Code No: RT22031 **R13** SET - 1

II B. Tech II Semester Regular Examinations, May/June - 2015
KINEMATICS OF MACHINERY
(Com. to ME, AME, MM)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**

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PART-A

1. a) Define the term degrees of freedom of a mechanism.
b) What are the disadvantages of a Davis steering gear mechanism?
c) How do you determine the direction of coriolis component of acceleration?
d) What are the different types of cams?
e) Explain the phenomenon of interference.
f) Differentiate between a belt drive and a chain drive.
h) What is a differential gear? Where is it used? (2M+2M+3M+2M+4M+3M+3M+3M)

PART-B

2. a) Distinguish among complete, incomplete and successful constraint relative motion between two elements or links.
b) The length of the fixed link of a crank and slotted lever mechanism is 275 mm and that of the crank 110 mm. Determine, (i) the inclination of the slotted lever with the vertical in the extreme position. (ii) the ratio of the time of cutting stroke to the time of return stroke and (iii) the length of the stroke, if the length of the slotted lever is 495 mm and the line of stroke passes through the extreme positions of the free end of the lever.
(6M+10M)

3. a) Prove that the peaucellier mechanism generates a straight-line motion.
b) The track arm of a Davis steering gear is at a distance of 185 mm from the front main axle whereas the difference between their lengths is 90 mm. If the distance between steering pivots of the main axle is 1.2 m, determine the length of the chassis between the front and the rear wheels. Also find the inclination of the track arms to the longitudinal axis of the vehicle. (11M+5M)
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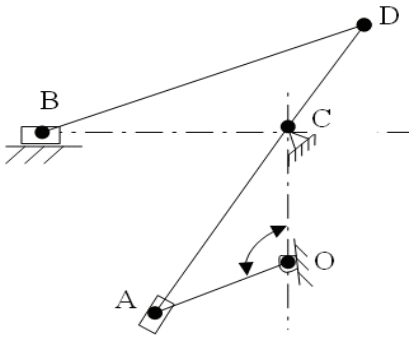
4. A shaper mechanism is shown in figure. The crank OA rotates at uniform speed of 20 rpm clockwise. The guide block A slides along the slotted lever AD that has its fulcrum at 'C'. The connecting rod BD connects the tool head B to AD. The tool head is constrained to move along BC perpendicular to OC. Find the velocity and acceleration of 'B'. OA= 200 mm; OC=400 mm; CD=200 mm; BD=500mm and angle AOC= 120^o. (16M)



5. A tangent cam with a base circle radius of 25 mm operates a roller follower whose radius is 10 mm. The line of stroke of the follower passes through the axis of the cam. The angle between the tangential faces of the cam is 60^0, speed of the cam is 200 r.p.m and the lift of the follower is 15 mm. Calculate the principal dimensions of the cam. Also, determine the accelerations of the follower at the beginning of the lift and at the apex of the circular nose. (16M)

6. a) Two spur gears each have 30 teeth of involute shape. The circular pitch is 25 mm and the pressure angle is 20^0. If the arc of contact is equal to twice the circular pitch, determine the required addendum for the teeth.
   b) Derive the expressions for the minimum number of teeth to avoid interference on pinion and gear wheels on involute teeth. (8M+8M)

7. a) A V-belt having a lap angle of 180^0 has a cross-sectional area of 3 cm^2 and runs in a groove of included angle of 45^0. The density of the belt is 0.015 N/cm^3, the maximum stress allowed is 400 N/cm^2 and coefficient of friction is 0.2. Determine the maximum power that can be transmitted if, the mean diameter of the wheel is 300 mm and runs at 900 r.p.m.
   b) Give the motion analysis for a differential of an automobile using tabular method (6M+10M)

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PART-A

1. a) Name any three lower pairs and indicate their number of degrees of freedom.
   b) Draw the polar velocity diagram for Hooke's joint.
   c) Define the terms centroid and axode.
   d) Define the following terms for a cam mechanism: pressure angle, base circle, angle of ascent and offset.
   e) State the law of gearing.
   f) Name the materials used for the manufacture of belts, ropes and chains.
   g) Differentiate between a compound and epicyclic gear train.
   h) What is the effect of a centrifugal tension in a belt drive?

(3M+3M+2M+4M+3M+3M+2M+2M)

PART-B

2. Describe the following mechanisms with neat sketches and state on which kinematic chain each one is based: (i) oscillating cylinder engine (ii) crank and slotted lever quick return mehanism (iii) elliptical trammel (iv) Rotary engine (16M)

3. a) Show that the pantograph can produce paths exactly similar to the ones traced out by a point on a link on an enlarged or a reduced scale.
   b) Two shafts are connected by a Hooke's joint. The driving shaft revolves uniformly at 500rpm. If the total permissible variation in speed of a driven shaft is not to exceed = 6% of the mean speed, find the greatest permissible angle between the centerlines of the shafts. Also determine the maximum and minimum speeds of the driven shaft. (10M+6M)

4. In a Whitworth Quick return motion, a crank AB rotates about a fixed center A. The end B operates a slider reciprocating in a slotted link, rotating about a fixed center D, 40mm vertically above A. The crank AB which is 90mm long rotates in a clockwise direction at a speed of 150rpm. Find the angular acceleration of the slotted link for the configuration in which AB has turned an angle of 45^{o} past its lowest position. (16M)
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5. For a symmetrical tangent cam operating a roller follower, the least radius of the cam is 30 mm and roller radius is 17.5 mm. The angle of ascent is 75 degrees and the total lift is 17.5 mm. The speed of the camshaft is 500 r.p.m. Calculate the principal dimensions of the cam. Also, determine the accelerations of the follower at the beginning of the lift and at where the straigtht flank merges into circular nose. (16M)

6. a) Derive an expression for velocity of sliding between a pair of teeth in mesh.
   b) Two gears with 42 and 19 teeth are cut with involute teeth of pressure angle 20^0 and diametral pitch 5. The addendum of each is 5 mm. Find (i) the length of arc of contact (ii) the number of pair of teeth in contact. (8M+8M)

7. a) Derive the condition for maximum power transmission in a belt drive in terms of centrifugal tension.
   b) A rotating arm **A** carries two wheels **B** and **C** which are in gear. The speed of rotation of the arm is 100 r.p.m. The wheel **B** has 60 teeth and the axis of rotation same as the arm. An internal gear **D** having 120 teeth meshes with gear **C** and is mounted on the axis of rotation of the arm. Determine the speed and direction of rotation of **D** when **B** is fixed. (6M+10M)

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2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**

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PART-A

1. a) Give the Kutzbach criterion for planar mechanisms.
b) What are the applications of a pantograph?
c) State the Kenneddy's three centers in line theorem of instantaneous centers.
d) For a cam mechanism, indicate the number of kinematic pairs and their type. Also determine the number of degrees of freedom for a cam mechanism.
e) what are the advantages of a cycloidal gear profile?
f) Differentiate between a compound and simple gear train.
g) What is meant by crowning in a belt drive? (3M+3M+3M+4M+3M+3M+3M)

PART-B

2. Describe the following mechanisms with neat sketches and state on which kinematic chain each one is based: (i) Beam engine (ii) Whitworth quick return mehanism
(iii) Scoth yoke mechanism (iv) oldham coupling (16M)

3. a) Sketch and Describe the Scott-Russel and Robert’s straight-line motion mechanisms.
b) For an Ackermann steering gear, derive the expression for the angle of inclination of the track arms to longitudinal axis of the vehicle. (8M+8M)

4. a) Derive the expression to determine the magnitude of the coriolis component of acceleration
b) Explain the procedure to determine the velocity and acceleration of a four-bar mechanism by Klein’s construction. (8M+8M)

5. Derive the expressions for the displacement, velocity and acceleration of a follower when it is moving with (a) simple harmonic motion (b) uniform acceleration and deceleration. Also, draw their displacement, velocity and acceleration diagrams. (16M)

6. a) Derive an expression for the length of arc of contact for two involute gears of unequal size in terms of pressure angle, the pitch circle radii and the addendum radii.
b) A pair of 20^0 involute spur gears having a velocity ratio of 2.5 mesh externally. Pinion rotates at 200 r.p.m. Module is 5 mm and the addendum is 1.2 times module. Determine the minimum number of teeth on each wheel to avoid interference. (8M+8M)

7. a) Carry out the motion analysis for a sun and planet gear when the sun wheel is fixed using tabular method.
b) A flat belt transmits 15 kW power from a pulley of 80 cm diameter which runs at 300 r.p.m. The angle of embrace of belt and pulley is 150 degrees and coefficient of friction between belt and pulley is 0.25. The thickness of the belt is 8 mm and has a density of 1 g/cm^3. Determine the minimum width of the belt for a maximum stress of 180 N/cm^2. (6M+10M)

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Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**

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PART-A

1. a) Derive the relation between the number of links and joints for a planar mechanism with total number of degrees equal to one.
   b) What is the condition for correct steering of an automobile?
   c) What are the components of acceleration of a point, relative to a fixed point on a moving?
   d) What are the types of followers?
   e) Give the applications of a cam mechanism.
   f) What are the advantages of a worm gear over that of spiral gear?
   g) What is a reverted gear train? Give applications.
   h) Explain the phenomenom of creep in a belt drive.
   (4M+3M+3M+2M+2M+3M+3M+2M)

PART-B

2. a) Describe all the inversions of double slider crank chain.
   b) Two parallel shafts, with the distance between, their axes being 15mm, are connected by an Oldham coupling. If the speed of the shafts is 300rpm, find the maximum speed of sliding of each tongue of the intermediate piece along its groove. (10M+6M)

3. a) Sketch and describe the peaucellier and Hart straight-line motion mechanisms
   b) The driving shaft of Hooke's joint runs at a uniform speed of 280 r.p.m and the angle α between the shaft axes is 20^{o}. The driven shaft with attached masses has a mass of 60 kg at a radius of gyration of 15 cm. If a steady torque of 200 N-m resists rotation of the driven shaft, find the torque required at the driving shaft, when $\theta = 45^{0}$; g=981 cm/sec^{2}. At what value of α will the total fluctuation of speed of the driven shaft be limited to 28 rpm.
   (8M+8M)
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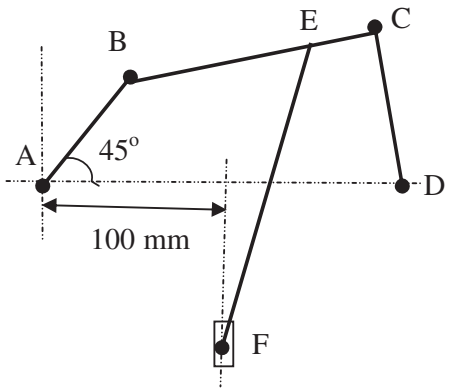
4. The link AB of the mechanism shown in the figure rotates uniformly in a clockwise direction at 200 r.p.m. If the lengths of the links are AB= 60 mm, BC= 160 mm, CD=100 mm, AD=200 mm, EF=200 mm and EC=40 mm, determine the linear velocity and acceleration of F for the position shown. Also, determine the angular velocity and angular acceleration of EF. (16M)



5. Derive expressions for displacement, velocity and accelerations for a roller follower of a circular camwhen the contact is on (a) circular flank and (b) on circular nose. (16M)

6. a) State and prove law of gearing.
   b) A pair of gears in mesh have a module of 10 mm and a pressure angle of 25^0. The number of teeth on the pinion and gear are 20 and 52 respectively. The addendum on both the gears is equal to one module. Determine the ratio of velocity of sliding to the rolling velocity at the pitch point and at the beginning and end of engagement. (8M+8M)

7. a) Derive the ratio of friction tensions in a V-belt drive.
   b) the annular wheel **A** of an epicyclic gear train having 54 teeth meshes with a planet gear **B** which gears with a sun wheel **C**. The wheels **A** and **C** are co-axial. The wheel **B** is carried on an arm **P** which rotates about the axis of the wheels **A** and **C**. If the wheel **A** makes 10 r.p.m in clockwise direction and the arm rotates at 80 r.p.m in anti clockwise direction, determine the speed of rotation of the wheel **C**. (8M+8M)