CLASS TEST

S.No. : 01 SPME_A+B_270124

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MACHINE TOOLS, METROLOGY & AUTOMATION

MECHANICAL ENGINEERING

Date of Test : 27/01/2024

ANSWER KEY

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

DETAILED EXPLANATIONS

Q.No. 1 to Q.No. 10 carry 1 mark each

1. (c)

The grinding wheel is said to be loaded when the metal particles get embedded in the wheel surface blocking the interspaces between the cutting grains. The grinding wheel may get loaded due to

(a) grinding of soft and ductile material.
(b) grinding wheel abrasive are hard
(c) wheel is being dressed too slowly
(d) grinding wheel rotating at low rpm thus giving time for adhesion between grit and chip
(e) wheel grit is too fine
(f) improper lubrication

2. (d)

The M and E system in metrology are used for measurement of surface finish.

- The M system expresses the arithmetical average departure of the actual surface both above and below a mean line, within a specified sampling length.
- The E system expresses the arithmetical departure of a surface both above and below a 'mean' curve.

3. (c)

Transfer machines are used to move the workpiece from one station to another in machine to enable various operation to be performed on parts.

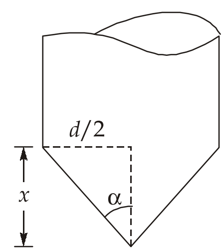
4. (c)

The line generated by the cutting motion is called generatrix and line generated by the feed motion is termed as directrix. During taper turning on a lathe machine, directrix is a straight line whereas generatrix is a circle.

5. (a)

Given; Drill point angle, $\alpha = 120°$, $D = 10$ mm

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



6. (b)

Number of sampling points, $n = 6$

$$R = \sqrt{\frac{y_1^2 + y_2^2 + ...y_n^2}{n}} = \sqrt{\frac{8^2 + 11^2 + 7^2 + 13^2 + 9^2 + 14^2}{6}} = 10.645 \text{ µm}$$

7. (a)

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

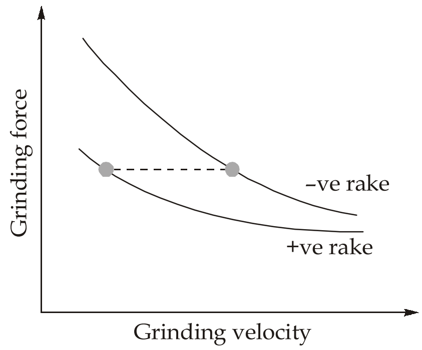
$$N_S \times p_S \times Z_S = N_L \times p_L$$
$$200 \times 1 \times 2 = N_L \times 4$$
$$N_L = 100 \text{ rpm}$$

8. (c)

M-code	**Description**
M-03	Spindle ON clockwise
M-06	Tool change
M-09	Coolant OFF
M-98	Call sub-program

9. (a)

A negative rake angle always leads to higher cutting force than what is produced with a cutting point having positive rake angle. The figure 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.



Q.No. 11 to Q.No. 30 carry 2 marks each

11. (a)

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

Width of cut = Diameter of the tool

$\Rightarrow$ w = 40 mm

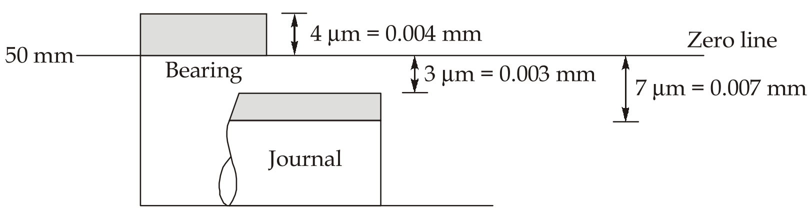
Material removal rate (MRR) = wdf_m

= 40 × 5 × 2 = 400 mm^3/s

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

= 6.8 kW

12. (a)



Allowance = Minimum clearance = 3 μm

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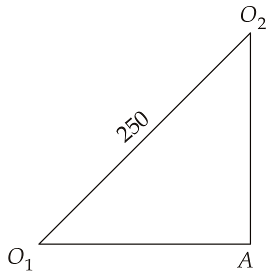
13. (b)



$$O_1A = 400 - (2R)$$
$$= 400 - 250$$
$$= 150 \text{ mm}$$
$$O_1O_2 = 250$$
$$O_2A = \sqrt{(O_1O_2)^2 - O_1A^2} = \sqrt{(250)^2 - (150)^2} = 200 \text{ mm}$$
$$H = 2R + 200$$
$$= 2 \times 125 + 200 = 450 \text{ mm}$$

14. (b)

Given: $D_{min} = 8$ mm, $D_{max} = 24$ mm, $v = 16$ m/min

$$N_{min} = \frac{1000 \times v}{\pi \times D_{max}} = \frac{1000 \times 16}{\pi \times 24} = 212.206 \text{ rpm}$$

15. (a)

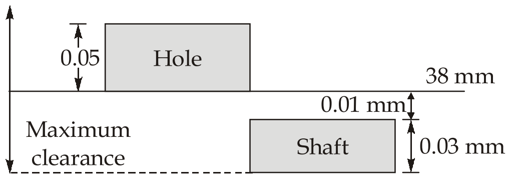
G90 - Absolute coordinate system.

G91 - Incremental coordinate system.

Coordinates of P_2 in Absolute positioning is (20, 10, 0).

Coordinates of P_2 in incremental positioning is (10, –10, 0).

16. (d)



Lower limit of hole = 38.000 mm

Higher limit of hole = 38 + 0.050 = 38.05 mm

Higher limit of shaft = 38 – 0.01 = 37.99 mm

Lower limit of shaft = 37.99 – 0.03 = 37.96 mm

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

= 38.05 – 37.96 = 0.09 mm

17. (c)

70 mm diameter lies in the diameter step of 60-80 mm therefore, geometric mean diameter

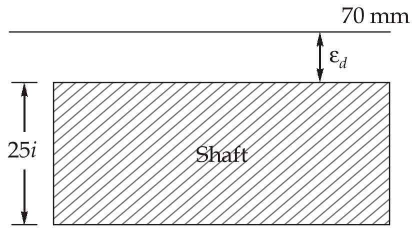
$$D = \sqrt{D_{max} \times D_{min}} = \sqrt{60 \times 80} = 69.28 \text{ mm}$$

Fundamental tolerance,

$$i = \left(0.45D^{1/3} + 0.001D\right)\mu\text{m} = \left(0.45(69.28)^{1/3} + 0.001(69.28)\right)$$
$$= 1.9174 \ \mu\text{m}$$
$$i = 0.0019174 \text{ mm}$$
$$IT8 = 25i = 25 \times 0.0019174 \text{ mm}$$
$$= 0.047936 \text{ mm} \simeq 0.048 \text{ mm}$$

Fundamental deviation for '*f*' shaft

$$\varepsilon_d = -5.5D^{0.31} = -5.5\ (69.28)^{0.31} = -20.46\ \mu\text{m} \simeq -20\ \mu\text{m} = -0.020 \text{ mm}$$



$$\text{Upper size of shaft} = \text{Basic size} - \text{Fundamental deviation}$$
$$= 70 - 0.020$$
$$= 69.980 \text{ mm}$$
$$\text{Lower limit of shaft} = \text{Upper limit} - \text{Tolerance}$$
$$= 69.980 - 0.048$$
$$= 69.932 \text{ mm}$$

18. (b)

Total material removal rate,

$$\text{MRR} = \frac{\pi}{4}D_1^2 f_m + \frac{\pi}{4}D_2^2 f_m$$
$$= \frac{\pi}{4} f_m \left(D_1^2 + D_2^2\right)$$
$$\Rightarrow \quad \frac{\pi}{4} \times \left(13^2 + 19^2\right) \times f_m = 24580$$
$$f_m = 59.049 \text{ mm/min}$$

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

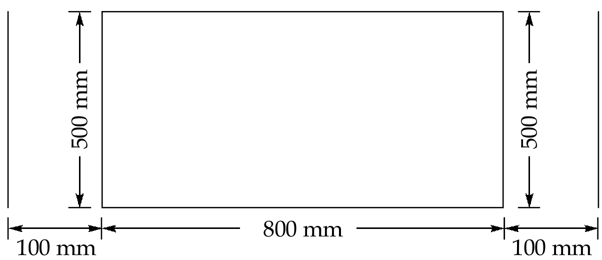
$$\text{Compulsory approach for drill 2, } x_2 = \frac{D_2/2}{\tan\frac{\alpha}{2}} = \frac{19/2}{\tan 59^\circ} = 5.708 \text{ mm}$$

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

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

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

19. (b)



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$$L = 100 + 800 + 100 = 1000 \text{ mm}$$

$$\text{Cutting time per stroke} = \frac{1000 \text{ mm}}{6000 \text{ mm/min}} = \frac{1}{6} \text{min}$$

$$\text{Return time} = \frac{1}{2} \text{ of cutter time} = \frac{1}{12} \text{min per stroke}$$

$$\text{Total time per stroke} = \frac{1}{6} + \frac{1}{12} = \frac{1}{4} \text{min}$$

$$\text{Number of stroke} = \frac{500}{2} = 250$$

$$\therefore \text{Total time for machining} = \frac{1}{4} \times 250 = 62.5 \text{ min}$$

20. (c)

$$\text{BLU (mm/pulse)} = \frac{\alpha}{360} \times P \times \frac{1}{4}$$

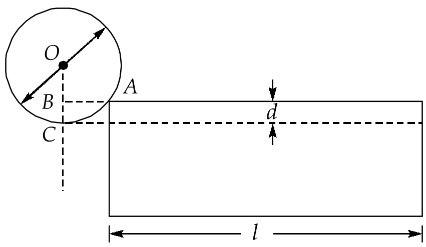
$$= \frac{3.6}{360} \times 3 \times \frac{1}{4} = 7.5 \times 10^{-3} \text{ mm}$$

$$\text{Table speed, } V = 18 \text{ mm/s}$$

$$\text{Pulse frequency (pulse/second)} = \frac{V}{(BLU)} \frac{(mm/s)}{(mm/pulse)}$$

$$= \frac{18}{7.5 \times 10^{-3}} = 2400 \text{ Hz}$$

21. (a)



Given: $BC = d = 20$ mm; $l = 150$ mm; $z = 10$; $D = 120$ mm; $V = 40$ m/min

Now, cutter over travel = AB

$$AB = \sqrt{Dd - d^2}$$

$$= \sqrt{120 \times 20 - 20^2} = 44.72 \text{ mm}$$

and,
$$V = \frac{\pi DN}{1000} \text{ m/min}$$

$$40 = \frac{\pi \times 120 \times N}{1000}$$

$\Rightarrow$ $N = 106.1$ rpm

So, table feed = fNZ

$$= (0.2)(106.1)(10) = 212.20 \text{ mm/min}$$

$$\text{Slot machining time, } T = \frac{\text{Total cutter travel}}{\text{Table feed}}$$

$$\Rightarrow \quad T = \frac{AB + l}{212.20} = \frac{44.72 + 150}{212.20}$$

$$T = 0.9176 \text{ min} \simeq 55 \text{ seconds}$$

22. (a)

Since, it is case of tolerance sink, final product will have tolerance due to error in the block and also due to error in the cutter location,

So, maximum offset will be (–0.05 – 0.02) to (0.05 + 0.02) = ±0.07 mm.

23. (b)

$$\text{Basic size} = 110 \text{ mm}$$

$$D = \sqrt{120 \times 80} = 97.98 \text{ mm}$$

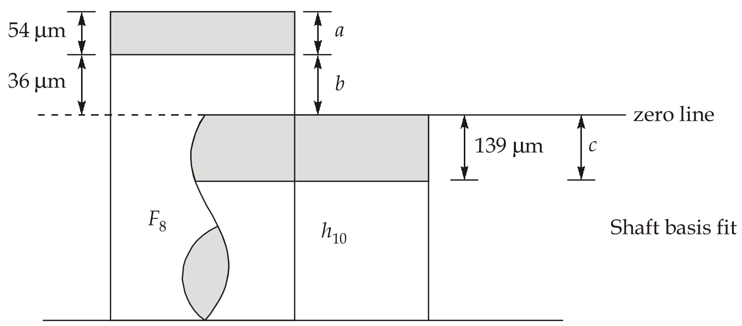
Fundamental deviation of shaft = $5.5D^{0.41}$ = +36 μm

$$i = 0.45D^{1/3} + 0.001D = 0.45 \times 97.97^{1/3} + 0.001 \times 97.97$$

$$i = 2.17 \ \mu\text{m}$$

$$\text{IT8} = 25i = 25 \times 2.17 = 54.3 \ \mu\text{m}$$

$$\text{IT10} = 64i = 64 \times 2.17 = 139 \ \mu\text{m}$$



24. (b)

$$\text{Offset, } S = \frac{(D-d)L}{2l}$$

where, L = full length of workpiece, l = portion of work piece

As taper is on full length,

$$S = \frac{(68-46)500}{2 \times 500} = 11 \text{ mm}$$

26. (d)

As 1 division of main scale = 1 mm

$$\Rightarrow \quad \text{least count} = \frac{\text{1 main scale division reading}}{\text{divisions on vernier scale}}$$

$$= \frac{1}{25} = 0.04 \text{ mm}$$

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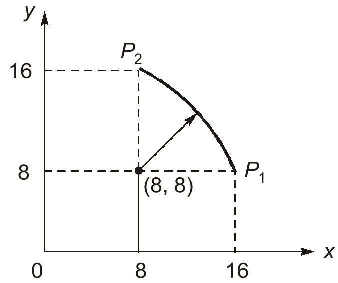
27. (b)



29. (d)

Generally the hole diameters produced by drilling are slightly larger than the drill diameter, as one can note by observing that a drill can be easily removed from the hole it has just produced.

30. (c)

Grinding ratio is the ratio of volume of material removed to the volume of wheel wear.

■■■■