ISRO | BHEL | DRDO & OTHER PSUs

GATE

PRODUCTION

METAL CUTTING

MOST EXPECTED QUESTIONS

PART-2

Live@ 11:30Am

Gaurav sir

YouTube Classes Schedule

MECHANICAL ENGINEERING

EXAM TARGET	SUBJECT	TIME	FACULTY
ALL PSUs	ENGINEERING MATHS	10:00 AM	ANANT SIR
ALL PSUs	PRODUCTION	11:30 AM	GAURAV SIR
ALL PSUs	THERMODYNAMICS	3:00 PM	KANISTH SIR
GATE 2024-25	HMT	4:30 PM	YOGESH SIR
GATE 2024-25	SOM	9:00 PM	MUKESH SIR

FREE APP CLASS SCHEDULE

MECHANICAL ENGINEERING

HMT	MONDAY Live @11AM	YOGESH SIR
PRODUCTION	TUESDAY Live @11AM	GAURAV SIR
SOM	WEDNESDAY Live @8PM	MUKESH SIR
THERMODYNAMICS	THURSDAY Live @11AM	KANISTH SIR
ENGINEERING MATHEMATICS	FRIDAY Live @11AM	ANANT SIR

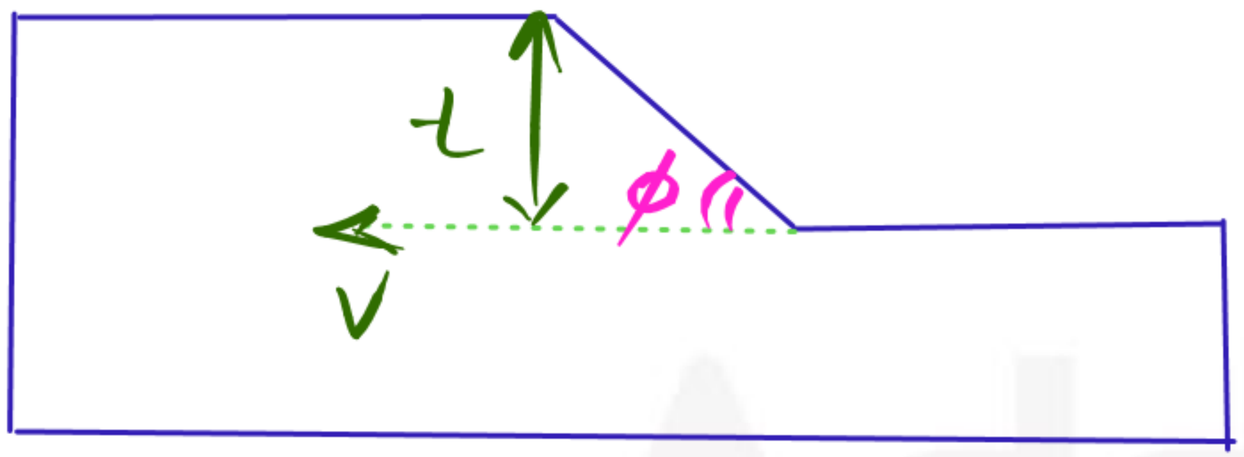
In orthogonal cutting, shear angle is the angle between

[✓ (a)] Shear plane and the cutting velocity

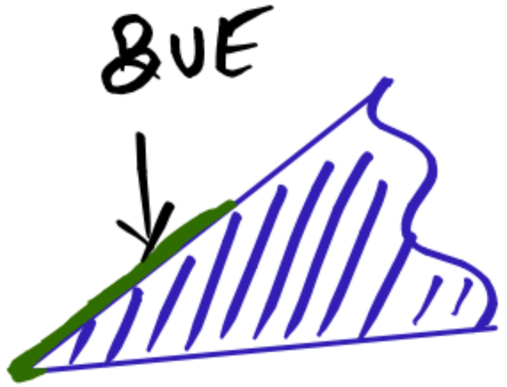
(b) Shear plane and the rake plane

(c) Shear plane and the vertical direction

(d) Shear plane and the direction of elongation of crystals in the chip



$$* \quad \tan\phi = \frac{r\cdot\cos\alpha}{1-r\sin\alpha}$$



× BUE → Built up Edge

Consider the following machining conditions: BUE will form in

[✓ (a) Ductile material.]

(b) High cutting speed.

(c) Small rake angle.

(d) Small uncut chip thickness.

condition for Discontenious chip.

- * Work Material → Brittle Material OR Hard Material
- * feed → Large
- * Rake Angle → −ve
- * cutting fluid → Present

With Multipoint cutter → Disconteneous chip Even Material is Ductile.

condition for conteniouschip without BuE

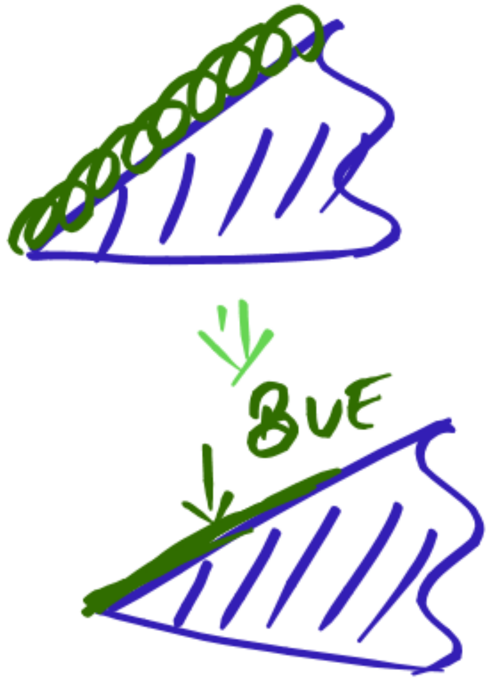
⇓

* Rake Angle → +ve
* work Material → Ductile Material oR soft
* cutting velocity → High
* cutting fluid → Present (Both Lubrication And cooling)
* feed → Low

condition for contenious chip with BUE

⇓

- * work Material → Ductile
- * Rake Angle → +ve
- * cutting velocity → low
- * cutting fluid → Absent



Plain milling of mild steel plate produces

(a) Irregular shaped discontinuous chips

[✓ (b) Regular shaped discontinuous chip]

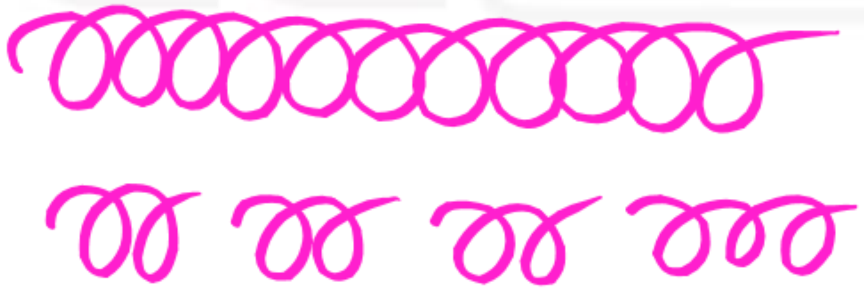
(c) Continuous chips without built up edge

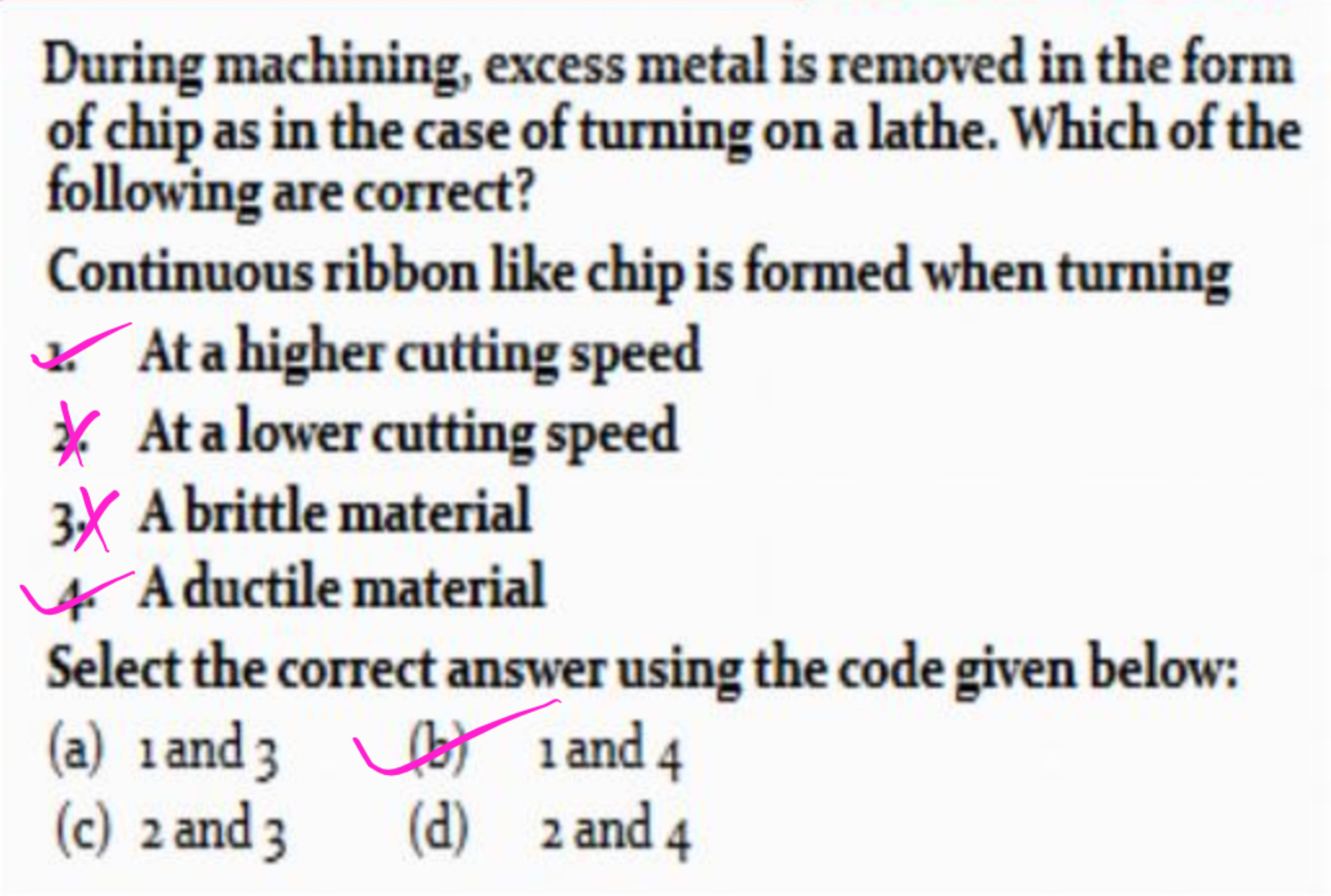
(d) Joined chips

Mild Steel

⇓

Ductile Material





During machining, excess metal is removed in the form of chip as in the case of turning on a lathe. Which of the following are correct?

Continuous ribbon like chip is formed when turning

1. [✓ At a higher cutting speed]
2. ✗ At a lower cutting speed
3. ✗ A brittle material
4. [✓ A ductile material]

Select the correct answer using the code given below:

(a) 1 and 3 [✓ (b) 1 and 4]
(c) 2 and 3 (d) 2 and 4

If V = cutting velocity, ϕ = shear angle, α = rake angle, the chip velocity is

[✓ (a)] $\dfrac{V\sin\phi}{\cos(\phi-\alpha)}$

(b) $\dfrac{V\cos(\phi-\alpha)}{\sin\phi}$

(c) $\dfrac{V\cos\phi}{\sin(\phi-\alpha)}$

(d) $\dfrac{V\sin(\phi-\alpha)}{\cos\phi}$

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

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

Given data :→ orthogonal Machining

- $* \ F_c = 1200\,N$
- $* \ F_t = 500\,N$
- $* \ \alpha = 0$
- $* \ V = 1\,m/s$
- $* \ doc = 0.8\,mm$
- $* \ t_c = 1.5\,mm$
- $* \ \beta = ?$

In an orthogonal machining test, the following observations were made

Cutting force	1200 N
Thrust force	500 N
Tool rake angle	zero
Cutting speed	1 m/s
Depth of cut	0.8 mm
Chip thickness	1.5 mm

Friction angle during machining will be

[✓ (a) 22.6°] (b) 32.8° (c) 57.1° (d) 67.4°

Solution :→ $* \ \beta = \tan^{-1}\mu \Rightarrow \tan^{-1}\left(\frac{500}{1200}\right)$

$* \ \beta = 22.6^{\circ}$

$$* \ \mu = \frac{F}{N} = \frac{F_c \cancelto{0}{\sin\alpha} + F_t \cos\alpha}{F_c \cos\alpha - \cancelto{0}{F_t \cdot \sin\alpha}}$$

$$* \ \mu = \frac{F_t}{F_c} = \frac{200}{1200}$$

Given Data:→ Orthogonal Turning

$(\lambda = 90^\circ)$

* $F_c = 1000$ N

* $F_t = 800$ N

* $\alpha = 0^\circ$

* $\beta = 25^\circ$

* $\frac{F}{N} = \mu = ?$

In orthogonal turning of low carbon steel pipe with principal cutting edge angle of 90°, the main cutting force is 1000 N and the feed force is 800 N. The shear angle is 25° and orthogonal rake angle is zero. Employing Merchant's theory, the ratio of friction force to normal force acting on the cutting tool is

~~(a) 1.56~~ ~~(b) 1.25~~ [✓ (c) 0.80] (d) 0.64

Solution:→ $\mu = \frac{F}{N} = \frac{F_c \sin\alpha + F_t \cos\alpha}{F_c \cos\alpha - F_t \sin\alpha} \Rightarrow \frac{F_t}{F_c} = \frac{800}{1000}$

* $\mu = 0.80$

A/c to Merchant Theory

$\Downarrow$

* $\phi = \frac{\pi}{4} + \frac{\alpha}{2} - \frac{\beta}{2}$

* $\boxed{\phi = 45^\circ + \frac{\alpha}{2} - \frac{\beta}{2}}$

Minimum cutting Force/Power

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

Amount of energy consumption per unit volume of metal removal is maximum in

(a) Turning
(b) Milling
(c) Reaming
[✓ (d) Grinding]

Specific Energy consumption (J/mm^3)

⇓

Lathe Machine operation → 2.3 J/mm^3

Grinding → 20 J/mm^3

Unconventional Machining (ECM) → 200 J/mm^3

Power consumption in metal cutting is mainly due to

(a) Tangential component of the force ✓ $= F_c$

(b) Longitudinal component of the force

(c) Normal component of the force

(d) Friction at the metal-tool interface

* Power = cutting force × cutting velocity

* $P = F_c \times V$

In an orthogonal cutting test, the cutting force and thrust force were observed to be 1000N and 500 N respectively. If the rake angle of tool is zero, the coefficient of friction in chip-tool interface will be

[✓ (a) $\frac{1}{2}$]

(b) 2

(c) $\frac{1}{\sqrt{2}}$

(d) $\sqrt{2}$

Given data:→ orthogonal cutting

* $F_c = 1000 N$
* $F_t = 500 N$
* $\alpha = 0^\circ$
* $\mu = ?$

Solution:→

* $\mu = \frac{F}{N} = \frac{F_c \sin\alpha + F_t \cos\alpha}{F_c \cos\alpha - F_t \sin\alpha}$
* $\mu = \frac{F_t}{F_c} = \frac{500}{1000} = \frac{1}{2}$

An orthogonal turning operation is carried out under the following conditions: rake angle = 5^0, spindle rotational speed = 400 rpm, axial feed = 0.4 m/min and radial depth of cut = 5 mm. The chip thickness, t_c is found to be 3 mm . The shear angle (in degrees) in this turning process is _____

Given Data:→ Orthogonal Turning

$\Downarrow$

$\lambda = 90^0$

- * $\alpha = 5^0$
- * $N = 400$ rpm
- * $F_X = 0.4$ m/min
- * doc = 5 mm
- * $t_c = 3$ mm
- * $\phi = ?$

* $f_x = f_z \cdot \sin\lambda$

* $f_x = f_z = 0.4$ m/min

Solution:→ $\lambda = 90^0$

* $t = f \cdot \sin\lambda = f \cdot \sin 90 = f$

* $t = f = 1$

Solution :→

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

* $\tan\phi = \dfrac{0.33\cdot\cos 5}{1-0.33\cdot\sin 5}$

* $\phi =$

☺ * $r = \dfrac{t}{t_c} = \dfrac{1}{3} = 0.33$

☺ $$\underset{\substack{\downarrow \\ m/min}}{V_f} = \underset{\substack{\downarrow \\ mm/rev}}{f} \times \underset{\substack{\downarrow \\ rev/min}}{N}$$

* $0.4\times1000 = f\times400$

* $f = \dfrac{0.\cancel{4}\times1\cancel{000}}{\cancel{4}\cancel{00}\times1\cancel{0}} = 1$ mm/rev ✓

Given Data:→

A medium carbon steel workpiece is turned on a lathe at 50 m/min. cutting speed 0.8 mm/rev feed and 1.5 mm depth of cut. What is the rate of metal removal?

(a) 1000 mm^3/min

[✓ (b) 60,000 mm^3/min]

(c) 20,000 mm^3/min

(d) Can not be calculated with the given data

- * $v = 50\ m/min = 50\times10^3\ mm/min$
- * $f = 0.8\ mm/rev$
- * $doc = 1.5\ mm$
- * $MRR = ?$

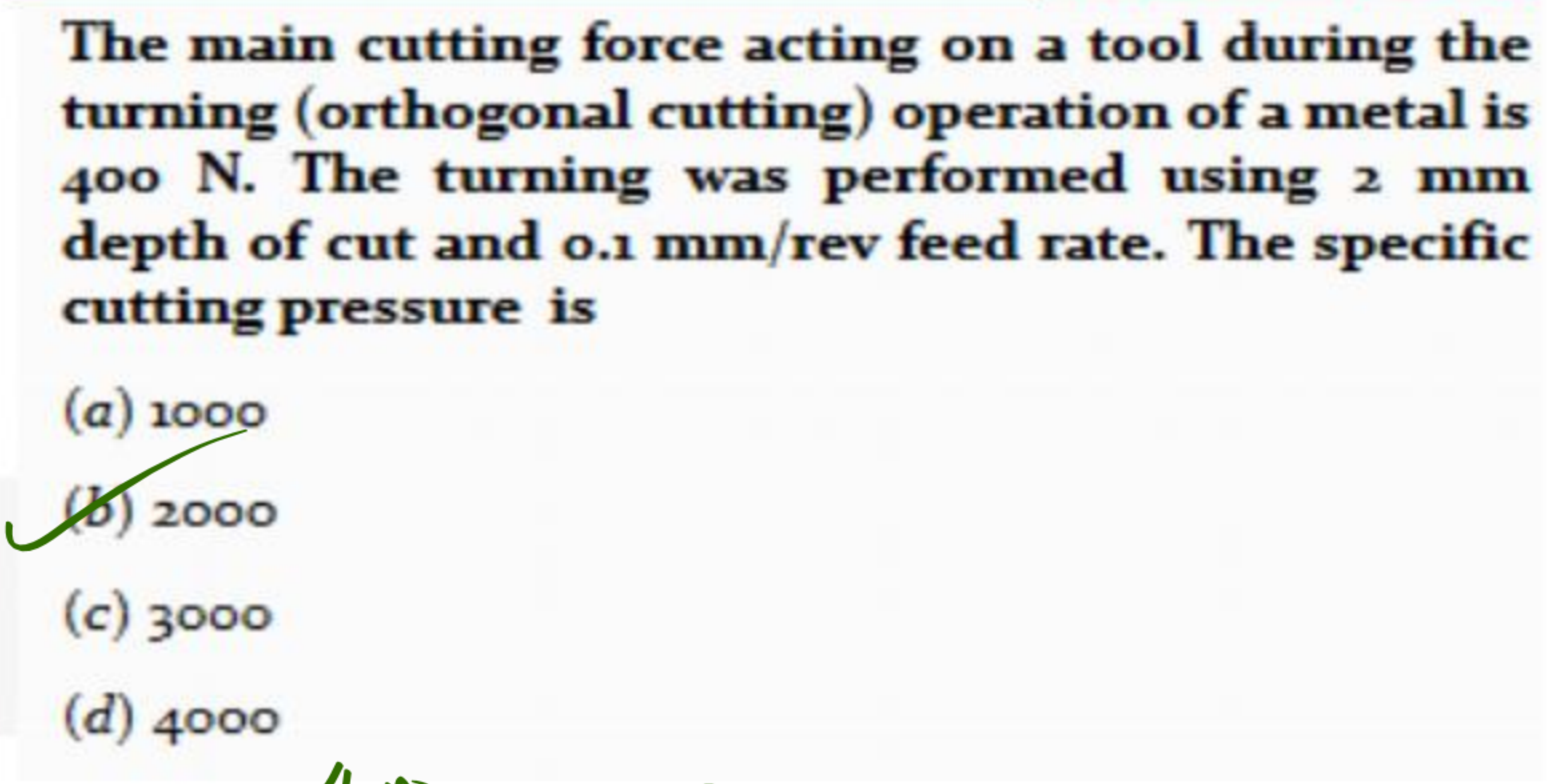
Solution:→ * $\underset{mm^3/min}{MRR} = \underset{mm/rev}{f} \times \underset{mm}{doc} \times \underset{mm/min}{V} \Rightarrow 50\times10^3 \times 0.8 \times 1.5 = 60{,}000\ mm^3/min$

$$\underset{\text{mm}^3/\text{min}}{\underset{\downarrow}{MRR}} = \underset{\text{mm}^2}{\underset{\downarrow}{A_c}} \times \underset{\text{mm}/\text{min}}{\underset{\downarrow}{V}}$$

✗ $MRR = A_c \times V = b \cdot t \times V = f \times doc \times V$ ✓

Given Data :→

- $F_c = 400N$
- $doc = 2mm$
- $f = 0.1 mm/rev$
- $Scp = ?$



The main cutting force acting on a tool during the turning (orthogonal cutting) operation of a metal is 400 N. The turning was performed using 2 mm depth of cut and 0.1 mm/rev feed rate. The specific cutting pressure is

(a) 1000

[✓ (b) 2000]

(c) 3000

(d) 4000

Solution :→ $* \; scp = \frac{F_c}{f \times doc} = \frac{400}{0.1 \times 2} = 2000$

☺ specific cutting energy (J/mm^3)(e)

$$* \quad e = \frac{\text{Power} \leftarrow J/s}{\text{MRR} \leftarrow mm^3/s} \Rightarrow J/mm^3$$

$$* \quad e = \frac{F_c \times V}{b \cdot t \cdot V} = \frac{F_c \times V \leftarrow m/s}{f \times doc \times V \leftarrow mm/s} = \frac{F_c}{1000 \times f \times doc}$$

$$* \quad e = \frac{F_c}{1000 \times b \times t} = \frac{F_c}{1000 \times f \times doc}$$

Specific cutting pressure → N/mm^2

$$SCP = \frac{Fc^{\nearrow N}}{\underset{\uparrow mm}{f} \times \underset{\uparrow mm}{doc}} = \frac{Fc}{b \times t}$$

Sliding Friction => (colomb's law)

* $\mu = \frac{F}{N}$

Machining

⇓

Sliding And Sticking

The effect of rake angle on the mean friction angle in machining can be explained by

(A) sliding (Coulomb) model of friction

[✓ (B) sticking and then sliding model of friction]

(C) sticking friction

(D) Sliding and then sticking model of friction

At low speed

⇓

Chip : w/p : Tool

33% : 33% : 33%

At High speed

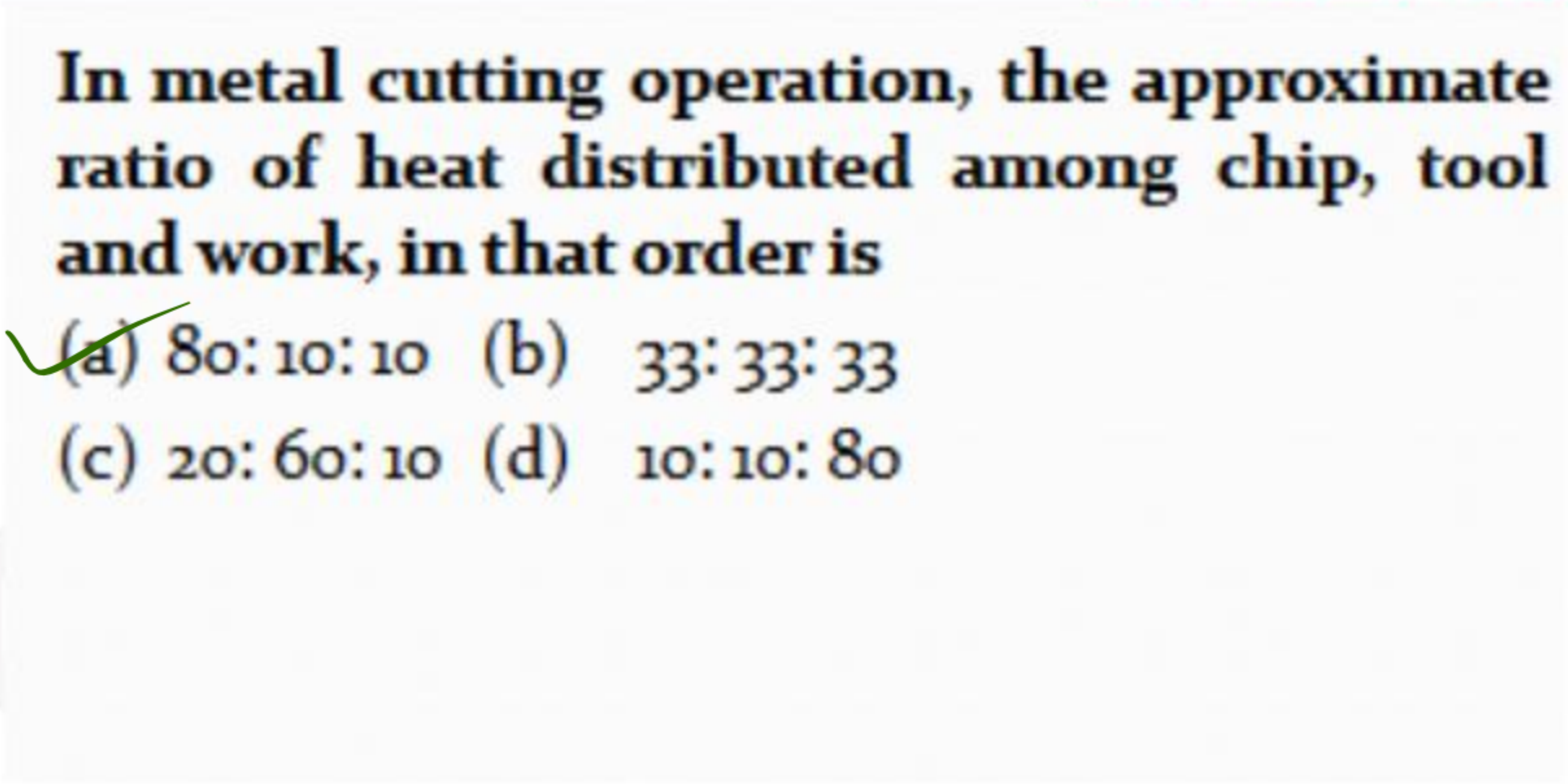
⇓

Chip : w/p : Tool

80% : 10% : 10%

In a machining process, the percentage of heat carried away by the chips is typically

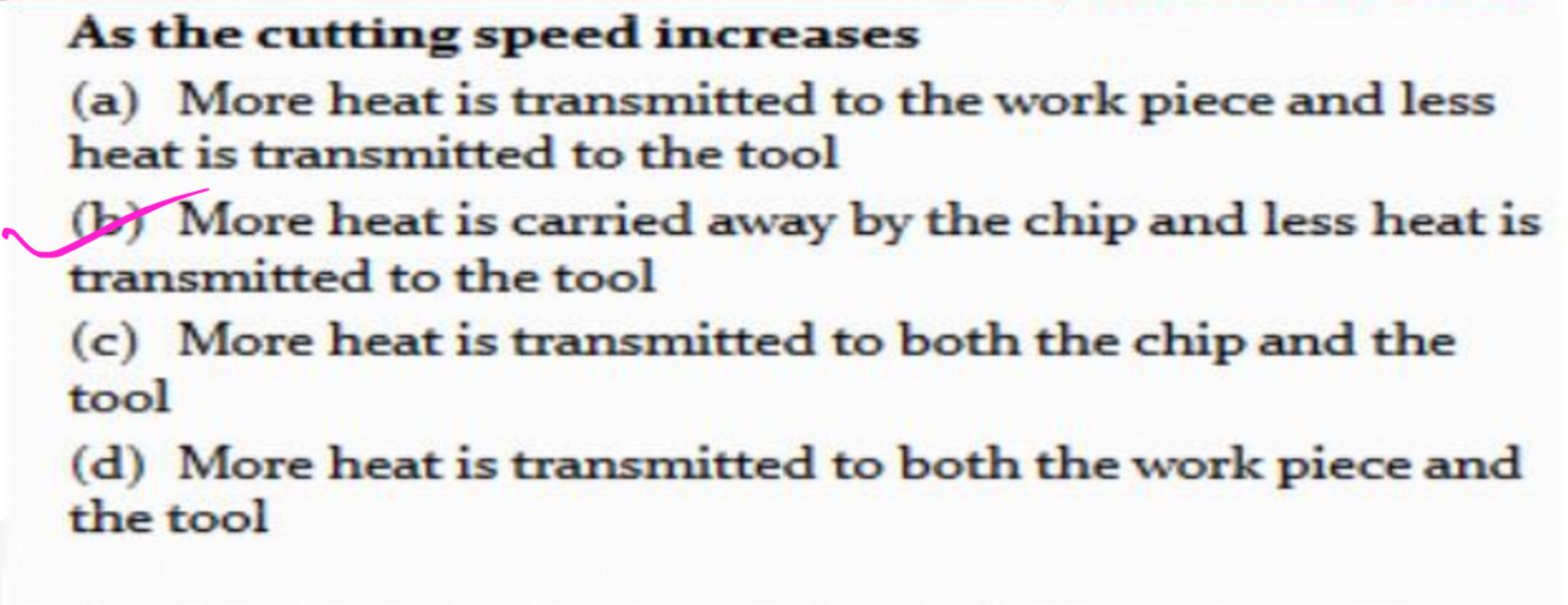
(a) 5%	(b) 25%
(c) 50%	[✓ (d) 75%]



In metal cutting operation, the approximate ratio of heat distributed among chip, tool and work, in that order is

[✓ (a) 80: 10: 10] (b) 33: 33: 33

(c) 20: 60: 10 (d) 10: 10: 80



As the cutting speed increases

(a) More heat is transmitted to the work piece and less heat is transmitted to the tool

[✓ (b)] More heat is carried away by the chip and less heat is transmitted to the tool

(c) More heat is transmitted to both the chip and the tool

(d) More heat is transmitted to both the work piece and the tool

The instrument or device used to measure the cutting forces in machining is :

(a) Tachometer

(b) Comparator

[✓ (c) Dynamometer] → F_c, F_t

(d) Lactometer

Merchant Theory

⇓

$$\boxed{\phi = 45^0 + \frac{\alpha}{2} - \frac{\beta}{2}}$$

$$2\phi - \alpha + \beta = 90^0$$

$$2\phi - \alpha + \beta = c$$

The relationship between the shear angle Φ, the friction angle β and cutting rake angle α is given as

(a) $2\beta + \Phi - \alpha = C$

[✓ (b) $2\Phi + \beta - \alpha = C$]

(c) $2\alpha + \beta - \Phi = C$

(d) $\Phi + 2\beta - \alpha = C$