CLASS TEST

S.No. : 02_SP_ME_D+E_09092022

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METROLOGY+METAL CUTTING+MACHINE TOOL

MECHANICAL ENGINEERING

Date of Test : 09/09/2022

ANSWER KEY

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

DETAILED EXPLANATIONS

2. (c)

Given,

$T_1 = 20$ min, $T_2 = 100$ min,

$V_1 = 120$ m/min $V_2 = 80$ m/min

If $V_3 = 100$ m/min, $T_3 = ?$

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

$$n = \frac{ln\frac{V_2}{V_1}}{ln\frac{T_1}{T_2}} = \frac{ln\frac{80}{120}}{ln\frac{20}{100}} = \frac{-0.405}{-1.61} = 0.252$$

$\therefore$
$$V_1 T_1^n = V_3 T_3^n$$

$$T_3^n = \frac{120 \times 20^{0.252}}{100} = 2.55 \text{ min}$$

Therefore,
$$T_3 = (2.55)^{1/n} = (2.55)^{1/0.252} = 41.232 \text{ min}$$

4. (a)

$$V = \frac{\pi DN}{60}$$

$$\frac{30 \times 1000}{60} = \frac{\pi \times 90 \times N}{60}$$

$$N = \frac{3 \times 10^4}{90\pi} = 106.1 \text{ rpm}$$

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

$\therefore$
$$t_{min} = 0$$

$\therefore$
$$t_{avg} = \frac{f}{Nz}\sqrt{\frac{d}{D}}$$

$$0.031 = \frac{180}{106.1 \times 10}\sqrt{\frac{d}{90}}$$

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

5. (d)

Maximum clearance = Higher limit of hole – Lower limit of shaft

= 30.020 – (30 – 0.018)

= 0.038 mm

Minimum clearance = Lower limit of hole – Higher limit of shaft

= 30.00 – 29.995

$$= 0.005 \text{ mm}$$

$$\text{Ratio} = \frac{0.038}{0.005} = 7.6$$

6. (d)

In orthogoanl turning, $t_c = f$

$$\text{Cutting ratio} \Rightarrow r = \frac{t}{t_c}$$

$$r = \frac{0.2}{0.62} = 0.322$$

$$\text{Chip reduction coefficient} = \frac{1}{r} = 3.1$$

7. (a)

$$t_1 = f\cos\psi$$

$$t_1 = 0.25\cos 30° = 0.22 \text{ mm}$$

$$\therefore \quad U_c = 0.81 t_1^{-0.4} \text{ J/mm}^3 = 1.47 \text{ J/mm}^3$$

$$\therefore \quad Q = fdLN$$

$$= \frac{0.25 \times 4 \times 200 \times 60}{60} \text{ mm}^3\text{/sec} = 200 \text{ mm}^3\text{/sec}$$

$$\therefore \quad P_{total} = U_c Q = 1.47 \times 200 = 294 \text{ W}$$

8. (d)

We have,

Sensitivity towards tool life is in the order,

Speed > Feed > Depth of cut

As there parameter are increased, tool life decreases.

∴ First depth of cut is to be increased, then feed and then speed.

10. (b)

$$\therefore \quad l_1 b_1 t_1 = l_2 b_2 t_2$$

$$v_1 b_1 t_1 = v_2 b_2 t_2$$

$$\therefore \quad v_1 t_1 = v_2 t_2 \qquad (\because \text{ No side flow})$$

$$v_2 = \frac{v_1 t_1}{t_2} = \frac{3 \times 0.5}{0.75} \Rightarrow 2 \text{ m/s}$$

11. (c)

Number of degrees of freedom which restricted = 9

Number of degrees of freedom which are free = 3

$$\text{Ratio} = \frac{9}{3} = 3$$

12. (b)

For minimum power,

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

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

$$\tan(\beta - \alpha) = \frac{F_T}{F_c} = \tan 20^\circ,$$

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

13. (c)

$$\text{Feed per minute} = 0.3 \times 10 = 3 \text{ mm}$$

$$\text{Time taken} = \frac{400}{3} = 133.33 \text{ min}$$

14. (b)

$$\text{Maximum interference} = \text{Shaft}_{max} - \text{Hole}_{min}$$

$$= 50.04 - 50.03$$

$$= 0.01 \text{ mm}$$

15. (d)

$$\text{Length of uncut chip, } l = \frac{\pi(75+73)}{2} = 232.4779 \text{ mm}$$

$$\text{Cutting ratio, } r = \frac{l_c}{l} = \frac{73.9}{232.4779} = 0.3178$$

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

$$= \frac{0.317\cos 10^\circ}{1 - 0.317\sin 10^\circ}$$

$$\Rightarrow \quad \tan\phi = 0.33$$

$$\Rightarrow \quad \phi = \tan^{-1}(0.33) = 18.281^\circ$$

16. (d)

$$\text{Total travel} = 150 + 8 + 10 + (0.3 \times 40) = 180 \text{ mm}$$

$$\text{Time taken} = \frac{\pi DL}{1000 f V}$$

$$= \frac{\pi \times 40 \times 180}{1000 \times 0.8 \times 30} = 0.9424 \text{ minute}$$

17. (c)

When $\propto = 0$,

$$F_c = N, \; F_T = F$$

Here, $F_c = 400 \text{ N} = \text{N},$

$$R = 500 \text{ N}$$

$$R = \sqrt{F^2 + N^2}$$

$$\Rightarrow \quad F = 300\text{ N}$$

$$\mu = \frac{F}{N} = \frac{300}{400} = 0.75$$

18. (b)

$$L = 350\text{ mm},\ H = 140\text{ mm},\ d = 30\text{ mm}$$

$$h = H - \frac{d}{2} = 140 - 15 = 125\text{ mm}$$

$$\sin\theta = \frac{h}{L} = \frac{125}{350}$$

or $$\theta = 20.92°$$

19. (c)

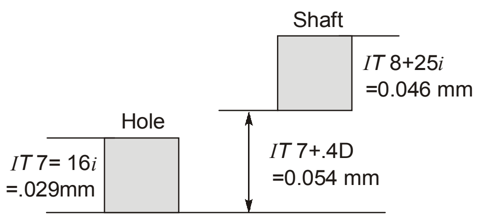
$$\text{Strain rate} = \frac{V_s}{\frac{t_1}{\sin\phi}}$$

$$\text{Strain rate} = \frac{2.2}{\frac{0.32 \times 10^{-3}}{\sin 30°}} = 3437.5\text{ s}^{-1}$$

20. (a)

$$D = \sqrt{50 \times 80} = 63.24\text{ mm}$$

Fundamental tolerance,



$$i = 0.45\, D^{1/3} + 0.001D$$

$$i = 0.45\,(63.24)^{1/3} + 0.001(63.24)$$

$$i = 1.85\text{ microns}$$

$$\text{Hole} \rightarrow \text{max} = 50.029\text{ mm}$$

$$\text{min} = 50\text{ mm}$$

$$\text{shaft} \rightarrow \text{max} = 50.10\text{ mm}$$

$$\text{min} = 50.054\text{ mm}$$

$$\text{Allowance} = 0.054 + 0.046 = 0.10\text{ mm}$$

21. (a)

According to data,

$$\frac{f}{\tan\psi + \cot\psi_1} = \frac{f^2}{8r}$$

$$\frac{0.05}{\tan 50° + \cot\psi_1} = \frac{(0.268)^2}{8 \times 1.8}$$

$$\Rightarrow \quad \psi_1 = 6.459° \simeq 6.46°$$

22. (c)

$$\text{Minimum hole size} = 19.96 \text{ mm}$$
$$\text{Maximum hole size} = 20.06 \text{ mm}$$
$$\text{Work tolerance} = 20.06 - 19.96 = 0.1 \text{ mm}$$
$$\text{Wear allowance} = 0.01 \text{ mm} = \text{gauge tolerance}$$
$$\text{Minimum go gauge size} = 19.96 + 0.01 = 19.97 \text{ mm}$$
$$\text{Maximum go gauge size} = 19.96 + 0.01 + 0.01 = 19.98 \text{ mm}$$
$$\text{Size of go gauge} = 20^{-0.02}_{-0.03} \text{ mm}$$

23. (c)

$$L = L_1 + L_2 + L_3 + L_4$$
$$L_1 = \text{Depth of hole} = 100 \text{ mm}$$
$$L_2 = \text{Approach length} = 0 \text{ mm}$$
$$L_3 = \text{Length of tip} = \frac{0.5D}{\tan\theta} = \frac{0.5\times 20}{\tan 67.5°} = 4.14$$

(Where, 2θ = point angle or lip angle)

$$L_4 = \text{Over travel} = 0 \text{ mm}$$
$$\Rightarrow \quad L = L_1 + L_3 = 104.142$$
$$\text{Machining time, } T = \frac{L}{f\times N} = \frac{104.142}{0.2\times 600} = 0.86785 \text{ minutes}$$
$$\text{Tool life} = 300 \times 0.86785 = 260.355 \text{ minutes}$$
$$\text{Cutting speed} = \frac{\pi DN}{1000} = \frac{\pi\times 20\times 600}{1000} = 37.699 \text{ m/minutes}$$
$$\Rightarrow \quad VT^{0.3} = 37.699 \times (260.355)^{0.3} = 199.986 \simeq 200$$

24. (c)

$$\tan i = -\tan\alpha_s \cos\lambda + \tan\alpha_b \sin\lambda$$

Since $i = 0$

$\therefore$ $\tan\alpha_s \cos\lambda = \tan\alpha_b \sin\lambda$

$$\tan 10 \cos\lambda = \tan 6 \sin\lambda$$

or $$\tan\lambda = \frac{\tan 10}{\tan 6} = 1.6776$$

$$\lambda = 59.2°$$
$$90 - c_s = 59.2°$$
$$c_s = 30.8°$$

25. (d)

$$t_{1\max} = \frac{2f}{Nz}\sqrt{\frac{d}{D}}$$

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

$\therefore$ $$t_{2\max} = t_{1\max}$$

There is no change in maximum uncut thickness.

$$t_{2\,max} - t_{1\,max} = 0$$

26. (a)

By Merchant's theory

$$\frac{F_c}{F_s} = \frac{R\cos(\beta-\alpha)}{R\cos(\phi+\beta-\alpha)}$$

$$\alpha = 7°$$

$$\beta = ?$$

$$\phi = ?$$

$$\tan\phi = \frac{r\cos\alpha}{1-r\sin\alpha} = \frac{0.5\cos 7}{1-0.5\sin 7}$$

$$\phi = 27.8553°$$

$$2\phi = 90° + \alpha - \beta$$

$$2 \times 27.8553° = 90° + 7° - \beta$$

$$\beta = 41.2892°$$

$$F_s = \frac{\tau_s bt}{\sin\phi} = \frac{250\times 3\times 0.2}{\sin 27.8553} = 321.0340 \text{ N}$$

$$F_c = 321.0340\times\frac{\cos(41.2892-7)}{\cos(41.2892+27.8553-7)}$$

$$F_c = 567.66 \text{ N}$$

27. (a)

Given : $t = 0.3$ mm; $t_c = 0.9$ mm; $\alpha = 0°$; $F_c = 900$ N, $F_T = 400$ N; $\tau_s = 380$ N/mm^2

Now, $$\tan\phi = \frac{r\cos\alpha}{1-r\sin\alpha} = r = \frac{t}{t_c} = \frac{1}{3}$$

$\Rightarrow$ $$\phi = \tan^{-1}\left(\frac{1}{3}\right) = 18.43°$$

Now, the shear force (F_s) is given by

$$F_s = F_c\cos\phi - F_T\sin\phi = 900\cos(18.43°) - 400\sin(18.43°)$$

$$F_s = 727.38 \text{ N}$$

$\therefore$ Area of shear plane is,

$$A_s = \frac{F_s}{\tau_s} = \frac{727.38}{380} = 1.914 \text{ mm}^2$$

28. (b)

The basic dimension of X will be,

$$X = 30 - 9 - 9 - 10 = 2 \text{ mm}$$

The tolerance of x will be the sum of all tolerance,

$$= 0.01 + 2 \times 0.006 + 0.005 = 0.027 \text{ mm}$$

Hence the dimension of X is 2 ± 0.027 mm

30. (b)

Diameter of cutter, D = 180 mm, Number of tooth, $z = 12$, $v = 12$ m/min = 12000 mm/min

Overall feed/table feed, f = 80 mm/min

$$v = \pi DN$$

$$\Rightarrow \quad N = \frac{12000}{\pi \times 180} = 21.22 \text{ rpm}$$

$$\text{Feed per tooth, } f_t = \frac{f}{zN} = \frac{80}{12 \times 21.22} = 0.314 \text{ mm/tooth}$$

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