

Code No: R09220302

**R09****Set No. 2**

II B.Tech II Semester Examinations, APRIL 2011

**KINEMATICS OF MACHINERY**Common to Mechanical Engineering, Mechatronics, Production  
Engineering, Automobile Engineering

Time: 3 hours

Max Marks: 75

Answer any FIVE Questions  
All Questions carry equal marks

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1. (a) What is the importance of pressure angle of a cam?  
(b) A cam is to operate a flat-faced follower having uniform acceleration and deceleration during ascent and descent. The least radius of the cam is 50mm. During descent, the deceleration period is half of the acceleration period. The ascent lift is 37.5mm. The ascent is for  $\frac{1}{4}^{th}$  period, dwell for  $\frac{1}{4}^{th}$ , descent for  $\frac{1}{3}^{rd}$ , and dwell for the remaining  $\frac{1}{6}$  the period. The cam rotates 600 rpm. Find the maximum velocity and acceleration during ascent and descent.  
[4+11]
2. A crank and rocker mechanism ABCD has the following dimensions: AB = 0.75m, BC = 1.25 m, CD = 1 m, AD = 1.5 m and CF = 500 mm. AD is the fixed link. F lies on BC produced. Crank AB has an angular velocity of 30 rad/s counter clock-wise and a deceleration of 200 rad/s<sup>2</sup> at the instant angle DAB = 30°. Find  
(a) The instantaneous linear acceleration of C and F and  
(b) The instantaneous angular velocities and accelerations of links BC and CD.  
[15]
3. Determine the maximum power that can be transmitted through a flat belt having the following data:  
cross section of the belt = 300mm × 12mm  
Ratio of belt tensions = 2.2  
Maximum permissible tension in belt = 2N/mm<sup>2</sup>  
Mass density of the belt material = 0.0011 g/mm<sup>3</sup>.  
[15]
4. (a) Name the two inversions obtained by fixing the crank of a single slider crank chain. Describe them with neat sketches.  
(b) In a Whitworth quick return motion mechanism, as shown in Figure 4 lengths of driving crank AC = 90mm, the distance between fixed centers CD = 60mm, the length of slotted lever, AP is 180mm and the length of the connecting rod PR is 162mm. Find the ratio of the time of cutting stroke to that of return stroke and also the length of effective stroke.  
[7+8]

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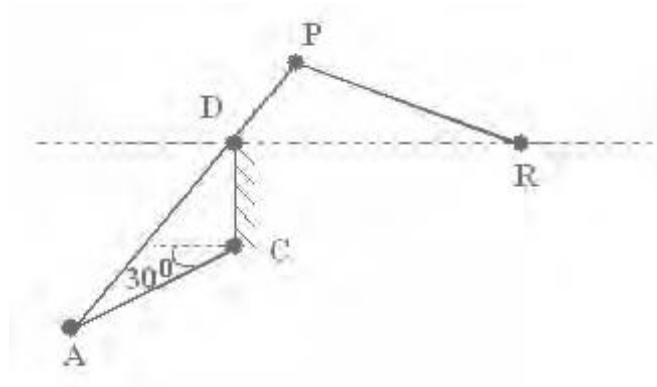
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Figure 4

5. In grasshopper straight-line motion mechanism figure (5) the point 'P' traces an approximate vertical straight-line motion as the crank OA rotates. The lengths of the links  $PQ = 24\text{cm}$ , vertical link  $O_1Q = 24\text{cm}$  and  $QA = 6\text{cm}$ . Determine the length of the crank OA. Also find the maximum deviation of P from the vertical straight line in a travel of 6cm on each side of its mean position. [15]

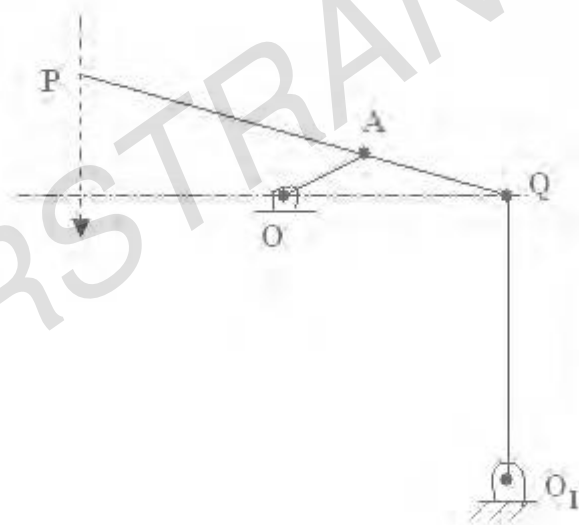


Figure 5

6. The epicyclic gear train known as Ferguson's paradox is shown in figure 6. Gear 1 is fixed to the frame. The arm A and gears 2 and 3 are free to rotate on the shaft S. Gears 1, 2 and 3 have 100, 101, and 99 teeth respectively. The planet gear has 20 teeth. The pitch circle diameter of all the gears is the same so that the planet gear P meshes with all of them. Determine the revolutions of gears 2 and 3 for one revolution of the arm A. [15]

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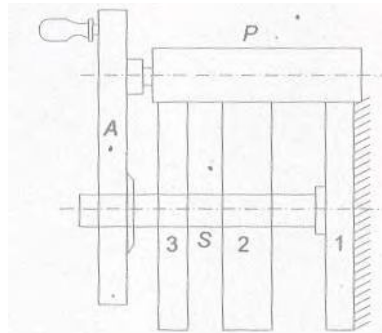
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Figure 6

7. (a) Differentiate between cycloidal and involute teeth profiles.  
 (b) Two gears in mesh have 10 teeth and 40 teeth respectively. They are full-depth teeth and pressure angle is  $20^\circ$ . The module is 8.5mm. Determine the  
 i. reduction in addendum of the gear to avoid interference, and  
 ii. contact ratio. [6+9]
8. The distance between the pivots of the front stub axles of a car is 147 cm, the length of track rod is 161 cm, the wheel track is 177 cm and the wheelbase is 330 cm. What should be the length of track arm if the Ackermann steering gear is to be given a correct steering, when rounding a corner of 6-meter radius? [15]

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1. Prove that the tracing point, giving the horizontal straight-line motion in Tchebicheff's mechanism, lies at the mid point of the coupler. [15]
2. A countershaft is to be driven at 240rpm from a driving shaft rotating at 100rpm by an open-belt drive. The diameter of the driving pulley is 480mm. The distance between the centre line of shafts is 2m. Find the width of the belt to transmit 3kW of power if the safe permissible stress in tension is 15N/mm width of the belt. Take  $\mu = 0.3$ . [15]
3. (a) Classify gear trains.  
(b) In a reduction gear shown in figure 3b, the input S has 24 teeth, P and C constitute a compound planet having 30 and 18 teeth respectively. If all the gears are of the same pitch, find the speed ratio of the reduction gear. Assume A to be fixed. [2+13]

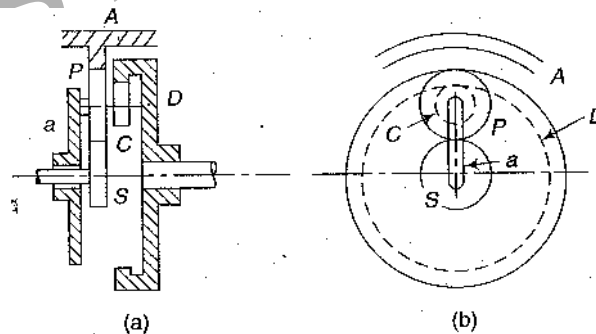


Figure 3b

4. A shaper mechanism is shown in Figure 4. The crank OA rotates at uniform speed of 20 rpm clockwise. The guide block A slides along the slotted lever AD that has its fulcrum at 'C'. The connecting rod BD connects the tool head B to AD. The tool head is constrained to move along BC perpendicular to OC. Find the velocity and acceleration of 'B'. OA= 200 mm; OC=400 mm; CD=200 mm; BD=500mm and angle AOC= 120°. [15]
5. (a) For an Ackermann steering gear, derive the expression for the angle of inclination of the track arms to longitudinal axis of the vehicle.  
(b) A Hooke's joint connects two shafts whose axes intersect at 150°. The driving shaft rotates uniformly at 120rpm. The driven shaft operates against a steady torque of 150 Nm and carries a flywheel whose mass is 45 Kg and radius of gyration 150mm. Find the maximum torque which will be exerted by the driving shaft. [7+8]

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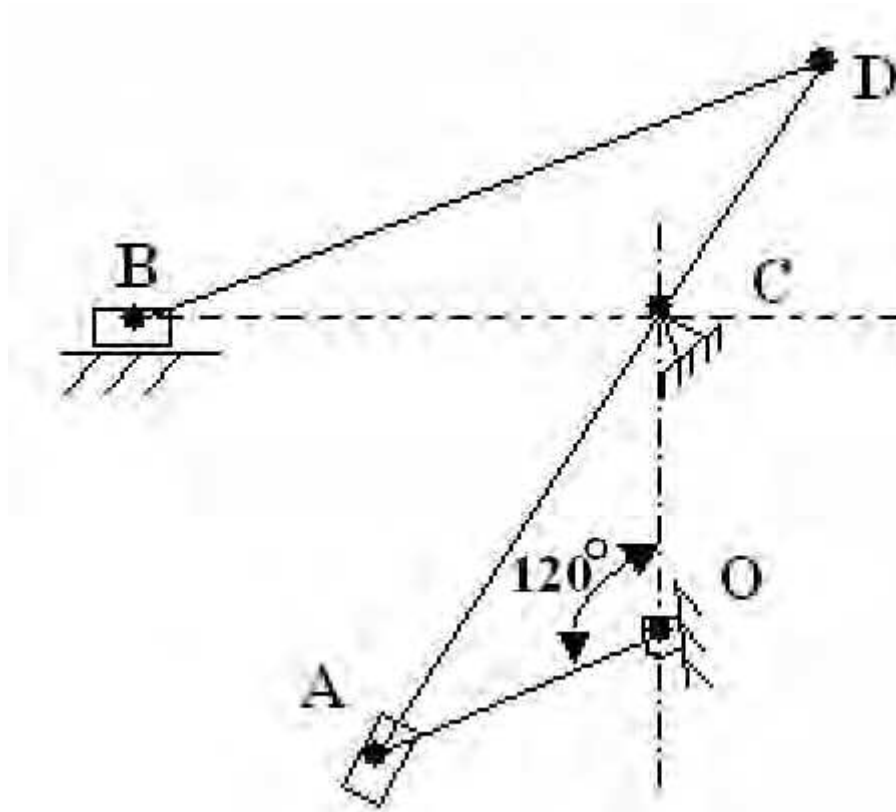


Figure 4:

6. The following data relate to a cam operating an oscillating roller follower:  
 Minimum radius of cam = 44mm. Diameter of roller = 14mm, Length of the follower arm = 40mm. Distance of fulcrum centre from cam centre = 50mm, Angle of ascent =  $75^\circ$ , Angle of descent =  $105^\circ$ , Angle of dwell for follower in the highest position =  $60^\circ$ , Angle of oscillation of follower =  $28^\circ$ . Draw the profile of the cam if the ascent and descent both take place with SHM. [15]
7. (a) Show that for the scotch yoke mechanism shown in figure 7 uniform rotation of the crank 'b' will produce simple harmonic motion of the slider 'd'.  
 (b) Name the inversion obtained by fixing link 'b' of the scotch yoke mechanism shown in figure 7. Describe the inversion with neat sketch. [7+8]

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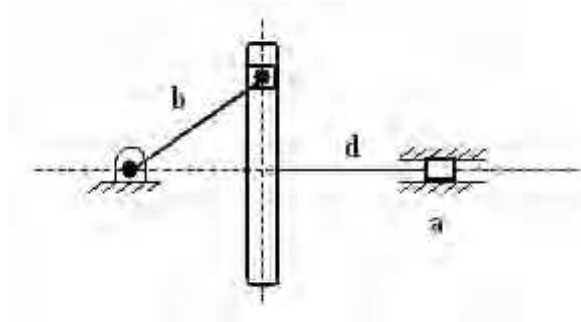


Figure 7

8. (a) State and derive the law of gearing.
- (b) Following data relate to two meshing involute gears:  
 Number of teeth on the gear wheel = 60, Pressure angle =  $20^\circ$ , Gear ratio = 1.5, Speed of the gear wheel = 100rpm, module = 8mm.  
 The addendum on each wheel is such that the path of approach and the path of recess on each side are 40% of the maximum possible length each. Determine the addendum for the pinion and the gear and the length of the arc of contact.  
 [6+9]

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1. (a) What is cam? What is displacement diagram with reference to cam?  
 (b) The following data relate to a cam profile in which the follower moves with uniform acceleration and deceleration during ascent and descent.  
 Minimum radius of cam = 25 mm, Roller diameter = 7.5 mm, Lift = 28 mm, Offset of follower axis = 12 mm towards right, Angle of ascent =  $60^\circ$ , Angle of descent =  $90^\circ$ , Angle of dwell between ascent and descent =  $45^\circ$ , Speed of the cam = 200 rpm.  
 Draw the profile of the cam and determine the maximum velocity and the uniform acceleration of the follower during the outstroke and the return stroke.  
[4+11]
2. (a) Deduce an equation for velocity of sliding of gears.  
 (b) Two spur gears of 24 teeth and 36 teeth of 8mm module and  $20^\circ$  pressure angle are in mesh. Addendum of each gear is 8mm. The teeth are of involute form and the pinion rotates at 450rpm. Determine the velocity of sliding when the pinion is at a radius of 102mm.  
[6+9]
3. (a) What is a Kinematic pair? Explain different types of Kinematic pairs as classified by relative motion.  
 (b) The distance between the axes of two parallel shafts is 1cm. The shafts are connected by Oldham coupling. Find the maximum Kinetic energy of the intermediate piece of mass 5 kg when the shafts revolve at 300rpm.  
[9+6]
4. Figure 4 shows a mechanism in which OA = 300 mm, AB = 600 mm, AC = BD = 1.2 m. OD is horizontal for the given configuration. If OA rotates at 200 rpm in the clockwise direction find:  
 (a) the linear velocities of C and D, and  
 (b) the angular velocities of links AC and BD.  
[7+8]

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R09

Set No. 1

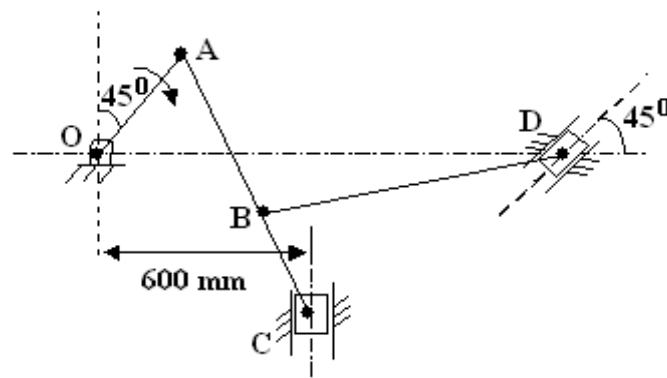


Figure 4

5. Show that for Tchebicheff's straight-line motion shown in figure 5, the point P that bisects the link BC will lie in a straight line parallel to AD. When it is directly above the midpoint of AD, if the proportions of the links are  $BC: AD: AB = 1:2:2.5$ . [15]

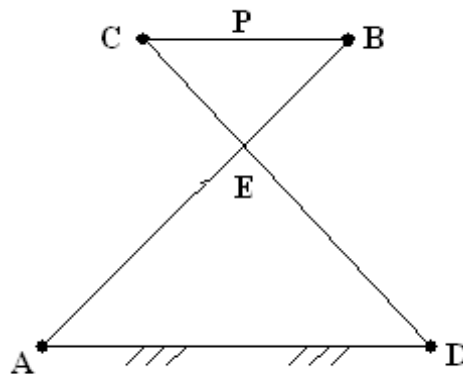


Figure 5

6. (a) Differentiate between simple and compound gear trains.  
 (b) Figure 6b shows a port indicator for a twin-screw ship. It is found that the pointer P remains stationary if the propellers run at the same speed and drive the gears C and D in the same direction through equal gears A and B. If the number of teeth on G and F are 24 and 50 respectively, find the ratio of the number of teeth on C to that on D.

What will be the speed of the pointer if B runs at 5% faster than A and if the speed of C is 100rpm? [4+11]

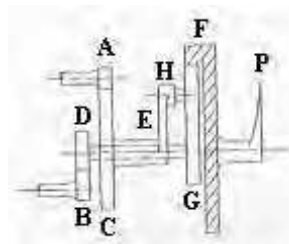


Figure 6b



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7. A countershaft acting as a driver has speed of 240rpm. It is connected to another shaft parallel to it at a centre distance of 3 meters. The desired angular speeds of the driven shaft are 80, 120, or 160rpm obtained by fixing speed cones in the two shafts, the minimum diameters of the speed cones being 25cm. Determine the remaining diameters of the speed cones for an open belt drive. [15]
8. The distance between the pivots of the front stub axles of a car is 130 cm, the length of track rod is 120 cm, the wheel track is 145 cm and the wheelbase is 280cm. What should be the length of track arm if the Ackermann steering gear is to be given a correct steering, when rounding a corner of 6-meter radius? [15]

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FIRSTRANKER

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1. (a) Explain what is meant by coriolis Acceleration?
- (b) In the mechanism shown in Figure 1 the crank OA makes 200rpm in the counter clockwise direction. Find
  - i. angular velocity of link BA and
  - ii. Velocity of the slider at B. OA=60mm, BC=300mm and OB= 220mm.

[6+9]



Figure 1

2. (a) What condition must be satisfied by the steering gear of a car in order that the wheels may have a pure rolling motion when rounding a curve? Deduce the relationship between the inclinations of the front stub axles to the rear axle, the distance between the pivot centers for the front axles and the wheelbase of the car.
  - (b) What is a Hooke's joint? Show that for a Hooke's joint  $\tan \theta = \cos \alpha \tan \phi$ , where  $\theta$  and  $\phi$  are the angles turned by the driving and driven shafts at any instant and  $\alpha$  is the angle of inclination of driven shaft with driving shaft.
- [6+9]
3. (a) Differentiate between
    - i. Element and kinematic Link
    - ii. Mechanism and machine
    - iii. Closed pair and unclosed pair
    - iv. Lower pair and Higher pair.
  - (b) In a Whitworth quick return motion mechanism, the length of the driving link is 75 mm while the distance between the fixed centers is 50 mm. Find the ratio of the time of cutting stroke to that of return stroke.
- [7+8]
4. (a) Explain how can involute profile of gear teeth be formed.

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(b) A pair of  $20^\circ$  pressure angle gears in mesh have the following data:

Speed of pinion = 400rpm

Number of teeth on pinion = 24

Number of teeth on gear = 28

Determine the addendum of the gears if the path of approach and recess is half the maximum value. Determine also the arc of contact and the maximum velocity of sliding between the mating surfaces. [6+9]

5. An epicyclic gear train, as shown in figure 5, is composed of a fixed annular wheel A having 150 teeth. The wheel A is meshing with wheel B which drives wheel D through an idler wheel C, D being concentric with A. The wheels B and C are carried on an arm which revolves clockwise at 100rpm about the axis of A and D. If the wheels B and D have 25 teeth and 40 teeth respectively, find the number of teeth on C and the speed and sense of rotation of C. [15]

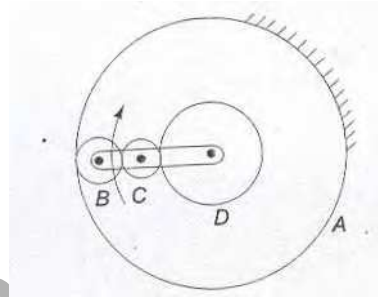


Figure 5

6. A tangent cam with a base circle diameter of 50mm operates a roller follower 20mm in diameter. The line of stroke of the roller follower passes through the axis of the cam. The angle between the tangential faces of the cam is  $60^\circ$ , speed of the cam shaft 200 rpm and the lift of the follower 15mm. Calculate,

(a) The main dimensions of the cam.

(b) The acceleration of the follower at

i. The beginning of lift.

ii. Where the roller just touches the nose. i.e. the apex of the circular nose. [15]

7. In the figure 7 shown OA and AC are the crank and connecting rod respectively. B is a point lying on the extension of AC. Find the length of the crank in order that the point B traverses approximately along a straight line when the connecting rod rotates from angle  $\theta_1$  to angle  $\theta_2$ . [15]

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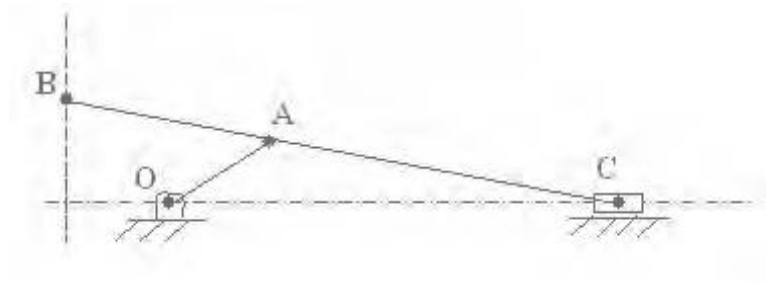


Figure 7

8. (a) Derive an expression for velocity ratio of belt drive
- (b) Design a set of stepped pulleys to drive a machine from countershaft that runs at 220 rpm. The distance between centres of the two sets of pulleys is 2m the diameter of the smallest step on the countershaft is 160mm. The machine is to run at 80, 100 and 130rpm and should be able to rotate in either direction.

[15]

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