MACHINE TOOLS TEST 5

Number of Questions 25 **Time:60 min.**

Directions for questions 1 to 25: Select the correct alternative from the given choices.

1. The uncut chip thickness and the width of the cut are 5 mm and 10 mm respectively in an orthogonal cutting operation. What is the area of the shear plane when the shear angle is 20°?
(A) 1.461×10^{-4} m^2 (B) 146.19 mm^2
(C) Both *A* and *B* (D) None of these

2. By observing the shear zone the shear angle was found to be 25° in a orthogonal cutting process with a tool rake angle of 10°. What is the cutting ratio of the process?
(A) 0.5516 (B) 1.8126
(C) 0.4375 (D) 2.2855

3. The most significant process variable in calculating the tool life of a tool-work interface is
(A) Depth of cut (B) Feed
(C) Cutting speed (D) Hardness of the tool

4. In turning of a bar of length 150 mm and diameter 50 mm the cutting speed was maintained at 15π m/min for a feed of 2 mm/rev. What is the time taken for a single pass in seconds?
(A) 250 (B) 900
(C) 15 (D) 30

5. Machining of Cast iron is done using a tool of small rake angle at a low cutting speed. The type of chips produced are
(A) Continuous (B) Discontinuous
(C) Continuous with BUE (D) None of these

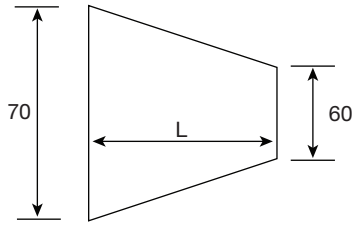
6. Which of the following tool materials has the highest hardness?
(A) High speed steel (B) High carbon steel
(C) Ceramic (D) Cemented carbides

7. A work piece of width 200 mm is machined using a shaper to remove one layer of material from the surface. Feed of 2.5 mm per stroke and a depth of cut of 5 mm is given. How many strokes are required to complete the process?
(A) 40 (B) 160
(C) 80 (D) 32

8. Which of the following machines does NOT use reciprocating action for the removal of material?
(A) Planer (B) Shaper
(C) Slotter (D) Miller

9. In which of these milling process, the axis of rotation of the cutter is parallel to the work?
(A) Slab milling (B) End milling
(C) Face milling (D) None of these

10. In a taper turning operation the amount of taper produced is $\frac{1}{10}$. What is the length of the taper for the given diameters?



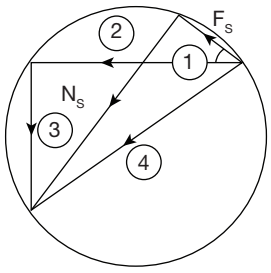
(A) 100 mm (B) 200 mm
(C) 300 mm (D) 50 mm

11. The cutting force and the thrust force in an orthogonal cutting operation are found to be 2 kN and 1.5 kN respectively. What is the rake angle of the cutting tool when the shear angle and the friction angle are 16° and 70° respectively?
(A) 85.07° (B) 43.09°
(C) 66.54° (D) 33.13°

12. The friction force and the normal force in an orthogonal cutting operation are found to be 1200 N and 500 N respectively. What is cutting force applied (in N) if the thrust force is 800 N?
(A) 1024.7 (B) 32.01
(C) 1050 (D) 1300

13. The cutting force and thrust force are 1500 N and 1000 N respectively in an orthogonal cutting operation with a tool of rake angle 10°. What is the coefficient of friction between the tool and the chip interface?
(A) 1.0468 (B) 0.9553
(C) 1.9553 (D) 0.0468

14. A part of the Merchant's circle of an orthogonal cutting operation is given where F_S is the force on the shear plane and N_S is the normal force to the shear plane. Match List I with the notations from the figure.



	List I
P	Cutting force
Q	Shear angle (ϕ)
R	Thrust force
S	Resultant force

	P	Q	R	S
(A)	3	1	4	2
(B)	3	1	2	4
(C)	2	1	4	3
(D)	2	1	3	4

15. The cutting force and thrust force for an orthogonal cutting operation are 1600 N and 1200 N respectively. What is mean shear stress induced in the shear plane for a width of cut of 15 mm and uncut chip thickness of 4 mm? (Take shear angle = 18°)

(A) 592.7 MPa (B) 5.927 MPa
(C) 5.927 kPa (D) None of these

16. The cutting speeds and tool life's of a tool-work interface are found to be 150 m/min, 300 m/min and 75 min, 30 min respectively. What is the speed exponent (n) in the Taylor's tool life equation?

(A) 0.7564 (B) 0.6351
(C) 0.6931 (D) 1.32

17. In a turning operation the tool life is given by the equation:

$VT^n d^x f^y = C$

Where $n = 0.7$, $x = 0.25$ and $y = 0.5$, V is cutting velocity, T is tool life, d and f are the depth of cut and feed (mm/rev) given to the tool. What is the tool life when the cutting speed is doubled, depth of cut is halved and the feed is tripled?

(A) 1.6330 T (B) 0.4904 T
(C) 2.9129 T (D) 0.2171 T

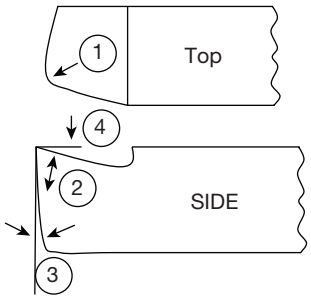
18. Which of the following statements are true?

(P) A Jig holds and locates the work piece.
(Q) A Jig guides the cutting tool.
(R) A fixture holds and locates the work piece.
(S) A fixture guides the cutting tool.

(A) (*P*) and (*S*) (B) (*P*), (*Q*) and (*R*)
(C) (*P*), (*Q*) and (*S*) (D) (*P*), (*R*) and (*S*)

19. Match List-I with the numbering from the figures

	List I
P.	Rake angle
Q.	Nose radius
R.	Lip angle
S.	Relief angle



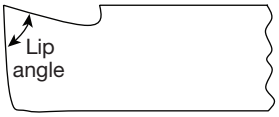
	P	Q	R	S
(A)	3	1	2	4
(B)	3	2	1	4
(C)	4	1	2	3
(D)	4	2	1	3

20. The purpose of using cutting fluids is/are:

(1) Improve the surface finish.
(2) Lubricate and reduce friction.
(3) Cause chip breaks.
(4) Protect the finished surface from corrosion.

(A) (1), (2) and (3) (B) (2) and (4)
(C) (1), (2) and (4) (D) (1), (2), (3) and (4)

21. The lip angle of a single point cutting tool is shown in the figure. Which type of rake angle will have the greatest lip angle?



(A) Negative (B) Positive
(C) Neutral (D) Both (*A*) and (*B*)

22. The constant in the Taylor's tool life equation was found to be 450 when the tool life was 1 minute. What is the value of the exponent (n) if the tool life was 4 minutes when used at 150 m/min cutting speed?

(A) 0.79 (B) 0.84
(C) 0.39 (D) 0.48

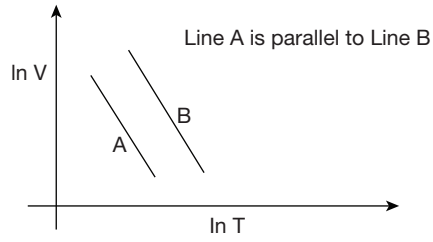
23. In drilling a hole of 48 mm diameter and 50 mm depth of mild steel the cutting speed is maintained at 60 m/min and feed rate at 0.25 mm/rev. What is the material removal rate in cm^3/min?

(A) 180.0 (B) 27.14
(C) 57.30 (D) 397.89

24. In which of the milling processes is the work piece forced against the table or the holding device?

(A) Down milling (B) Up milling
(C) Both *A* and *B* (D) None of these

25. The graphs of two different materials on the ln$T$ *Vs* ln$V$ plot is given, where T is the machining time and V is the cutting speed. Which material has higher machining constant (C) according to Taylor's tool life equation?



(A) *A*
(B) *B*
(C) Both have equal machining constant.
(D) Data is insufficient.

Answer Keys

1. C	**2.** C	**3.** C	**4.** C	**5.** B	**6.** C	**7.** C	**8.** D	**9.** A	**10.** A
11. D	**12.** A	**13.** B	**14.** D	**15.** B	**16.** A	**17.** D	**18.** B	**19.** C	**20.** D
21. A	**22.** A	**23.** A	**24.** A	**25.** B					

Hints and Explanations

1. Area of shear plane $= A_S = \dfrac{bt}{\text{Sin}\,\varphi}$

$b = 10$ mm, t = 5 mm and $\phi = 20^o$

$\therefore \quad A_S = \dfrac{5\times10}{\text{Sin}(20)} = 146.19 \text{ mm}^2$

$= 1.461 \times 10^{-4}$ m^2 Choice (C)

2. r = cutting ratio or chip thickness ratio $= \dfrac{\text{Sin}\,\varphi}{\text{Cos}(\varphi-\alpha)}$

$\phi = 25^o$ and $\alpha = 10^o$

$\therefore\ r = \dfrac{\text{Sin}(25)}{\text{Cos}(25-10)} = 0.4375$ Choice (C)

3. Choice (C)

4. $V = 15\ \pi$ m/min, $f = 2$ mm/rev, $L = 150$ mm and $D = 50$ mm

$V = \dfrac{\pi DN}{1000}$ m/min

$\Rightarrow \quad N = \dfrac{1000\times V}{\pi\times D} = \dfrac{1000\times15\pi}{\pi\times50} = 300$ rpm

$\therefore \quad$ Time taken for single pass $= \dfrac{L}{fN} = \dfrac{150}{2\times300} = \dfrac{1}{4}$ min

$= 15$ sec Choice (C)

5. Cast iron is brittle in nature and machining at low cutting speed and small rake angle produces discontinuous chips. Choice (B)

6. Choice (C)

7. $W = 200$ mm, f = 2.5 mm/stroke, $d = 5$ mm

Number of strokes $= \dfrac{W}{f} = \dfrac{200}{2.5} = 80$ Choice (C)

8. Milling machine has a cutter fitted on the arbor, which rotates for removal of material. Choice (D)

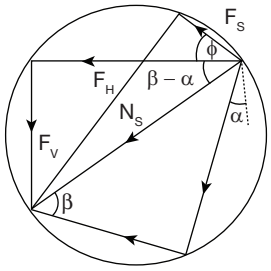
9. Choice (A)

10. Amount of taper = k $= \dfrac{1}{10} = \dfrac{D-d}{L}$

$\therefore \quad \dfrac{70-60}{L} = \dfrac{1}{10}$

$\Rightarrow \quad L = 100$ mm Choice (A)

11. Cutting force = Horizontal force = 2×10^3 N.
Shear force = Vertical force = 1.5×10^3 N
By Merchant's circle



Where, β = friction angle = 70° and α = rake angle.

$\text{Tan}\,(\beta-\alpha) = \dfrac{F_V}{F_H} = \dfrac{1.5}{2} = 0.75$

$\Rightarrow \quad \beta - \alpha = 36.869°.$

$\alpha = 70 - 36.869 = 33.13°$ Choice (D)

12. The resultant force on the chip and the tool are equal in orthogonal cutting.

$\therefore \quad R = \sqrt{F^2+N^2} = \sqrt{1200^2+500^2} = 1300$ N

$\Rightarrow \quad 1300^2 = F_H^2 + F_V^2 = F_H^2 + 800^2$

$\Rightarrow \quad F_H = 1024.7$ N

Choice (A)

13. Coefficient of friction = $\mu = \dfrac{F}{N} = \text{Tan}\,\beta$

$F_H = 1500\ N$, $F_V = 1000\ N$ and $\alpha = 10^o$
F = Friction force = $F_H \text{ Sin } \alpha + F_V \text{ Cos } \alpha$
N = Normal force = $F_H \text{ Cos } \alpha - F_V \text{ Sin } \alpha$.

$\mu = \dfrac{F}{N} = \dfrac{1500\,\text{Sin}(10)+1000\,\text{Cos}(10)}{1500\,\text{Cos}(10)-1000\,\text{Sin}(10)}$

$\therefore \quad \mu = 0.9553$ Choice (B)

14. Choice (D)

15. $F_H = 1600$ N, $F_V = 1200\ N$, $\phi = 18^o$, $b = 15$ mm and $t = 4$ mm
F_S = Shear force along shear plane = $F_H \text{Cos}\phi - F_V \text{Sin}\phi$
$\therefore \quad F_S = 1600 \text{ Cos}(18) - 1200 \text{ Sin}(18) = 1150.87$ N

$F_S = \tau A_S$, where $A_S = \dfrac{bt}{\text{Sin}\,\varphi} = \dfrac{15\times4\times10^{-6}}{\text{Sin}(18)}$

$\therefore \quad A_S = 1.9417 \times 10^{-4}$ m^2.

$\therefore \quad \tau = \dfrac{F_S}{A_S} = \dfrac{1150.87}{1.9417\times10^{-4}} = 5.927$ MPa Choice (B)

16. $V_1 = 150$ m/min, $T_1 = 75$ min
$V_2 = 300$ m/min, $T_2 = 30$ min
Taylor's tool life equation is

$VT^n = C$

$\Rightarrow \quad V_1 T_1^n = V_2 T_2^n$

$\therefore \quad 150 \times 75^n = 300 \times 30^n$

$$\left[\frac{75}{30}\right]^n = 2$$

$\Rightarrow \quad n \ln(2.5) = \ln(2)$

$\Rightarrow \quad n = 0.7564$ Choice (A)

17. $VT^n d^x f^y = c$

$\therefore \quad V_1 T_1^n d_1^x f_1^y = V_2 T_2^n d_2^x f_2^y$

$V_2 = 2V_1,\ d_2 = \dfrac{d_1}{2}$ and $f_2 = 3f_1$

$$\left(\frac{T_2}{T_1}\right)^n = \frac{V_1 d_1^x f_1^y}{2V_1 \cdot \left(\frac{d_1}{2}\right)^x (3f_1)^y} = \left(\frac{V_1}{2V_1}\right) \cdot \left(\frac{2d_1}{d_1}\right)^x \cdot \left(\frac{f_1}{3f_1}\right)^y$$

$$\left(\frac{T_2}{T_1}\right)^n = \frac{1}{2} \cdot 2^x \left(\frac{1}{3}\right)^y \Rightarrow \left(\frac{T_2}{T_1}\right)^{0.7}$$

$$= 0.5 \times 2^{0.25} \times \left(\frac{1}{3}\right)^{0.5}$$

$$\Rightarrow \quad 0.7 \ln\left(\frac{T_2}{T_1}\right) = \ln(0.3433)$$

$$\ln\left(\frac{T_2}{T_1}\right) = -1.5274$$

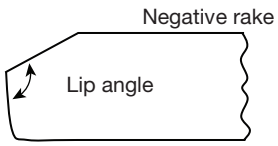
$\therefore \quad T_2 = 0.2171\ T_1 = 0.2171\ T$ Choice (D)

18. Choice (B)

19. Choice (C)

20. Choice (D)

21. A tool has a negative rake angle when the face of the tool slopes away from the cutting edge and slants upward.



Choice (A)

22. $T = 1$ min, $C = 450$

$VT^n = C \Rightarrow V = 450$ m/min

$$\therefore \quad V_1 T_1^n = V_2 T_2^n \Rightarrow \left(\frac{T_1}{T_2}\right)^n = \left(\frac{V_2}{V_1}\right)$$

$$\Rightarrow \quad \left(\frac{1}{4}\right)^n = \frac{150}{450}$$

$\Rightarrow \quad n \ln(1/4) = \ln(1/3) \Rightarrow \quad n = 0.792$ Choice (A)

23. $D = 48$ mm, $f = 0.25$ mm/rev, $V = 60$ m/min

$$V = \frac{\pi DN}{1000} \Rightarrow N = \frac{1000V}{\pi D} = \frac{1000 \times 60}{\pi \times 48} = 397.89 \text{ rpm}$$

$$MRR = \frac{\pi D^2 f N}{4} = \frac{\pi \times 48^2 \times 0.25 \times 397.89}{4}$$

$MRR = 1{,}80{,}000$ mm^3/min $= 180$ cm^3/min Choice (A)

24. In down milling, the cutting tool rotates in the direction of the motion of the table movement (feed). This forces the work piece against the table and hence the work need not be clamped tightly. Choice (A)

25. Taylor's tool life is: $VT^n = C$

$\Rightarrow \quad \ln V + n \ln T = \ln C$

As both lines are parallel their slopes are equal.

Take, $\ln T = x$ and $\ln V = y$ and $\ln C = c$

i.e., $nx + y = c$

here, when x is same for both lines y is greater for line B.

Similarly, when y is same for both the lines x is greater for line B.

$\therefore$ The machining constant C is higher for line B. Choice (B)