

III B.Tech. I Semester Regular Examinations, November -2006
KINEMATICS OF MACHINERY
(Automobile Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
 All Questions carry equal marks

- Differentiate between Mechanism & machine with relevant examples.
 - A double slider mechanism is used to draw an ellipse with major axis 20cms, minor axis 15cms. Set out the mechanism and draw the locus of the points tracing the required ellipse. [6+10]
- Explain about back - lash & interference and how can these be avoided?
 - The module pitch of a rack is 12.5mm and addendum is equal to module. Determine the smallest pinion that will mesh with a rack without interference when the pressure angle is $14\frac{1}{2}^\circ$ & 20° . [6+10]
- Fig.1 shows a compound epi-cyclic train. The number of teeth are shown in the figure 1. The arm is given an input velocity of 40rpm in counter - clockwise direction and the gear A is driven clockwise 80rpm. Determine the speed of ring gear 'D' and the fundamental basic gear train ratio.

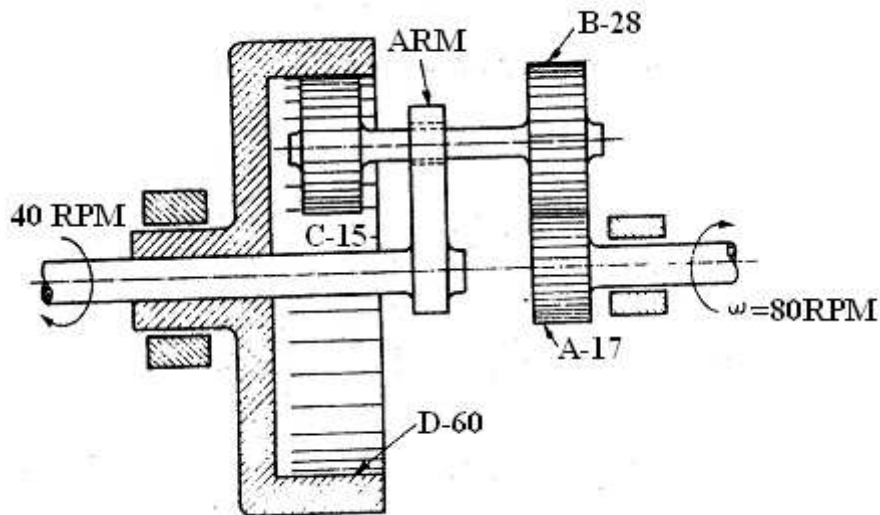


Figure 1:

- A rope drive transmits 125kW at 225rpm. by ropes 2.5cm in dia, and mass of 0.6kg per metre run. The max rope tension is 1360N and it is designed for maximum power conditions. The angle of contact is 165° and the coefficient of friction is 0.3. The groove angle is 45 degrees. Determine the diameter of pulley and the number of ropes. [8+8]

5. A cam of base circle 50mm is to operate a roller follower of 20mm. dia. The follower is to have SHM. The speed of the cam is 360rpm. Draw the cam profile for the lift of 40mm. Angle of ascent= 60° , angle of dwell= 40° and angle of descent = 90° followed by dwell again. Also calculate the max. Velocity & Acceleration during ascent. [8+4+4]
6. (a) Sketch and explain working of Scott Russel straight line mechanism and give exact mathematical analysis involved.
(b) What is the condition for correct steering? Sketch and show one type of steering gear and discuss its relative advantages. [8+8]
7. The angle between two horizontal shafts to be connected by Hooke's Joint is 150° . The speed of driving shaft is 150rpm. The driven shaft carries a fly wheel of mass 15kg and having a radius of gyration of 10mm. If the forked end of the driving shaft rotates 30° from the horizontal plane, find the torque required to drive the shaft to overcome the inertia of fly wheel. [16]
8. For the mechanism shown in fig.2 the length of the various links are OE=15cms, AB=40cms, BC=60cms CD=20cms. The crank OE rotates at 70rpm. For the configuration shown in the figure 2 determine,
 - (a) Velocity of the block in the slot of lever AB.
 - (b) Linear acceleration of point B.
 - (c) Linear acceleration of point C.
 - (d) Coriolis component acceleration of E with respect to F. [4+4+4+4]

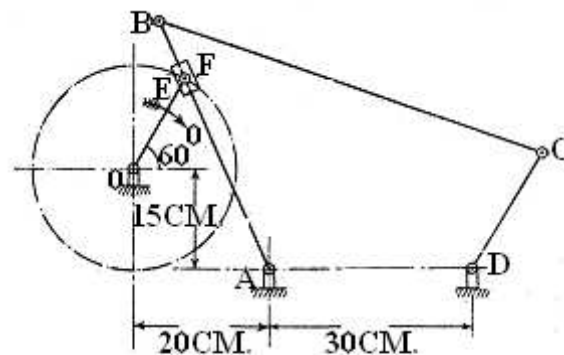


Figure 2:

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1. (a) Explain giving examples about Kinematic link, Kinematic chain, Kinematic pair & Mechanism.
 (b) The distance between the axes of the parallel shafts connected by Oldham's coupling is 20mm. The speed of rotation of the shafts is 300 rpm. Determine the maximum velocity of the sliding of each tongue in its slot. [6+10]
2. (a) Prove that the velocity of sliding is proportional to the distance of the point of contact from the pitch point
 (b) A pair of gears have 16 & 22 teeth, module pitch 12.5mm, addendum 12.5mm, dedendum 14.25mm and pressure angle is 20° . The pinion drives in counter-clockwise direction. Determine
 - i. pitch circle radii
 - ii. the base circle radii
 - iii. circular pitch & base pitch
 - iv. the length of path of contact.
3. Figure 3 shows a compound epi-cyclic train employed to run a winch drum. Input shaft keyed to Gear 1 is driven at 40rpm clockwise and gear 'D' is fixed (grounded). Number of teeth on each gear wheel is given in figure. Determine the speed and direction of the drum.

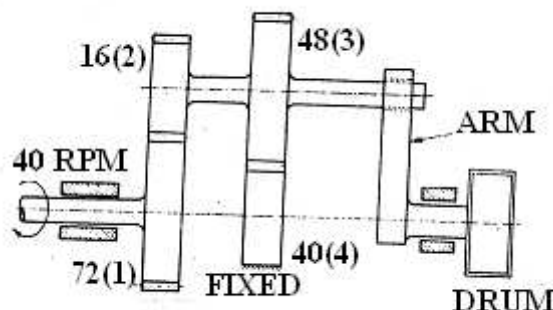


Figure 3:

4. (a) Explain the terms 'slip' and creep as referred to belt drive. On what factors does it depend.

- (b) A shaft running at 90rpm is to drive another shaft at 250rpm. and transmits 12KW. The belt is 12cms wide & 6mm. thick and coefficient of friction between belt and pulley is 0.3. The distance between the shafts is 3m. and the smaller pulley is 60cm. diameter. Calculate the stress in the belt assuming the open belt drive.
5. A cam with a minimum radius of 25mm, rotating clockwise at a uniform speed is to be designed for a roller follower at the end of valve rod. The valve rod is raised through 50mm during 120° rotation. angle of dwell is 30° . The valve is lowered through next 60° . The valve is closed during the rest of revolution 150° . The diameter of roller is 20mm and the dia of cam shaft is 25mm. Draw the profile of the cam when the line of the stroke is offset 15mm from the axis of the cam shaft. The displacement is occurred by SHM. Determine the maximum acceleration of the valve rod when the cam shaft rotates at 100rpm.
6. (a) Sketch a pantograph and explain its working and show that it can be used to reproduce to an enlarged scale a given figure.
(b) Prove that the for fluctuations of velocity ratio varies as the square of shaft angle in the Hooke's Joint.
7. (a) Sketch & explain the working of Hart mechanism to obtain the straight line motion.
(b) Two shafts are connected by a Hooke's Joint. The driving shaft rotates at a uniform speed of 1200rpm. The angle between the shafts is 15° . Calculate the maximum & minimum speeds of driven shaft, when the acceleration of the driven shaft is maximum.
8. In the mechanism shown in figure 4, the slider moves uniformly vertically downwards at 5m/sec. The various dimensions of the link are AB=15cms, AC=10cms, CD=20cms, Determine,
(a) Linear velocity of slider links 4&6
(b) Angular velocity of link 5
(c) Linear acceleration of slider6. [4+4+4+4]

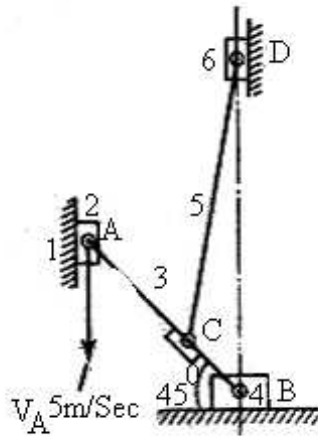


Figure 4:

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1. (a) Differentiate between lower kinematic pair and higher kinematic pair giving examples.
(b) In a crank and slotted lever quick return mechanism, the distance between the fixed centers is 150mm. and driven crank is 75mm. long. Determine the ratio of the time taken on the cutting and return stroke. [6+10]
2. (a) Derive an expression for minimum number of teeth in involute rack and pinion arrangement. How are these related to pressure angle.
(b) Two gears of module pitch 4.25mm have 24 and 33 respectively. Each wheel has a standard addendum of 1 module. Determine the length of the arc of contact and maximum velocity of the sliding between the mating teeth, if the smaller wheel runs at 150r.p.m. The pressure angle is 20° . [6+10]
3. In an epi-cyclic gear shown in figure 5, the wheel 'C' is keyed to the shaft B and the wheel E is keyed to the shaft A. C and E rotate together on a pin fixed to the arm G. C has 35 teeth. D has 65 teeth. E has 32 teeth and F has 68teeth. If A rotates at 60rpm and B rotates at 28rpm in the opposite direction to A find the speed and direction of arm G. [16]
4. (a) Derive an equation to find the length of the belt of cross-belt drive.
(b) A shaft running at 160 r.p.m is to drive another shaft at 250 r.p.m and transmit 21 KW. The belt is 12cm. wide and 4mm. thick. The coefficient of friction between the belt and pulley is 0.3. The distance between the shafts is 3meters. The smaller pulley is 60cms. diameter. Determine the stress in the belt assuming it to be open belt drive. [6+10]
5. Draw the cam profile for the data given below.
Base circle of cam = 50mm. Lift = 40mm,
Angle of ascent= 60° , Angle of dwell= 40°
Angle of descent = 90° , Speed = 300rpm
Motion of follower = SHM,
Type of follower = knife edge.
Also find the velocity and acceleration during ascent. [8+4+4]
6. (a) Sketch & explain peaucellier straight line mechanism and give exact mathematical analysis involved.
(b) State precisely what an automobile steering mechanism is expected to do? [8+8]

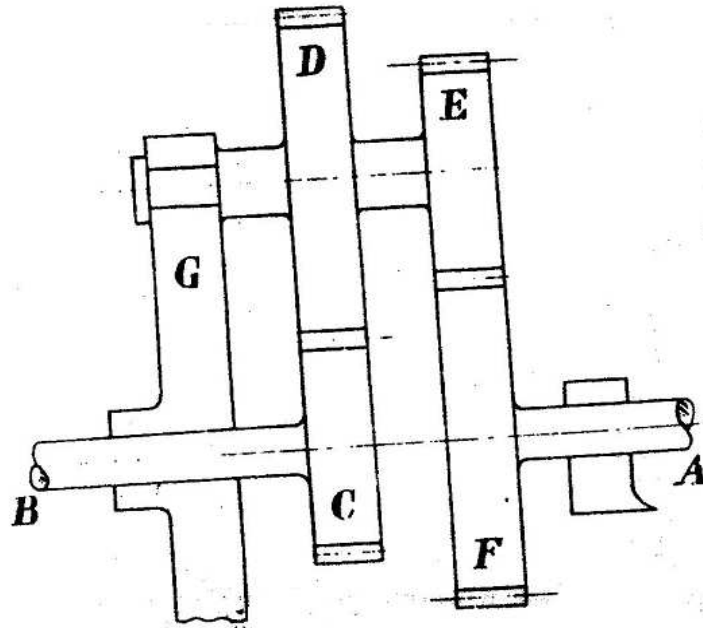


Figure 5:

7. The driving shaft of a Hooke's Joint runs at a speed of 300rpm. the angle between the shaft is 20° . The driven shaft with attached masses has a mass of 60kg at a radius of gyration of 200mm. If a steady torque of 500 N.m resists the rotation of driven shaft, find the torque required at the driving shaft when angle turned through by the driving shaft is 45° . [16]
8. The mechanism of a vertical slotting machine is shown in figure6. The crank AP rotates at 60 r.p.m and the block 'O' slides along the link OR giving non-uniform motion about O. The slider 'D' is connected to OR at B by link BD and moves vertically in guides. Determine
 - (a) Linear acceration of slider D
 - (b) Angular accleleration of link BD.
 - (c) Sliding acceleration of P with respect to Q. [5+5+6]

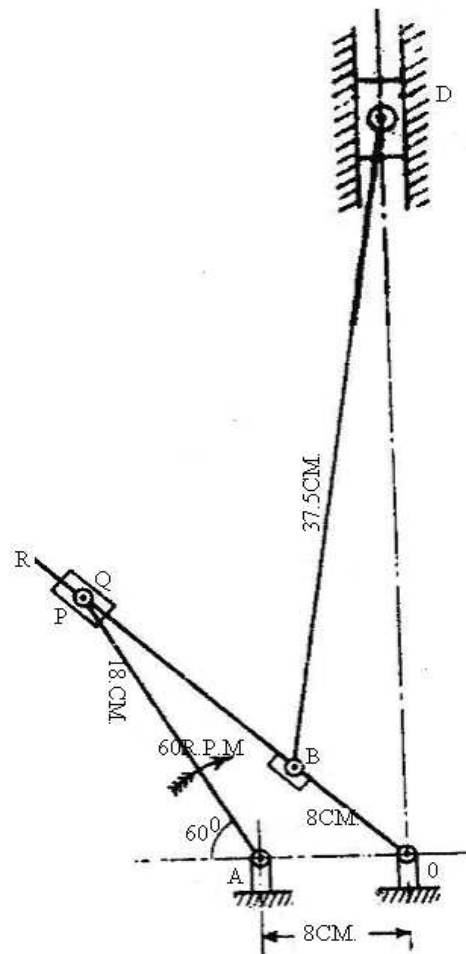


Figure 6:

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1. (a) Explain with sketches the inversions of slider crank chain.
(b) Explain Grubler's criterion for determining degree of freedom for mechanisms. Using Grubler's, criterion for plane mechanisms prove that the minimum number of binary links in a constrained mechanism with simple hinges is four. [6+10]
2. (a) Explain about circular pitch, diametral pitch & module.
(b) A gear wheel with 40 involute teeth drives another with 20 teeth. The teeth are as long as possible and pressure angle is 16° . Determine the greatest sliding velocity between pair of teeth when the linear velocity of the pitch lines is 3m/sec. [4+12]
3. An epi-cyclic gear in figure 7 consists of two sun wheels S_1 & S_2 with 24 & 26 teeth respectively engaged with a compound planet wheel with 26 & 29 teeth. S_1 is keyed to the driving shaft which is co-axial with the driven shaft. Find the velocity ratio of the gear. If 7.5KW power is transmitted at the input speed of 1000r.p.m, what torque is required to hold S_1 & S_2 ? [16]

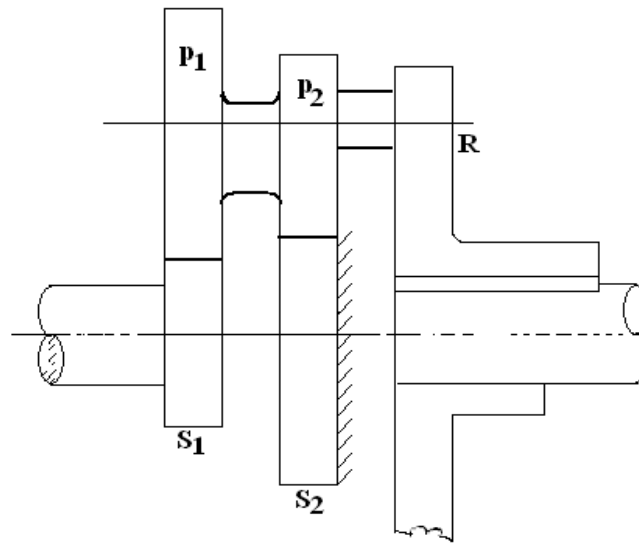


Figure 7:

4. (a) Derive an equation to find the length of open - belt drive.
 (b) 120kW power is transmitted by a rope drive through a 150cm dia. 45 degrees grooved pulley running at 200 r.p.m. Angle of overlap is 160° and coefficient of friction between the pulley and the rope is 0.3. Mass of the rope is 0.8 Kg/m and it can withstand a tension of 800N. Considering centrifugal tension, determine
 - i. number of ropes required
 - ii. the tension in the rope before starting.
5. A cam is to be designed for a knife edge follower with the following data:
 cam lift = 40mm during 90° of cam rotation with SHM. Dwell of the next 30° ,
 Angle of descent = 60° ,
 Dwell during the remaining period. Draw the cam profile when the line of stroke of the follower passes through the axis of cam. The radius of the base circle of the cam is 40mm. Determine the maximum velocity and acceleration of the follower during the ascent when the speed of cam?
6. (a) Sketch & explain Watt mechanism and give the mathematic analysis involved in it.
 (b) The distance between the pivots of the front stub axles of a car is 1.35m. The length of track rod is 1.25m. the wheel track is 1.5m. and the wheel base is 2.8m. What should be the length of the arm, if the gear is to be given a correct steering, when rounding a corner of radius 5m
7. A Hooke's Joint is to connect two shafts whose axes intersect at 150° . The driving shaft rotates uniformly at 150r.p.m. The driven shaft operates against a steady torque of 150N-m and carries a fly wheel whose mass is 45Kg and radius of gyration 15cm. What is the maximum value of the torque which must be exerted by the driving shaft.

8. Arrangement of a slider crank mechanism is shown in figure 8. For angular velocity of 300rpm, the link O_2Q in counter clockwise direction, determine the angular velocity of link 4. Velocity & acceleration of point P. The main dimensions of the linkages are $O_2Q=6\text{cms}$, $O_4P=30\text{cm}$.

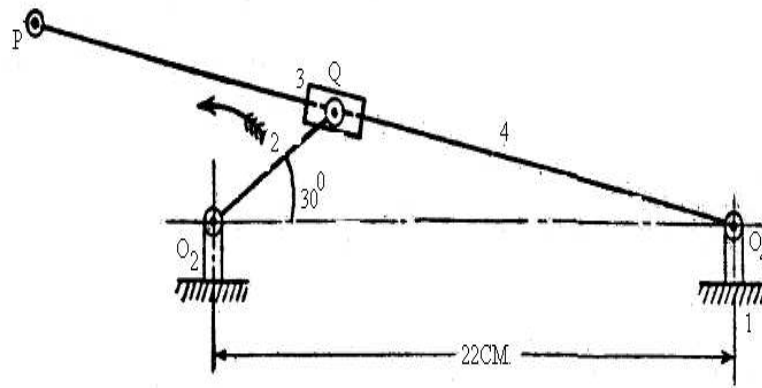


Figure 8:
