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Manufacturing Engineering

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CLASS TEST
2019-2020

MECHANICAL ENGINEERING

Date of Test : 23/06/2019

ANSWER KEY ➤ Manufacturing Engineering

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

Detailed Explanations

1. (c)

$$\text{Shear angle } \phi = \tan^{-1}\left(\frac{r\cos\alpha}{1-r\sin\alpha}\right)$$

Where,

$$r = \frac{0.28}{0.84} = 0.333$$

$$\phi = \tan^{-1}\left(\frac{0.33\cos 10}{1-0.333\sin 10}\right) = 19.19°$$

$$F_s = F_c\cos\phi - F_t\sin\phi = 900\cos 19.19 - 450\sin 19.19$$
$$= 702.07\text{ N}$$

$$\tau_s = \frac{F_s}{bt/\sin\phi} = \frac{702.07\times\sin 19.19}{2.5\times 0.28} = 329.67\text{ MPa}$$

2. (c)

$$\because \quad \text{Wire size } (d) = \frac{P}{2}\sec\alpha = \frac{2}{2}\sec 30° = 1.154$$

$$\because \quad \text{Effective dia } (D) = m-\left(d+\frac{P}{2}\tan\alpha\right) = 18.6-\left(1.154+\frac{2}{2}\tan 30°\right)$$
$$= 16.86\text{ mm}$$

3. (a)

$$F = \tau\pi dt = 420\times\pi\times 20\times 5 = 131.95\text{ kN}$$

4. (a)

$$D = \sqrt{d^2+4dh}$$
$$= \sqrt{(100)^2+4\times 100\times 30}$$
$$= 148.32\text{ mm}$$

5. (b)

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

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

or

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

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

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

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

6. (c)

$$\varepsilon_T = \ln\frac{L}{L_0} = \ln\left(\frac{50}{100}\right) = -\ln(2) = -0.693$$

$$|\varepsilon_T| = 0.693$$

$$\text{Flow stress, } \sigma_0 = \sigma_f = 200\,(0.02 + 0.693)^{0.42}$$

8. (a)

A – Type of abrasive
36 – Grit size
M – Grade
7 – Structure
V – Bond
49 and 24 – Manufacturer's optional code number = 173.511 MPa

11. (b)

$$\text{Chip thickness ratio (r)} = \frac{t_0}{t_c} = \frac{V_c}{V}$$

$$\therefore \qquad V_C = V \times \frac{t_0}{t_c} = 3 \times \frac{0.2}{0.35} = 1.714 \text{ m/sec}$$

$$F = F_c \sin\alpha + F_t \cos\alpha$$
$$= 600 \sin 12^\circ + 150 \cos 12^\circ = 271.47 \text{ N}$$

$$\text{Total power } (F_c \cdot V) = F \cdot V_c + F_s V_s$$

% energy dissipated in shear plane

$$= \frac{F_s V_s}{F_c \cdot V} \times 100$$

$$= \frac{Fc \cdot V - F \cdot V_c}{F_c \cdot V} \times 100 = \left(1 - \frac{F \cdot V_c}{F_c \cdot V}\right) \times 100$$

$$= \left(1 - \frac{271.47 \times 1.714}{600 \times 3}\right) \times 100 = 74.15\%$$

12. (a)

Given $V = 0.6$ m/s, b = 5 mm, $t_1 = 0.25$ mm

$\alpha = 8°, \mu = 0.3, \beta = \tan^{-1}\mu = 16.69°$

By using lee and Shaffer's relation

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

$$\phi = 45° + 8 - 16.69 = 36.31°$$

Component of shear force is given by,

$$F_s = \tau_s A_s = \frac{\tau_s bt}{\sin\phi} \qquad \left[\tau_s = \frac{\sigma_y}{2} = 200 \text{ MPa}\right]$$

$$F_s = \frac{200 \times 0.25 \times 5}{\sin 36.31} = 422.187 \text{ N}$$

$$R = \frac{F_s}{\cos(\phi + \beta - \alpha)} = \frac{422.187}{\cos 45°} = 597.06 \text{ N}$$

Cutting force (F_c) = $R\cos(\beta - \alpha) = 597.06 \cos(16.69 - 8) = 590.74$ N

13. (b)

Given: $n = 0.2$

$c = 650$

$C_e =$ ₹ 50

$C_h =$ ₹ 5/min.

$t_s = 1$ min.

$$V_{\text{optimum}} = \frac{C}{\left[\left(\frac{1}{n} - 1\right)\left(t_s + \frac{C_e}{C_h}\right)\right]^n} = \frac{650}{\left[\left(\frac{1}{0.2} - 1\right)\left(1 + \frac{50}{5}\right)\right]^{0.2}} = 304.95 \text{ m/min}$$

15. (c)

The width of the strip is much larger than its thickness and no significant widening takes place i.e. the rolling strip is under plain strain condition.

16. (b)

Effective diameter, E = T + P

T = Dimensions under the wires = $S - (R_1 - R_2)$

S = Standard diameter of cylinder = 30.5 mm

R_1 = 13.3768 mm,

R_2 = 12.2428 mm

$R_1 - R_2$ = 1.134 mm

∴ T = 30.5 − 1.134 = 29.366 mm

$$P = \frac{p}{2}\cot\frac{x}{2} - d\left[\operatorname{cosec}\frac{x}{2} - 1\right]$$

Where, p = pitch

Here, p = 3.5 mm, x = 60°, d = 2 mm

∴ P = 0.866 p – d = 0.866 × 3.5 – 2 = 1.031 mm

∴ E = T + P = 29.366 + 1.031 = 30.397 mm

18. (d)

Given:

$$\Delta h = (8-5)\text{ mm} = 3\text{ mm}$$

$$R = \frac{500}{2}\text{ mm} = 250\text{ mm}$$

$$\text{Projected length, } L_P = \sqrt{R\Delta h} = \sqrt{250\times 3} = 27.386\text{ mm}$$

$$\text{Arm length, } a = 0.5\, L_P \text{ for hot rolling}$$

$$= 0.5 \times 27.386 = 13.693\text{ mm}$$

20. (c)

$$\text{The percentage of the energy} = \frac{\text{Friction energy}}{\text{Total energy}} = \frac{FV_C}{F_C V} = \frac{F.r}{F_C}$$

$$\frac{V_C}{V} = r = \frac{t}{t_C} = \frac{0.1}{0.2} = 0.5 \qquad [V_C = \text{chip velocity; } V = \text{cutting velocity}]$$

$$F = R\sin\beta$$

$$F_C = R\cos(\beta-\alpha)$$

$$R = \sqrt{F_t^2 + F_C^2} = \sqrt{200^2+500^2} = 538.51\text{ N}$$

$$\Rightarrow \quad 500 = 538.51\cos(\beta-10^\circ) \text{ or } \cos(\beta-10^\circ) = 0.928476$$

$$\beta - 10^\circ = 21.8^\circ \text{ or } \beta = 31.8^\circ$$

$$F = 538.51\sin(31.8^\circ) = 283.77\text{ N}$$

$$\text{Percentage} = \frac{283.77\times 0.5}{500} = 0.28377 \text{ or } 28.37\%$$

21. (b)

In drilling operation,

$$\text{MRR} = \left(\frac{\pi}{4}\times d^2\right)\times f \times N = \frac{\pi}{4}\times 10^2 \times 0.4 \times 600 = 18849.5559\text{ mm}^3/\text{min}$$

$$P_{\text{Total}} = 3.55\times\frac{18849.5559}{60}\times\left(\frac{W-s}{\text{mm}^3}\times\frac{\text{mm}^3}{s}\right)$$

$$P_{\text{Total}} = 1115.2653\text{ W}$$

$$P = \frac{2\pi NT}{60}$$

$$T = \frac{1115.2653\times 60}{2\times\pi\times 600}$$

$$T = 17.75\text{ N-m}$$

22. (c)

$$\text{Time/cut} = \frac{\text{Number of double strokes} \times \text{time}}{\text{double stroke}}$$

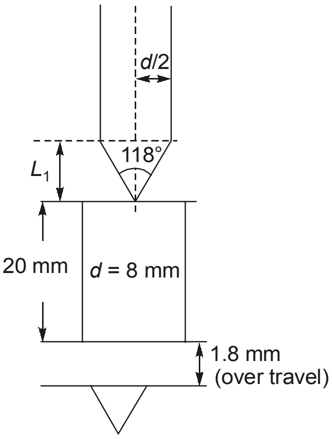
$$= \frac{B}{f} \times \frac{1}{10}$$

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

23. (b)

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

24. (a)



Point angle $2\beta = 118°$

(L) total length $= L_1 + 20 + 1.8 = L_1 + 21.8$

$$\frac{d/2}{L_1} = \tan 59°$$

$$L_1 = \frac{8}{2\tan 59°}$$

$$L_1 = 2.403 \text{ mm}$$

$$L = 2.403 + 21.8 = 24.203$$

$$T = \frac{L}{f \times N} = \frac{24.203}{0.2 \times 250} = 0.484 \text{ min}$$

$$= 29.044 \text{ sec}$$

25. (d)

$$\text{Machining cost} = \frac{C_m \pi DL}{1000 f V}$$

$$\text{Machining cost} \; \alpha \; \frac{1}{V}$$

Non productive cost is independent of velocity

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

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 [$VT^n = C$]

Note: To derive all these parameter (different costs) refer the economics of machining.

26. (d)

$2\phi + \beta - \alpha = 90°$

$$\tan\phi = \frac{\cos\alpha}{\frac{t_2}{t_1} - \sin\alpha} = \frac{\cos 7°}{2 - \sin 7°}$$

$$\phi = 27.85°$$

$$\phi \simeq 28°$$

From Merchant first analysis we know that

$2\phi + \beta - \alpha = 90°$

$2 \times 28 + \beta - 7 = 90°$

$$\beta = 41°$$

$$F_s = \frac{\tau\omega t_1}{\sin\phi} = \frac{250 \times 3 \times 0.2}{\sin 28°} = 319.5\text{ N}$$

$$\simeq 320\text{ N}$$

27. (b)

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

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

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

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

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

29. (c)

ψ major cutting edge angle = 60

ψ_1 minor cutting edge angle = ?

∴ Maximum height of roughness

∴ $$H_{max} = \frac{f}{(\tan\psi + \cot\psi_1)} \quad \ldots (1)$$

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

Given that

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

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

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

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

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

$$\tan 60 + \cot\psi_1 = 4.1667$$

$$\cot\psi_1 = 4.1667 - 1.732 = 2.4316$$

$$\tan\psi_1 = 0.41074 = 22.33°$$

30. (b)

V	T
50 m/min	45 min
100 m/min	10 min

(V_{opt}) max productivity, $T_C = 2\text{min}$

$$VT^n = C$$

$$\Rightarrow \quad (50)(45)^n = C$$

$$\Rightarrow \quad (100)(10)^n = C$$

$$\Rightarrow \quad (50)(45)^n = (100)\quad(10^n)$$

$$= n\, ln\, 45 = ln\, 2 + 1/n\, ln\, 10$$

$$= n\,[ln\, 45 - ln\, 10] = ln\, 2$$

$$= n = 0.46$$

$$C = 50\,(45)^{0.46}$$

$$C = 100\,(10)^{0.46}$$

$$C = 288.036$$

$$V_{opt} = \frac{C}{\left[\left(\frac{1}{n}-1\right)T_C\right]^n} = \frac{288.036}{\left[\left(\frac{1}{0.46}-1\right)2\right]^{0.46}}$$

$$\Rightarrow \quad V_{opt} = 194.51 \text{ m/min}$$

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