CLASS TEST

S.No. : 03_SP_ME_E_17042023

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MACHINE TOOLS

MECHANICAL ENGINEERING

Date of Test : 17/04/2023

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (b)

Mixture of abrasive and carrier gas will come out from the nozzle

$$Q = A \times v$$

$$= \frac{\pi}{4} \times (0.1)^2 \times 200 \times 100$$

$$= 157.08 \text{ cm}^3/\text{s}$$

2. (a)

$$\text{Cone height} = \frac{D/2}{\tan\frac{\alpha}{2}} = \frac{5}{\tan 60°} = 2.886 \text{ mm}$$

3. (b)

$$\text{cutting velocity, } (V) = \frac{\pi d N}{1000}$$

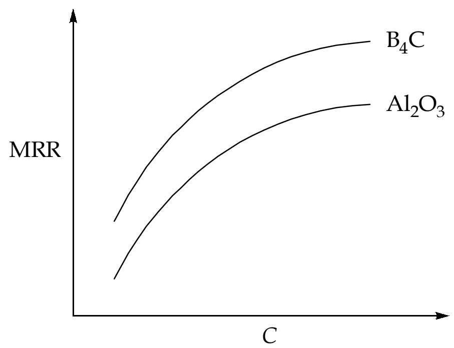
$$71.5 = \frac{\pi d \times 350}{1000}$$

$$\text{diameter } (d) = 65.026 \text{ mm}$$

4. (a)

In USM the variation of material removal rate (MRR) with respect to the volume concentration of abrasive in water slurry is governed by:

$$\text{MRR} \propto \frac{c^{1/4} A^{1/4} F^{3/4} a_0^{3/4} d_g f}{\sigma_w^{3/4} (1+\lambda)^{3/4}} \mu^{3/4}$$



Volume concentration of abrasive slurry, C

5. (a)

A negative rake angle always leads to higher cutting force than what is produced with a cutting point having positive rake angle. This further illustrates that at low grinding velocity this difference in grinding force is more pronounced. It is interesting to note that the difference is narrowed at a high grinding velocity and the grinding force becomes virtually independent to the rake angle. This is one of the reasons of conducting grinding at a very high velocity in order to minimize the influence of negative rake angle.

6. (b)

It does not cause any thermal damage to the part.

7. (b)

1. EDM has the lowest specific power requirement and can achieve sufficient accuracy.
2. ECM has the highest metal removal rate.
3. USM and AJM have low MRR and combined with high tool wear, are used for non-metal cutting
4. LBM and EBM have high penetration rates with low MRR and, therefore, are commonly used for micro drilling, sheet cutting.

8. (d)

Disadvantages of ECM:

1. Use of corrosive media as electrolytes makes it difficult to handle.
2. Sharp interior edges and corners (< 0.2 mm radius) are difficult to produce.
3. Very expensive machine.
4. Forcesare large with this method because of fluid pumping forces.
5. Very high specific energy consumption (about 150 times that required for conventional prcoess)
6. Not applicable with electrically non-conducting materials and jobs with very small dimensions.
7. Lower fatigue strength.

9. (c)

Glazing is the phenomenon in which the grinding wheel becomes dull due to wearing out of sharp edges of grit on continuous machining.

10. (d)

As MRR (metal removal rate) = fdv

$$= (0.6 \times 2.5 \times 150 \times 10^3)\ \text{mm}^3/\text{min}$$

$$= 225000\ \text{mm}^3/\text{min or } 22.5 \times 10^4\ \text{mm}^3/\text{min}$$

11. (a)

Given : Depth (d) = 5 mm, f_m = 2 mm/s

Width of cut = Diameter of the tool

$\Rightarrow$ w = 40 mm

Material removal rate (MRR) = wdf_m

$$= 40 \times 5 \times 2 = 400\ \text{mm}^3/\text{s}$$

$$\text{Power required} = \frac{(\text{Specific energy}) \times MRR}{\eta} = \frac{8.5 \times 400}{0.5}$$

$$= 6.8\ \text{kW}$$

12. (d)

Time taken for cutting,

$$t = \frac{L}{V_c} = \frac{150 \times 60}{200} = 45\,\text{sec}$$

13. (b)

Total material removal rate,

$$\text{MRR} = \frac{\pi}{4}D_1^2 f_m + \frac{\pi}{4}D_2^2 f_m$$

$$= \frac{\pi}{4} f_m \left(D_1^2 + D_2^2\right)$$

$$\Rightarrow \quad \frac{\pi}{4} \times \left(13^2 + 19^2\right) \times f_m = 24580$$

$$f_m = 59.049 \text{ mm/min}$$

Compulsory approach for drill 1, $x_1 = \dfrac{D_1/2}{\tan\frac{\alpha}{2}} = \dfrac{13/2}{\tan 59°} = 3.905 \text{ mm}$

Compulsory approach for drill 2, $x_2 = \dfrac{D_2/2}{\tan\frac{\alpha}{2}} = \dfrac{19/2}{\tan 59°} = 5.708 \text{ mm}$

$$\text{Time required to drill hole 1} = \frac{L + x_1}{f_m} = \frac{40 + 3.905}{59.049} \times 60 = 44.612 \text{ seconds}$$

$$\text{Time required to drill hole 2} = \frac{L + x_2}{f_m} = \frac{40 + 5.708}{59.049} \times 60 = 46.44 \text{ seconds}$$

$$= 46.44 \text{ seconds}$$

As both the drills are working simultaneously, so the time for the complete operation is 46.44 seconds.

14. (b)

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

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

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

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

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

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

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

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

15. (a)

We know, MRR is given by,

$$\text{MRR} = \frac{AI}{\rho VF}$$

So, $$I = \frac{(MRR) \times \rho VF}{A}$$

$\therefore$ $$I = \frac{(2.5/60) \times 8 \times 2 \times 96500}{56} = 1148.81 \text{ Amp.}$$

16. (d)

In AJM process, the MRR is proportional to,

$$\text{MRR} \propto Qd^3$$

where, Q = Flow rate of abrasives

d = mean diameter

So, $$\frac{10}{MRR'} = \frac{Qd^3}{2Q\times(d/2)^3}$$

$$MRR' = 10\times\frac{2}{8} = 2.5 \text{ mm}^3/\text{s}$$

17. (c)

$$A_{gap} = 25 \times 25 = 625 \text{ mm}^2$$

$$Z = 2$$

$$A = 55.85$$

$$\text{Current, } I = \frac{V}{R} = \frac{12}{1.2\times10^{-2}} = 1000 \text{ A}$$

$$\text{MRR} = \frac{AI}{ZF} = \frac{55.85\times1000}{2\times96500} = 0.2894 \text{ g/ sec}$$

$$= \frac{0.2894\times10^{-3}(\text{kg/ sec})}{7860(\text{kg/ m}^3)}$$

$$= 3.68 \times 10^{-8} \text{ m}^3/\text{sec.}$$

$$\text{Feed rate} = \frac{MRR}{\text{Surface Area }(A_{gap})} = \frac{3.68\times10^{-8}}{625\times10^{-6}} \text{ m/ sec}$$

$$= 5.889 \times 10^{-5} \text{ (m/sec)}$$

$$= 5.889 \times 10^{-5} \times 10^3 \times 60 \text{ mm/min}$$

$$= 3.533 \text{ mm/min}$$

18. (c)

19. (b)

$$\text{MRR} = \frac{\pi}{4}D^2 fN$$

$$D = 25 \text{ mm} \qquad f = 0.25 \text{ mm/rev}$$

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

$$\Rightarrow \quad 30 = \frac{\pi\times25\times N}{1000}$$

$$N = 381.972 \text{ rpm}$$

$$\text{MRR} = \frac{\pi}{4}\times25^2\times0.25\times381.972 \text{ mm}^3/\text{ min}$$

$$= 46874.9 \text{ mm}^3/\text{min} = 0.78 \text{ cm}^3/\text{sec}$$

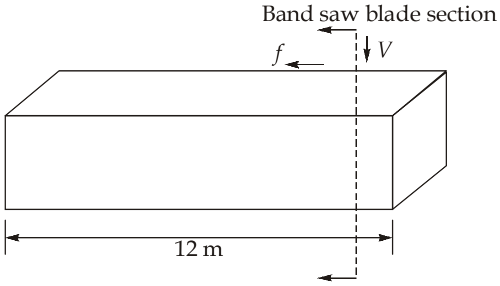
20. (a)

Saw has 12 teeth per meter

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

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

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



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

$$\text{Feed per minute} = 1800 \times 0.003 = 5.4\ \text{m/min}$$

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

21. (b)

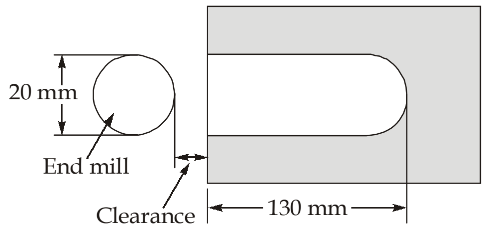
$$\text{Cutting speed, } v = \frac{\pi DN}{1000}$$

$$95 = \frac{\pi \times 20 \times N}{1000}$$

$$N = 1511.9719\ \text{rpm}$$

$$\text{Feed per min} = \text{Feed per tooth} \times \text{No. of teeth} \times \text{rpm}$$

$$= 0.15 \times 5 \times 1511.9719 = 1133.97897\ \text{mm/min}$$



$$\text{Approach distance } A_D = \frac{D}{2} = \frac{20}{2} = 10\ \text{mm}$$

$$L = 130 + 10 = 140\ \text{mm}$$

$$\text{Cutting time} = \frac{140}{1133.97897} = 0.12345\ \text{min}$$

$$= 7.40\ \text{sec}$$

22. (c)

Power required in turning is given by

$$P = K.d.f.V$$

$$V = \frac{\pi DN}{1000} = \frac{\pi \times 50 \times 140}{1000} = 21.99\ \text{m/min}$$

$$P = \frac{1600 \times 3 \times 1 \times 21.99}{60}$$

$$P = 1.76\ \text{kW}$$

23. (b)

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

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

24. (a)

Chemical machining $\rightarrow$ Corrosive reaction
Electro-chemical machining $\rightarrow$ Ion displacement
Electro discharge machining $\rightarrow$ Fusion and vaporization
Ultrasonic machining $\rightarrow$ Erosion

25. (a)

$$t_1 = \frac{2f}{Nz}\sqrt{\frac{d}{D}}$$

$$t_2 = \frac{2f}{Nz}\sqrt{\frac{3d}{3D}}$$

$$\therefore \quad \% \text{ change } t_2 - t_1 = 0$$

26. (a)

Given:
$$N_{min} = 35 \text{ rpm}$$
$$N_{max} = 300 \text{ rpm}$$
$$n = 6$$

$$\text{Sped, ratio, } r = \sqrt[(n-1)]{\frac{N_{max}}{N_{min}}} = \sqrt[5]{\frac{300}{35}} = 1.537$$

$$3^{rd} \text{ spindle speed, } N_3 = N_1 r^2$$
$$= 35(1.537)^2 = 82.66 \text{ rpm}$$

27. (d)

Given,
$$Z = 10$$
$$N = 100 \text{ rpm}$$
$$f = 50 \text{ mm/min}$$

$$\text{Feed per revolution, } f_N = \frac{50}{100} = 0.5 \text{ mm/rev.}$$

$$\text{Feed per tooth, } f_Z = \frac{f_N}{Z} = \frac{0.5}{10} = 0.05 \text{ mm/tooth}$$

28. (a)

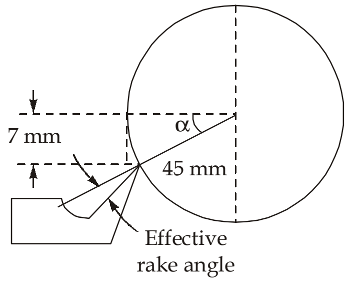
$$\pi DN = 18 \text{ m/min}$$
$$\pi D_{min} \times N_{max} = 18$$
$$N_{max} = \frac{18}{\pi \times 6.25 \times 10^{-3}} = 916.732 \text{ rpm}$$
$$\pi D_{max} \times N_{min} = 18$$
$$N_{min} = \frac{18}{\pi \times 25 \times 10^{-3}} = 229.183 \text{ rpm}$$
$$N_{min} = N_1$$
$$N_{max} = N_1 r^{8-1}$$
$$916.73 = 229.183\ r^7$$
$$r = \sqrt[7]{\frac{916.73}{229.183}}$$
$$r = 1.219 \simeq 1.22$$
$$\frac{N_1}{N_2} = 1.22$$

29. **(d)**

Given : N_s = 200 rpm, D_s = 1 mm, Z_s = 2, p_L = 4 mm

$$N_S \times p_S \times Z_S = N_L \times p_L \times Z_L \times 4$$
$$200 \times 1 \times 2 = N_L \times 4$$
$$N_L = 100 \text{ rpm}$$

30. **(c)**



$$\sin\alpha = \left(\frac{7}{45}\right)$$
$$\alpha = \frac{7}{45}\text{ rad}$$
$$\alpha = \frac{7}{45}\times\frac{180}{\pi} = \frac{7\times 4}{\frac{22}{7}} = \frac{98}{11}$$
$$\alpha = 8.909°$$
$$\text{Effective rake angle} = 10° - \alpha°$$
$$= 10° - 8.909° = 1.091°$$
$$\text{Effective clearance angle} = 5° + 8.909° = 13.909°$$

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