- (vi) A slider on a link rotating at 60 r.p.m. slides with a linear velocity of 10 cm/s. The magnitude of Coriolis component of acceleration is (a) 10π cm/s²
 (b) 20π cm/s²
 (c) 5π cm/s²
 (d) 40π cm/s².
- (vii) Which of the fallowing mechanisms is used to enlarge or reduce the size of drawing?
 - (a) Grasshopper mechanism (b) Pantograph
 - (c) Hart's mechanism (d) Watt's mechanism.
- (viii) A pinion drives a gear. Both have same size of addendum. The interference can occur between
 (a) tip of pinion and flank of gear
 (b) tip of gear and flank of pinion
 (c) tips of both pinion and gear
 (d) flanks of both pinion and gear
- (ix) Minimum number of teeth in pinion with 14.5° full depth involute tooth profile avoiding interference is,
 (a) 20
 (b) 18
 (c) 22
 (d) 40.
 - Which of the following mechanisms using lower pairs is an exact
 - straight line mechanism? (a) Tchebicheff (b) Watt (c) Paucellier (d) Grasshopper.

Group – B

2. (a) Distinguish between: Higher pair and lower pair, machine and mechanism.

Find the degree of freedom of the mechanism shown in figure 1



(b) For the kinematic linkage shown in figure 2, find the number of binary links (N_b) , ternary links (N_t) , other links, total links (N), loops (L), joints or pairs (P_t) and degree of freedom (F).

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(b) Power is transmitted using a V-belt drive. The included angle of a Vbelt groove is 30° . The belt is 20mm deep and maximum width is 20mm. If the mass of the belt is 0.35kg per meter length and maximum allowable stress is 1.4 MPa, determine the maximum power transmitted when angle of lap is 140° . Consider $\mu = 0.15$.

7 + 5 = 12

- 7. (a) Prove that between rack and pinion the minimum number of teeth on the pinion to avoid interference is 18.
 - (b) A leather belt is required to transmit 7.5 KW from a pulley 1.2 m in diameter, running at 250 rpm. The angle embraced is 165° and the coefficient of friction between the belt and the pulley is 0.3. If the safe working stress for the leather belt is 1.5 MPa, density of leather 1000 Kg/m³ and thickness of belt is 10 mm, determine the width of the belt taking centrifugal tension into account.

5 + 7 = 12

Group – E

8. Draw the profile of a cam operating in a knife-edge follower having a lift of 35mm. The cam raises the follower with SHM for 150° of the rotation followed by a period of dwell of 60°. Follower descends for the next 100° rotation of the cam with uniform velocity, again followed by a dwell. The cam rotates at a uniform velocity of 120 rpm and has a base circle radius of 20mm.

12

- 9. (a) What is the condition for correct steering? Sketch and show the two main types of steering gears and discuss their relative advantages.
 - (b) What are straight line mechanisms? Describe one type of exact straight line motion mechanism with the help of a sketch.

(2+5) + (2+3) = 12

(x)

KINEMATICS OF MACHINES (MECH 2202)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and <u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A (Multiple Choice Type Questions)

 $10 \times 1 = 10$

(i) The motion of circular rod in a circular hole is an example of
(a) successfully constrained motion
(b) completely constrained motion
(c) incompletely constrained motion
(d) partially constrained motion.

1. Choose the correct alternatives for the following:

(ii) The total number of instantaneous centre of a mechanism having *n* links is

(a) n (n – 1) /2	(b) (<i>n</i> – 1) / 2
(c) <i>n</i> (<i>n</i> + 1) / 2	(d) (<i>n</i> + 1) / 2.

- (iii) In a four-link mechanism, mechanical advantage is maximum when transmission angle is
 (a) zero
 (b) 180°
 (c) 45°
 (d) as close to 90° as possible.
- (iv) The point on the cam with the maximum pressure angle is known as the

(a) cam centre	(b) pitch point
(c) trace point	(d) prime point.

- (v) The direction of relative velocity of two points in a rigid link is(a) along the line joining the two points
 - (b) perpendicular to the line joining the two points
 - (c) parallel to the line joining the points
 - (d) dependent upon the rigidity of the link.

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(4+3) + 5 = 12

3. (a) What is meant by inversion of mechanism?

How are Whitworth mechanism and crank and slotted-lever mechanism different from each other?

The length fixed link of a crank and slotted lever mechanism is 250 mm and that of the crank is 100 mm. determine the quick return ratio and length of the stroke, if the length of the slotted lever is 450 mm and the line of stroke passes through the extreme positions of the free end of the lever.

(b) State the Grashof's law. Find the nature of the mechanism as shown in Figure 3 and also determine the maximum and minimum transmission angles. The figure indicates the dimensions in standard units of length.



Group – C

4. (a) In the mechanism shown in the figure 4, the dimensions of various links are as follows: OA = 25 mm, AB = 80 mm, BC = 20 mm, CD = 33 mm, DE = 20 mm. If the crank OA is inclined at 45° and revolves at uniform speed of 120 rpm in counter clockwise direction, determine the angular velocities of links *AB*, *BC* and *CD*. Also find the linear

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(4+3) + 5 = 12

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How are Whitworth mechanism and crank and slotted-lever mechanism different from each other?

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(1+2+5) + (1+3) = 12

Group – C

4. (a) In the mechanism shown in the figure 4, the dimensions of various links are as follows: OA = 25 mm, AB = 80 mm, BC = 20 mm, CD = 33 mm, DE = 20 mm. If the crank OA is inclined at 45° and revolves at uniform speed of 120 rpm in counter clockwise direction, determine the angular velocities of links *AB*, *BC* and *CD*. Also find the linear

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velocity of slider *B*. For the above mechanism, determine the linear acceleration of slider and angular acceleration of link *AB*.



12

- 5. (a) State and prove Kennedy's theorem of Instantaneous Centre.
 - (b) Explain the procedure to construct Klein's Construction to determine the velocity and acceleration of a slider-crank mechanism.

5 +7=12

Group – D

6. (a) In an epicyclic gear (as shown in figure 5 below) the wheel A fixed to S_1 has 30 teeth and rotates at 500 rpm. B gears with A and is fixed rigidly to C, both being free to rotate on S_2 . The wheel B, C and D have 50, 70 and 90 teeth respectively. If D rotates at 80 rpm in a direction opposite to that of A, find the speed of the shaft S_2 .



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velocity of slider *B*. For the above mechanism, determine the linear acceleration of slider and angular acceleration of link *AB*.



- 5. (a) State and prove Kennedy's theorem of Instantaneous Centre.
 - (b) Explain the procedure to construct Klein's Construction to determine the velocity and acceleration of a slider-crank mechanism.

5+7=12

Group – D

6. (a) In an epicyclic gear (as shown in figure 5 below) the wheel A fixed to S_1 has 30 teeth and rotates at 500 rpm. B gears with A and is fixed rigidly to C, both being free to rotate on S_2 . The wheel B, C and D have 50, 70 and 90 teeth respectively. If D rotates at 80 rpm in a direction opposite to that of A, find the speed of the shaft S_2 .



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