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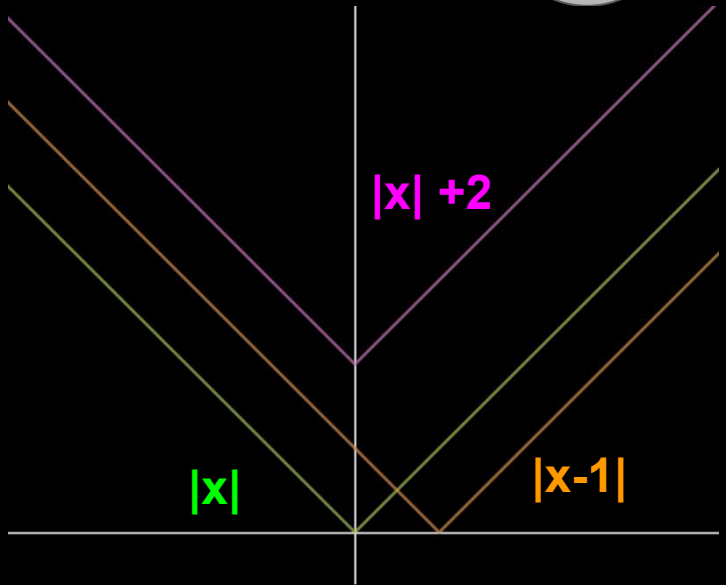
Functions

LECTURE 6

Modulus Function - 3



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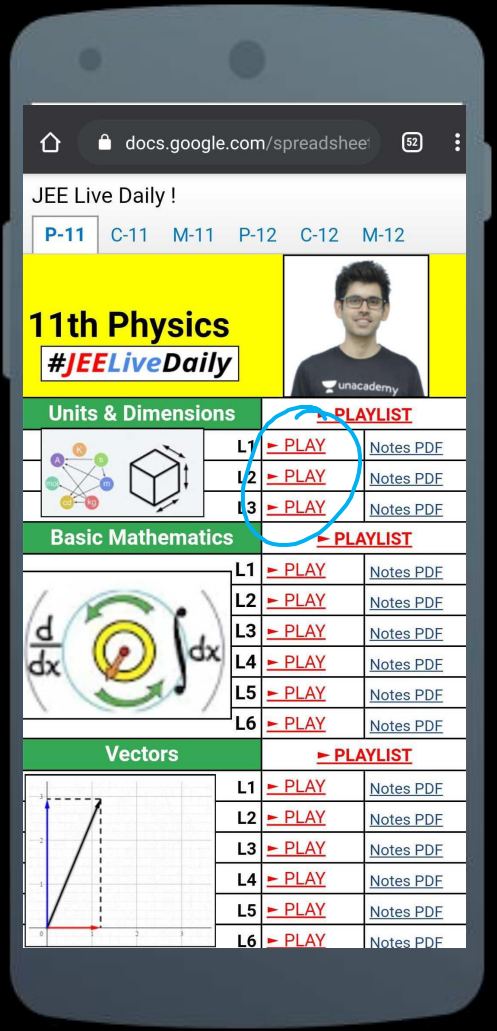

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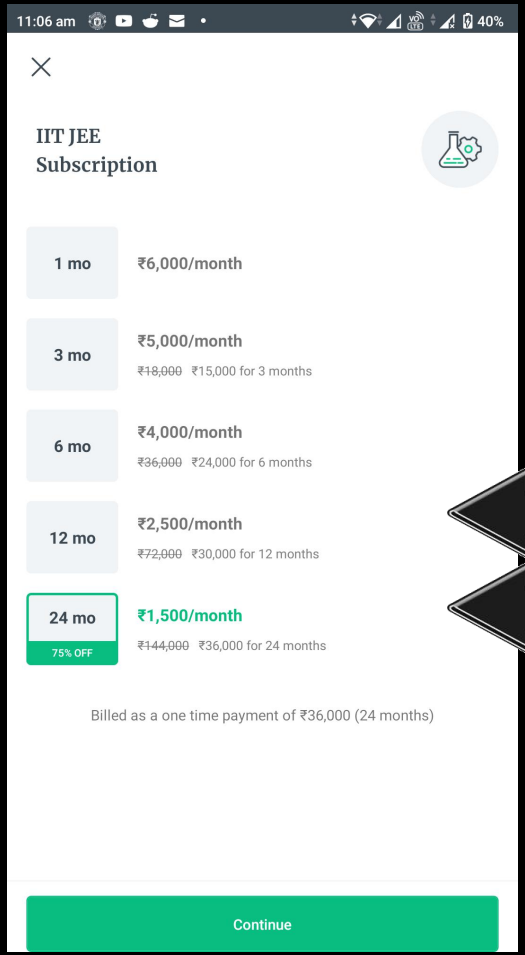

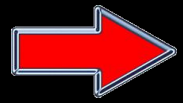

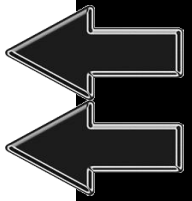

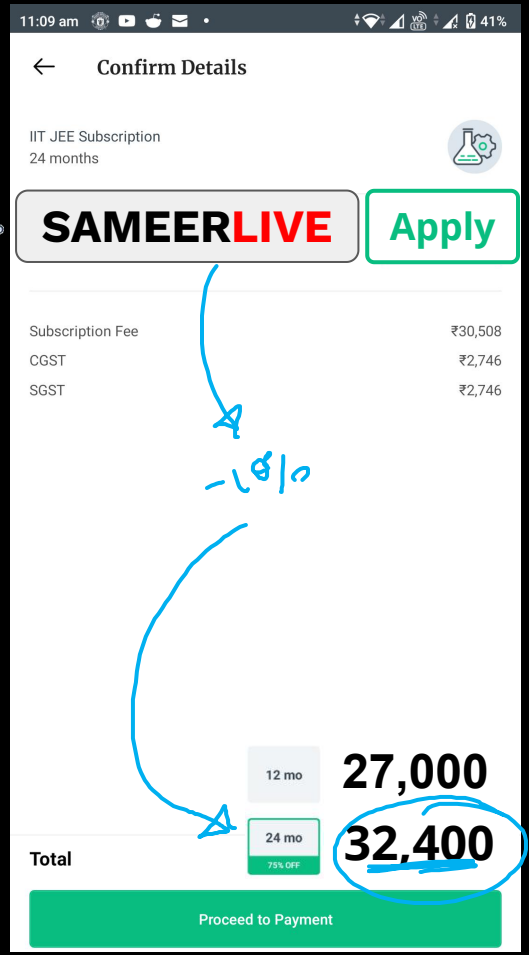

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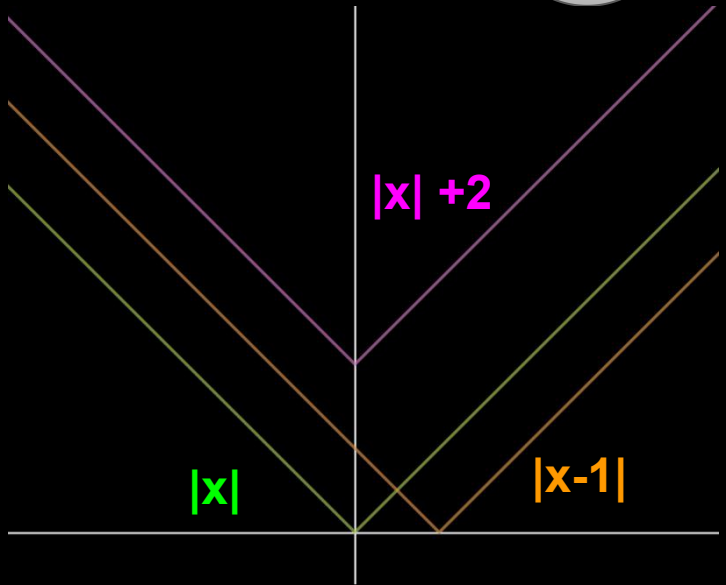
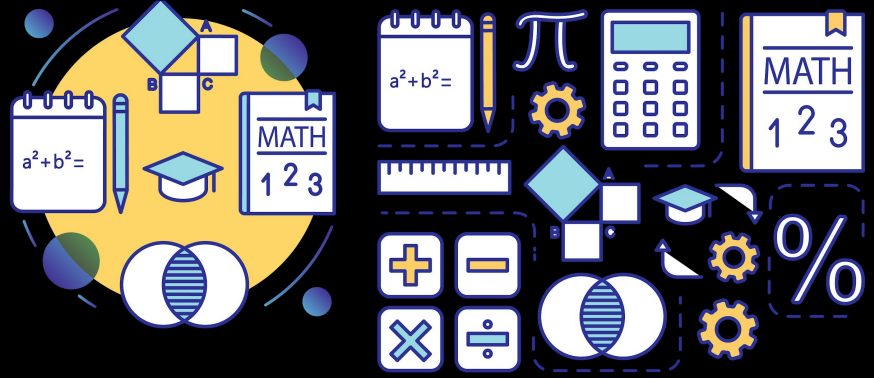
Functions

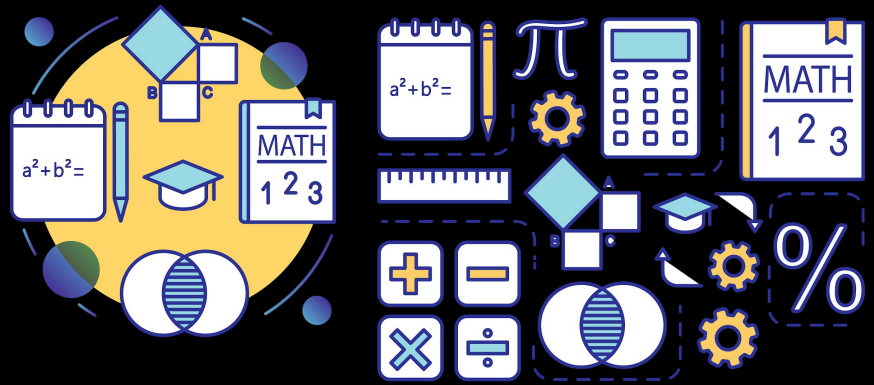
LECTURE 6

Modulus Function - 3





Homework Discussion



Example

$|x^3 - 1| \geq 1 - x$

A. $(-\infty, -1] \cup [0, \infty)$ **B.** $(-\infty, 0] \cup [1, \infty)$

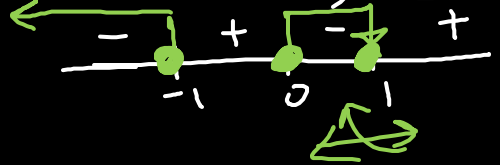
C. $(-\infty, 0) \cup (1, \infty)$ **D.** $(-\infty, 0) \cup (0, \infty)$

$-(x^3-1) \geq 1-x$

$-x^3 + 1 \geq 1 - x$

$x^3 - x \leq 0$

$x(x-1)(x+1) \leq 0$



$x^3 - 1 \geq 1 - x$

$x^3 + x - 2 \geq 0$

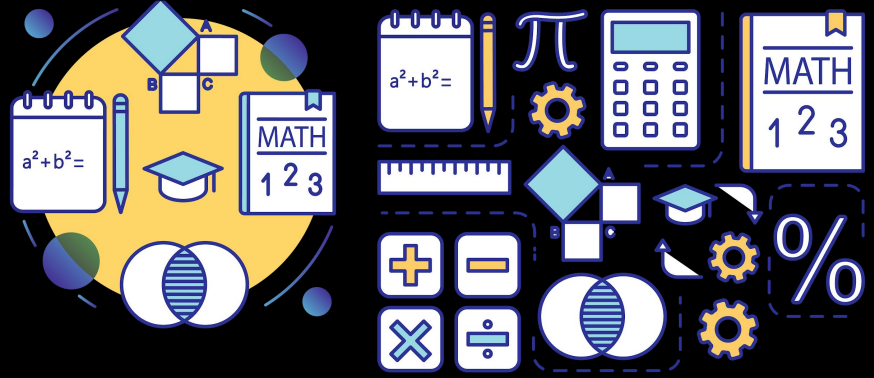
$x^2(x-1) + x(x-1) + 2(x-1) \geq 0$

$(x-1)(x^2 + x + 2) \geq 0$

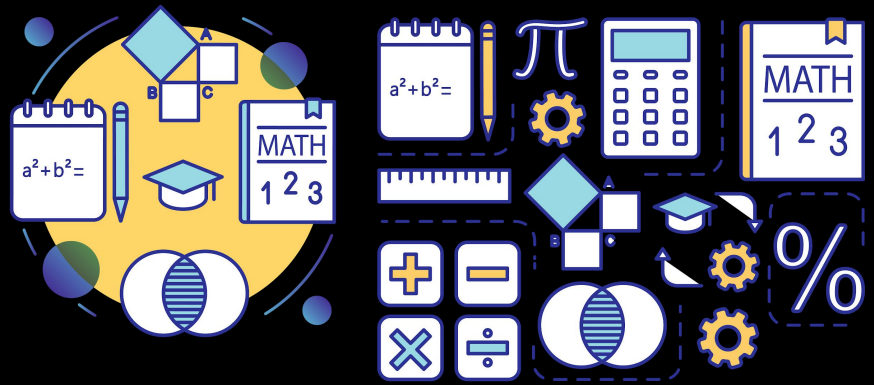
$(x^2 + x + 2)$ → (always +ve)

$\Rightarrow \boxed{x \geq 1}$

$\boxed{(-\infty, -1] \cup [0, \infty)}$



Properties of Modulus Function



Properties of Modulus Function

Property 1

$$|a.b| = |a|.|b|$$

Eg: $a = 2$; $b = -3$

$|2 \times (-3)|$ $\quad$ $|2| \cdot |-3|$

$|-6|$ $\quad$ 2×3

6 $\quad = \quad$ 6

Properties of Modulus Function

Property 2

$$\left|\frac{a}{b}\right| = \frac{|a|}{|b|}$$

Eg: $a = 2$; $b = -3$

$$\left|\frac{2}{(-3)}\right| \quad \left\{ \quad \frac{|2|}{|-3|}\right.$$

$$\frac{2}{3} \quad = \quad \frac{2}{3}$$

Properties of Modulus Function

Property 3

$$|a| + |b| \geq |a + b|$$

In General

$$|a_1| + |a_2| + |a_3| + \ldots + |a_n| \geq |a_1 + a_2 + a_3 + \ldots + a_n|$$

Eg: $a = 2$; $b = -3$

$LHS = |2| + |-3| = 5$

$RHS = |2 + (-3)| = |-1| = 1$

$a = 2$ & $b = 3$

$LHS = 5$

$RHS = 5$

same sign gives equality

Properties of Modulus Function

Property 3.1

$$|a| + |b| = |a + b| \Rightarrow a.\, b \geq 0$$

implies

Property 3.2

$$|a| + |b| > |a + b| \Rightarrow a.\, b < 0$$

Properties of Modulus Function

Property 4

$$||a| - |b|| \leq |a - b|$$

$\mp$ $\mp$ $=$ $-$

Subtraction

Eg: $a = 2$; $b = -3$

LHS $= ||2| - |-3|| = |-1| = 1$

RHS $= |2 - (-3)| = 5$

$-$ to $+$

add.

Properties of Modulus Function

Property 4.1

$$\big||a| - |b|\big| < |a - b| \Rightarrow a.b < 0$$

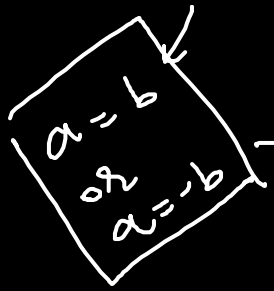
effective additions

Property 4.2

$$\big||a| - |b|\big| = |a - b| \Rightarrow a.b \geq 0$$

Properties of Modulus Function

Property 5



* $|a| = |b| \Rightarrow (a + b)(a - b) = 0$ and

* $|a| > |b| \Rightarrow (a + b)(a - b) > 0$

Proof:

$|a| = |b|$

$|a|^2 = |b|^2$

$a^2 = b^2$

$a^2 - b^2 = 0$

Example

Solve the equation $|x^2 - 1| + |2 - x^2| = 1$

A. $x \in [-\sqrt{2}, \sqrt{2}]$

B. $x \in [-\sqrt{2}, -1] \cup [1, \sqrt{2}]$

C. $x \in [-1, 1]$

D. None of these

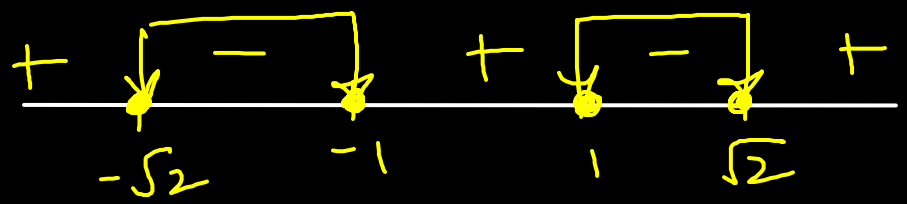
$$|x^2-1| + |2-x^2| = |(x^2-1) + (2-x^2)|$$

$$\Rightarrow |a| + |b| = |a+b| \Rightarrow a \cdot b \geq 0$$

$$(x^2-1)(2-x^2) \geq 0$$

$$(x^2-1)(x^2-2) \leq 0$$

$$(x-1)(x+1)(x-\sqrt{2})(x+\sqrt{2}) \leq 0$$



Example

The solution set of $|x-1|+|x+5|=6$ is

A. $[-5, 1]$ B. $[1, \infty)$ C. $(-\infty, -5]$ D. R

$|a| = |-a|$

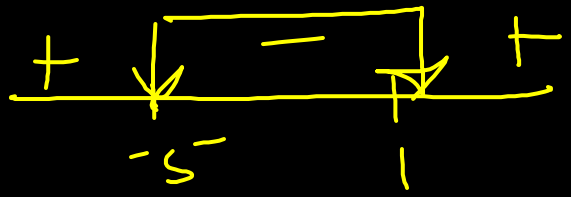
$|x-1| + |x+5| =$

$|1-x| + |x+5| = |(1-x) + (x+5)|$

$|a| + |b| = |a+b| \Rightarrow a \cdot b \geq 0$

$(1-x)(x+5) \geq 0$

$(x-1)(x+5) \leq 0$



$x \in [-5, 1]$

Example

Find the number of integral solutions of: $|x^2 - 1| + |x^2 - 5x + 6| = |5x - 7|$

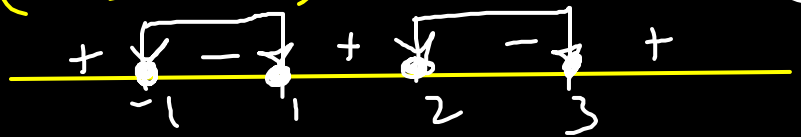
A. 1 B. 3 C. 5 D. 7

$$|x^2-1| + |-x^2+5x-6| = |(x^2-1)+(-x^2+5x-6)|$$

$$\Rightarrow (x^2-1)(-x^2+5x-6) \geq 0$$

$$\Rightarrow (x^2-1)(x^2-5x+6) \leq 0$$

$$\Rightarrow (x-1)(x+1)(x-2)(x-3) \leq 0$$



$\{x = -1, 0, 1, 2, 3\}$

Example

Solve for x: $||x^2 - 1| - |x^2 - 3x - 4|| < 3|x + 1|$

$$||a| - |b|| < |a - b| \Rightarrow a \cdot b < 0$$

$$(a-b) = (x^2-1) - (x^2-3x-4)$$

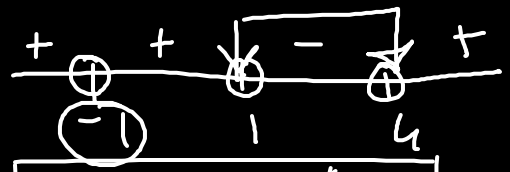
$$= 3x + 3$$

$$= 3(x+1)$$

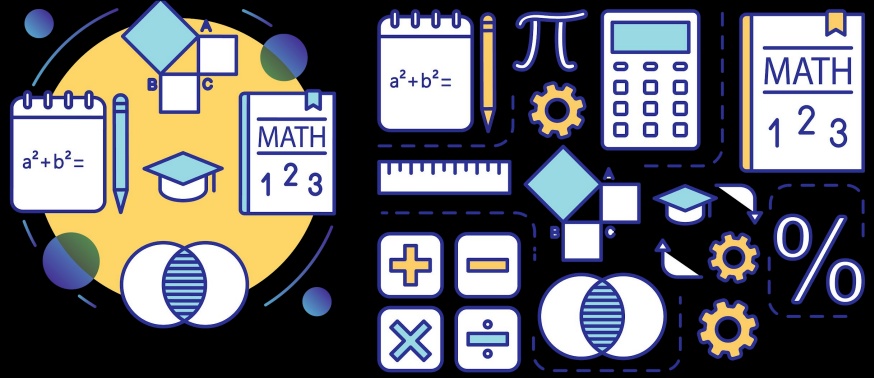
$$(x^2-1)(x^2-3x-4) < 0$$

$$(x-1)(x+1)(x-4)(x+1) < 0$$

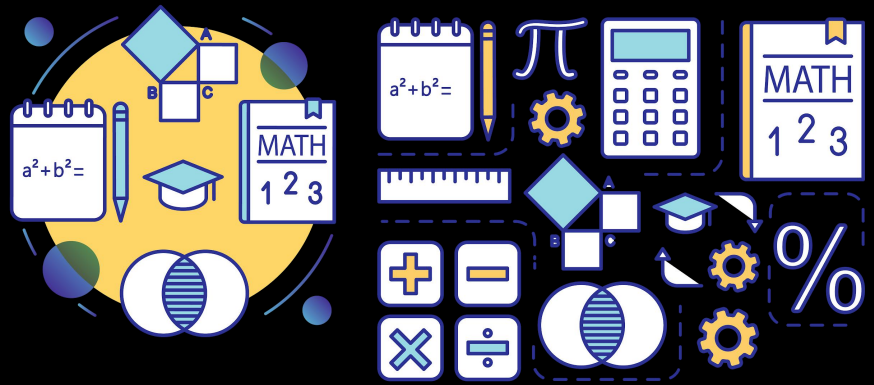
$$(x-1)(x+1)^2(x-4) < 0$$



$$x \in (1, 4)$$



Domain related Questions



Example

Find the domain of: $f(x) = \sqrt{1 - \frac{|x-1|}{(x+2)}}$

$1 - \frac{|x-1|}{(x+2)} \geq 0$

Case-1: $x \geq 1$ ①

Case-2: $x < 1$ ②

$\Rightarrow x \geq 1$ — ①

Case-2:

$1 + \frac{x-1}{x+2} \geq 0$

$\frac{x+2+x-1}{x+2} \geq 0$

$\frac{2x+1}{x+2} \geq 0$

Case-1:

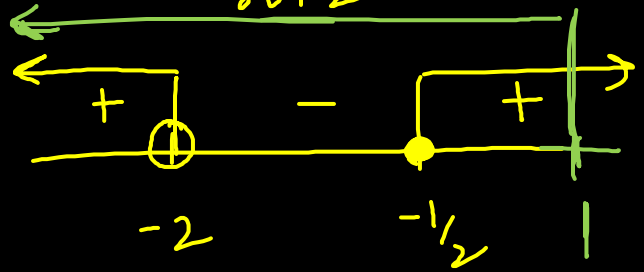
$1 - \frac{(x-1)}{(x+2)} \geq 0$

$\frac{x+2-x+1}{x+2} \geq 0$

$\left(\frac{3}{x+2}\right) \geq 0 \Rightarrow x > -2$

① ∩ ② ∩ ③

$$\frac{2x+1}{x+2} \geq 0 \quad (1)$$



$$x \in (-\infty, -2) \cup \left[-\frac{1}{2}, 1\right) \quad (2)$$

$$(1) \cup (2) : \left[(-\infty, -2) \cup \left[-\frac{1}{2}, \infty\right)\right]$$

Example

Find the domain of $f(x) = \sqrt{\left|\frac{2x-1}{x^2-1}\right| - 1}$

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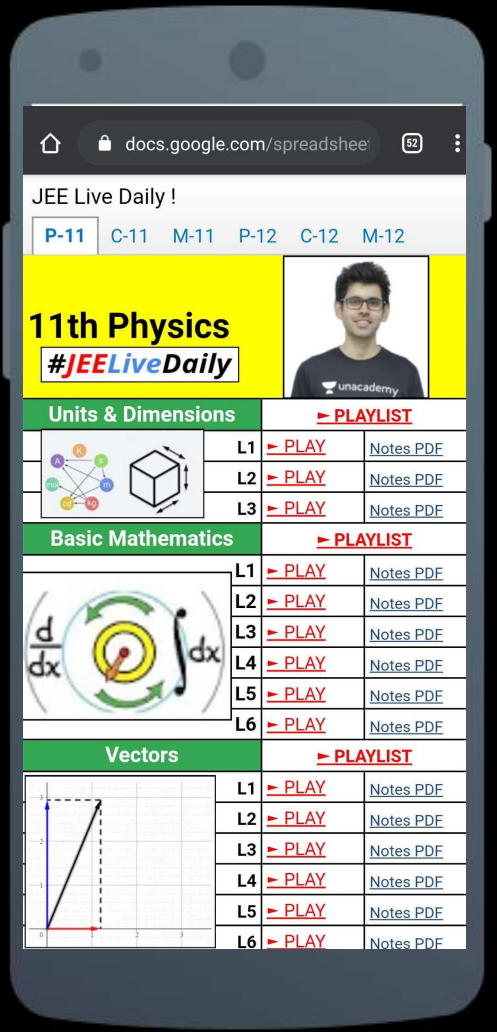

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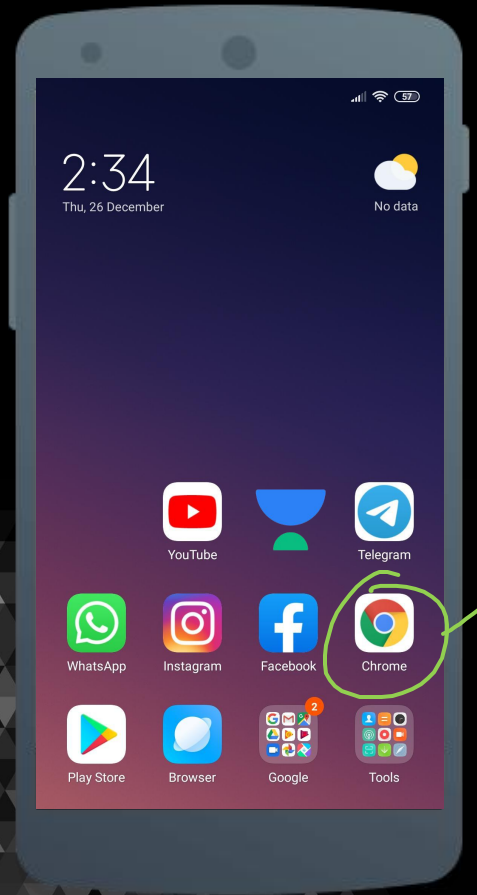

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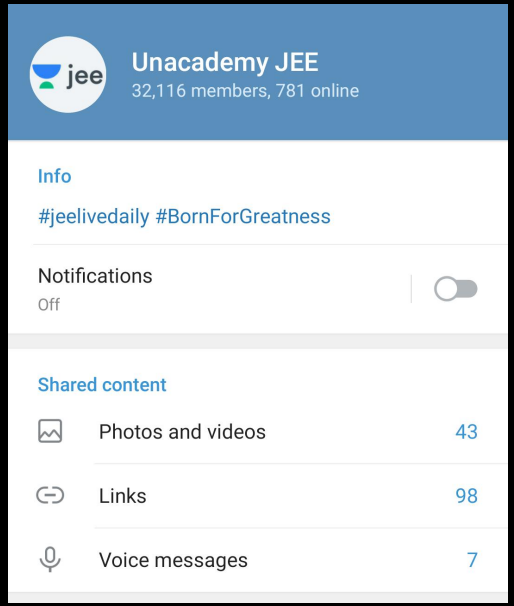

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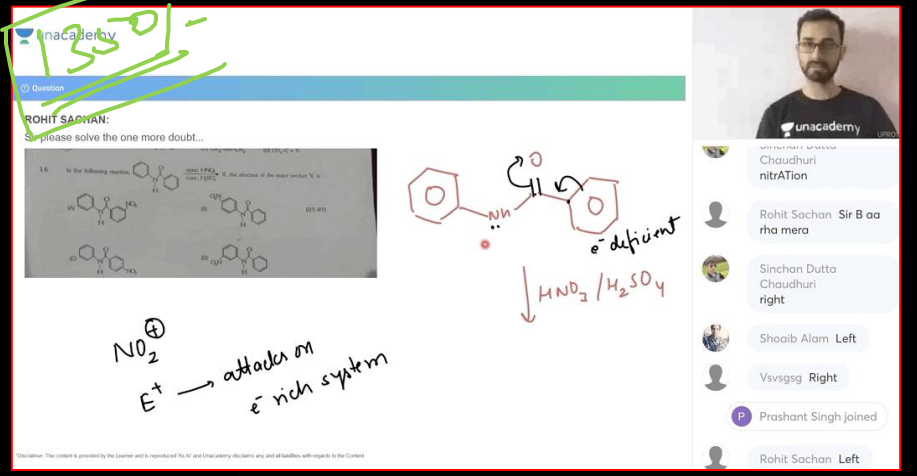

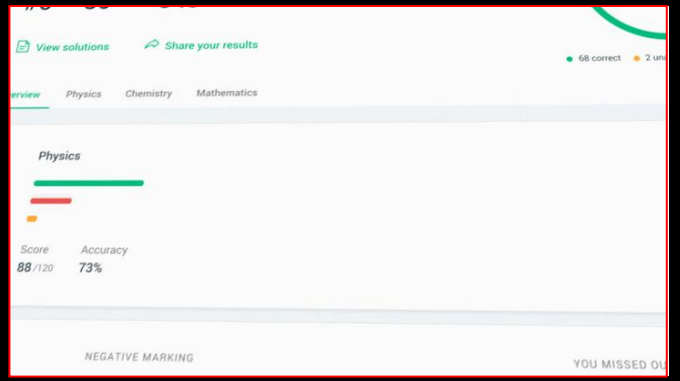

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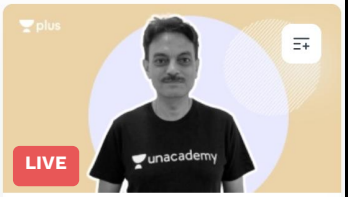

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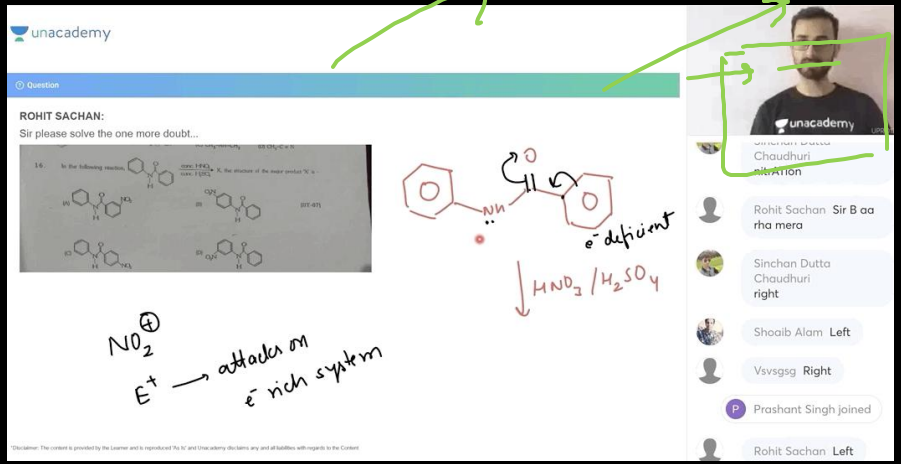

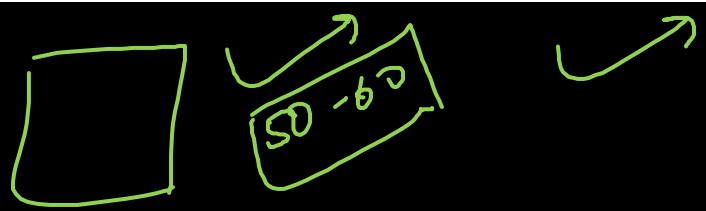

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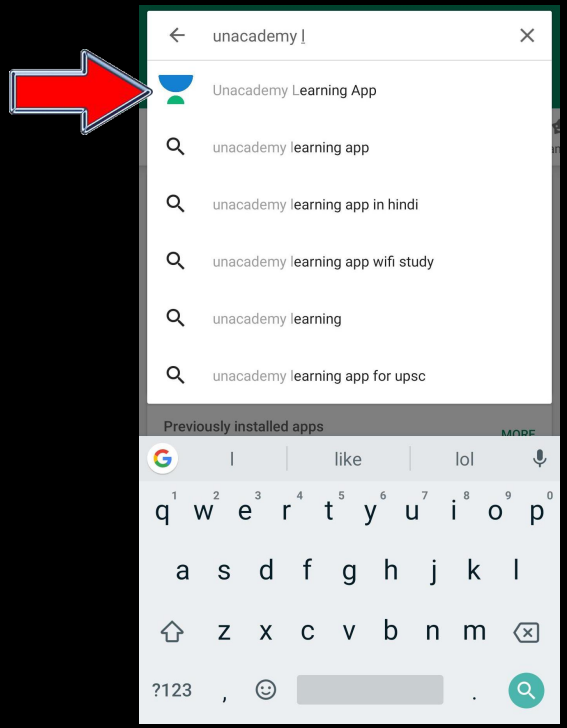
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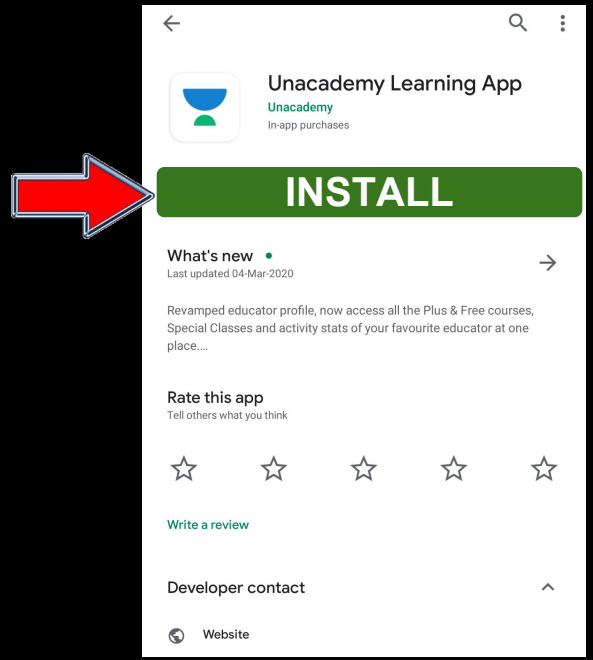
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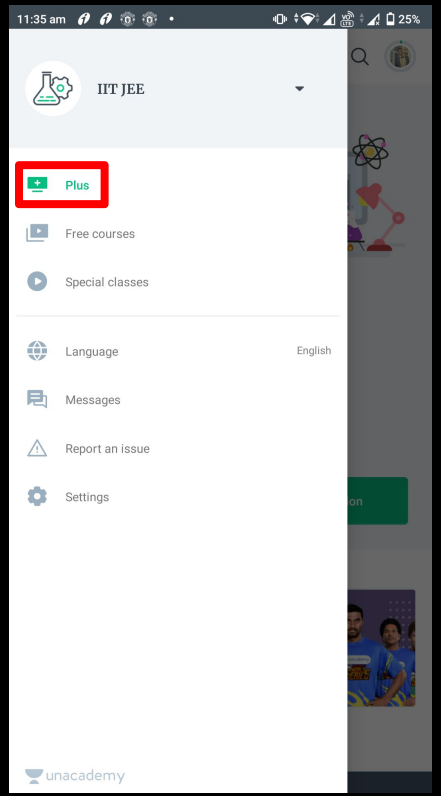

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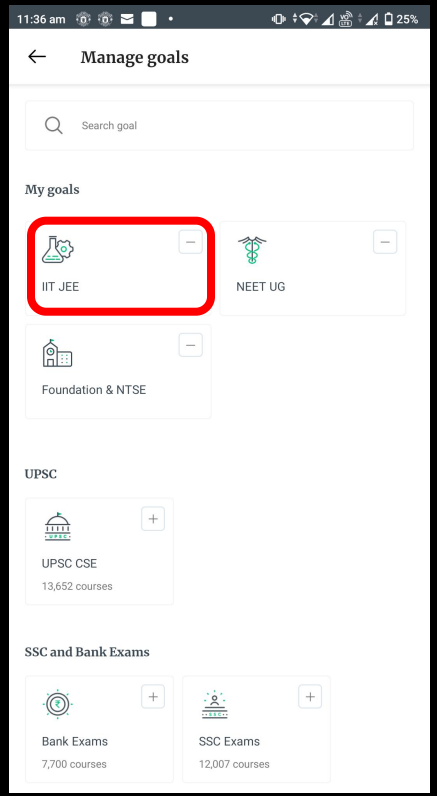

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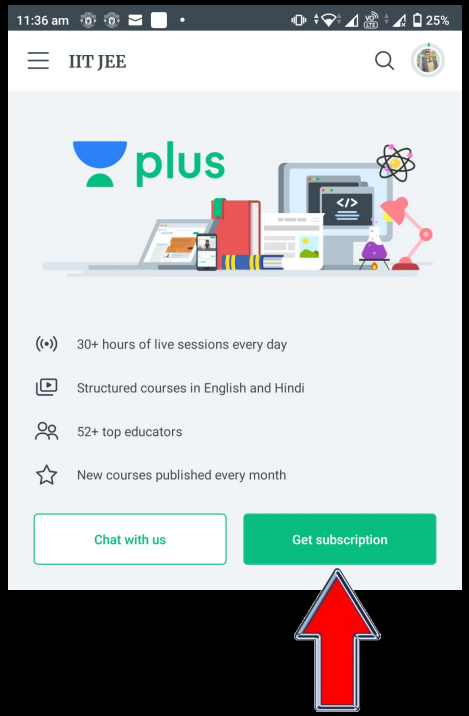

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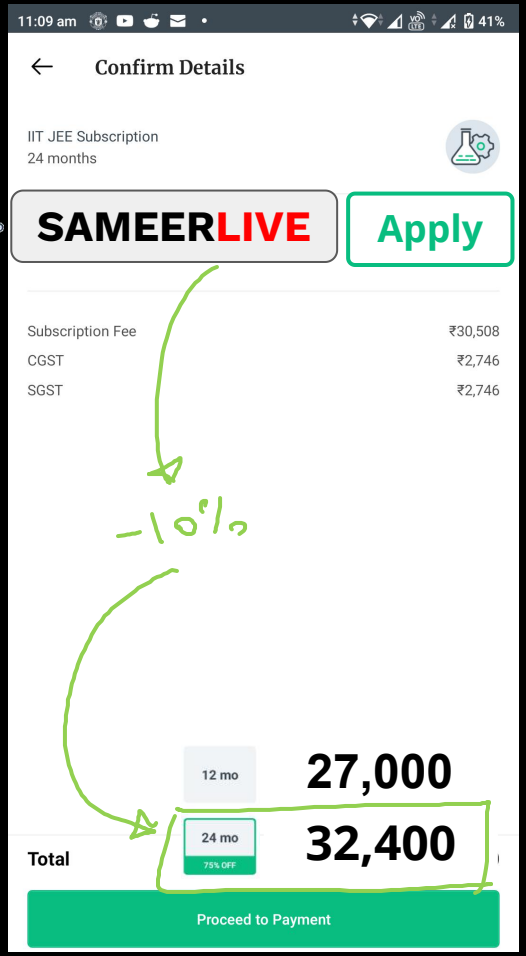
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