B.Tech. III Year II Semester Regular and Supplementary Examinations

Set-4
Solutions

April/May - 2013

METROLOGY

(Mechanical Engineering)

Time: 3 Hours   Max. Marks: 70

*Answer any **FIVE** Questions*

***All** Questions carry **equal** marks*

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1. Discuss the following in respect of IS 919: 1969.

   (a) Grades of tolerance

   (b) Fundamental deviations. **(Unit-I, Topic No. 1.5)**

2. What is the procedure of transfer from line standard to end standard? Give example. **(Unit-II, Topic No. 2.1.1)**

3. (a) What are the conditions that have to be satisfied for interference to occur? **(Unit-III, Topic No. 3.2.2)**

   (b) Discuss about the sources of light suitable for interferometry. **(Unit-III, Topic No. 3.1.4)**

4. (a) What are the different lay patterns that may observe in different machining operations?

   (Unit-IV, Topic No. 4.1.1)

   (b) Explain the methods of numerically expressing the surface roughness. **(Unit-IV, Topic No. 4.1.2)**

5. (a) Indicate briefly the effect of the lead angle on a three wire measurement for an effective diameter of a screw thread. **(Unit-V, Topic No. 5.3)**

   (b) Using three wires of 2.5 mm diameter over the threads of M 60×4 mm bolt, a micrometer reading of 61.4012 mm was obtained. Find the pitch error and hence the deviation in the included angle. **(Unit-V, Topic No. 5.3)**

6. (a) Explain the tests for the true running of the main spindle and its axial movements. **(Unit-VI, Topic No. 6.2)**

   (b) Explain the tests for the parallelism of spindle axis to guide ways. **(Unit-VI, Topic No. 6.2)**

7. (a) State the instruments used to find the base tangent thickness of a gear tooth. **(Unit-VII, Topic No. 7.1.3)**

   (b) Calculate length of the base tangent over two teeth for helical gear having the following specifications:

   Width of the gear: 30 mm

   Number of teeth: 10, helix angle: 30º

   Pressure angle: 20º

   Module: 4. **(Unit-VII, Topic No. 7.1.3)**

8. (a) What are the advantages of surface engineering? **(Unit-VIII, Topic No. 8.1)**

   (b) Explain various methods used to protect the surface of the base metals. **(Unit-VIII, Topic No. 8.2)**

SOLUTIONS TO APRIL/MAY-2013, SET-4, QP

Q1. Discuss the following in respect of IS 919: 1969.

    (a) Grades of tolerance

    (b) Fundamental deviations.

Answer : April/May-13, Set-4, Q1

For answer refer Unit-I, Q29.

Q2. What is the procedure of transfer from line standard to end standard? Give example.

Answer : April/May-13, Set-4, Q2

For answer refer Unit-II, Q4.

Q3. **(a)** What are the conditions that have to be satisfied for interference to occur?

Answer : April/May-13, Set-4, Q3(a)

1.   It is necessary to have the sources which emits the waves of equal wave length or frequency.

2.   The amplitudes of interfering wave trains must be same or approximately equal in order to obtain interference fringes.

3.   It is essential to have the two sets of wave trains from the two different sources that must be having the same phase relationship or a constant difference between the phases.

5.   The sources must be very close and confined.

6.   It is required to have the sources which are closer to each other while emitting a set of interfering beam.

    (b) Discuss about the sources of light suitable for interferometry.

Answer : April/May-13, Set-4, Q3(b)

It is necessary to have the sources with very confined lines in order to obtain the interference over the larger path differences. This enables the decrease in pressure and temperature of discharge hence medium, surface of brightness is achieved. There are extensive forms of light sources available for interferometry but an appropriate source can be selected based upon the results obtained from interferometers also the cost involved and its utility. Light sources varies based upon the applications such as testing of surface geometry, requires a lamp with a filter which transmits only a narrow band of wavelength. For advanced applications, mercury 198, cadmium, krypton 86, thallium, helium, hydrogen, neon, sodium, potassium, zinc, laser mixed radiations are required.

Q4. **(a)** What are the different lay patterns that may observe in different machining operations?

Answer : April/May-13, Set-4, Q4(a)

For answer refer Unit-IV, Q1, Topic: Lay.

    (b) Explain the methods of numerically expressing the surface roughness.

Answer : April/May-13, Set-4, Q4(b)

The following methods are used to express the surface roughness numerically,

1.   **Maximum Peak to Valley Height Method**

For answer refer Unit-IV, Q6, Topic: Peak to Valley Height Method.

2.   **Root Mean Square Method**

For answer refer Unit-IV, Q8, Topic: RMS Value.

3.   **Centre Line Average Method**

For answer refer Unit-IV, Q7.

Q5. **(a)** Indicate briefly the effect of the lead angle on a three wire measurement for an effective diameter of a screw thread.

Answer : April/May-13, Set-4, Q5(a)

Effect of the Lead Angle on Three Wire Method

In case of with worms and quick traversing lead screw, if the lead angle is larger i.e. 55° then the formula applied for checking the effective diameter is incorrect. Due to this, the effect of lead angle on the position of wires need to be considered which is based upon the size of the lead angle and the degree of accuracy (required for checking the effective diameter) to certain extent.

If the lead angle is 41/2° for 60° single screw thread, the error is noted about 0.0125 mm.

If the lead angle is greater than 41/2° then, correction factors such as rake and compression should be considered.

(b) Using three wires of 2.5 mm diameter over the threads of M 60 × 4 mm bolt, a micrometer reading of 61.4012 mm was obtained. Find the pitch error and hence the deviation in the included angle.

Answer :   April/May-13, Set-4, Q5(b)

Given that,

Diameter of wire, $d = 2.5$ mm

Bolt dimension $= M\,60 \times 4$ mm

Where, pitch, $P = 4$ mm

Micrometer reading, $M = 61.4012$ mm

Assumptions

Thread: whitworth thread

Angle, $\theta = 60º$

∴   Pitch of screw for whitworth thread is given by,

$P = 0.9605\,P - 1.1657\,d$

$= (0.9605 \times 4) - (1.1657 \times 2.5)$

∴ $P = 0.928$ mm

∴   Effective diameter for a three wire system is given by,

$$E = M - d\,(1 + \mathrm{cosec}\,\theta) + \left(\frac{P}{2} \times \cot \theta\right)$$

$$= 61.4012 - 2.5\,(1 + \mathrm{cosec}\,(60)) + \left(\frac{0.928}{2} \times \cot(60)\right)$$

$$= 61.4012 - 5.387 + 0.268$$

$\boxed{\therefore E = 56.282 \text{ mm}}$

Change in diameter is given by,

$\delta E = M - E$

$= 61.4012 - 56.282$

$\boxed{\therefore \delta E = 5.119 \text{ mm}}$

We known that, for a whitworth thread, pitch error is given by,

$$\delta P = \frac{\delta E}{1.921}$$

∴ $\delta P = \dfrac{5.119}{1.921}$

$\boxed{\therefore \delta P = 2.665 \text{ mm}}$

And,

Deviation in included angle is given by,

$$\delta E = \frac{2d}{\sin 2\theta} \times \delta\theta$$

Where,

$\delta\theta$ = Deviation in angle

d = Diameter of thread wire.

$$5.119 = \frac{2 \times 2.5}{\sin(2 \times 60°)} \times \delta\theta$$

$\therefore \qquad \delta\theta = 0.887$ radians

$$= 0.887 \times \frac{\pi}{180}$$

$$\boxed{\therefore \delta\theta = 0.015°}$$

$\therefore$ Deviation in angle, $\delta\theta = 0.015°$

Q6. (a) Explain the tests for the true running of the main spindle and its axial movements.

Answer : April/May-13, Set-4, Q6(a)

For answer refer Unit-VI, Q5, Topics: True Running of Locating Cylinder of Main Spindle, Axial Slip of Main Spindle and True Running of Shoulder Face of Spindle Nose.

(b) Explain the tests for the parallelism of spindle axis to guide ways.

Answer : April/May-13, Set-4, Q6(b)

For answer refer Unit-VI, Q6, Topic: Parallelism of Spindle Axis and Bed.

Q7. (a) State the instruments used to find the base tangent thickness of a gear tooth.

Answer : April/May-13, Set-4, Q7(a)

For answer refer Unit-VII, Q18, Topic: Base Tangent Method.

(b) Calculate length of the base tangent over two teeth for helical gear having the following specifications,

Width of the gear: 30 mm

Number of teeth: 10, helix angle: 30º

Pressure angle: 20º

Module: 4.

Answer : April/May-13, Set-4, Q7(b)
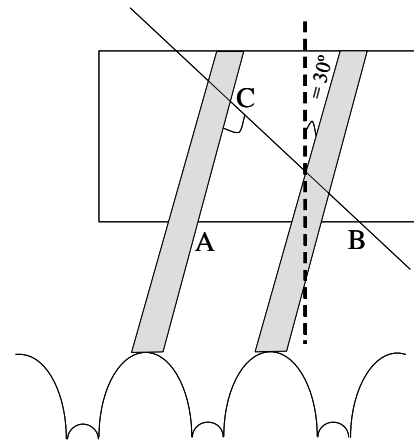
Given that,

Number of teeth on helical gear, $T_h = 2$

Width of gear, $b = 30$ mm

Number of teeth on super gear, $T_s = 10$

Helix angle, $\alpha = 30°$

Pressure angle, $\phi = 20°$

Module of spur gear, $m_{spur} = 4$

Figure

From the geometry of the figure,

We have,

$$AC = BC \cos\alpha$$

$\therefore \quad m_{helical} = m_{spur} \times \cos\alpha$

$$= 4 \times \cos 30°$$

$$= 3.464 \text{ mm}$$

$\tan\phi_{helical} = \tan\phi_{spur} \times \cos\alpha$

$$= \tan(20°) \times \cos 30°$$

$\tan\phi_{helical} = 0.315$

$\therefore \quad \phi_{helical} = \tan^{-1}(0.315)$

$$= 17.495 \simeq 17.5°$$

$\therefore \quad \phi_{helical} = 17.5°$ or $17.5 \times \dfrac{\pi}{180}$

$$= 0.305 \text{ radians}$$

Length of base tangent can be determined by using the following relation,

$$= T_s \times m_{helical} \times \cos\phi_{helical} \left(\tan\phi_{helical} - \phi_{helical} - \frac{\pi}{2 \times T_s} + \frac{\pi \times T_h}{T_s} \right)$$

$$= 10 \times 3.464 \times \cos 17.5° \left(\tan 17.5° - 0.305 - \frac{\pi}{2 \times 10} + \frac{\pi \times 2}{10} \right)$$

$\therefore$ Length of base length $= 15.908$ mm

Q8. (a) What are the advantages of surface engineering?

Answer :   April/May-13, Set-4, Q8(a)

For answer refer April/May-12, Set-2, Q1(b).

(b) Explain various methods used to protect the surface of the base metals.

Answer :   April/May-13, Set-4, Q8(b)

Method Used to Protect The Surface of Base Metals

The various methods used for protecting the surface of base metals are as follows,

1. Organic Coatings

For answer refer Unit-VIII, Q9, Topic: Organic Coatings.

2. Inorganic Coatings

For answer refer Unit-VIII, Q11.