

If the questions attempted are in excess of the prescribed number, only the questions attempted first up to the prescribed number shall be valued and the remaining ones ignored.

Answers may be written either in English or in Bengali but all answers must be in one and the same language.

Answer any five questions.

1. Select the most appropriate alternative from the options given :
- (i) The motion transmitted between the teeth of gears in mesh is
(a) Sliding (b) rolling or sliding (c) rolling and sliding
(d) rolling.
- (ii) The cam and follower without spring forms a
(a) lower pair (b) higher pair (c) self closed pair (d) force closed pair.
- (iii) The Grubler's criterion for determining the degrees of freedom (n) of a mechanism having plane motion is
(a) $n = (L-1) - j$ (b) $n = 2(L-1) - 2j$ (c) $n = 3(L-1) - 3j$
(d) $n = 4(L-1) - 3j$ when, L = no. of links and j = number of binary joints.
- (iv) The velocity of belt for maximum power is
(a) $\sqrt{\frac{T}{3m}}$ (b) $\sqrt{\frac{T}{4m}}$ (c) $\sqrt{\frac{T}{5m}}$ (d) $\sqrt{\frac{T}{6m}}$
when, m = mass of belt in kg/m.
- (v) Effective number of atoms in a diamond cubic (DC) unit cell is
(a) 4 (b) 6 (c) 8 (d) 12
- (vi) The crippling load, according to Euler's theory of long columns when both ends are hinged, is equal to
a) $\frac{\pi^2 EI}{l^2}$ b) $\frac{\pi^2 EI}{4l^2}$ c) $\frac{2\pi^2 EI}{l^2}$ d) $\frac{4\pi^2 EI}{l^2}$
- (vii) The torsional rigidity of a shaft is defined as the torque required to produce
(a) maximum twist in shaft (b) maximum shear stress in shaft
(c) minimum twist in shaft (d) twist of 1 rad per unit length of the shaft.
- (viii) If a grinding wheel is designated as 30A36H6VB,
then the letter 'H' stands for
(a) grade of bond (b) type of bond (c) structure (d) type of abrasive.
- (ix) The cutting fluid used in machining cast iron jobs is
(a) water (b) soluble oil (c) air-blast (d) mineral oil
- (x) Which one of the following materials is viscoelastic in nature?
(a) rubber (b) nylon (c) glass (d) graphite

2. (a) State and explain Gibb's phase rule. What is its utility ?
(b) Assuming that lattice points of lattice parameter 'a' in a BCC structure are occupied by spherical atoms of radius 'r', Calculate :
- (i) the free volume of a unit cell
 - (ii) the radius of largest sphere that will fit into the void produced by the lattice point atoms not occupying the full volume of the cell.

20+20

3. A quick return mechanism of a Crank and Slotted lever type has the following dimensions of its various links :
- The distance between fixed centres = 800 mm
 - The length of the crank = 300 mm
 - The length of the slotted lever = 1300 mm
 - The length of the straight link joining the slotted lever to the ram block = 400 mm
 - The angle it makes with horizontal = 30°
 - The crank makes an angle of 45° with the vertical and rotates at 40 rpm in the counter clockwise direction.

Find :

- (i) Velocity of the ram
- (ii) Angular velocity of the slotted lever

Draw space diagram and velocity diagram.

40

4. (a) A multi-disc clutch has three discs on the driving shaft and two on the driven shaft. The outside diameter of the contact surfaces is 240 mm and inside diameter 120 mm. Assuming uniform wear and co-efficient of friction as 0.3, find the maximum axial intensity of pressure between the discs transmitting 25 KW at 1575 rpm.
(b) The input shaft of a transmission rotates clockwise at 1800 rpm. The output shaft is driven at 160 rpm in the counter clockwise direction. None of the gears in the transmission is to be an idler, and the gear ratio at any given mesh is not to exceed 3:1. Gears are available that have all tooth numbers between 13 and 85, however, only one gear is available with each number. Select appropriate gears and sketch the configuration. Label the gears and tooth numbers.

25+15

5. (a) A mild steel rod was subjected to orthogonal turning at 100 m/min, feed of 0.20 mm/rev and 2.0 mm depth of cut by a carbide tool of geometry $0^\circ, 10^\circ, 8^\circ, 7^\circ, 15^\circ, 60^\circ, 0$ (mm). Assuming co-efficient of friction at the chip-tool interface equal to 0.50, determine the following for the above machining:

- (i) Width of Cut (ii) thickness of chip after cut
- (iii) shear angle

- (b) Find the percentage change in cutting speed required to give an 80% reduction in tool life when the value of $n = 0.12$.

- (c) For certain machining conditions the total cost of operating the machine is Rs.420 per hour and the total cost of a tool change is Rs.252.00. If for the depth of cut and feed employed, $V_{60} = 36$ m/min and $n = 0.14$, find the economic cutting speed.

15+10+15

6. (a) A bar of uniform cross-section 'A' and length 'L' hangs vertically, subjected to its own weight. Prove that the strain energy stored within the bar is given by

$$U = \frac{A \times P^2 \times L^3}{6E}$$

where P = Weight per unit volume of the bar
E = Modulus of Elasticity.

- (b) A beam AB of length 6 m, fixed at both ends, carries point loads of 160 KN and 120 KN at distances of 2 m and 4 m from the left end 'A'. Find the fixed end moments and the reactions at the supports. Draw B.M. and S.F. diagrams.

15+25

7. (a) Discuss the process of electrodischarge machining with particular reference to the workpiece, surface finish, metal removal rate and tool wear.

State the typical applications of the process.

- (b) What are TTT diagrams ? Explain.

How are they determined ?

20+20