

- (b) An epicyclic gear train as shown in Figure 6 consists of an arms and two gears P and S having 40 and 50 teeth respectively. The arms rotates about the centre of the gear P at a speed of 80 rpm counter-clockwise. Determine the speed of the gear S if (i) the gear P is fixed, and (ii) the gear P revolves at 360 rpm clockwise instead of being fixed.

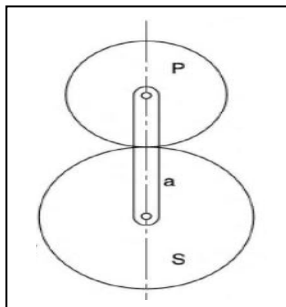


Fig 6

$$5 + 7 = 12$$

7. (a) Two involute gears in mesh have a module of 8 mm and a pressure angle of 20° . The larger gear has 40 while the pinion has 20 teeth. If the addendum on the pinion and gear wheels are equal to one module, find the -
 (i) Contact ratio (the number of pairs of teeth in contact)
 (ii) Angle of action of the pinion and the gear wheel.
- (b) An open belt drive transmits 4kW of power. The smaller pulley is the driver and rotates at 300 rpm. The diameter of the two pulleys are 280 mm and 640 mm and the centre distance is 3m. The coefficient of friction between the belt and the pulley is 0.3. If the safe working stress is 8 N/mm width, determine the minimum width of the belt. Also calculate the initial tension in the belt and the length of the belt required.

$$6 + 6 = 12$$

Group - E

8. Draw the profile of a cam operating a knife edge follower having a lift of 40 mm. The cam raises the follower with SHM for 150° of the rotation followed by a period of dwell for 60° . The follower descends for the next 100° rotation of the cam with uniform velocity again followed by a dwell period. The cam rotates at a uniform velocity at 120 rpm and has a least radius of 30 mm.

$$12$$

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) Prove that a pantograph produces path exactly similar to the ones traced out by a point on the linkage on an enlarged or reduced scale.

$$(2 + 5) + 5 = 12$$

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 any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A (Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) For Class-I mechanism, if the link next to the shortest link is fixed, what type of mechanism is obtained?
 (a) Double crank mechanism (b) Linkage is not planar
 (c) Double rocker mechanism (d) Crank rocker mechanism.
- (ii) The number of inversions for a slider crank mechanism is
 (a) 6 (b) 5 (c) 4 (d) 3.
- (iii) The Klein's method of construction for reciprocating engine mechanism is to determine
 (a) acceleration of each link (b) velocity of each link
 (c) reaction force of each link (d) displacement of each link.
- (iv) Coriolis component of acceleration of a slider which is sliding at 10 cm/s in a link rotating at 60 RPM will be
 (a) $40\pi^2$ cm/s² (b) 0.4π cm/s²
 (c) 40π cm/s² (d) 4π cm/s².
- (v) Two intersecting shafts can be connected by gears.
 (a) straight Spur (b) spiral
 (c) cross- helical (d) straight bevel.
- (vi) Crowning of a pulley is done to
 (a) prevent the slipping of a belt
 (b) increase the tension of a belt
 (c) increase the angle of contact
 (d) decrease the tension of a belt.

- (vii) The product of the diametral pitch and circular pitch is equal to
 (a) 1 (b) $1/\pi$ (c) π (d) 2π .
- (viii) The angle between the axis of the follower and the normal to the pitch curve is known as the
 (a) base angle (b) pressure angle
 (c) pitch angle (d) prime angle.
- (ix) 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.
- (x) A Hooke's joint is used to join two shafts which are
 (a) aligned (b) intersecting (c) parallel (d) Inline.

Group - B

2. (a) Prove that for planar mechanisms having lower pairs only with even number of links, DOF has to be odd. Determine the degree of freedom of the linkages as shown in Figure 1.

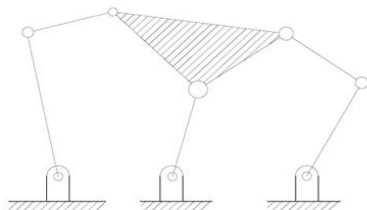


Fig1(a)

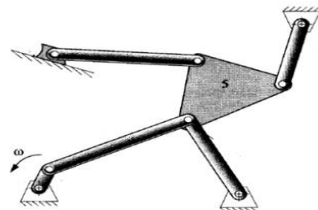


Fig 1(b)

- (b) Sketch the equivalent mechanism for the mechanism shown in Figure 2. Show that it has same DOF as the original mechanism.

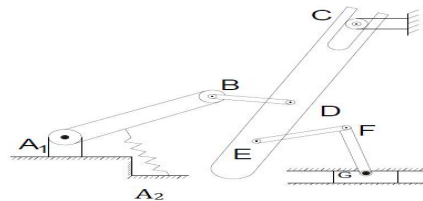


Fig 2.

$$(2 + 3 + 3) + (2 + 2) = 12$$

3. (a) State Grashof's law? Describe various inversions of four bar mechanism when sum of shorter and longer link is equal to sum of other two links.
- (b) Draw and explain elliptical trammel mechanism. What is the condition for drawing a circle using elliptical trammel?

$$(3 + 4) + (4 + 1) = 12$$

Group - C

4. (a) Following figure (Fig. 3) represents a crank and slotted lever mechanism. Dimension of each link of the mechanism have been given as following:

Crank, $OP = 8$ cm,
 Slotted Lever, $AR = 36$ cm
 Fixed link, $AO = 24$ cm
 Link, $RS = 30$ cm long.
 Distance, $AH = 30$ cm

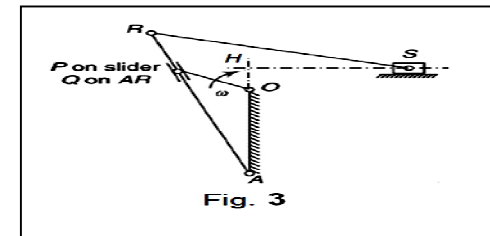


Fig. 3

If crank rotates at uniform speed of 200 RPM clockwise.

Draw the velocity polygon for the configuration when the crank makes an angle of 120 degree with fixed link and determine

- (i) The linear velocity of point S on RAM.
 (ii) Angular velocity of lever.

- (b) State Arnold Kennedy theorem for three centers.

$$10 + 2 = 12$$

5. (a) For the position of the links in the mechanism shown in Figure 4, find the velocity of slider B for the given configuration if the velocity of the slider A is 3 m/s.

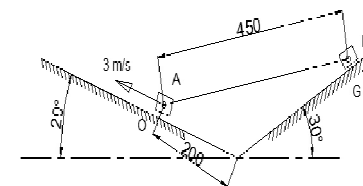


Fig 4 (All dimensions are in mm)

- (b) The sewing machine needle bar mechanism is shown in Figure 5. Crank O_1A rotates at 450 rpm. Determine the velocity of the needle at D using I-centre method. $O_1A = 15$ mm, $O_2B = 25$ mm, $AB = 65$ mm, $BC = 20$ mm, $CD = 60$ mm, and angle $O_2BC = 90^\circ$. All dimensions are in mm

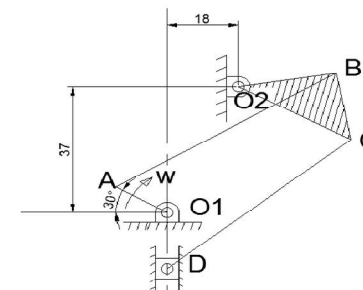


Fig 5 (All dimensions are in mm)

$$5 + 7 = 12$$

Group - D

6. (a) Derive the condition for maximum power transmission by a belt drive considering the effect of centrifugal tension.