Code No: R22032 **R10** SET - 1

II B. Tech II Semester Supplementary Examinations January – 2014
KINEMATICS OF MACHINERY
(Com. to ME, AME, MM)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
Provide Figures Wherever Necessary
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1. a) Distinguish between the concept of 'motion of a point' and 'motion of a rigid body'.
   b) What do you understand by degree of freedom? Consider a plane mechanism; derive an expression for Grubler's criteria?
   c) Justify the statement 'Slider crank mechanism' is a special case of four bar chain.
   d) Define the term Inversion. What are the properties of Inversion?
   e) Explain the second inversion of slider crank chain with a neat sketch? (5×3M=15M)

2. a) For what purpose is Pantograph used? Sketch one form of Pantograph and show that it satisfies the required conditions.
   b) What is difference between the copied and generated straight line motions? Give examples for each of them? (10M+5M)

3. a) What is the importance of finding the accelerations of various points in a mechanism?
   b) Obtain an expression for radial and tangential acceleration when a link is moving in a circular path?
   c) A four bar mechanism is represented by a quadrilateral ABCD in which AD (fixed link) is 400 mm long. The crank AB 75 mm long rotates at 2 rps in cw direction and drives the CD 125 mm long by means of the connecting link BC 350 mm long. Find the angle through which CD oscillates. Also find angular acceleration BC and acceleration of the point E on BC such that EC is 90 mm. (2M+4M+9M)

4. a) What do you mean by steering gear? Get an expression for correct steering?
   b) For a Davis steering gear, compute and plot steering angles of inner and outer wheels of a car with wheel base (H) is equal to wheel tread width (T). The distance between the pivots is 0.9 T. Plot the angles of outer wheel versus inner wheel angles for a range 5^0 to 45^0. Find the radius of path of travel in terms of T when the inner wheel is at 45^0.
   c) What are the limitations of a single Hooke's Joint? How are these limitations over in a double Hooke's Joint? (5M+5M+5M)

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5. a) Draw the displacement, velocity and acceleration diagrams for a follower moving with uniform velocity. Also draw the modified displacement, velocity and acceleration diagrams. Why a modification in these diagram is are done?
   b) Derive an expression to find the velocity of the roller follower for a tangent cam when roller is in contact with nose. (8M+7M)

6. a) Prove that the change in centre distance within limits between involute gear wheels does not change the angular velocity ratio but alters the pressure angle.
   b) Two mating involutes spur gears of 20^0 pressure angle have a gear ratio of 2. The number tooth on the pinion (driver) is 20 and its speed 250 rpm. The module pitch of the teeth is 12 mm. If the addendum on each wheel is such that the path of approach and the path of recess on each side are half the maximum possible length each, find: i) the addendum for pinion and gear wheel. ii) The length of arc of contact iii) The maximum velocity of sliding during approach and recess. (5M+10M)

7. a) Derive an expression for ratio of tensions for a flat belt passing over a pulley, when it is just on the point of slipping?
   b) A belt drive consists of two V-belts in parallel, on grooved pulleys of same size. The groove angle is 30^0. The cross-sectional area of the belt is 750 mm^2 and $\mu = 0.12$. The density of the belt material is 1.20 mega-gm/m^3 and the maximum safe stress in the material is 7 MPa. Calculate the power that can be transmitted between pulleys of 300mm diameter rotating at 1500 rpm. Find the shaft speed in rpm at which the power transmitted is maximum.
   (5M+10M)

8. a) What do you mean by train value? How is it related to velocity ratio?
   b) In a reverted epicyclic train, the arm F carries two wheels A and D and a compound wheel B-C. Wheel A meshes with wheel B and the wheel D meshes with wheel C. The numbers of teeth on the A, D and C are 80, 48 and 72 respectively. Find the speed and direction of wheel D when wheel A is fixed and arm F, makes 200 rpm cw. (5M+10M)

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1. a) What are the different types of constrained motions? Explain each with an example?
   b) Explain all inversions of a double-slider crank chain with the help of sketches? (3M+12M)

2. a) What are straight line mechanisms? How are they classified?
   b) Design a pantograph to be used in an engine indicator to obtain the indicator diagram. The pencil point is located at a distance of 200 mm from the fixed point. The vertical ordinate on the diagram should be magnified by 4 times the displacement of the piston.
   c) Explain Hart-Straight Line motion mechanism with help of a neat sketch and prove that tracing point describes a straight line path? (3M+4M+8M)

3. a) What do you mean by Instantaneous Centre? Explain the properties of instantaneous centre.
   b) Crank of a slider-crank mechanism is 480 mm long and rotates at 190 rpm in ccw direction. The connecting rod is 1440 mm long. When the crank has turned through 50^0 from the IDC position, determine using instantaneous centre method, the velocity of point E located at a distance of 450 mm on the connecting rod extended. Also find point F on the connecting rod having the least absolute velocity and angular velocity of the connecting rod. (5M+10M)

4. a) Sketch and show the two main types of steering gears and discuss their relative merits and demerits.
   b) A Hooke's Joint is used to connect two shafts whose axes are out of line by 25^0. The driving shaft rotates uniformly at 150 rpm. The driven shaft has attached masses of 200 kg at radius of gyration of 150 mm. If a steady torque of 490 N-m resists rotation of the driven shaft, determine the
   i) The torque required at the driving shaft when θ is 45^0. The angle θ is measured from the position when the driven shaft fork lies in plane of the shafts. Also find
   ii) The maximum angular acceleration of the driven shaft
   iii) The minimum and maximum angular speed of driven shaft and
   iv) The values of angle between the shaft for total fluctuation angular speed of 30 rpm. (6M+9M)

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5. a) What is the difference between the cam angle and pressure angle?

   b) From the following data draw the cam profile in which the follower moves with SHM during ascent and uniformly accelerated and decelerated motion during descent. The diameter of the roller follower is 30mm and lift of the follower is 40 mm.

   i) Angle of ascent = 48^0 and angle of descent = 60^0

   ii) Angle of dwell between ascent and descent = 42^0

   iii) The least radius of the cam is 50 mm and the distance between line of action of follower and axis of cam = 20 mm

   If the cam rotates at 360 rpm ccw, find the maximum velocity and acceleration of the follower during ascent and descent. (3M+12M)

6. a) Define the terms: Helical gears, helix angle, normal pith and circular pitch.

   b) A pair of 20^0 full depth involute spur gears having 30 and 50 teeth respectively of module 4 mm arc in mesh, the smaller gear rotates at 1000 rpm. Determine i) the sliding velocities at engagement and at disengagement of a pair of teeth and ii) the contact ratio. (3M+12M)

7. a) Prove that the angle of contact is equal to (180 - 2α) for an open belt drive whereas it is (180 + 2α) for cross belt drive.

   b) An open belt connects two flat pulleys, the smaller pulley being of 400 mm in diameter. The angle of lap on the smaller pulley is 160^0 and μ between belt and pulley is 0.25. Which of the following would be more effective in increasing the power transmitted: i) Increasing the intension by 10%. ii) Increasing the μ by 10% by applying suitable dressing to the belt. (5M+10M)

8. a) Explain the working of a reverted gear train with a neat sketch? Get an expression for the speed ratio of reverted gear train.

   b) The arm of an epicyclic train rotates at 100 rpm in ccw direction. The arm carries two wheels A and B having 36 and 45 teeth respectively. The wheel A is fixed and arm rotates about the centre of wheel A. Find the speed of wheel B, if the wheel A instead of being fixed, makes 200 rpm cw? (6M+9M)

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1. a) "Kinematic link may be a machine component but machine component may not be Kinematic link." Explain the statement.
   b) What is a kinematic chain? What conditions required to be satisfied by a kinematic chain to give constrained motion?
   c) Explain the construction of Oldham's coupling and give its uses?
   d) Explain two inversions of slider crank chain giving quick return mechanisms.
   (2M+3M+4M+6M)

2. a) Explain the Tchebicheff straight line mechanism and establish the proportions of the other links considering coupler to be of unit length.
   b) The simplex engine indicator is used to obtain the indicator diagram. The pencil point is located at a distance of 120 mm from the fixed point. The indicator diagram should be magnified by 4 times the displacement of the piston. Design the pantograph to be sued in the indicator.
   c) Explain clearly the difference between the Scott-Russel mechanism and modified Scott-Russel's mechanism? (6M+5M+4M)

3. a) Describe the method of drawing the acceleration diagram for a slider-crank chain with a suitable example?
   b) What do you mean by Coriolis component of acceleration? When will it exist?
   c) Get an expression to find the magnitude of Coriolis component of acceleration and how will you find its directions. (7M+3M+5M)

4. a) Explain the working of Davis Steering gear with a neat sketch and show that it satisfies the condition for correct steering.
   b) Two shafts, whose axes are out of line by an angle α, are connected by a Hooke's Joint. The driving shaft rotates at a uniform speed of ω rad/sec. Show that the speed of the driven shaft for any given angular position θ of the driving shaft is Where θ is measured from the position in which the driving shaft fork lies in the plane of the shafts.
   c) Explain why two Hooke's Joints are used to transmit motion from the engine to the differential of an automobile. (7M+5M+3M)

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5. a) Describe the various factors which govern the choice of the cam profile?
   b) A symmetric tangent cam with a roller follower has the following Minimum radius of the cam = 40 mm; Lift = 20 mm; speed = 360 rpm; diameter of the roller = 44 mm; angle of ascent = 60^0. Calculate the acceleration of follower at the beginning of the lift. Also find its values when the roller just touches the nose and is at the apex of the circular nose. Sketch the variation of displacement, velocity and acceleration during ascent. (3M+12M)

6. a) Distinguish between the involute and cycloidal forms of teeth?
   b) Two parallel shafts are to be connected by a spur gear the shaft are 600 mm apart approximately. Speed of one shaft is 360 rpm and of the other is 120 rpm the circular pitch is 25 mm. Find: i) number of teeth on each gear
   ii) the pitch circle diameter of the gears and
   iii) exact center distance between two shafts. (3M+12M)

7. a) What do mean by initial tension in belts. Obtain an expression for maximum power transmission considering the effect of initial tension.
   b) The compressor is driven through belt from a line shaft, the pulley on the compressor being 400 mm in diameter. The angle of lap of the belt is 160^0. When the belt is moved from the loose to fast pulley, it slips for 8 seconds until the compressor attains its speed of 400 rpm. The flywheel of the compressor has a moment of inertial of 3.5 kg-m^2 and the friction requires a constant torque of 3.5 N-m. If the coefficient of friction is 0.3, find the tensions in the belt tension (both) and also the energy lost in that time due to slip. (5M+10M)

8. a) What are the functions of a differential gear in an automobile?
   b) A four speed sliding gear box of a motor car is required to give speed ratios from driving shaft driven shaft of 4:1, 2.5:1, 1.5:1 and 1:1 approximately in the first, second, third and top gears respectively. The pitch of gear in module is 3.25 mm and centre to centre distance between mating gears is 70 mm. Find suitable number of teeth on various gear, if the minimum number of teeth on pinion is 14. (3M+12M)

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SET - 4

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1. a) Explain the term kinematic with a schematic diagram. What is its role in kinematic analysis and synthesis?
   b) Explain Grashof's criterion for plane mechanism to obtain the degree of freedom?
   c) Discuss how I C Engine mechanism and steam engine mechanism are kinematically identically?
   d) Define the term Inversion. What are the properties of Inversion?
   e) Describe the elliptical trammel. How does it enable us to describe a true ellipse?
   (5×3M=15M)

2. a) Explain the Watt's straight line mechanism and show that the tracing point P on the coupler divides it in the ratio of the length of oscillating links.
   b) A torque of 100 N-m is applied to the OA at A of a Grass-Hopper mechanism as shown in figure 1. The link OA makes angle of 20^0 with the horizontal. Find the magnitude of the vertical force exerted at G to overcome the resisting torque of 100 N-m. The lengths of links are given as OA=40 mm, AC=60 mm and CB=150 mm. (6M+9M)

3. In a four bar mechanism, the dimensions of the links in mm are AB = 50, BC = 66, CD = 56 and AD = 100. At the instant when the angle DAB = 60^0, the crank AB has an angular velocity of 10.5 rad/sec in counter clockwise and retardation of 26 rad/sec^2 direction. Determine:
   i) The linear velocity & acceleration of point C.
   ii) The velocity of point E on the BC when BE = 40 mm.
   iii) Angular velocity and angular acceleration of the links BC and CD.
   iv) The velocity of an offset point F on the BC if BF = 45mm, CF = 30mm and BCF is read Clockwise.
   v) The velocity of an offset point G on the CD if CG = 24mm, DG = 44mm and DCG is Read clockwise.
   vi) The linear acceleration of the points E, F and G. (15M)

4. a) Draw a neat sketch of Ackerman steering gear and show that the condition of correct steering is satisfied for only three positions. Why Ackerman steering gear preferred over Davis steering gear?
   b) What is a Hooke's Joint? Show that for a Hooke's Joint $\tan\theta = \tan\varphi\cos\alpha$
   c) Two shafts are connected by a Hooke's Joint. The driving shaft revolves uniformly at 500 rpm. If the total permissible variation in speed of the driven shaft is not to exceed ±6% of the mean speed, find the greatest permissible angle between the centre lines of the shafts.
   (6M+5M+4M)

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5. a) What do mean by pressure angle in a cam? Discuss its importance in cam design?
   b) A cam having a lift of 10 mm operates the suction valve of a 4-stroke petrol engine. The least radius of the cam is 20 mm and nose radius is 2.5 mm. The crank angle of the engine, when suction valve open is 4^0 after TDC and it is 50^0 after BDC when the suction valve closes. The cam shaft has a speed of 1000 rpm. The cam is of circular type with circular nose and flanks. It is integral with cam shaft and operates as a flat-faced follower. Find
   i) the max. velocity of the valve; ii) the max. acceleration and retardation of the valve and iii) the min. force to be exerted by the spring to overcome inertia of the valve parts which weigh 2 N. (3M+12M)

6. a) A gear wheel with the involute form of teeth is driving a large wheel, the pressure angle being θ. For the driving wheel, the radius of the base circle is R_b, of the pitch circle R_p and of the addendum circle as R_a. Show that the arc of the recess measured along the pitch circle is: $R_p(\tan\beta - \tan\varphi)$ where $\beta = \cos^{-1}(R_b/R_a)$
   b) Two mating involutes spur gears of 20^0 pressure angle have a gear ratio of 2. The number teeth on the pinion (driver) are 20 and its speed 250 rpm. The module pitch of the teeth is 12 mm. If the addendum on each wheel is such that the path of approach and the path of recess on each side are half the maximum possible length each, find: i) the addendum for pinion and gear wheel. ii) The length of arc of contact iii) The maximum velocity of sliding during approach and recess. (5M+10M)

7. a) Derive an expression for the optimum speed of the flat belt for the transmission of maximum power considering the effect of centrifugal tension.
   b) Power is transmitted using a V-belt drive. The included angle of V-groove is 30^0. The belt is 20 mm deep and maximum width is 20 mm. If the mass of the belt is 3.5 gm/cm length and maximum allowable stress is 140 N/cm^2, determine the maximum power transmitted when angle of lap is 140^0 and μ is 0.15. (7M+8M)

8. a) Show that if the planet wheels are at equal; angular intervals it is a condition for assembly that the sum of the number of teeth in the sun wheel and the annulus must be divisible by three.
   b) An epicyclic gear train has a fixed annular wheel C concentric with sun wheel A. A planet wheel B gears with A and C and can rotate freely on a pin carried by an arm D which rotates about an axis co-axial with that of A and C. If T_1 and T_2 are the numbers of teeth on A and C respectively, show that the ratio of the speeds of D to A is $T_1/(T_1+T_2)$. If the least number of teeth on any wheel is 18 and $T_1+T_2 = 120$. Find the greatest and least speed of D when wheel A rotates at 500 rpm. (5M+10M)

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