Nishant Jindal

$58 \times \frac{47}{58} = 47$

Q good Mains Level

Let $f(x) = \frac{1}{\pi}\left(\sin^{-1}x + \cos^{-1}x + \tan^{-1}x\right) + \frac{x+1}{x^2+2x+10}$

If absolute max$^m$ value of $f(x)$ is M then $52M = ?$

$-1 \le x \le 1$

$$f(x) = \frac{1}{\pi}\left(\sin^{-1}x + \cos^{-1}x + \tan^{-1}x\right) + \frac{x+1}{(x^2+2x+1)+9}$$

$$= \frac{1}{\pi}\left(\frac{\pi}{2} + \tan^{-1}x\right) + \frac{x+1}{(x+1)^2+9}$$

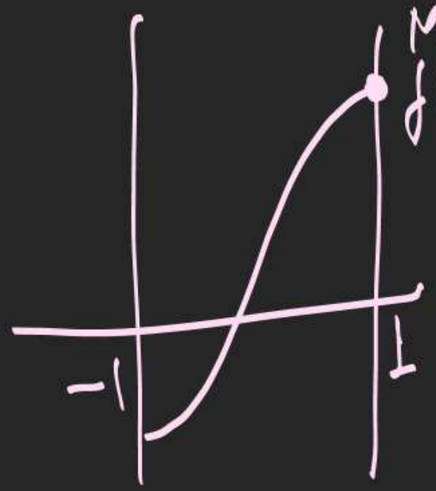
HW

$$f(x) = \frac{1}{\pi}\left(\frac{\pi}{2} + \tan^{-1}x\right) + \left(\frac{x+1}{(x+1)^2+9}\right)$$

$\frac{\pi}{2} + \tan^{-1}x$ : $-1 \to 1$ : $0 \to \frac{\pi}{2}$

$\frac{x+1}{(x+1)^2+9} \ge 0$ to $9$

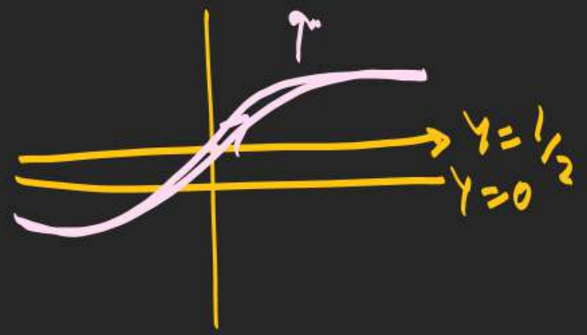
Max Tabaayega when Dr is Min$^m$





$\frac{\pi}{2} + \tan^{-1}x \in \left[\frac{\pi}{4} + \frac{3\pi}{4}\right]$

$\frac{1}{\pi}\left(\frac{\pi}{2} + \tan^{-1}x\right) \in \left[\frac{1}{4}, \frac{3}{4}\right]$




$$\text{Max } f(1) = \frac{1}{\pi}\left(\frac{\pi}{2} + \tan^{-1}(1)\right) + \left(\frac{1+1}{(1+1)^2+9}\right) = \frac{3}{4} + \frac{2}{13} = \frac{39+8}{52} = \frac{47}{52}$$

Nishant Jindal

Level Bahang Padegi

Commonly Asked Qs.

Q Find Range of $f(x) = (\sin^{-1}x)^2 + (\cos^{-1}x)^2$

$f(x) = (\sin^{-1}x)^2 + (\frac{\pi}{2} - \sin^{-1}x)^2$

$= (\sin^{-1}x)^2 + \frac{\pi^2}{4} - \pi\sin^{-1}x + (\sin^{-1}x)^2$

$f(x) = 2(\sin^{-1}x)^2 - \pi\sin^{-1}x + \frac{\pi^2}{4}$ → Q Eq^ ki Range when Domain is Bounded

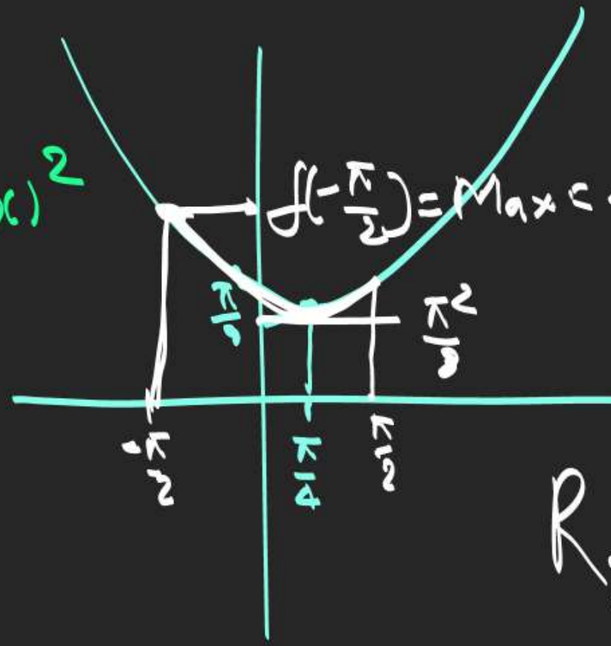
$= 2t^2 - \pi t + \frac{\pi^2}{4}$ ; $\sin^{-1}x = t \in [-\frac{\pi}{2}, \frac{\pi}{2}]$

graph. $y = 2t^2 - \pi t + \frac{\pi^2}{4}$

$\frac{dy}{dt} = 4t - \pi + 0 = 0$

$t = \frac{\pi}{4}$

→ $y = 2\cdot\frac{\pi^2}{16} - \pi\cdot\frac{\pi}{4} + \frac{\pi^2}{4} = \frac{\pi^2}{8}$ $V \equiv (\frac{\pi}{4}, \frac{\pi^2}{8})$




$R_f \in [\frac{\pi^2}{8}, \frac{5\pi^2}{4}]$

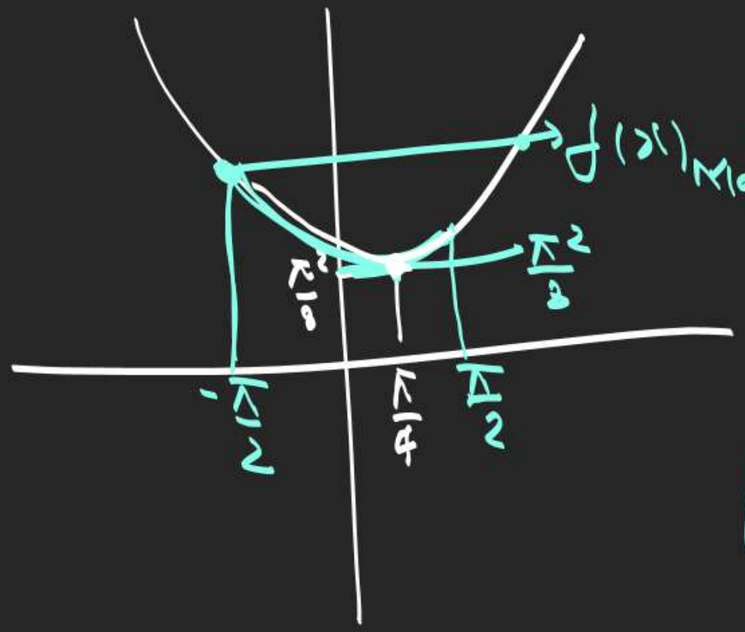
$f(x) = (\sin^{-1}x)^3 + (\cos^{-1}x)^3$

Q $f(x) = (\tan^{-1}x)^2 + (\cot^{-1}x)^2$ Just Range.

$= (\tan^{-1}x)^2 + (\frac{\pi}{2} - \tan^{-1}x)^2$

$f(x) = 2\tan^{-1}x - \pi\tan^{-1}x + \frac{\pi^2}{4}$

$y = 2t^2 - \pi t + \frac{\pi^2}{4}$ $\quad t = \tan^{-1}x \in (-\frac{\pi}{2}, \frac{\pi}{2})$




$= 2\times\frac{\pi^2}{4} - \pi(-\frac{\pi}{2}) + \frac{\pi^2}{4} = \frac{5\pi^2}{4}$

$R_f \in [\frac{\pi^2}{8}, \frac{5\pi^2}{4})$

Nishant Jindal

# Prop 3 → $T(T^{-1}(x)) =$ Trigo(InverseTrigo).

$$T(T^{-1}(x)) = x$$

Garib → Hoshiyaar

1) $\sin(\sin^{-1}x) = x$ → $x \in [-1,1]$ → $|x| \le 1$
2) $\cos(\cos^{-1}x) = x$ → $x \in [-1,1]$ → $|x| \le 1$
3) $\tan(\tan^{-1}x) = x$ → $x \in R$ → $|x| \ge 0$
4) $\cot(\cot^{-1}x) = x$ → $x \in R$ → $|x| \ge 0$
5) $\operatorname{cosec}(\operatorname{cosec}^{-1}x) = x$ → $x \le -1 \cup x \ge 1$ → $|x| \ge 1$
6) $\sec(\sec^{-1}x) = x$ → $x \le -1 \cup x \ge 1$ → $|x| \ge 1$

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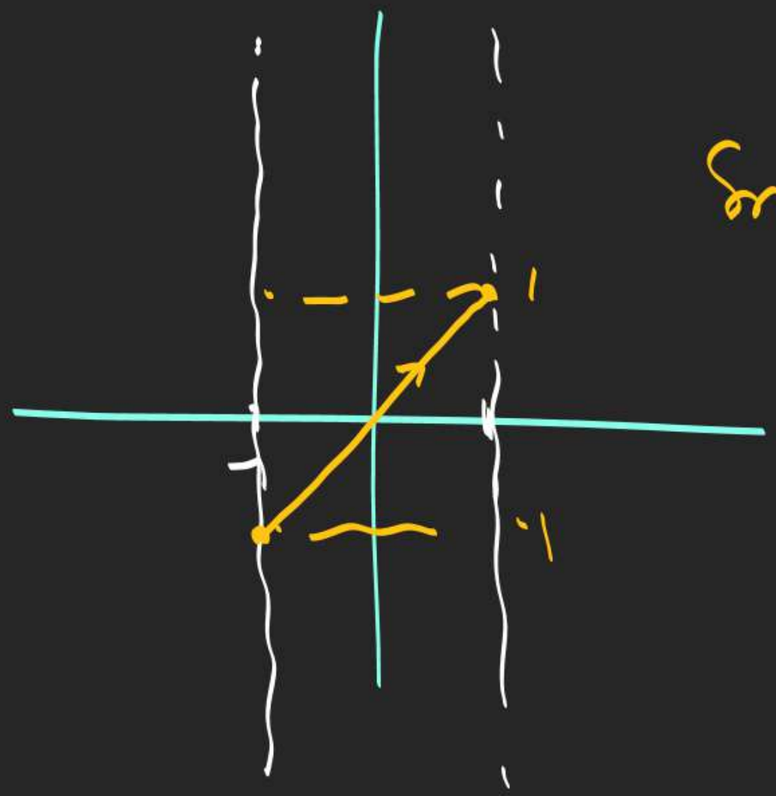
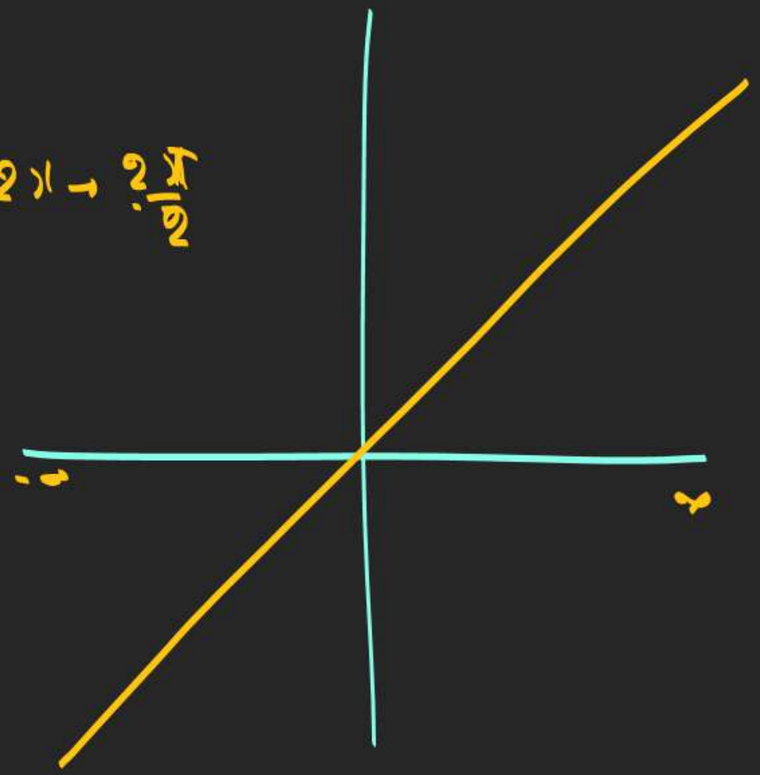
① $y = \sin(\sin^{-1} x) = x$

$-1 \le x \le 1$




② $y = \tan(\tan^{-1} x) = x$

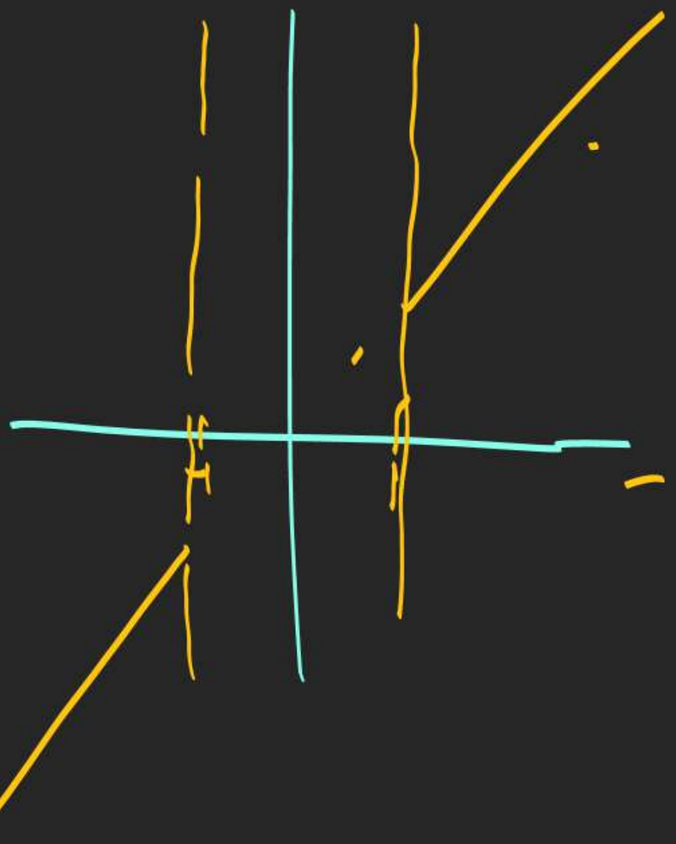
$x \in R$



$\sin 2x \to 2x$

③ $y = \sec(\sec^{-1} x) = x$

$x \le -1 \cup x \ge 1$



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Q A) $\cos(\cos^{-1}(-1)) = 2$

$\cos(\cos^{-1}(x)) = x$

$= -1$

(C) $\sec(\sec^{-1}(\frac{1}{2}))$ $x \le -1 \quad x \ge 1$

$\frac{1}{2} \ge 1$ ⊗

$= \phi$

(D) $\tan(\tan^{-1}(2))$

$-1 \le 2 \le 1$ ⊗

$= \phi$

$\sec(\sec^{-1}x)$
$x \le -1 \cup x \ge 1$

$\tan(\tan^{-1}x)$
$-1 \le x \le 1$
$\tan(\tan^{-1}x) = x$
$x \in R$

B) $\cos(\cos^{-1}(-\frac{\sqrt{3}}{2}))$

$-\frac{1.7}{2} = -.85 \notin [-1,1]$

$= -\frac{\sqrt{3}}{2}$

(E) $\tan(\tan^{-1}(\frac{1}{2}))$ $\frac{1}{2} \in (-\infty, \infty)$

$= \frac{1}{2}$

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Q find $x \to f(x) \sin^{-1}(3+x) + \cos^{-1}(3+x) + \sin^{-1} x + \cos^{-1} x$ find value?

$\pi \leq \frac{\pi}{2}$ ← Normal Bchhgs

$+ \quad \frac{\pi}{2}$

$\frac{\pi}{2}$ Degu wb

$-1 \leq 3+x \leq 1$

$-4 \leq x \leq -2$

&

$\frac{\pi}{2}$ hogi wb $-1 \leq x \leq 1$

$-1 \leq x \leq 1$

$x = \phi \Rightarrow$ Not defined

## Prop 4 Converting one ITF into another

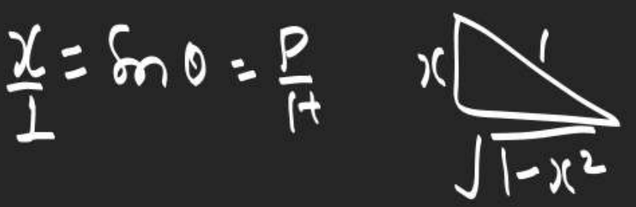
Raaz 3 → Jab bhi E k ITF Ko dusre me Badlna ho use Tarbooz

Tribuz → Δ^r.

Q Convert $\sin^{-1}x$ into $\cos^{-1}(\ )$ & $\cot^{-1}(\ )$

① $\sin^{-1}x = \theta$

$\frac{x}{1} = \sin\theta = \frac{P}{H}$




| Demand $\cos^{-1}$ | Demand $\cot^{-1}$ |
|---|---|
| Think Cos | Think Cot |
| $\cos\theta = \frac{B}{H} = \frac{\sqrt{1-x^2}}{1}$ | $\cot\theta = \frac{B}{P} = \frac{\sqrt{1-x^2}}{x}$ |
| $\theta = \cos^{-1}\sqrt{1-x^2}$ | $\theta = \cot^{-1}\frac{\sqrt{1-x^2}}{x}$ |

$$\sin^{-1}x = \cos^{-1}\sqrt{1-x^2} = \cot^{-1}\frac{\sqrt{1-x^2}}{x}$$

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# Q Convert $\tan^{-1}x$ into $\sin^{-1}(\ )$ & $\sec^{-1}(\ )$

① $\tan^{-1}x = \theta$

$\tan\theta = \frac{x}{1} = \frac{P}{B}$


Demand $\sin^{-1}$

$\sin\theta = \frac{P}{H} = \frac{x}{\sqrt{1+x^2}}$

$\theta = \sin^{-1}\frac{x}{\sqrt{1+x^2}}$

Demand $\sec^{-1}$

$\sec\theta = \frac{H}{B} = \frac{\sqrt{1+x^2}}{1}$

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

$$\tan^{-1}x = \sin^{-1}\frac{x}{\sqrt{1+x^2}} = \sec^{-1}\sqrt{1+x^2}$$

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# Props- Reciprocal Prop.

Trigo me $\sec\theta = \frac{1}{\cos\theta}$

$\tan\theta = \frac{1}{\cot\theta}$

In IIT

$x \le -1 \cup x \ge 1$ $\quad \sin^{-1}\left(\frac{1}{x}\right) = \csc^{-1}(x)$

$\quad \csc^{-1}\left(\frac{1}{x}\right) = \sin^{-1}(x)$

$-1 \le x \le 1$

$x \le -1 \cup x \ge 1$ $\quad \cos^{-1}\left(\frac{1}{x}\right) = \sec^{-1}(x)$

$\quad \sec^{-1}\left(\frac{1}{x}\right) = \cos^{-1}(x)$

$-1 \le x \le 1$

Issue

$\tan^{-1}\left(\frac{1}{x}\right) = \cot^{-1}x \rightarrow x \ge 0$

$\tan^{-1}\left(\frac{1}{x}\right) = -\pi + \cot^{-1}x \quad x < 0$

Check HW. Mon

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# Property 1 and Constant Property

**Q.1** Find the range of $f(x) = \sin^{-1} x + \cos^{-1} x + \tan^{-1} x$

Done

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# Property 1 and Constant Property

**Q.2** Solve for x: $4\sin^{-1}(x-2)+\cos^{-1}(x-2)=\pi$

$$4\left(\frac{\pi}{2}-\cos^{-1}(x-2)\right)+\cos^{-1}(x-2)=\pi$$

$$2\pi-4\cos^{-1}(x-2)+\cos^{-1}(x-2)=\pi$$

$$\pi=3\cos^{-1}(x-2)$$

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

$$\cos\frac{\pi}{3}=x-2 \Rightarrow x-2=\frac{1}{2}$$

$$\boxed{x=\frac{5}{2}}$$

$\sin^{-1}x+\cos^{-1}x=\frac{\pi}{2}$

$\sin^{-1}(x-2)+\cos^{-1}(x-2)=\frac{\pi}{2}$

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

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# Property 1 and Constant Property

**Q.3** Solve for $x : \sin^{-1}(x^2 - 2x + 1) + \cos^{-1}(x^2 - x) = \frac{\pi}{2}$

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

$1 = x$

**Rough**

$\sin^{-1} x + \cos^{-1} y = \frac{\pi}{2}$ ho

then it is PSBL only

when $x = y$

Nishant Jindal

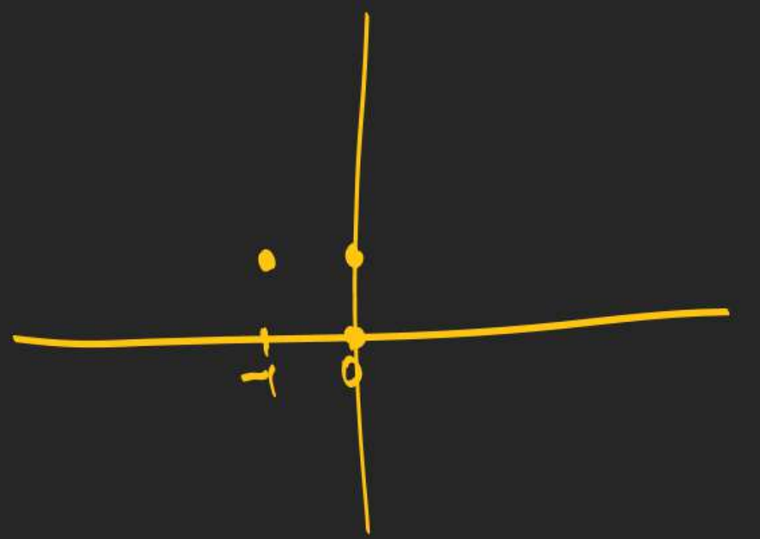
# Property 1 and Constant Property

= values of $x$ = Domain

**Q.4** Find the number of **real solutions** of $\tan^{-1}\sqrt{x(x+1)} + \sin^{-1}\sqrt{x^2+x+1} = \frac{\pi}{2}$

R

Range $= \left\{\frac{\pi}{2}\right\}$




$x(x+1) \geq 0$

$-1 \leq \sqrt{x^2+x+1} \leq 1$

-ve ≤ +ve hamesha.

Ignore for domain

$\sqrt{x^2+x+1} \leq 1$

Sq$^{n}$

$x^2+x+1 \leq 1$

$x^2+x \leq 0$

$x(x+1) \leq 0$

$x(x+1) = 0 \Rightarrow x = 0, -1$

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# Property 1 and Constant Property

Q.5 If $\sin^{-1}\left(x-\frac{x^2}{2}+\frac{x^3}{4}-\cdots\ldots\right)+\cos^{-1}\left(x^2-\frac{x^4}{2}+\frac{x^6}{4}-\cdots\ldots\right)=\frac{\pi}{2}$, for $0<|x|<\sqrt{2}$, then find x.

Rough 2 → $\sin^{-1}x+\cos^{-1}y=\frac{\pi}{2}$ ⇒ $x=y$

$x$ = $x-\frac{x^2}{2}+\frac{x^3}{4}-\ldots\infty$

$r=-\frac{x}{2}$ ∞ h.p $\frac{a}{1-r}$

$y=\boxed{x^2}-\frac{x^4}{2}+\frac{x^6}{4}-\ldots$

∞ h.p → $r=-\frac{x^2}{2}$

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

$$\Rightarrow 2+x^2=2x+x^2$$

$$\boxed{x=1}$$

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# Property 1 and Constant Property

**Q.6** Solve for $x : \sin^{-1} x > \cos^{-1} x$

Chhoti Inequality

$\sin^{-1}x > \cos^{-1}x$

$\frac{\pi}{2} - \cos^{-1}x > \cos^{-1}x$

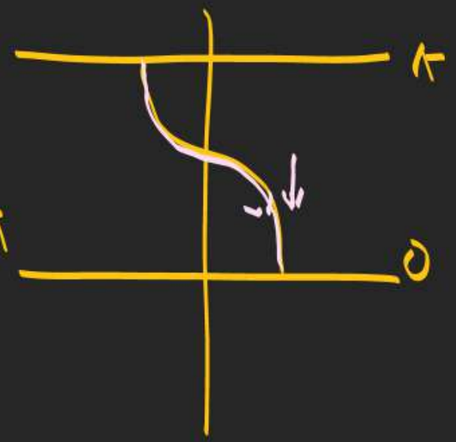
$\Rightarrow 2\cos^{-1}x < \frac{\pi}{2}$

$\cos^{-1}x < \frac{\pi}{4}$

$\sin^{-1}x = \frac{\pi}{2} - \cos^{-1}x$

We know

$0 \le \cos^{-1}x \le \pi$




← घुम घुमाकर आना


$0 \le \cos^{-1}x < \frac{\pi}{4}$

$\cos 0 \ge x > \cos\frac{\pi}{4} \Rightarrow \frac{1}{\sqrt{2}} < x \le 1$

$x \in \left(\frac{1}{\sqrt{2}}, 1\right]$

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# Property 1 and Constant Property

**Q.7** $(\sin^{-1} x)^2 - 3\sin^{-1} x + 2 = 0$ ← ($\sin^{-1}x$) का Q Eqn जैसा.

$t^2 - 3t + 2 = 0$

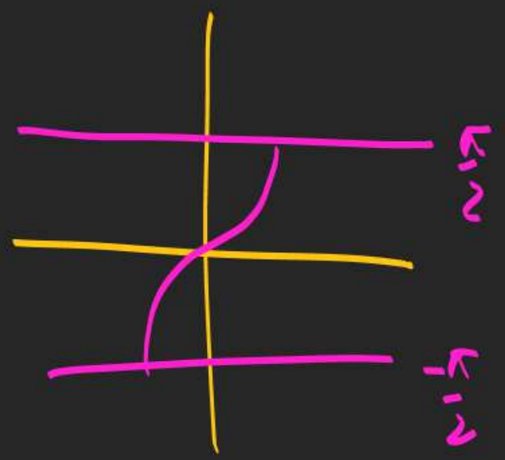
$(t-1)(t-2) = 0$

$t = 1$ or $t = 2$

$\sin^{-1}x = 1$ or $\sin^{-1}x = 2$

$x = \sin 1$

Not possible




$-1.57 \le \sin^{-1}x \le 1.57$

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# Property 1 and Constant Property

**Q.8** $\sin^{-1} x + \sin^{-1} 2y = \pi$

$\sin^{-1} x + \sin^{-1} 2y = \pi$

PSble only $\sin^{-1} x = \frac{\pi}{2}$ & $\sin^{-1} 2y = \frac{\pi}{2}$

$x = 1$ $\quad 2y = 1$

$x = 1, \quad y = \frac{1}{2}$

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# Property 1 and Constant Property

$\uparrow + \pi = 2\pi$

**Q.9** $\cos^{-1} x + \cos^{-1} x^2 = 2\pi$

$0 \le \cos^{-1} x \le \pi$

$2\cos^{-1} x = 2\pi$

$(\cos^{-1} x)_{max}$ De Rahe $= \pi$

$\cos^{-1} x = \pi$ & $\cos^{-1} x^2 = \pi$

$x = -1$ & $x^2 = -1$

$x^2 = -1$ ✗

$x = \phi$

Check

$\cos^{-1}(-1) + \cos^{-1}(-1)^2 = 2\pi$

$\pi + \underset{\cos^{-1}(1)}{0} = 2\pi$ ✗

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# Property 1 and Constant Property

**Q.10** $\cos^{-1} x + \cos^{-1} x^2 = 0$

$0 \le \cos^{-1} x \le \pi$

$\cos^{-1} x$ | $\cos^{-1} x^2$ ka Sum = 0 ⇒ When Both $\cos^{-1}$ are giving 0

$0 + 0 = 0$

$\cos^{-1} x = 0$ & $\cos^{-1} x^2 = 0$

$x = \cos 0$ $\quad$ $x^2 = \cos 0$

$x^2 = 1$

$x = 1$ $\quad$ $x = 1, -1$

$x = 1$

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# Property 1 and Constant Property

**Q.11** $4\sin^{-1}(x-1) + \cos^{-1}(x-1) = \pi$

$$4\sin^{-1}(x-1) + \frac{\pi}{2} - \sin^{-1}(x-1) = \pi$$

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

$$\sin^{-1}(x-1) = \frac{\pi}{6}$$

$$x-1 = \sin\frac{\pi}{6} = \frac{1}{2}$$

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

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# Property 1 and Constant Property

$\tan^{-1}x + \cot^{-1}x = \frac{\pi}{2}$

**Q.12** $\cot^{-1}\left(\frac{1}{x^2-1}\right) + \tan^{-1}(x^2-1) = \frac{\pi}{2}$ → Rqaz 2 → $\cot^{-1}x + \tan^{-1}y = \frac{\pi}{2}$ Psbl.

$x = y$

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

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

$$x^2-1 = \pm 1$$

$x^2-1 = 1$

$x^2 = 2$

$x = \sqrt{2}, -\sqrt{2}$

$x^2-1 = -1$

$x = 0$

Check

$\{0, \sqrt{2}, -\sqrt{2}\}$

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# Property 1 and Constant Property

**Q.13** $\cot^{-1}\left(\frac{x^2-1}{2x}\right)+\tan^{-1}\left(\frac{2x}{x^2-1}\right)=\frac{2\pi}{3}$

Kisi Aur Property Ka Q. ||

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# Property 1 and Constant Property

**Q.14** $4\sin^{-1} x + \cos^{-1} x = \frac{3\pi}{4}$

$\frac{\pi}{2} - \sin^{-1} x$

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# Property 1 and Constant Property

**Q.15** $5\tan^{-1} x + 3\cot^{-1} x = \frac{7\pi}{4}$

$\frac{\pi}{2} - \tan^{-1} x$

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# Property 1 and Constant Property

**Q.16** $5\tan^{-1} x + 4\cot^{-1} x = 2\pi$

$\frac{\pi}{2} - \tan^{-1} x$

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# Property 1 and Constant Property

**Q.17** $\cot^{-1} x - \cot^{-1}(x+1) = \frac{\pi}{2}$

Kisi Aur Prob.

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# Property 1 and Constant Property

**Q.18** $[\sin^{-1} x] + [\cos^{-1} x] = 0$

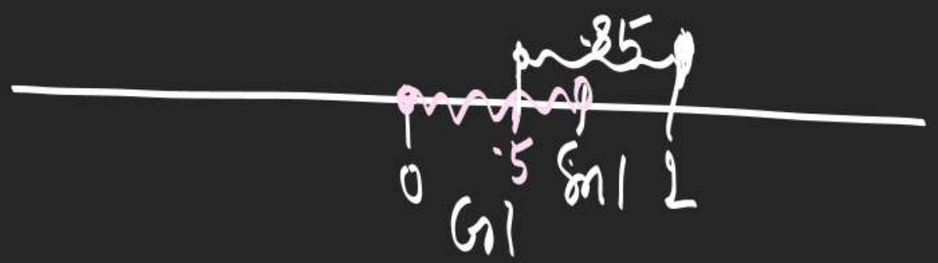
$[\sin^{-1} x] = 0$ & $[\cos^{-1} x] = 0$

$0 \le \sin^{-1} x < 1$ $\quad 0 \le \cos^{-1} x \le 1$

$\sin 0 \le x < \sin 1$ $\quad \cos 0 \ge x > \cos 1 = \cos 60 = \frac{1}{2}$

$0 \quad \sin 60 = \frac{\sqrt{3}}{2} = \frac{1.7}{2} = .85$ $\quad .5$

$x > .5$




$x \in (\cos 1, \sin 1)$

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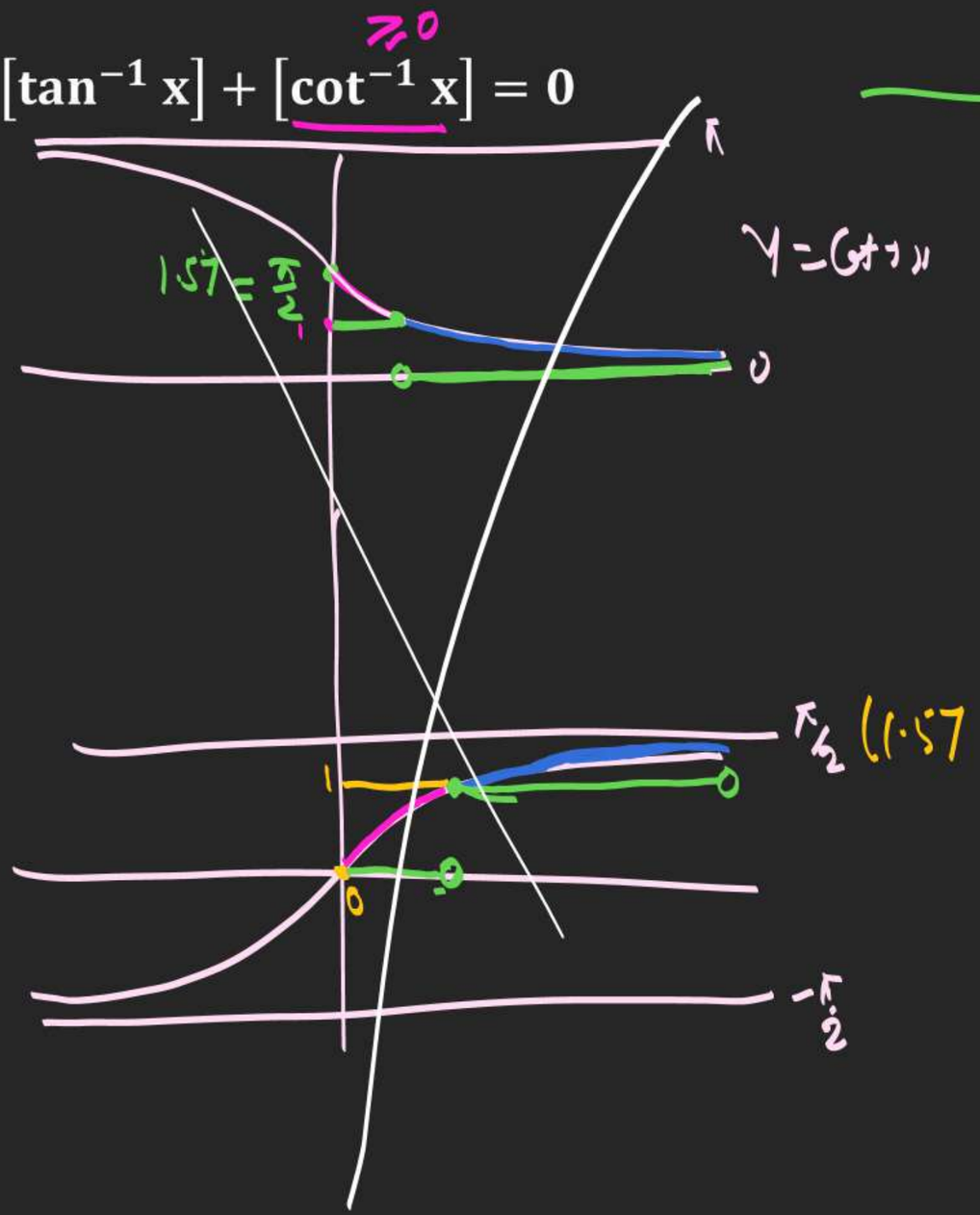
# Property 1 and Constant Property

**Q.19** $[\tan^{-1} x] + [\cot^{-1} x] = 0$




$\Rightarrow [\tan^{-1} x] = 0 \quad \& \quad [\cot^{-1} x] = 0$

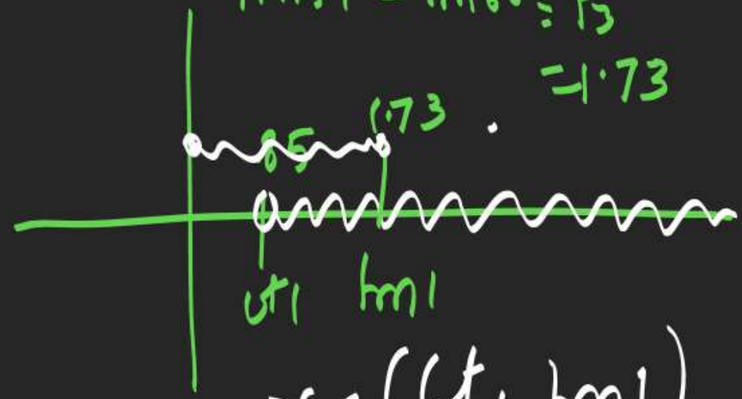
$0 \le \tan^{-1} x < 1 \qquad 0 < \cot^{-1} x \le 1$

$\tan 0 \le x < \tan 1 \quad \& \quad \cot 1 < x \le \cot 0$

$0 \le x < \tan 1 \qquad 1 < x < \infty$

$\tan 57^\circ = \tan 60^\circ = \sqrt{3} = 1.73$

$\cot 57^\circ = \cot 60^\circ = \frac{1}{\sqrt{3}} = \frac{1}{1.7} \approx .85$




$x \in (\cot 1, \tan 1)$

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# Property 1 and Constant Property

**Q.20** $[\sin^{-1}\cos^{-1}\sin^{-1}\tan^{-1}x] = 0$

Level

$0 \le \sin^{-1}\cos^{-1}\sin^{-1}(\tan^{-1}x) < 1$ (Rem)

$\sin 0 \le \cos^{-1}\sin^{-1}(\tan^{-1}x) < \sin 1$ (Rem)

$\cos(0) \ge \sin^{-1}(\tan^{-1}x) > \cos(\sin 1)$

$\sin(1) \ge \tan^{-1}x > \sin(\cos(\sin 1))$

$\tan(\sin 1) \ge x > \tan(\sin(\cos(\sin 1)))$

$x \in (\tan(\sin(\cos(\sin 1))), \tan(\sin 1)]$

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# Property 1 and Constant Property

**Q.21** $\left[\sin^{-1}\cos^{-1}\sin^{-1}\tan^{-1}x\right] = 1$

$[x]=1 \Rightarrow 1 \le x < 2$

hint

$1 \le \sin^{-1}(\cos^{-1}(\sin^{-1}(\tan^{-1}x))) < 2$

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# Property 1 and Constant Property

Sol:

**Q.22** $(\tan^{-1}x)^2 + (\cot^{-1}x)^2 = \frac{5\pi^2}{8}$

Do Inverse me mat khelo
Same Inverse me khelo.

$(\tan^{-1}x)^2 + \left(\frac{\pi}{2} - \tan^{-1}x\right)^2 = \frac{5\pi^2}{8}$

$(\tan^{-1}x)^2 + \frac{\pi^2}{4} + (\tan^{-1}x)^2 - 2\times\frac{\pi}{2}\tan^{-1}x = \frac{5\pi^2}{8}$

$2(\tan^{-1}x)^2 - \pi\tan^{-1}x = \frac{5\pi^2}{8} - \frac{2\pi^2}{8}$

$2t^2 - \pi t - \frac{3\pi^2}{8} = 0$

$16t^2 - 8\pi t - 3\pi^2 = 0$

$16t^2 - 12\pi t + 4\pi t - 3\pi^2 = 0$

$(4t+\pi)(4t-3\pi) = 0$

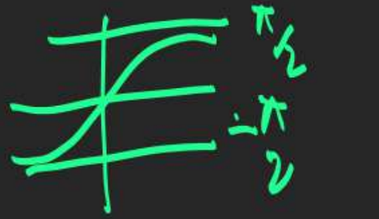
$t = -\frac{\pi}{4}$ or $t = \frac{3\pi}{4}$ MSSST

$\tan^{-1}x = -\frac{\pi}{4}$

$x = \tan\left(-\frac{\pi}{4}\right)$

$x = -1$

$\times$ $\tan^{-1}x = \frac{3\pi}{4}$ Not Pssbl



Nishant Jindal

# Property 1 and Constant Property

Q.23 Find the value of $\cos\left(\frac{1}{2}\cos^{-1}\left(\frac{3}{5}\right)\right)$.

Raaz! All ITF are θ

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

$\cos\left(\frac{\theta}{2}\right)$ Puchh Rahahai When $\theta = \cos^{-1}\left(\frac{3}{5}\right)$

$\cos\theta = \frac{3}{5}$

$2\cos^2\frac{\theta}{2} - 1 = \frac{3}{5}$

$2\cos^2\frac{\theta}{2} = \frac{8}{5}$

$\cos^2\frac{\theta}{2} = \frac{4}{5}$

$\cos\frac{\theta}{2} = -\frac{2}{\sqrt{5}}, \frac{2}{\sqrt{5}}$ (X)

$\frac{\pi}{2} \quad \pi$

$\frac{1}{\sqrt{5}}$

Nishant Jindal

# Property 1 and Constant Property

**Q.24** Find the value of $\sin\left(\frac{\pi}{4} + \sin^{-1}\left(\frac{1}{2}\right)\right)$.

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

$\sin\theta = \frac{1}{2}$

$\theta = 30°$

$\sin\left(\frac{\pi}{4} + \theta\right)$ Puchna nahi!!

$\sin\frac{\pi}{4}\cos\theta + \cos\frac{\pi}{4}\sin\theta$

$\frac{1}{\sqrt{2}} \times \frac{\sqrt{3}}{2} + \frac{1}{\sqrt{2}} \cdot \frac{1}{2}$

Nishant Jindal

# Property 1 and Constant Property

**Q.25** If $m$ is a root of $x^2 + 3x + 1 = 0$, then find the value of $\tan^{-1}(m) + \tan^{-1}\left(\frac{1}{m}\right)$.

Agar Ki Prop Ka Use