WELCOME

TO Adda247

"There is nothing impossible to they who will try."

GATE 2024

प्रचण्ड Batch

PRODUCTION

METAL CUTTING

LEC-6

Mechanical Engineering

GATE 2024

प्रचण्ड Batch

MECHANICAL ENGINEERING

MON/ TUE/ WED- 9PM

THEORY OF MACHINE (TOM)

THUR/ FRI/ SAT- 6PM

PRODUCTION ENGINEERING

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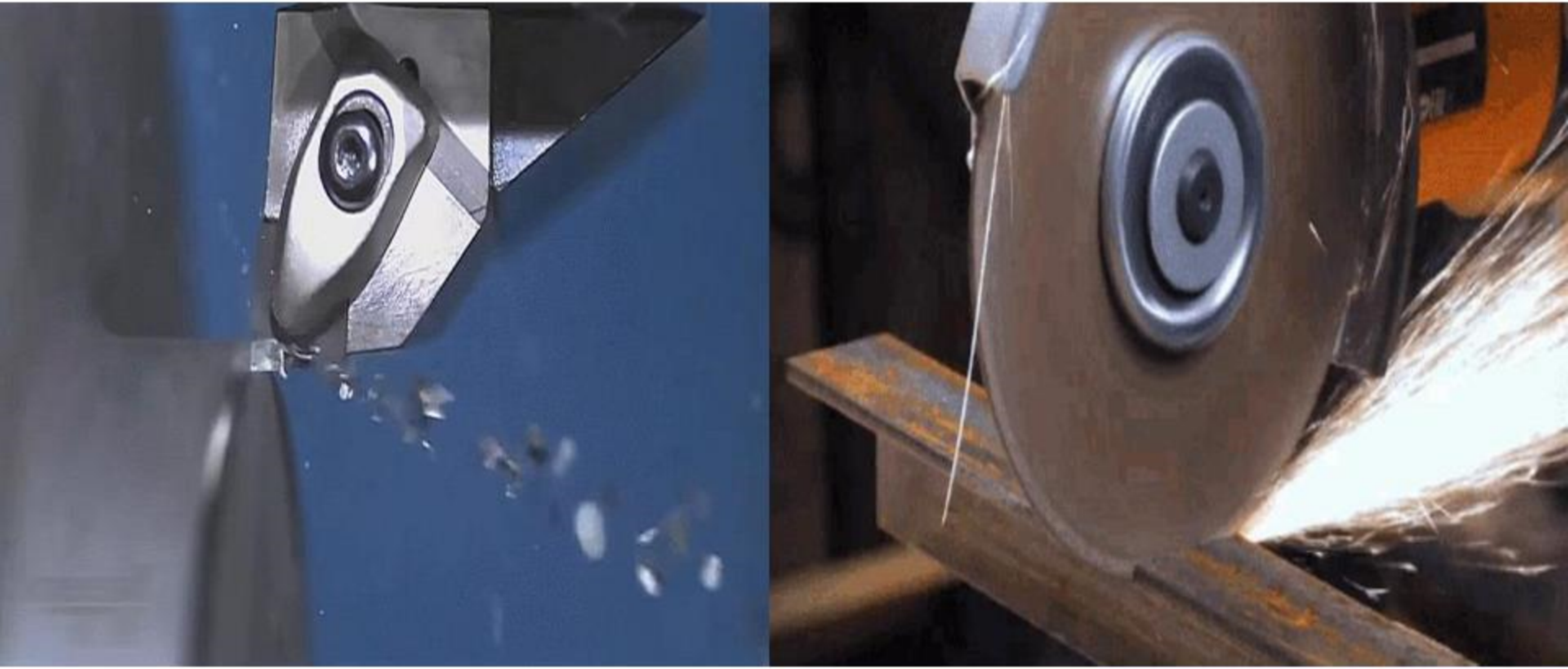
METAL CUTTING



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1.Itroduction to Metal cutting

2.Machining operation

3.Turning operation And analysis

4 .Orthogonal Machining Analysis

5 .Side cutting edge angle And end cutting edge angle

6.Nose Radius

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1. Shear Angle

2 Velocity in Metal cutting

3.Cutting shear strain

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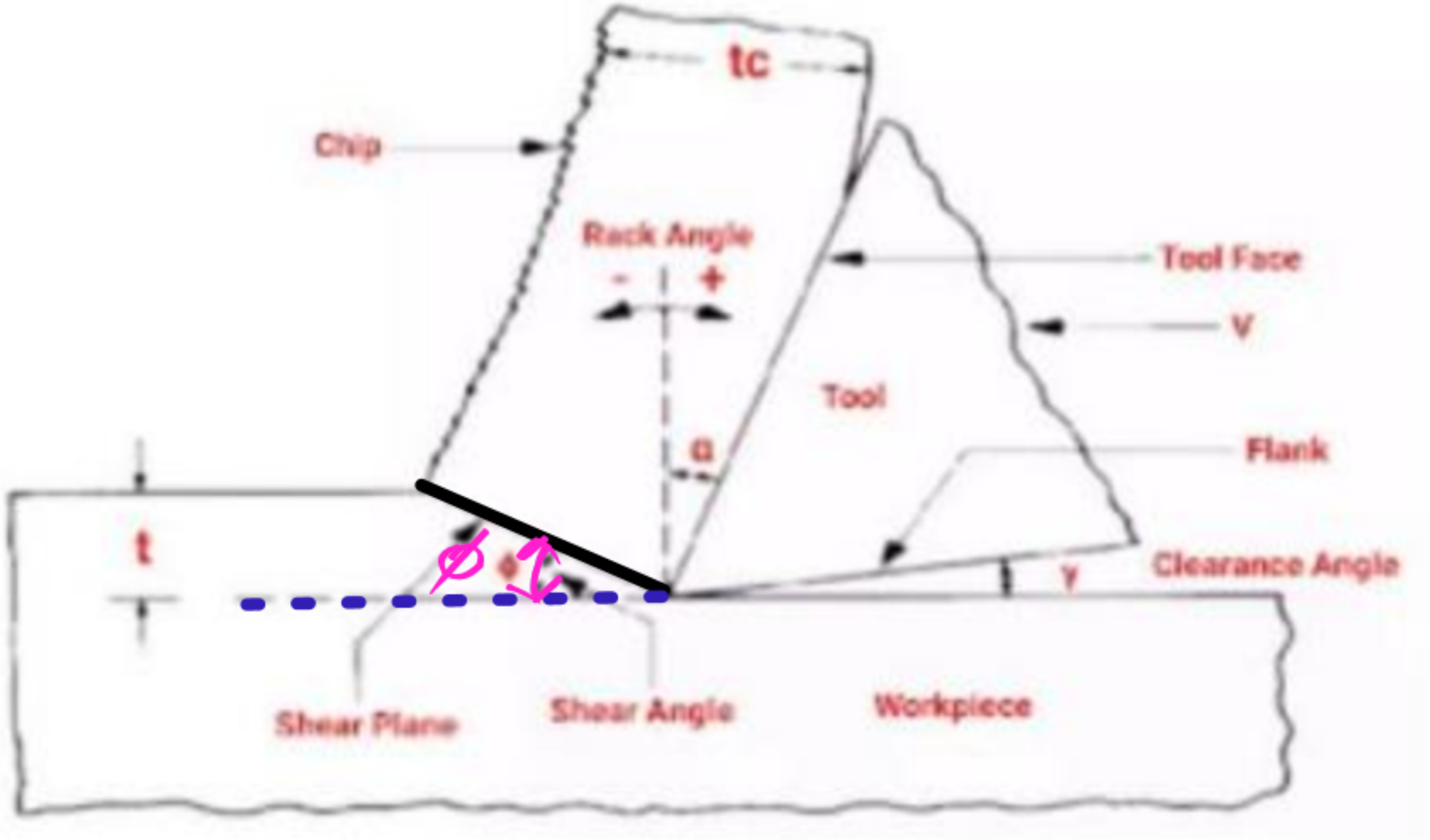
Shear Angle (ϕ)

$$\boxed{\tan\phi = \frac{r\cos\alpha}{1-r\sin\alpha}}$$

* r → chip Thickness Ratio

* α → Rake Angle



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$$* \ \boxed{r = \frac{t}{t_c} = \frac{V_c}{V} = \frac{l_c}{l} = \frac{\sin\phi}{\cos(\phi-\alpha)}} \ ***$$

- V_c → chip velocity
- V → cutting speed
- l_c → chip length
- l → uncut chip length

ΔACB

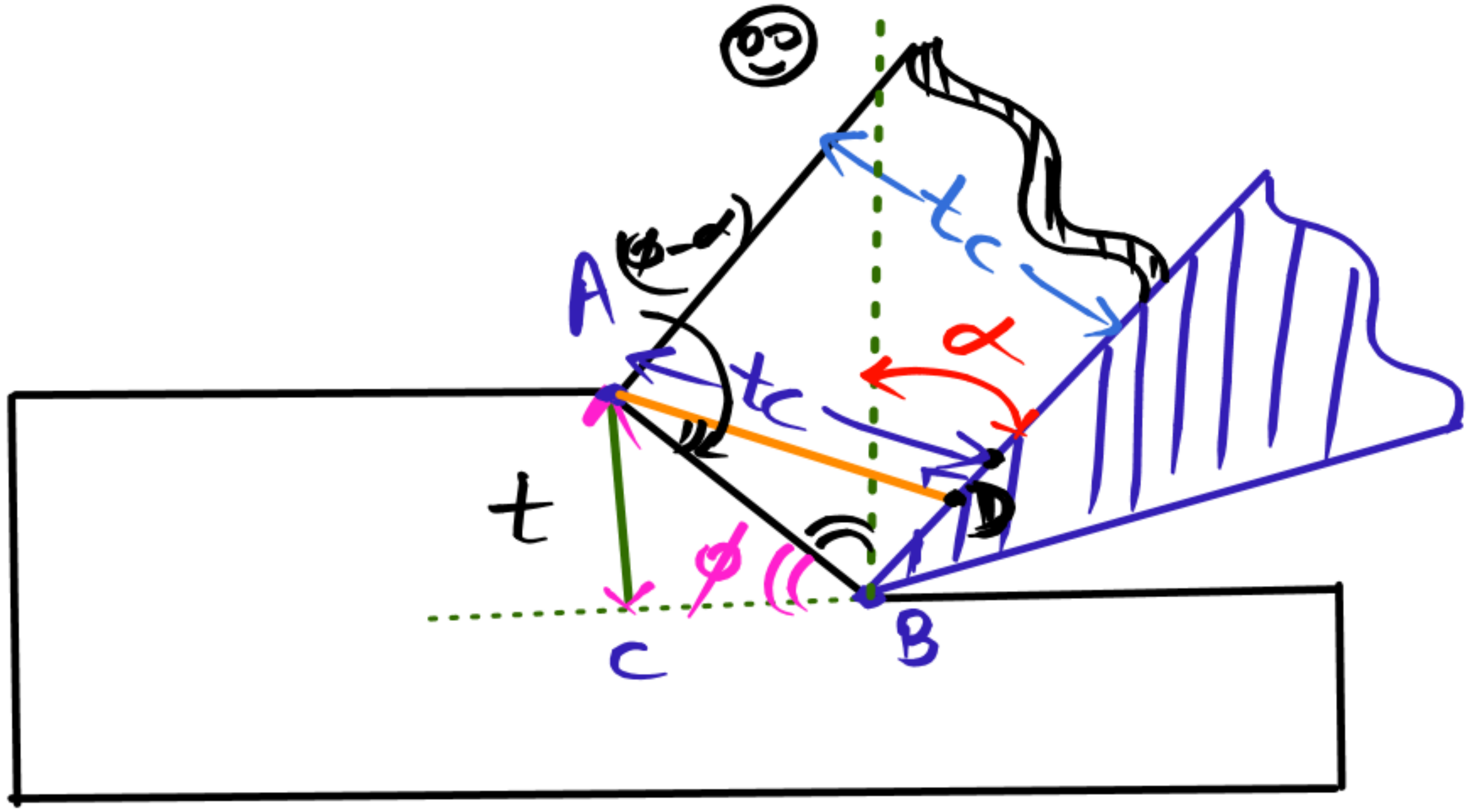
$$* \ \sin\phi = \frac{t}{AB}$$

$$* \ AB = \frac{t}{\sin\phi}$$

$$* \ t = AB \cdot \sin\phi \quad —— \ ①$$

ΔADB

$$* \ \angle B = (90 - \phi + \alpha)$$



* $x + \cancel{90} - \phi + \alpha + \cancel{90} = \cancel{180}$

* $x = \phi - \alpha$

* $\cos(\phi - \alpha) = \frac{t_c}{AB}$

* $t_c = AB \cdot \cos(\phi - \alpha)$ — ②

Divide eq^n ① by eq^n ②

* $$\frac{t}{t_c} = \frac{\cancel{AB} \cdot \sin\phi}{\cancel{AB} \cdot \cos(\phi - \alpha)}$$

* $$\frac{t}{t_c} = \frac{\sin\phi}{\cos(\phi - \alpha)}$$

* $$\frac{t}{t_c} = \frac{\sin\phi}{\cos(\phi - \alpha)}$$

* $$r = \frac{\sin\phi}{\cos(\phi - \alpha)}$$

* $\sin\phi = r\cos(\phi - \alpha)$

* $\sin\phi = r[\cos\phi \cdot \cos\alpha + \sin\phi \cdot \sin\alpha]$

* $\sin\phi = r\cos\phi \cdot \cos\alpha + r \cdot \sin\phi \cdot \sin\alpha$

* $\sin\phi - r\sin\phi \cdot \sin\alpha = r\cos\phi \cdot \cos\alpha$

* $\sin\phi - \gamma\sin\phi\cdot\sin\alpha = \gamma\cos\phi\cdot\cos\alpha$

* $\sin\phi(1-\gamma\sin\alpha) = \gamma\cos\phi\cdot\cos\alpha$

* $\dfrac{\sin\phi}{\cos\phi} = \dfrac{\gamma\cos\alpha}{1-\gamma\sin\alpha}$

* $\boxed{\tan\phi = \dfrac{\gamma\cos\alpha}{1-\gamma\sin\alpha}}$ ***

* $\phi = f(\gamma,\alpha)$

☺ If $\alpha = 0$

* $\tan\phi = \dfrac{\gamma\cdot\cos 0}{1-\gamma\cdot\sin 0}$

* $\tan\phi = \gamma$

* $\phi = \tan^{-1}(\gamma)$

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Q During orthogonal cutting of mild steel with a 10° rake angle tool, the chip thickness ratio was obtained as 0.4. The shear angle (in degrees) evaluated from this data is

(a) 6.53
(b) 20.22
[✓ (c) 22.94]
(d) 50.00

Given Data :→ orthogonal

- $\alpha = 10^\circ$
- $r = 0.4$
- $\phi = ?$

Solution :→

- $\tan\phi = \dfrac{r\cos\alpha}{1 - r\sin\alpha}$
- $\tan\phi = \dfrac{0.4 \times \cos 10}{1 - 0.4 \times \sin 10}$
- $\boxed{\phi = 22.94^\circ}$

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Q A single – point cutting tool with 12° rake angle is used to machine a steel work – piece. The depth of cut, i.e. uncut thickness is 0.81 mm. The chip thickness under orthogonal machining condition is 1.8 mm. The shear angle is approximately

(a) 22° [✓ (b) 26°] (c) 56° (d) 76°

Given Data :→ Orthogonal machining

* $\alpha = 12^\circ$
* doc $= 0.81\,mm = t$ ***
* $t_c = 1.8\,mm$
* $\phi = ?$

Solution :→ * $\tan\phi = \dfrac{r\cos\alpha}{1 - r\sin\alpha}$

* $\tan\phi = \dfrac{\left(\frac{0.81}{1.8}\right)\cdot\cos 12}{1 - \left(\frac{0.81}{1.8}\right)\cdot\sin 12}$

* $\phi = 25.90^\circ$

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* $r = \frac{t}{t_c}$

* $r = \frac{0.81}{1.8}$

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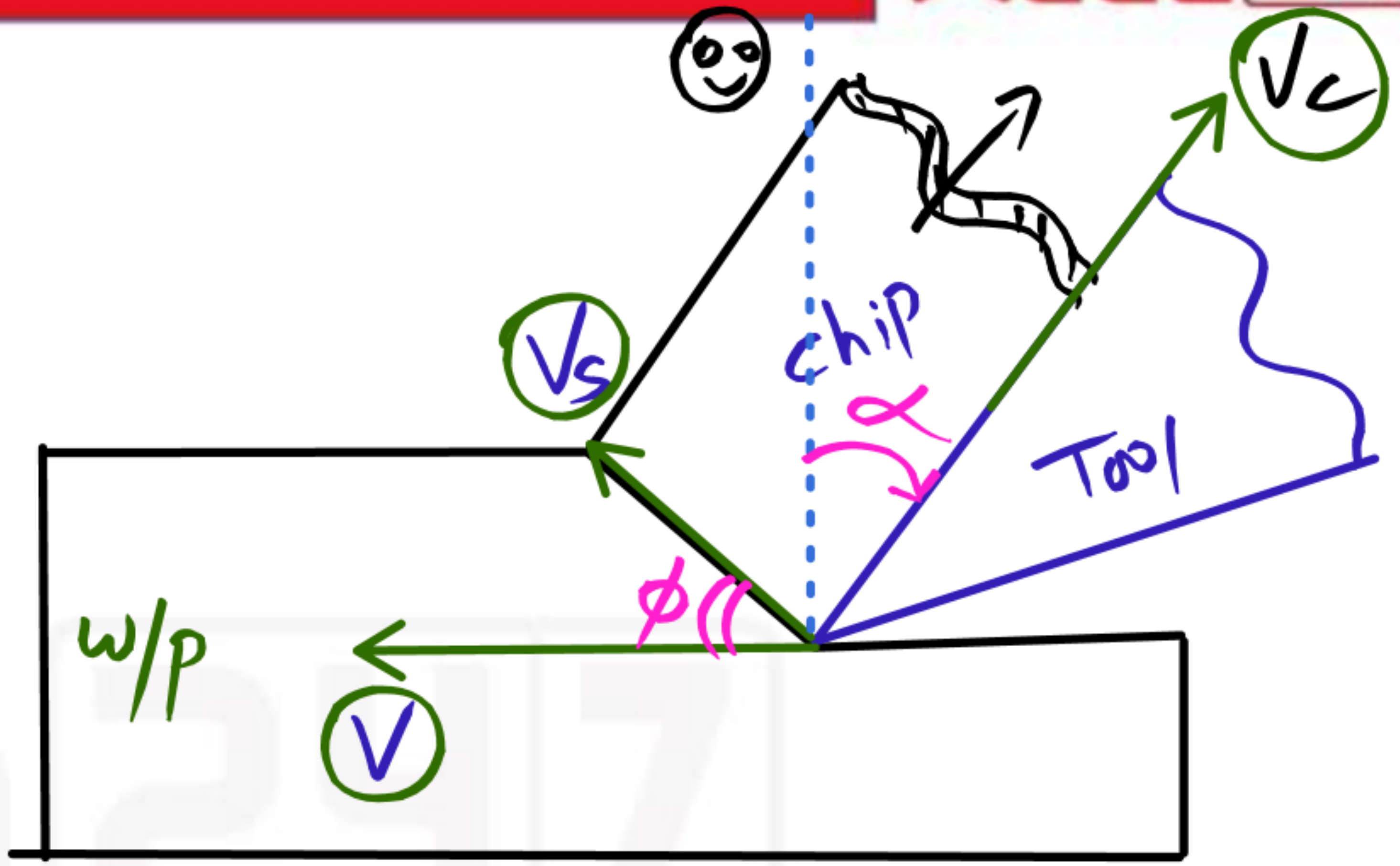
Velocity in Metal cutting



- V → cutting Speed
- V_c → chip velocity
- V_s → Shear velocity

- Velocity of Tool Relative to w/p called as cutting speed.

- Velocity of chip Relative to Tool called as chip velocity.
- Velocity of chip Relative to w/p called as Shear Velocity.

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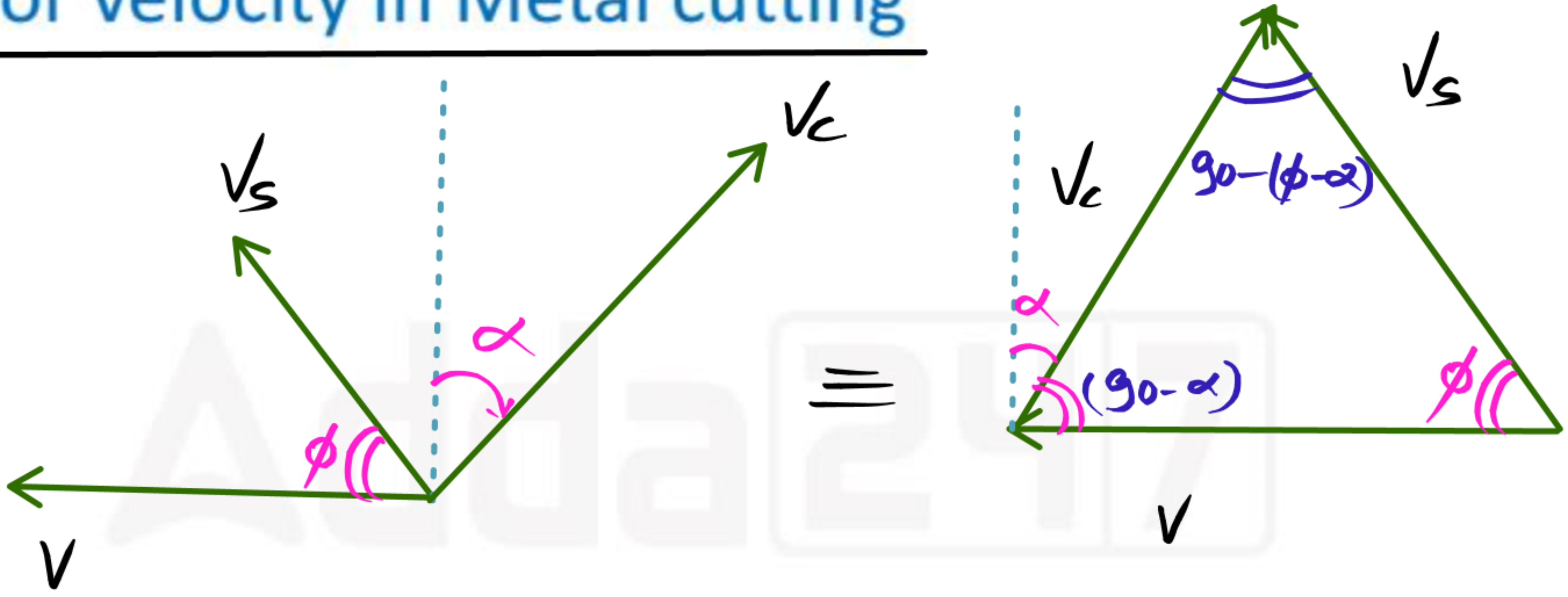
Expression for velocity in Metal cutting



* $x+90-\alpha+\phi=180$
* $x=180-90+\alpha-\phi$
* $x=90+\alpha-\phi$
* $x=90-(\phi-\alpha)$

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A/c to Lame's Rule OR "Sine" Rule

* $$\frac{V}{\sin[90-(\phi-\alpha)]} = \frac{V_s}{\sin(90-\alpha)} = \frac{V_c}{\sin\phi}$$

* $$\boxed{\frac{V}{\cos(\phi-\alpha)} = \frac{V_s}{\cos\alpha} = \frac{V_c}{\sin\phi}}$$

***

* $$\boxed{\frac{V_c}{V} = \frac{\sin\phi}{\cos(\phi-\alpha)}}$$

* $$\boxed{\frac{V_s}{V} = \frac{\cos\alpha}{\cos(\phi-\alpha)}}$$

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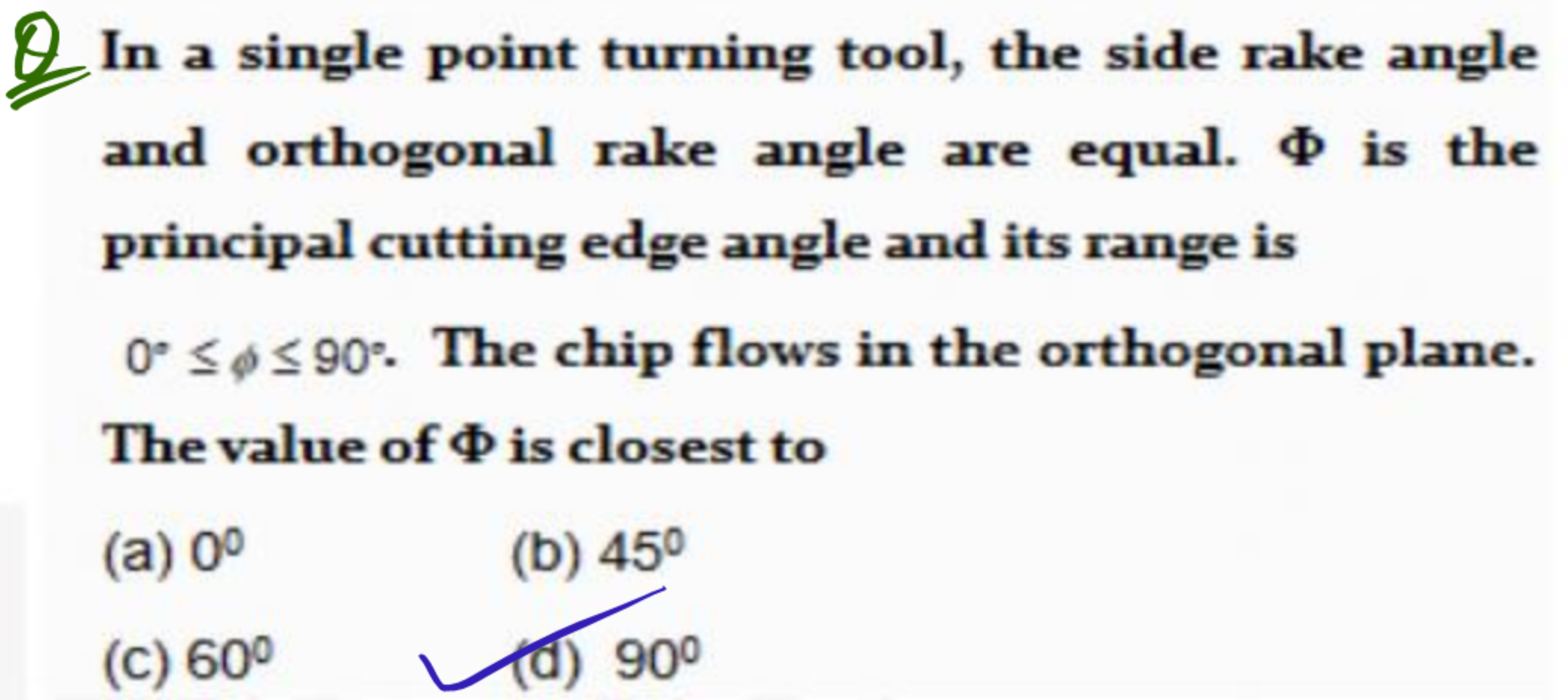
Given data:→

* $\alpha_s = \alpha$

* $\phi = \lambda$



Q In a single point turning tool, the side rake angle and orthogonal rake angle are equal. Φ is the principal cutting edge angle and its range is $0^\circ \le \phi \le 90^\circ$. The chip flows in the orthogonal plane. The value of Φ is closest to

(a) 0^0 (b) 45^0

(c) 60^0 [✓ (d) 90^0]

Solution:→ * α_s → ASA

* α → ORS

$$\tan\alpha = \tan\alpha_s \cdot \sin\lambda + \tan\alpha_b \cdot \cos\lambda$$

$$\Downarrow$$

$$\sin\lambda = 1$$

$$\lambda = 90^0$$

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Cutting shear strain (ε)

* * *

* $$\boxed{\varepsilon = \cot\phi + \tan(\phi - \alpha)}$$

* $$\varepsilon = \frac{\cos\alpha}{\sin\phi \cdot \cos(\phi - \alpha)}$$

If $\alpha = 0$

* $$\varepsilon = \cot\phi + \tan\phi$$

* $$\varepsilon = \underset{\substack{\downarrow \\ x}}{\cot\phi} + \underset{\substack{\downarrow \\ \frac{1}{x}}}{\tan\phi}$$

* $$\varepsilon = x + \frac{1}{x}$$

A.M ≥ G.M

* $$\frac{x + \frac{1}{x}}{2} \geq \sqrt{x \cdot \frac{1}{x}}$$

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

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* $\underbrace{x+\frac{1}{x}}_{\downarrow} \ge 2$

* $\varepsilon \ge 2$

☺ $(\varepsilon)_{Min} = 2$ only when $\alpha = 0$

AT

$\phi = 45^0$

☺ If $\alpha \neq 0$

* $\varepsilon = \cot\phi + \tan(\phi - \alpha)$

For Minimum Shear strain (ε_{Min})

⇓

* $\frac{d\varepsilon}{d\phi} = 0$

* $-\operatorname{cosec}^2\phi + \sec^2(\phi - \alpha) = 0$

$\phi = $ ____

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$$* \quad \boxed{\phi = \frac{90+\alpha}{2}}$$

Shear-Angle Relationship For Minimum Shear Strain

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Q. In a machining operation chip thickness ratio is 0.3 and the rake angle of the tool is 10°. What is the value of the shear strain?

(a) 0.31
(b) 0.13
(c) 3.00
[✓ (d)] 3.34

Given Data :→

- $r = 0.3$
- $\alpha = 10^0$
- $\varepsilon = ?$

- $\tan\phi = \dfrac{r\cos\alpha}{1 - r\sin\alpha} = \dfrac{0.3 \cdot \cos 10}{1 - 0.3\sin 10}$
- $\phi = 17.31^0$

Solution :→

- $\varepsilon = \cot\phi + \tan(\phi - \alpha)$
- $\varepsilon = \cot 17.31 + \tan(17.31 - 10)$
- $\boxed{\varepsilon = 3.34}$

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- $\alpha = 0$

$\Downarrow$

- $\varepsilon_{min} = 2$

At $\phi = 45^\circ$

Minimum shear strain in orthogonal turning with a cutting tool of zero rake angle is

(a) 0.0 (b) 0.5

(c) 1.0 [✓ (d) 2.0]

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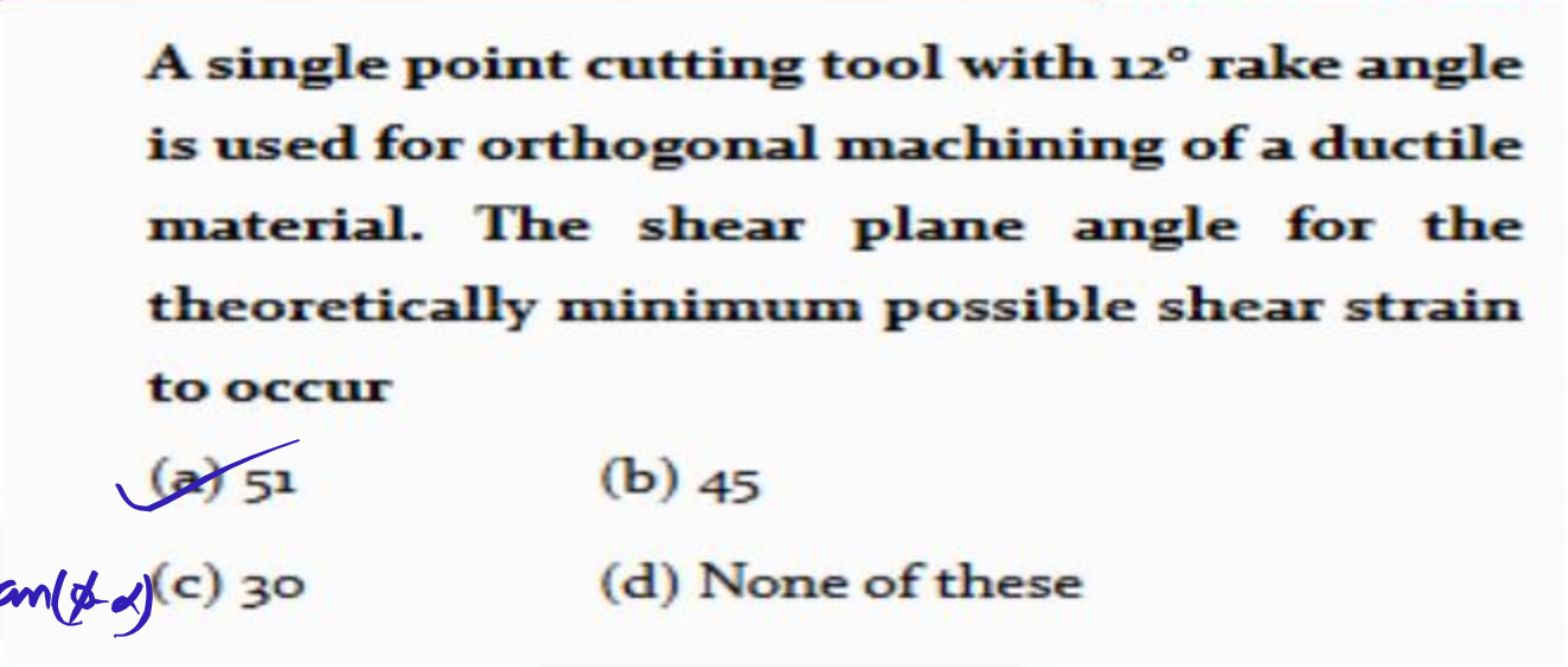
Given Data: →

$* \ \alpha = 12^{\circ}$

$* \ \phi = ? \text{ For } \varepsilon_{min}$



A single point cutting tool with 12° rake angle is used for orthogonal machining of a ductile material. The shear plane angle for the theoretically minimum possible shear strain to occur

[✓ (a) 51] (b) 45

(c) 30 (d) None of these

Solution: →

$$* \ \varepsilon = \cot\phi + \tan(\phi - \alpha)$$

$$* \ \varepsilon = \cot\phi + \tan(\phi - 12)$$

For Minimum Shear Strain $\left(\frac{d\varepsilon}{d\phi} = 0\right)$

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* $-\operatorname{cosec}^2\phi + \sec^2(\phi-12) = 0$
* $\operatorname{cosec}^2\phi = \sec^2(\phi-12)$
* $\sin^2\phi = \cos^2(\phi-12)$
* $\sin\phi = \cos(\phi-12)$
* $\sin\phi = \cos\phi\cdot\cos12+\sin\phi\cdot\sin12$
* $\sin\phi - \sin\phi\cdot\sin12 = \cos\phi\cdot\cos12$
* $\sin\phi[1-\sin12] = \cos\phi\cdot\cos12$
* $\frac{\sin\phi}{\cos\phi} = \frac{\cos12}{1-\sin12}$
* $\tan\phi = \frac{\cos12}{1-\sin12}$
* $\phi = 51^\circ$
* $(\epsilon)_{Min} = \cot51+\tan(51-12)$
* $\epsilon_{Min} = 1.6$

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for $(\varepsilon)_{min}$

$\Downarrow$

$$\phi = \frac{90+\alpha}{2} = \frac{90+12}{2}$$

* $\phi = 51^{\circ}$

* $\varepsilon_{min} = \cot 51 + \tan(51-12)$

* $\varepsilon_{min} = 1.6$

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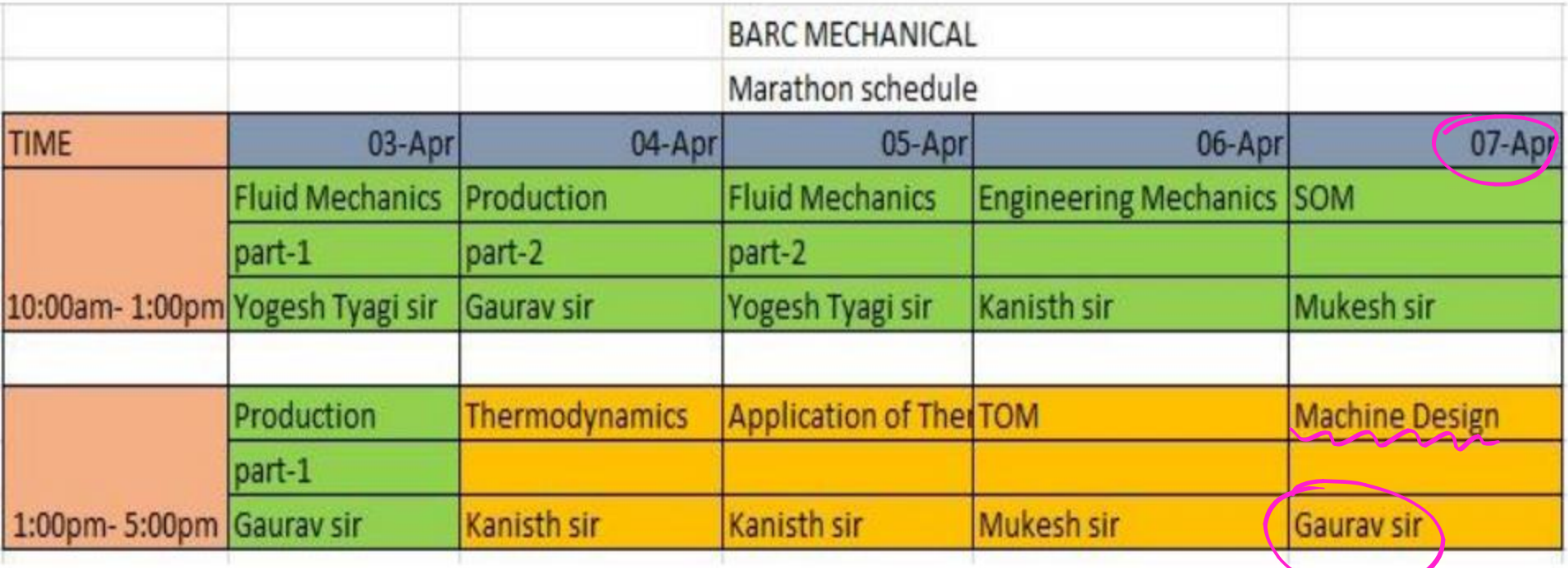

BARC MECHANICAL

Marathon schedule

TIME	03-Apr	04-Apr	05-Apr	06-Apr	07-Apr
10:00am- 1:00pm	Fluid Mechanics	Production	Fluid Mechanics	Engineering Mechanics	SOM
	part-1	part-2	part-2		
	Yogesh Tyagi sir	Gaurav sir	Yogesh Tyagi sir	Kanisth sir	Mukesh sir
1:00pm- 5:00pm	Production	Thermodynamics	Application of Ther	TOM	Machine Design
	part-1				
	Gaurav sir	Kanisth sir	Kanisth sir	Mukesh sir	Gaurav sir

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