\frac{3\pi}{7}\right)+\cos\left(\pi+\frac{\pi}{7}\right)$

$-\cos\frac{5\pi}{7}\quad-\cos\frac{3\pi}{7}\quad-\cos\frac{\pi}{7}$

$-\left[\cos\frac{\pi}{7}+\cos\frac{3\pi}{7}+\cos\frac{5\pi}{7}\right]$

$\alpha=\frac{\pi}{7}$

$\beta=\frac{2\pi}{7}$

$\frac{\beta}{2}=\frac{\pi}{7}$

$n=3$

$$= -\left[\frac{\sin\left(3\frac{\pi}{7}\right)}{\sin\left(\frac{\pi}{7}\right)} \cdot \cos\left(\frac{\pi}{7} + 2\cdot\frac{\pi}{7}\right)\right]$$

$$= -\left[\frac{2\sin\left(\frac{3\pi}{7}\right)\cos\left(\frac{3\pi}{7}\right)}{2\sin\frac{\pi}{7}}\right]$$

$$= -\frac{\sin\frac{6\pi}{7}}{2\sin\frac{\pi}{7}}$$

$$= -\frac{1}{2}$$

Find the value of: $\sin\frac{2\pi}{7}+\sin\frac{4\pi}{7}+\sin\frac{8\pi}{7}$

H.W

Arithmetic mean of $2\sin 2^0, 4\sin 4^0, 6\sin 6^0, \ldots\ldots$ Upto 90 terms

A. $\cot 1^0$ **B.** $\sec 1^0$ **C.** $\operatorname{cosec} 1^0$ **D.** $\tan 1^0$

$$S = 2\sin 2^\circ + 4\sin 4^\circ + 6\sin 6^\circ + \cdots\cdots + 180\sin 180^\circ$$

$$= (2\sin 2^\circ + 178\sin 178^\circ) + (4\sin 4^\circ + 176\sin 176^\circ)$$

$(180-2^\circ)$ $(180-4^\circ)$

$$+ (6\sin 6^\circ + 174\sin 174^\circ) + \cdots\cdots + (88\sin 88^\circ + 92\sin 92^\circ)$$

$$+ (90\sin 90^\circ)$$

180

(2 , 178)

(4 , 176)

(6 , 174)

(8 , 172)

⋮ ⋮

(, 96)

(, 94)

(88 , 92)

90

$180\left(\sin 2^\circ + \sin 4^\circ + \sin 6^\circ + \cdots + \sin 88^\circ\right) + 90$

$\alpha = 2^\circ,\ \beta = 2^\circ;\ \frac{\beta}{2} = 1^\circ;\ n = 44$

$180\left(\frac{\sin\left(44\left(1^\circ\right)\right)}{\sin\left(1^\circ\right)}\ \sin\left(2^\circ + 43\left(1^\circ\right)\right)\right)$

$+90$

$$180\left(\frac{\sin 44^\circ}{\sin 1^\circ}\times \sin 45^\circ\right)+90$$

$$=\frac{180}{\sqrt{2}}\left(\frac{\sin(45^\circ-1^\circ)}{\sin 1^\circ}\right)+90$$

$$=\frac{180}{\sqrt{2}}\left(\frac{\frac{1}{\sqrt{2}}\cos 1^\circ-\frac{1}{\sqrt{2}}\sin 1^\circ}{\sin 1^\circ}\right)+90$$

$$=\boxed{90\cot 1^\circ}-90+90$$

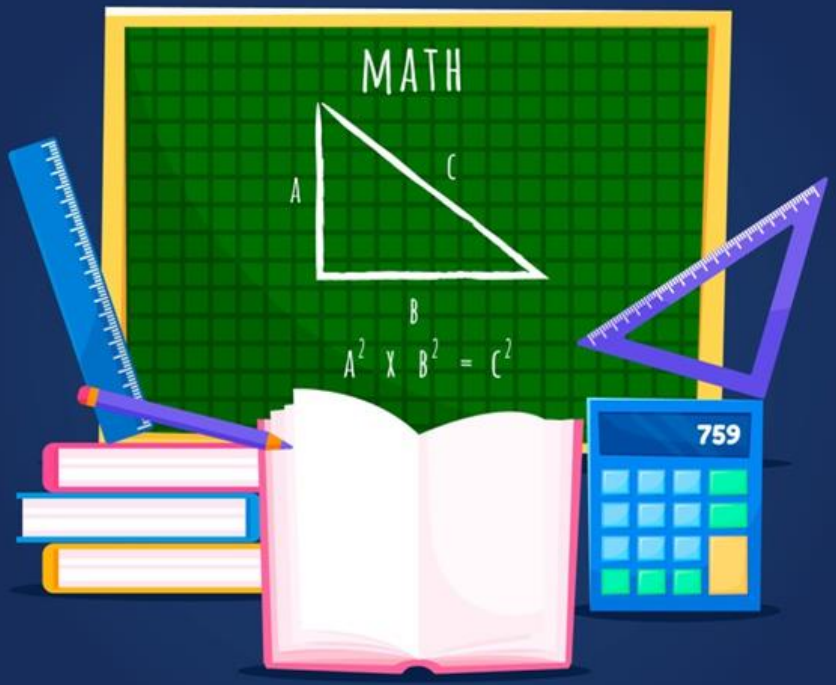
mean

$$=\frac{\text{Sum}}{90}$$

$$=\frac{90\cot 1^\circ}{90}$$

$$=\boxed{\cot 1^\circ}$$

Product of Cosines



Product of Cosine

$$\cos\theta \cdot \cos 2\theta \cdot \cos 2^2\theta \cdot \cos 2^3\theta \ldots\ldots \cos 2^{n-1}\theta = \frac{\sin 2^n\theta}{2^n \sin\theta}$$

$$\frac{2\sin\theta \cos\theta \cos 2\theta \cos 2^2\theta \cos 2^3\theta \cdots}{(2\sin\theta)}$$

$$\frac{2\times \sin 2\theta \cdot \cos 2\theta \cos 2^2\theta \cdot \cos 2^3\theta}{2\times 2\sin\theta}$$

$$2 \times \frac{\sin 4\theta}{(2\times 4)\sin\theta} \cdot \cos 2^2\theta \cos 2^3\theta \cdots$$

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

$$= \frac{\sin 2^4\theta}{2^4 \sin\theta}$$

Find the **value of**

$$64\cos\frac{\pi}{65}\cdot\cos\frac{2\pi}{65}\cdot\cos\frac{4\pi}{65}\cdot\cos\frac{8\pi}{65}\cdot\cos\frac{16\pi}{65}\cdot\cos\frac{32\pi}{65}$$

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

$\theta = \frac{\pi}{65}$

$2^5\left(\frac{\pi}{65}\right)$

$$64\left[\frac{\sin\left(2^6\frac{\pi}{65}\right)}{2^6\sin\pi/65}\right]$$

$$\frac{\sin\left(\frac{64\pi}{65}\right)}{\sin\left(\frac{\pi}{65}\right)}$$

$$= \frac{\sin\left(\pi - \frac{\pi}{65}\right)}{\sin\left(\pi/65\right)} = 1$$

Find the **value of** $\cos 2^3 \frac{\pi}{10} \cos 2^4 \frac{\pi}{10} \cos 2^5 \frac{\pi}{10} \ldots \cos 2^{10} \frac{\pi}{10} =$

A. 1/128

B. 1/256

C. $\frac{1}{512} \sin \frac{\pi}{10}$

D. $\frac{\sqrt{5}-1}{512} \sin \frac{3\pi}{10}$

$\theta = 2^3 \frac{\pi}{10}$

$2^7 \cdot \left(2^3 \frac{\pi}{10}\right)$

$\cos\theta \cos 2\theta \cos 2^2\theta \cdots \cos 2^7\theta$

$= \frac{\sin 2^8\theta}{2^8 \sin\theta} \rightarrow \frac{\sin\left(2^8 \, 2^3 \frac{\pi}{10}\right)}{2^8 \sin\left(2^3 \frac{\pi}{10}\right)}$

$$= \frac{\sin\left(2^{11}\frac{\pi}{10}\right)}{2^8 \sin\left(\frac{8\pi}{10}\right)}$$

$$= \frac{\sin\left(2048\frac{\pi}{10}\right)}{2^8 \sin\left(\frac{8\pi}{10}\right)}$$

$$= \frac{\sin\left(204\not{0}\frac{\pi}{1\not{0}} + \frac{8\pi}{10}\right)}{2^8 \sin\left(\frac{8\pi}{10}\right)}$$

$$= \frac{\cancel{\sin\left(\frac{8\pi}{10}\right)}}{2^8 \cancel{\sin\left(\frac{8\pi}{10}\right)}} = \frac{1}{2^8}$$

Find the **value of** $\sin\frac{\pi}{14}\sin\frac{3\pi}{14}\sin\frac{5\pi}{14}\sin\frac{7\pi}{14}\sin\frac{9\pi}{14}\sin\frac{11\pi}{14}\sin\frac{13\pi}{14}$

HW

#JEELiveDaily Schedule

jee

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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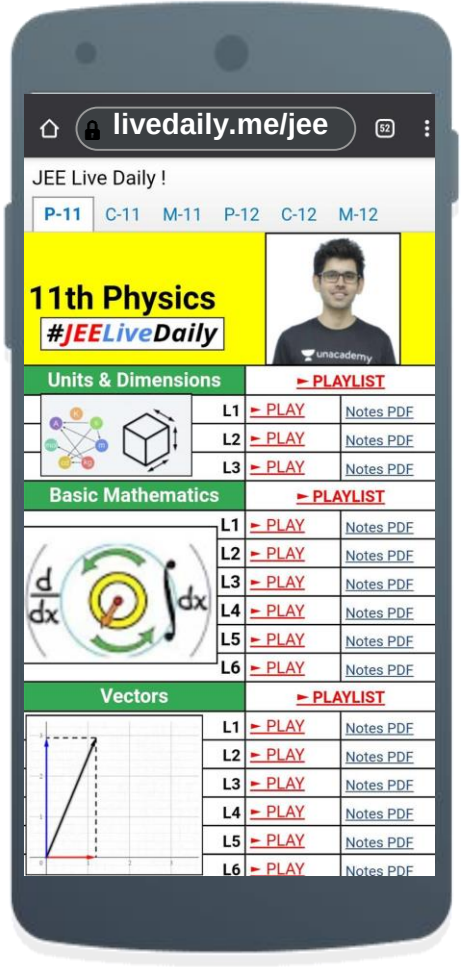

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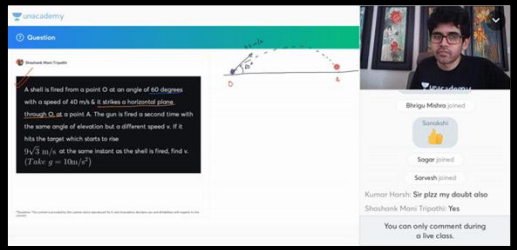

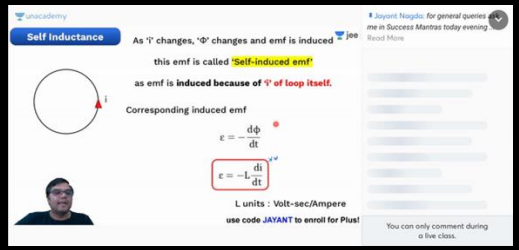

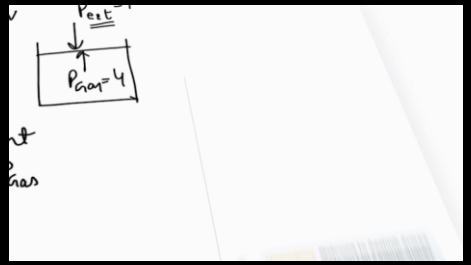

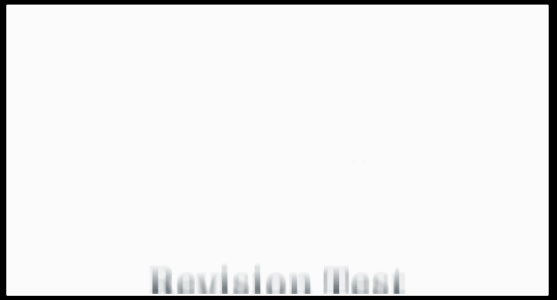

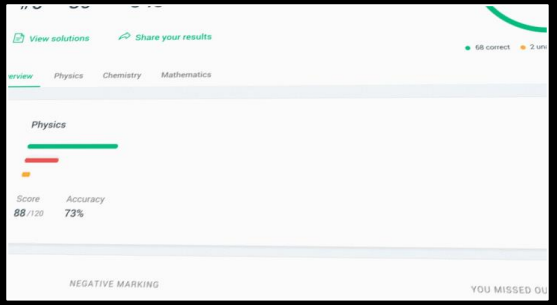

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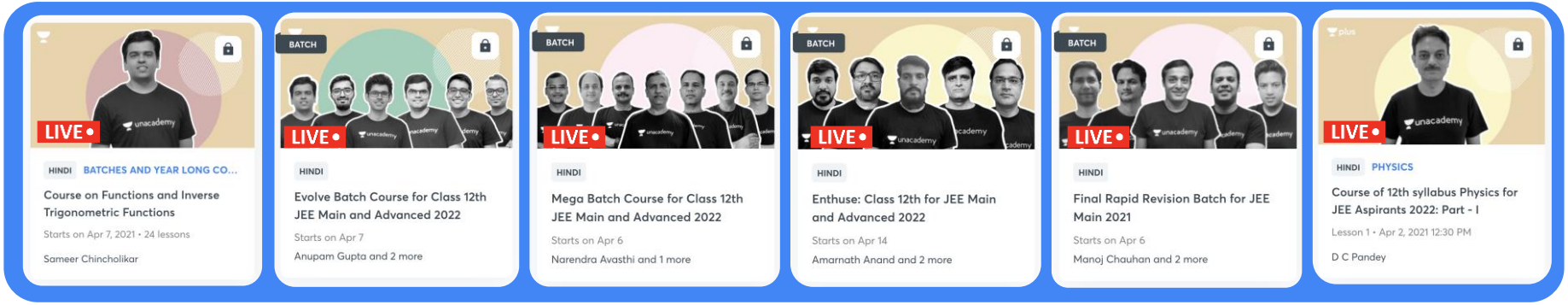

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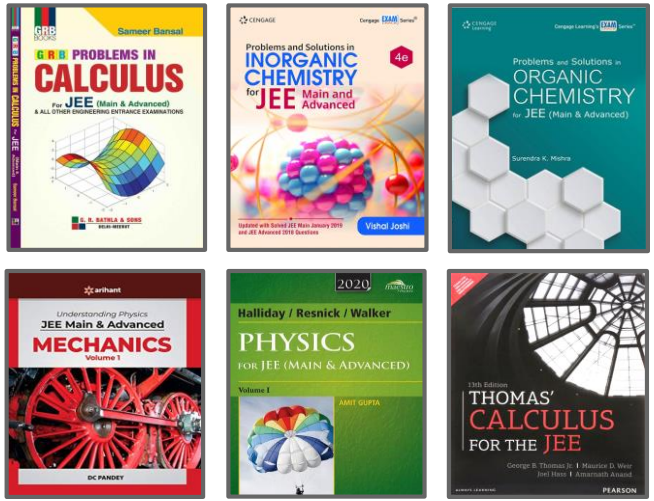

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98.85

Ayush Gupta
98.67

Megh Gupta
98.59

Naman Goyal
98.48

MIHIR PRAJAPATI
98.16

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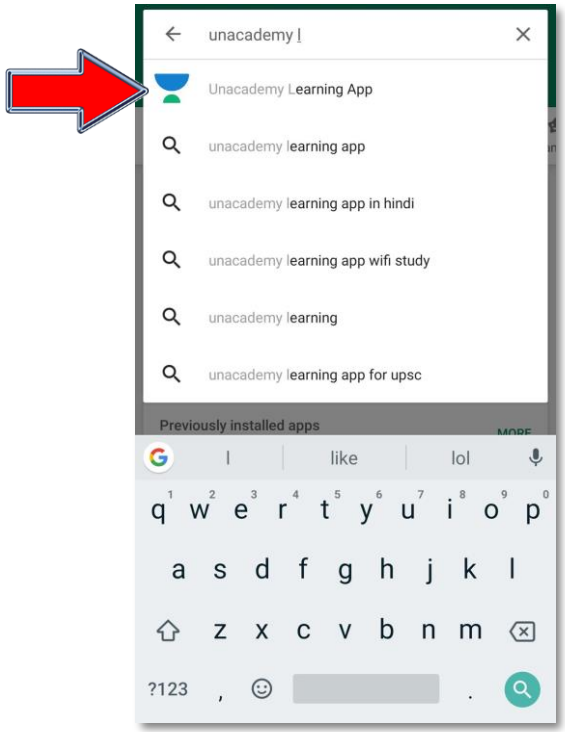
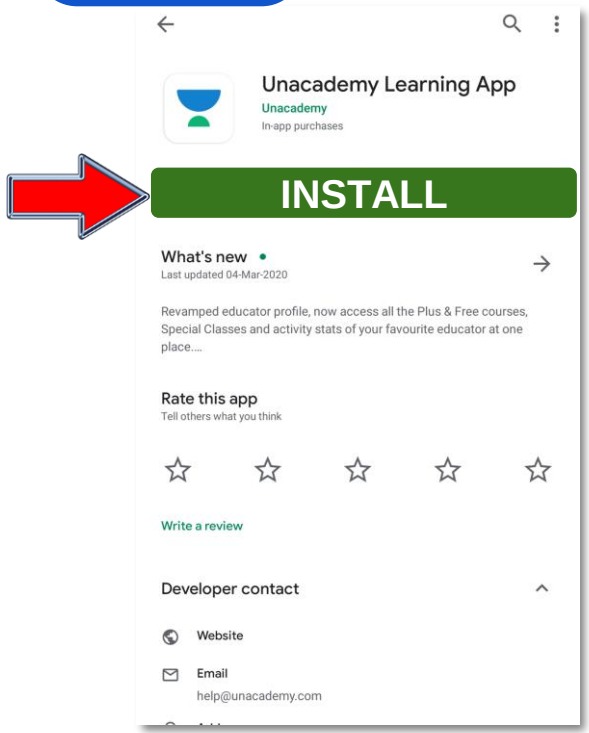
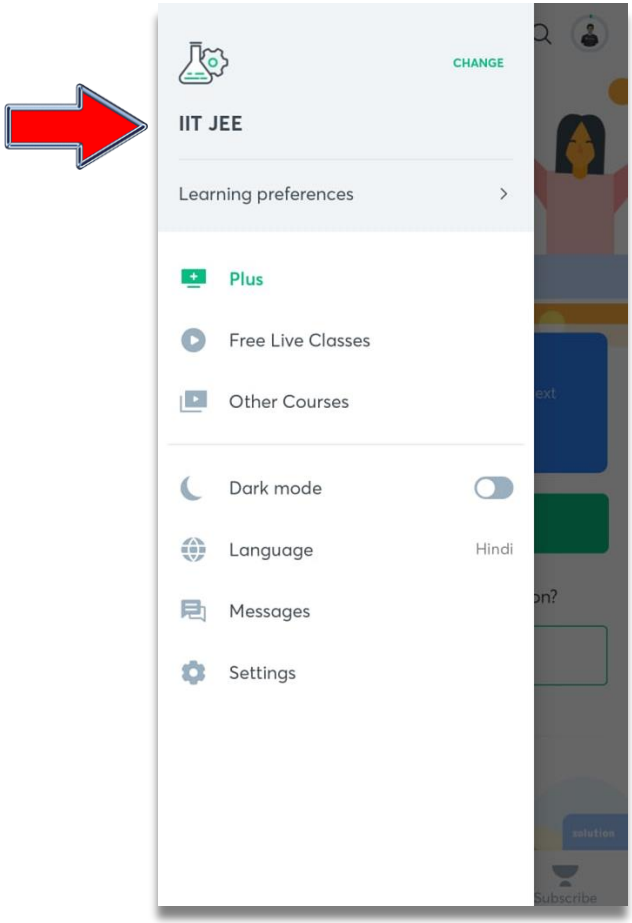
Step 1



Step 2

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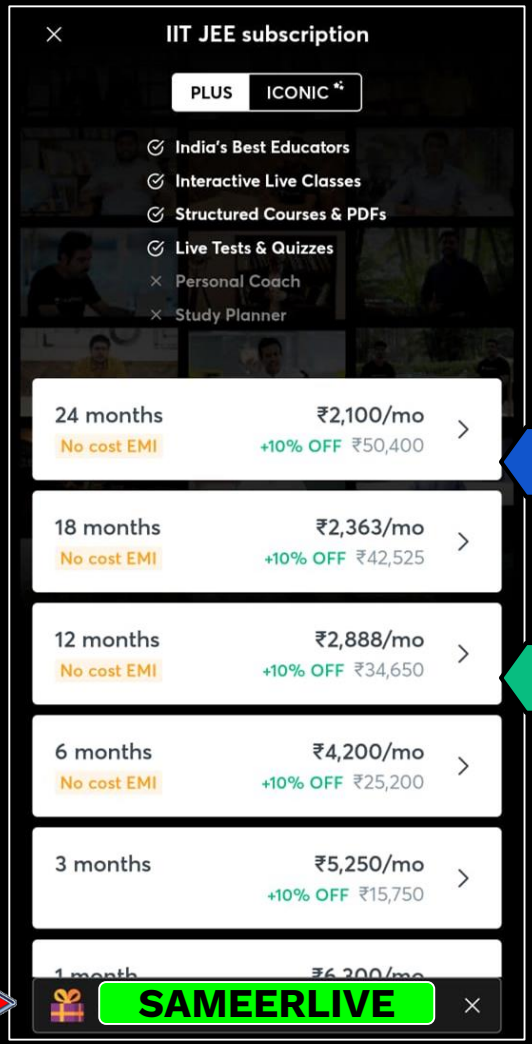

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