CLASS TEST

S.No. : 01_SP_ME_SFGHI_310822

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METROLOGY+METAL CUTTING+MACHINE TOOL

MECHANICAL ENGINEERING

Date of Test : 31/08/2022

ANSWER KEY

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

DETAILED EXPLANATIONS

2. (d)

$$\text{Maximum interference} = \text{Shaft}_{max} - \text{Hole}_{min} = 50.04 - 50.03 = 0.01 \text{ mm}$$

5. (b)

From Taylor's tool life equation,

$$VT^n = \text{constant } (K)$$

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

or

$$n = \frac{\log_e\left(\frac{V_1}{V_2}\right)}{\log_e\left(\frac{T_2}{T_1}\right)} = \frac{\log_e\left(\frac{70}{100}\right)}{\log_e\left(\frac{49}{90}\right)} = 0.5866$$

$\therefore$

$$K = 70 \times 90^{0.5866} = 980.52$$

Now,

$$T^n = \frac{K}{V} = \frac{980.52}{90} = 10.8946$$

$$\boldsymbol{T} = (10.8946)^{(1/0.5866)} = 58.638 \text{ min} \simeq 59 \text{ min}$$

6. (c)

Slip guage or guage blocks are used as standards for precision measurement.

7. (c)

$$T = \frac{L}{f \times N} = \frac{70}{0.3 \times 75} = 3.11$$

8. (c)

$$\sin\left(\frac{\alpha}{2}\right) = \tan\left(\frac{\alpha}{2}\right) = \frac{D-d}{2L} \qquad (\alpha = 4°)$$

$$\text{Tailstock offset} = \frac{D-d}{2} = L\sin\left(\frac{\alpha}{2}\right) = 600 \sin 2° = 20.94 \text{ mm}$$

9. (a)

Broaching is a multipoint cutting tool operation in which a bar or rod type cutter with a series of cutting edges gradually increasing in size are used.

10. (b)

$$V = \frac{NL(1+m)}{1000} = \frac{20 \times 300\left(1+\frac{3}{4}\right)}{1000} = 10.5 \text{ m/min}$$

11. (d)

$$V = 10 \text{ m/min},$$
$$\alpha = 35°$$
$$l_c = 55 \text{ mm}$$

Assuming no expansion along width,

$$\therefore \quad t_1 \cdot \pi D = l_c \cdot t_2$$

$$\therefore \quad \frac{t_1}{t_2} = \frac{l_c}{\pi D} \Rightarrow \text{chip-thickness ratio}$$

$$\Rightarrow \quad \frac{55}{\pi \times 30} \Rightarrow 0.5835$$

$$r = 0.5835$$

$$\therefore \quad \tan \phi = \frac{r\cos\alpha}{1 - r\sin\alpha} = \frac{0.5835\cos 35°}{1 - 0.5835\sin 35°}$$

$$\tan \phi = 0.7184$$

$$\phi = 35.694$$

$$V_s = \frac{V\cos\alpha}{\cos(\phi - \alpha)} = \frac{10\cos 35°}{\cos(35.694° - 35°)} = 8.192 \text{ m/min}$$

12. (b)

For minimum power,

$$2\phi + \beta - \alpha = 90°$$

$$\Rightarrow \quad \beta - \alpha = 20° \qquad [\because \phi = 35°]$$

$$\frac{F_T}{F_c} = \tan(\beta - \alpha) = \tan 20°$$

$$\therefore \quad \frac{F_c}{F_T} = 2.747$$

13. (c)

$$\text{Tool life } (T) \propto \frac{1}{\text{Flank wear}}$$

$$T \propto \frac{1}{\cot\alpha}$$

$$T \propto \tan\alpha$$

$$\frac{T_2}{T_1} = \frac{\tan\alpha_2}{\tan\alpha_1} = \frac{\tan 7°}{\tan 10°} = 0.7$$

$$T_2 = 0.7T_1$$

Tool life will decrease by 30%.

14. (c)

For diameter step 18-30 mm

$$D = \sqrt{18 \times 30} = 23.23 \text{ mm}$$

$$\text{Tolerance unit (i)} = 0.45D^{1/3} + 0.001D = 1.284 + 0.02323 = 1.307 \text{ microns}$$

$$IT8 = 26i = 26 \times 1.307$$

$$= 33.98 \approx 34$$

Therefore, tolerance $= 34\ \mu\text{m} = 0.034$ mm

$$\text{Tolerance for } 25H_8 = 0.034 \text{ mm}$$

$$\text{Hole size } 25H_8 = 25^{+0.034}_{+0.00} \text{ mm}$$

15. (c)

We know,

$$F = F_c \sin\alpha + F_t \cos\alpha = 450 \text{ N}$$
$$N = F_c \cos\alpha - F_t \sin\alpha = 900 \text{ N}$$
$$\mu = \frac{F}{N} = \frac{450}{900} = 0.5$$

16. (c)

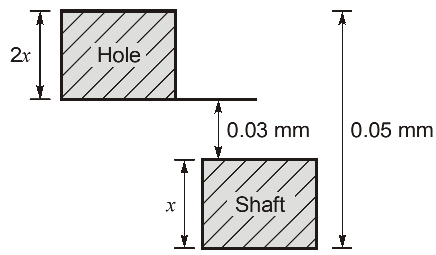
Given : $r = 0.5$; $\alpha = 12°$; $v = 2.4$ m/s

Now,
$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha} = \frac{0.5\cos 12°}{1 - 0.5\sin 12°}$$
$$\phi = \tan^{-1}(0.5458) = 28.63°$$

Shear velocity is,
$$v_s = \frac{v\cos\alpha}{\cos(\phi-\alpha)} = \frac{2.4\cos 12°}{\cos(28.63-12)} = 2.45 \text{ m/s}$$

$\therefore$ Shear strain rate $= \dfrac{v_s}{t_s} = \dfrac{2.45}{25\times10^{-6}} = 9.8 \times 10^4 \text{ s}^{-1}$

17. (c)



$$2x + 0.03 + x = 0.05$$
$$3x = 0.02$$
$$x = \frac{0.02}{3} = 6.66\times10^{-3}$$
$$= 0.00666 \text{ mm}$$
$$= 0.0067 \text{ mm}$$

Maximum limit of hole $= 40 + 2x = 40.0133$ mm

Minimum limit of hole $= 40$ mm

18. (d)

- Machining cost $= \dfrac{C_m \pi DL}{1000 f V}$

$\Rightarrow$ Machining cost $\alpha \dfrac{1}{V}$

- Non productive cost is independent of velocity

- Tool changing cost $= \dfrac{C_m \pi DL V^{\frac{1-n}{n}}}{1000 f C^{1/n}} \times T_C$

$\Rightarrow$ Tool changing cost increases with cutting velocity.

Here

C_m = Machining cost per unit time

T_c = Tool changing time per unit in min

f = Feed rate in mm per revolution

D = Diameter of work piece in mm

L = Length of job to be machined in mm

C = Constant from Taylor's tool life equation [$VT^n = C$]

19. (b)

From the Merchant's circle,

$$F = R\sin\beta$$

$$F_c = R\cdot\cos(\beta-\alpha)$$

Also, $$R = \sqrt{F_t^2+F_c^2} = \sqrt{539.55^2+245.25^2} = 592.67\text{ N}$$

Now, $$F_c = R\cdot\cos(\beta-\alpha)$$

$$539.55 = 592.67\times\cos(\beta-10)$$

$$\beta = 34.44°$$

Now, $$F = R\sin\beta = 592.67\sin 34.44° = 335.18\text{ N}$$

20. (c)

ψ major cutting edge angle = 60°

ψ_1 minor cutting edge angle = ?

$\therefore$ Maximum height of roughness

$$\therefore \quad H_{max} = \frac{f}{(\tan\psi+\cot\psi_1)} \quad \text{... (1)}$$

$$R_a = \frac{H_{max}}{4}$$

Given that

$$f = 0.05\text{ mm}$$

$$R_a = 3\times10^{-3}\text{ mm}$$

So $$R_a = \frac{f}{4(\tan\psi+\cot\psi_1)}$$

$$3\times10^{-3} = \frac{0.05}{4(\tan\psi+\cot\psi_1)}$$

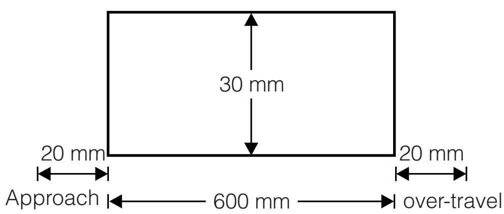
$$\tan\psi+\cot\psi_1 = \frac{50}{4\times3} = 4.1607$$

$$\tan 60°+\cot\psi_1 = 4.1667$$

$$\cot\psi_1 = 4.1667-\tan 60^\circ = 2.4346$$

$$\tan\psi_1 = 0.41074 = 22.33°$$

21. (d)



$$\text{Total forward stroke length} = 20+600+20 = 640\text{ mm}$$

$$\text{Forward time} = \frac{0.640}{8}\text{ min} = 0.08\text{ min}$$

$$\text{Return time} = \frac{0.08}{2} = 0.04\text{ min}$$

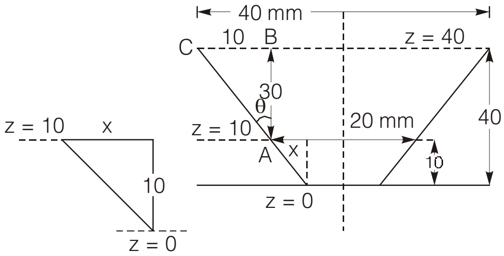
$$\text{Total time in completing one stroke} = 0.08 + 0.04 = 0.12 \text{ min}$$

$$\text{Number of strokes} = \frac{30}{0.3} = 100 \text{ strokes}$$

$$\text{Total machining time} = 0.12 \times 100 = 12 \text{ min}$$

22. (a)

$$\tan\theta = \frac{CB}{AB} = \frac{10}{30} = \frac{1}{3}$$



Now, $\tan\theta = \frac{x}{10}$

$$\frac{1}{3} = \frac{x}{10}$$

⇒ $x = \frac{10}{3}$ mm = 3.33 mm

So, diameter at $z = 0$,

$$= 20 - 2x = 20 - 2 \times 3.33 = 13.334 \text{ mm}$$

23. (b)

$$\text{Minimum clearance} = (\text{Hole})_{\text{minimum}} - (\text{Shaft})_{\text{maximum}}$$
$$= 50.02 - 50.005$$
$$\text{Minimum clearance} = 0.015 \text{ mm}$$

24. (d)

$$X_{max} = 50.02 - (37.985 + 9.99) = 2.045 \text{ mm}$$
$$X_{min} = 49.98 - (38.015 + 10) = 1.995 \text{ mm}$$
$$\text{Tolerance} = X_{max} - X_{min} = 2.045 - 1.995 = 0.09 \text{ mm}$$
∴ $X = 2 \pm 0.045$ mm

25. (b)

Maximum uncut chip thickness

$$t_{max.} = \frac{2f}{NZ}\sqrt{\frac{d}{D}}$$

where, N = rpm of cutter = 30 rpm

d = depth of cut = 2 mm

f = feed = 20 mm/min

Z = number of teeth = 30

D = cutter diameter = 80 mm

$$t_{max.} = \frac{2\times 20}{30\times 30}\sqrt{\frac{2}{80}} = 7.027 \ \mu\text{m}$$

27. (c)

Breakthrough distance, $d = \frac{D}{2\tan\alpha} = \frac{12}{2\tan 60} = 3.464$ mm

Drill point angle, $\alpha = 60$

Total length of travel = 24 + 3.464 + 3 = 30.464 mm

Time required to drill a hole $= \frac{L}{fN} = \frac{30.464}{0.3 \times 350}$ min = 17.408 sec.

28. (b)

$$\frac{\text{Time}}{\text{Cut}} = \frac{B}{fN}$$

$$= \frac{300}{0.2} \times \frac{1}{10} = 150 \text{ min}$$

29. (b)

Given: 0.4 thread $\rightarrow$ 1 mm

then, pitch of lead screw $(P) = \frac{1}{0.4} = 2.5$ mm

Ratchet has 30 teeth

$\therefore$ Pawl indexes $\frac{1}{30}$ revolution during each stroke

$\therefore$ feed $= \frac{1}{30} \times 2.5 = 0.083$ mm

30. (a)

$D = 80$ mm, $z = 8$

$$N = \frac{1000V}{\pi D} = \frac{1000 \times 20}{\pi \times 80} = 79.58 \text{ rpm}$$

$V = 20$ m/min, $f = 160$ mm/min

$d = 2$ mm

Maximum chip thickness,

$$t_{max} = \frac{2f_m}{Nz}\sqrt{\frac{d}{D}}$$

$$= \frac{2 \times 160}{79.58 \times 8}\sqrt{\frac{2}{80}} = 0.079 \text{ mm}$$

Minimum chip thickness,

$$t_{min} = 0$$

$$t_{avg} = \frac{t_{max} + t_{min}}{2} = 0.0395 \text{ mm}$$

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