CLASS TEST

S.No.: 02SKME_ABCDEFGHI_26725

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MACHINE TOOLS

MECHANICAL ENGINEERING

Date of Test : 26/07/2025

ANSWER KEY

1.	(a)	7.	(a)	13.	(b)	19.	(a)	25.	(a)
2.	(c)	8.	(a)	14.	(c)	20.	(c)	26.	(d)
3.	(b)	9.	(b)	15.	(a)	21.	(a)	27.	(c)
4.	(c)	10.	(c)	16.	(c)	22.	(c)	28.	(b)
5.	(a)	11.	(d)	17.	(b)	23.	(c)	29.	(a)
6.	(b)	12.	(a)	18.	(d)	24.	(a)	30.	(a)

DETAILED EXPLANATIONS

1. (a)

$$f = f_T \times Z \times N$$
$$f = \text{Table feed}$$
$$f_T = \text{feed/tooth}$$
$$Z = \text{Number of teeth}$$
$$N = \text{rpm}$$
$$f_T = \frac{400}{10 \times 200} = 0.2 \text{ mm per tooth}$$

2. (c)

$$\text{Tailstock offset, } s = \frac{L(D-d)}{2l}$$
$$s = \frac{300(85-75)}{2 \times 200} = 7.5 \text{ mm}$$

3. (b)

$$T = \frac{L}{fN}$$
$$L = 40 + 10 + 10 = 60 \text{ mm}$$
$$T = \frac{66}{0.2 \times 400} = 0.825 \text{ min}$$

4. (c)

Time for machining, T_M

$$T_M = \frac{L}{\text{Cutting Speed}} + \frac{L}{\text{Return Speed}}$$
$$= \frac{100 \times 10^{-2}}{12} + \frac{100 \times 10^{-2}}{25}$$
$$= 0.1234 \text{ mins}$$

5. (a)

$$d = 200 \text{ mm}$$
$$N = 500 \text{ rpm}$$
$$\text{Axial feed, } f = \frac{3000 \times 60}{30} = 6000 \text{ mm/min}$$

6. (b)

Straddle milling is a special form of gang milling where only one side and face milling cutters are used.

7. (a)

$$\text{Total distance} = \text{Approach} + \text{Length of workpiece} + \text{Exit}$$
$$= 125 + 250 + 125$$
$$= 500 \text{ mm}$$
$$\text{Time for 1 pass} = \frac{\text{Length}}{\text{Table Feed Rate}} = \frac{500}{10 \times 1000}$$
$$= 0.05 \text{ minutes}$$

$$\text{No. of passes required} = \frac{100}{5} = 20$$

$$\text{Total grinding time} = 20 \times 0.05 = 1 \text{ minute}$$

8. (a)

$$\text{Stroke length, } l = \frac{2 \times s \times r}{e}$$

$$= \frac{2 \times 200 \times 100}{15} = 2.67 \text{ m}$$

$$\text{Time for forward stroke} = \frac{\text{Stroke Length}}{\text{Cutting Velocity}}$$

$$= \frac{2.67}{10} = 0.267 \text{ min}$$

$$= 16.02 \text{ secs}$$

9. (b)

Saw has 12 teeth per meter

$$\text{Saw speed} = 150 \text{ m/min}$$

$$\text{So, Number of teeth engaging per minute} = \frac{12}{(\text{metre})} \times 150 \times \left(\frac{\text{metre}}{\text{min}}\right)$$

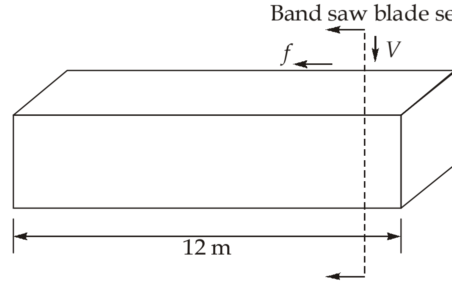
$$= 1800 \text{ Teeth/minute}$$

$$\text{Feed per tooth} = 0.003 \text{ meter}$$

$$\text{Feed per minute} = 1800 \times 0.003$$

$$= 5.4 \text{ m/min}$$

$$\text{Time taken to cut 12 m} = \frac{12}{5.4} = 2.223 \text{ min}$$



10. (c)

$$\text{Spindle speed, } N = \frac{1000 \times 30}{\pi \times 50} \approx 190.98 \text{ rpm}$$

The speed available is 176 rpm as 280 rpm will be much high.

$$\text{Machining time, } t = \frac{L}{fN} = \frac{120}{176 \times 0.24} = 2.840 \text{ min}$$

11. (d)

Normal rake angle at lip is

$$\tan \alpha_n = \frac{r \tan \psi}{\frac{D}{2} \sin \frac{\beta}{2}}$$

r = radius where rake angle to be measured.

β = Point angle = 120°

ψ = Helix angle = 30°

D = Drill diameter = 25 mm

Minimum normal rake angle, α_n

$$\tan\alpha_n = \frac{2\times\tan 30°}{12.5\sin 60°}$$

$$\tan\alpha_n = 0.1067$$

$$\alpha_n = \tan^{-1}(0.1067)$$

$$= 6.0904°$$

12. (a)

Given: $VT^{0.25} = 320;\ n = 0.25$

$T_C = 6$ min

Tooling cost, C_t = ₹0.3/edge

Machining cost, C_m = ₹6/hr = $\frac{6}{60}$ = ₹0.1/min

Optimum tool life for minimum machining cost

$$T_0 = \left(T_c + \frac{C_t}{C_m}\right)\left(\frac{1-n}{n}\right)$$

$$= \left(6 + \frac{0.3}{0.1}\right)\left(\frac{1-0.25}{0.25}\right) = 27 \text{ min}$$

Cutting speed, $V_0T_0^{0.25} = 320$

$$\Rightarrow \quad V_0 = \frac{320}{(27)^{0.25}} = 140.38 \text{ m/min}$$

13. (b)

Given : Length of the work piece, $L = 210$ mm; Width of the workpiece, $B = 120$ mm; $\lambda = 0.65$; $V = 25$ m/min; $d = 2.4$ mm; $f = 0.25$ mm/stroke

As observed from figure, approach = Overtravel = 5 mm

∴ Effective length, L_e = 210 + 10 = 220 mm

Number of strokes per min, $N = \frac{V\times 1000}{L_e(1+\lambda)} = \frac{25\times 1000}{220\times 1.65} = 68.87$ strokes/min

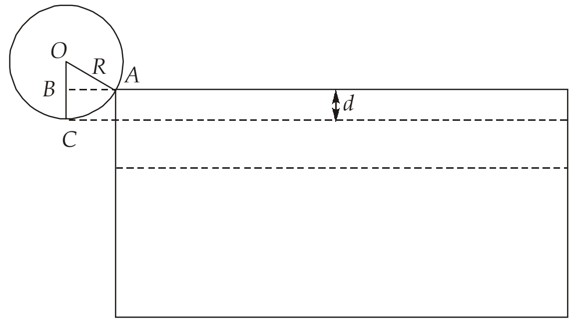
Machining time, $t_m = \frac{B}{fN} = \frac{120}{0.25\times 68.87} = 6.97$ min

$$\text{MRR} = \frac{L\times B\times d}{t_m} = \frac{210\times 120\times 2.4}{6.97}$$

$$= 8677.19 \text{ mm}^3\text{/min}$$

14. (c)

Given : Depth of cut, $d = 5$ mm; Slot depth = 30 mm; $V = 60$ m/min; $f_t = 0.25$ mm/tooth; $z = 12$; $D = 180$ mm; L = 250 mm; Approach + overtravel = 10 mm



$$\text{Compulsory approach, } X = AB = \sqrt{R^2 - OB^2}$$

$$= \sqrt{(90)^2 - (90-5)^2} = 29.58 \text{ mm}$$

$$V = \frac{\pi DN}{1000}$$

$$\Rightarrow \quad 60 = \frac{\pi \times 180 \times N}{1000}$$

$$\Rightarrow \quad N = 106.1 \text{ rpm}$$

$$\text{Effective length, } L_e = 250 + 29.58 + 10 = 289.58 \text{ mm}$$

$$\text{Number of passes, } n = \frac{30}{5} = 6 \text{ passes}$$

Time required to machine the slot,

$$t_m = \frac{L_e}{fN} \times n = \frac{L_e}{f_t \times z \times N} \times n$$

$$= \frac{289.58}{0.25 \times 12 \times 106.1} \times 6$$

$$= 5.46 \text{ min}$$

15. (a)

Given : D = 240 mm; N = 3600 rpm; b = 24 mm; d = 0.6 mm; v = 1200 mm/min; e = 40 W-s/mm^3

$$\text{Material removal rate, MRR} = bdv$$

$$= 24 \times 0.6 \times 1200$$

$$= 17280 \text{ mm}^3\text{/min}$$

$$\text{Specific cutting energy, } e = \frac{\text{Power}}{\text{MRR}}$$

$$\Rightarrow \quad \text{Power} = \frac{40 \times 17280}{60} = 11520 \text{ W}$$

Now,

$$\text{Power} = T \times \omega$$

$$\Rightarrow \quad 11520 = F_C \times \frac{D}{2} \times \omega$$

$$\Rightarrow \quad 11520 = F_C \times \frac{240}{2 \times 1000} \times \frac{2\pi \times 3600}{60}$$

$$\Rightarrow \quad F_C = 254.65 \text{ N}$$

16. (c)

$$L = 3000 + 275 + 275$$
$$= 3550 \text{ mm}$$

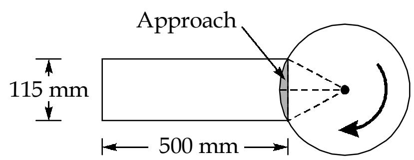
$$\text{Cutting velocity}(V) = \frac{n \times l(1+m)}{1000}$$

$$m = \frac{\text{Cutting speed}}{\text{Return speed}} = \frac{20}{75} = 0.2666$$

n = number of strokes

$$n = \frac{20 \times 1000}{3550(1+0.2666)} = 4.448 \simeq 5 \text{ strokes}$$

17. (b)



Top View

$$\text{Spindle speed, } N = \frac{1000 \times 60}{\pi \times 150} = 127.32 \text{ rpm}$$

$$\text{Approach distance, } A = \frac{1}{2}\left(D - \sqrt{D^2 - W^2}\right) = \frac{1}{2}\left(150 - \sqrt{(150^2 - 115^2)}\right)$$
$$= 26.846 \text{ mm}$$

$$\text{Time for machining, } T = \frac{500 + 2 \times 26.846}{0.18 \times 16 \times 127.32} = 1.51 \text{ minutes}$$

18. (d)

Given : Uncut chip thickness, t_1 = 0.22 mm; Width of cut, b = 2.2 mm;

Specific energy, $U_C = 1.4t_1^{-0.4}$ J/mm^3 $= 1.4 \times (0.22)^{-0.4}$ J/mm^3

Now, Specific energy, $U_C = \dfrac{F_C}{1000fd}$

For orthogonal cutting, $fd = bt_1$

$$\therefore \quad U_C = \frac{F_C}{1000\, bt_1}$$

$$\Rightarrow \quad F_C = 1.4 \times (0.22)^{-0.4} \times 1000 \times 2.2 \times 0.22$$
$$= 1241.66 \text{ N}$$

19. (a)

Given : Gear reduction ratio = 5 : 1; Pitch = $\dfrac{10}{1.25} = 8$ mm; Feed rate = 90 cm/min = 900 mm/min

To move the work table by 8 mm, 5 × 50 pulses are required.
So, to move the worktable at a speed of 900 mm/min, the pulse rate would be

$$f_p = \frac{5 \times 50}{8} \times \frac{900}{60} \text{ Hz} = 468.75 \text{ Hz}$$

20. (c)

Length of uncut chip, $l = \frac{\pi}{2}(D_i + D_f)$

Length of uncut chip, $l = \frac{\pi(75+73)}{2} = 232.48$ mm

$$\phi = 0.3328 \text{ radian} = 19.068°$$

$$\tan 19.068° = \frac{r\cos 15°}{1 - r\sin 15°}$$

$$r = \frac{l_c}{l}$$

$$0.3275 = \frac{l_c}{232.48}$$

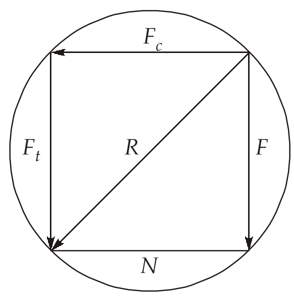
$$l_c = 76.137 \text{ mm}$$

21. (a)

$$F_c = F_z = 1200 \text{ N}$$

$$F_t = \frac{F_x}{\sin\lambda} = \frac{1000}{\sin 75°} = 1035.276 \text{ N}$$

Since, $\alpha = 0$, Merchant circle diagram become rectangle



$$F = F_t = 1035.27 \text{ N}$$

22. (c)

$$L = 1.5 \text{ m} = 1500 \text{ mm}$$

$$AL = OL = 20 \text{ mm}$$

$$L_{total} = 20 + 1500 + 20 = 1540 \text{ mm}$$

$$W = 5.5 + 600 + 5.5 = 611 \text{ mm}$$

Number of required stroke $= \frac{W}{f} = \frac{611 \text{mm}}{2 \text{mm/stroke}} = 305.5 \simeq 306$

Planning time $= \frac{W}{f}\left[\frac{L_{total}}{V_{forward}} + \frac{L_{total}}{V_{return}} + T_{reversing\ table}\right]$

$$= 306\left[\frac{1540}{21\times 1000} + \frac{1540}{42\times 1000} + 0.02\right]$$

$$= 39.78 \text{ min} \simeq 2386.8 \text{ sec}$$

23. (c)

In orthogonal machining, $\lambda = 90°$

$$\text{Depth of cut } d = b = 0.5 \text{ mm}$$
$$t = f(\text{feed}) = 0.3 \text{ mm/rev}$$
$$\alpha = 10°$$
$$\beta = \tan^{-1}(\mu) = \tan^{-1}(0.5317) = 28°$$

From merchant theory,

$$2\phi + \beta - \alpha = 90°$$
$$\Rightarrow \quad \phi = 36°$$
$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha}$$
$$\tan 36° = \frac{r\cos 10°}{1 - r\sin 10°}$$
$$r = 0.654$$
$$r = \frac{t}{t_c} = \frac{0.3}{t_c}$$
$$t_c = \frac{0.3}{0.654}$$
$$t_c = 0.46 \text{ mm}$$

24. (a)

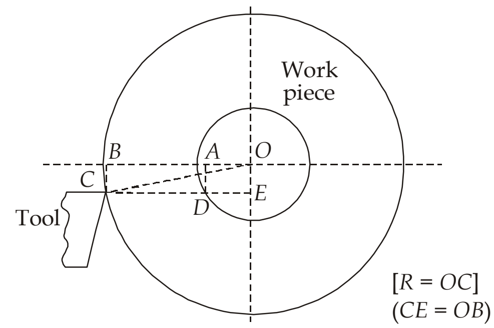
$$\text{Drilling time} = \frac{L}{fN}$$
$$L = L_1 + \text{Break through distance}$$
$$\text{Break through distance, } A = \frac{D}{2\tan\left(\frac{\alpha}{2}\right)} = \frac{30}{2\tan 59°} = 9.012 \text{ mm}$$
$$L = 45 + 9.012 = 54.012 \text{ mm}$$
$$\text{Spindle speed, } N = \frac{1000 \times 55}{\pi \times 30} = 583.568 \text{ rev/min}$$
$$\text{Drilling time} = \frac{54.012}{0.25 \times 583.568} = 0.3702 \text{ min}$$
$$= 22.21 \text{ sec}$$

25. (a)

$$\text{Taper angle, } \alpha = 4^\circ$$

Tool is set below the centre $OE = h = 2.5$ mm

First find the radius of big end,



$$OC^2 = OE^2 + CE^2$$
$$= OE^2 + OB^2$$
$$= OE^2 + (AB + OA)^2$$
$$= OE^2 + \left(AB + \sqrt{(OD^2 - AD^2)}\right)^2$$
$$= h^2 + \left(AB + \sqrt{r^2 - h^2}\right)^2$$
$$AB = CD$$

Taper angle, $$\tan\alpha = \frac{R - r}{l} = \frac{AB}{l}$$
$$AB = l\tan\alpha$$
$$OC^2 = h^2 + \left(l\tan\alpha + \sqrt{r^2 - h^2}\right)^2$$
$$= (2.5)^2 + \left(90\tan 4^\circ + \sqrt{(17.5)^2 - (2.5)^2}\right)^2$$
$$OC = 23.7458 \text{ mm}$$

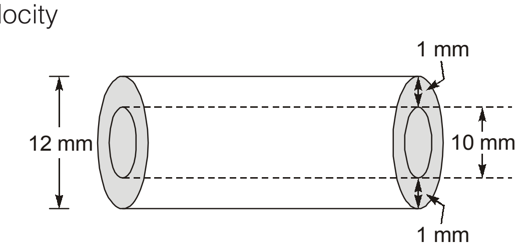
Produced taper angle is,

$$\alpha = \tan^{-1}\left[\frac{23.7458 - 17.5}{90}\right] = 3.96989^\circ$$

$$\text{Error in taper angle} = 4^\circ - 3.96989^\circ = 0.03011^\circ$$
$$= 1.81' \text{ (min)}$$

26. (d)

$$V = 150 \text{ mm/min}$$
$$\text{MRR} = \text{Cross-section} \times \text{Axial velocity}$$
$$= \frac{\pi}{4}(D_1^2 - D_2^2) \times V$$



$$= \frac{\pi}{4}(12^2 - 10^2) \times 150$$
$$= 5183.63 \text{ mm}^3\text{/min}$$

27. (c)

Given:
$$L = 200 \text{ mm}$$
$$N = 0.5 \text{ double strokes/sec}$$
$$= 30 \text{ double strokes/min}$$
$$V = 10 \text{ m/min}$$

Let, $$\frac{\text{Return time}}{\text{Cutting time}} = m = ?$$

Then, $$m = ?$$

$$V = \frac{NL(1+m)}{1000}$$

$$10 = \frac{30 \times 200(1+m)}{1000}$$

$$1 + m = \frac{10000}{30 \times 200} = 1.667$$

$$m = 0.667$$

28. (b)

Given:

$$n = 8$$

$$N_{max} = 1200 \text{ rpm}$$

$$N_{min} = 120 \text{ rpm}$$

$$r = ?$$

$$\because \quad N_{max} = N_{min}\,(r)^{n-1}$$

$$1200 = 120(r)^7$$

$$r = 1.389$$

29. (a)

Given:

$$N = 600 \text{ rpm}$$

$$f = 0.4 \text{ mm/rev.}$$

$$\text{Length of travel, } L = 200 + 2 + 2 = 204 \text{ mm}$$

$$\text{Machining time, } T = \frac{L}{fN} = \frac{204}{600 \times 0.4} = 0.85 \text{ min} = 51 \text{ sec}$$

30. (a)

Given:

$$w = 20 \text{ mm}$$

$$L = 10 \text{ cm} = 100 \text{ mm}$$

$$V_C = 60 \text{ m/min}$$

$$D = 20 \text{ mm}$$

$$z = 8$$

$$d = 3 \text{ mm}$$

$$f = 0.01 \text{ mm/flute}$$

$$\text{Approach distance, } A = \sqrt{d(D-d)} = \sqrt{3 \times 17} = 7.14 \text{ mm}$$

$$V_C = \frac{\pi D N}{1000}$$

$$N = \frac{1000 \times V_C}{\pi \times D} = \frac{1000 \times 60}{\pi \times 20} = 954.92 \text{ rpm}$$

$$\text{Time of cutting, } T = \frac{L + 2A}{fNz} = \frac{100 + (2 \times 7.14)}{0.01 \times 955 \times 8} = 1.4959 \text{ min}$$

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