CLASS TEST

S.No. : 01SPME_H+I_26052024

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METROLOGY + AUTOMATION

MECHANICAL ENGINEERING

Date of Test : 26/05/2024

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (d)

Groove depth is given by

$$d = \frac{B}{2} \times \frac{\lambda}{2}$$

Here, $B = 4, \lambda = 0.6$ microns

$$d = \frac{4}{2} \times \frac{0.6}{2} = 2 \times 0.3 = 0.6\,\mu\text{m}$$

2. (d)

Roughness R_a (μm)	Roughness symbol
12.5 to 25	∇
1.6 to 6.3	∇∇
0.2 to 0.8	∇∇∇
0.025 to 0.1	∇∇∇∇

3. (c)

IC engine cylinder and piston form clearance fit with very small clearance.

4. (c)

G21 is used for dimensioning in metric unit.

5. (a)

6. (c)

Allowance = LL of hole – HL of shaft

= 30.00 – (30 – 0.04) = 0.04 mm = 40 μm

7. (c)

8. (b)

$$R_a = \frac{H_{\max}}{4} = \frac{2}{4} = 0.5\,\mu\text{m}$$

9. (a)

10. (b)

$$\text{Step angle, } \alpha = \frac{360}{60} = 6^\circ$$

∴ Stepper motor turns 6° in 1 pulse while lead screw turns by $\frac{6}{4} = 1.5^\circ$ in 1 pulse.

Linear distance moved by table in 1 pulse,

$$= \frac{1.5}{360} \times 2.5 = 0.0104 \text{ mm}$$

The distance moved by table when 15 pulses are supplied to motor:

0.0104 × 15 = 0.15625 mm

11. (d)

$$\text{Least count of micrometer} = \frac{\text{Screw pitch}}{\text{Division on thimble}}$$

$$= \frac{0.5}{50} = 0.01 \text{ mm}$$

$$\Rightarrow \quad \text{Reading} = 10 \times 0.5 + 25 \times 0.01 = 5.25 \text{ mm}$$

12. (b)

Maximum clearance = HLH – LLS = 50.02 – (50 – 0.08) = 0.10 mm

Minimum clearance = LLH – HLS = 50.00 – (50.00 – 0.05) = 0.05 mm

Tolerance on hole = HLH – LLH = 50.02 – 50.00 = 0.02 mm

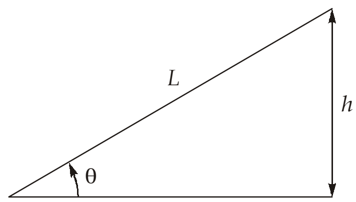
Tolerance on shaft = HLS – LLS = (50 – 0.05) – (50 – 0.08) = 0.03 mm

Since maximum and minimum clearance are positive so, it is a clearance fit.

Allowance = LLH – HLS = 50 – (50 – 0.05) = 0.05 mm

13. (b)

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



Differentiating,

$$\cos\theta d\theta = \frac{dh}{L} - \frac{h}{L^2}dL$$

As length L is constant So, $dL = 0$

$$\cos\theta d\theta = \frac{dh}{L}$$

So,
$$d\theta = \frac{dh}{L\cos\theta} = \frac{0.005}{125 \times \cos 30°} = 4.618 \times 10^{-5} \text{ radian}$$

$$= 2.65 \times 10^{-3} \text{ degree} = 2.65 \times 10^{-3} \times 60 \times 60 = 9.525''$$

14. (a)

$$D = \sqrt{30 \times 50} = 38.73 \text{ mm}$$

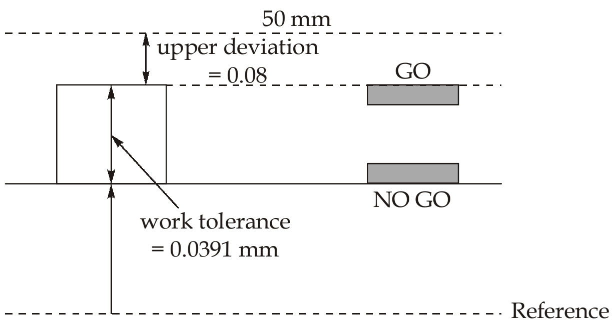
For shaft ⇒

Fundamental deviation of 'd' shaft = $-16D^{0.44}$

$= -79.95$ microns

≈ -0.08 mm

For ring gauges:



$$\text{Gauge tolerance} = \frac{1}{10}(\text{work tolerance})$$

$$= \frac{1}{10} \times 0.0391 = 3.91 \times 10^{-3} \text{ mm}$$

Dimensions of GO gauge are:

$$50 - 0.08 = 49.92 \text{ mm}$$

and $$49.92 - 3.91 \times 10^{-3} = 49.916 \text{ mm}$$

Dimensions of NO GO gauge are:

$$50 - 0.08 - 0.0391 = 49.8809 \text{ mm}$$

and $$49.8809 + 3.91 \times 10^{-3} = 49.8848 \text{ mm}$$

Ring gauge:

GO gauge = 49.92 mm
49.916 mm

NO GO gauge = 49.8848 mm
49.8809 mm

15. (c)

Given that clearance fit is required between shaft and bearing

Thus, (i) the lower limit of hole > upper limit of shaft

Also, hole basis system is followed

Thus, (ii) lower limit of hole = Basic size = 25 mm

Only option satisfying conditions (i) and (ii) and the given values of tolerance is option (c).

16. (c)

Let frequency of pulse = x Hz

$$\text{Distance travelled per pulse} = \frac{10}{120}$$

$$\text{Speed of table} = \frac{10}{120} \times x = 60$$

$$\therefore \quad x = \frac{60 \times 120}{10} = 720 \text{ pulses/sec} = 720 \text{ Hz}$$

17. (c)

Part programming codes	Functions
G43	Tool length compensation plus
G81	Canned drilling cycle
M09	Coolant off
M30	Program stop

18. (d)

Taylor's principle of gauging

- A Go gauge will check all the dimension of the work piece in the maximum metal condition (indicating the presence of the greater amount of material permitted at a prescribed surface). It should check the size of the component also the geometrical shape.
- NOT GO gauges will check only one dimension of the work piece at a time, for the minimum metal conditions (indicating the presence of the least amount of material permitted at a prescribed surface.)

In case of hole, the maximum metal condition is obtained when the hole is machined to the low limit of size, and minimum metal condition results when the hole is made to the high limit of size.

19. (b)

$$\text{CLA} = \frac{\Sigma A}{L} \times \frac{1}{\text{Vertical scale}} \times \frac{1}{\text{Horizontal scale}}$$

$$= \frac{(240+180+90+100)+(65+125+270+350)}{0.8 \times 10000 \times 100} = \frac{1420}{0.8 \times 10000 \times 100}$$

$$= 1.775 \times 10^{-3} \text{ mm}$$

$$= 1.775 \text{ µm}$$

20. (b)

Given pitch of lead screw = 5 mm

Thus, linear movement of table in one revolution = 5 mm

Since, sensitivity is 500 pulses per revolution.

Linear movement corresponding to 500 pulses = 5 mm

∴ Linear movement corresponding to 1 pulse = BLU = $\frac{5}{500}$ mm = 0.01 mm

21. (c)

22. (a)

$$D = \sqrt{18 \times 30} = 23.238 \text{ mm}$$

$$i = 0.45\sqrt[3]{D} + 0.001D = 0.45\sqrt[3]{23.238} + 0.001 \times 23.238 = 1.307 \text{ microns}$$

Fundamental tolerance = $25i = 25 \times 1.307$

= 32.675 microns

for hole 'H', fundamental deviation = 0

So, Upper limit of hole is = 25 + 25.03267 ≃ 25.033

23. (d)

$$\delta_2 - \delta_1 = (n_2 - n_1)\frac{\lambda}{2} = \text{Change in angular relation}$$

$$\text{Error in parallelism} = \frac{\delta_2 - \delta_1}{2} = (n_2 - n_1)\frac{\lambda}{4}$$

$$= (15-10) \times \frac{0.3}{4} = 0.375 \text{ µm}$$

24. (b)

$$R_a = \frac{10 \times 10 + 5 \times 20}{10 + 20} = \frac{100 + 100}{30}$$

$$= \frac{200}{30} = 6.67\mu$$

25. (b)

$$d\theta = -\tan\theta \frac{dl}{l} = -\tan(30°) \times \frac{0.1}{100}$$

$$d\theta = -\frac{0.577 \times 0.1}{100} = -5.77 \times 10^{-4} \text{ degrees}$$

26. (b)

27. (d)

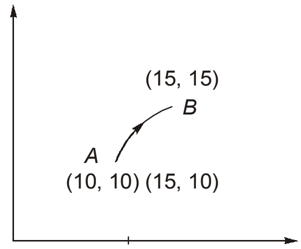
Incremental system of defining position is used.

∴ $Q(7, (13 - 8)$

∴ $Q(7, 5)$ is the answer.

28. (d)

We are moving from A to B.



The radius of arc is 5 and operation is being performed clockwise, hence (d) is the correct answer.

29. (a)

Maximum diameter of bushing = 30.05 mm

Minimum diameter of mandrel = 29.95 mm

$$\text{Eccentricity} = \frac{\text{Maximum clearance}}{2} = \frac{30.05 - 29.95}{2} = 0.05 \text{ mm}$$

30. (b)

Maximum clearance = High limit of hole – Low limit of shaft
= 30.020 – (30 – 0.018) = 0.038 mm

Minimum clearance = Low limit of hole – High limit of shaft
= 30.00 – 29.995 = 0.005 mm

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

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