Code: 9A14402

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B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

THEORY OF MACHINES
(Mechatronics)

Time: 3 hours Max Marks: 70

Answer any FIVE questions
All questions carry equal marks
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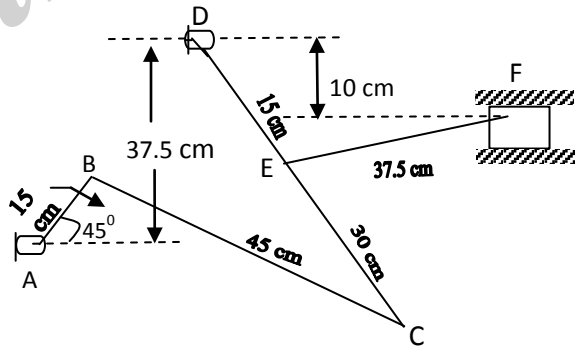
1 (a) What do you mean by successfully constrained motion? Explain with the help of an example.
(b) In a quick return motion mechanism of crank and slotted level type, the ratio of maximum velocities is 2.5 and the crank rotates at 100 r.p.m.. If the length of stroke is 30 cm, find
(i) The length of the slotted lever, (ii) The ratio of times of cutting and return strokes,
(iii) The maximum cutting velocity per second.

2 (a) Name the different mechanisms which give the approximate straight line motion.
(b) Describe Hart's mechanism with a neat sketch and prove that the tracing point describes a straight line path.

3 In the mechanism shown in figure. The crank AB rotates about A at uniform speed of 120 r.p.m in the clockwise direction. The lever DC oscillates about the fixed points D, which is connected to AB by the coupler BC. The block F moves in the horizontal guides. Being driven by the link EF. Determine:
(i) Velocity of the block F; (ii) Angular velocity of lever DC:
(iii) Rubbing velocity at the pin C which is 5 cm in diameter. The lengths of various links are;
AB = DE 15 cm; BC = CD = 45 cm and EF = 37.5 cm.



4 (a) A Hooke's joint connects a shaft running at a uniform speed of 1000 r.p.m. to a second shaft. The angle between their axes being 15 degrees. Find the velocity and acceleration of the driven shaft at an instant when the fork of the driving shaft has turned through an angle of 10^0 from plane containing the shaft axes.
(b) What do you mean by 'steering gear' Derive an expression for the fundamental equation of correct gearing?

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5 (a) What are the different types of followers? Classify them according to the motion of follower, location of axis of the follower and according to the shape of that part which is in contact with the cam.

(b) A cam rotates at a uniform speed of 360 r.pm. And given an oscillating follower, 6.5 cm long, angular displacement of 30^0 in each stroke. The follower is fitted with a roller 3 cm diameter which makes contact with the cam. The outward and return displacement each takes place with equal period of uniform acceleration and retardation, while the cam turns through 60^0 and there is a period of dwell in the outward position when the cam turns through 90^0. If the axis of the fulcrum is 8.8 cm from the axis of the cam, and the least distance of the roller axis from the cam axis is 5 cm, draw the outline of the cam. Also determine maximum angular velocity and acceleration of the follower.

6 (a) What do you mean by pitch point; circular pitch; module, addendum and dedendum of a gear?

(b) Two mating involute spur gears with module pitch of 8 mm have 23 and 57 teeth of 20^0 pressure angle. The addenda on pinion and gear wheel are equal to one module. Find:
(i) Number of pairs of teeth in contact, (ii) Angle turned through by pinion and gear wheels, and (iii) Ratio of sliding velocity to rolling velocity at the beginning of the contact, at the pitch point and at the end of contact.

7 (a) What do you mean by gear train? Mention the different types of the gear train.

(b) In an epicyclic train an annular wheel A having 54 teeth meshes with a plant wheel B which gears with a sun wheel C, the wheels A and C being co-axial. The wheel B is carried on a pin fixed on one end of arm P which rotates about the axis of the wheels A and C. If the wheel A makes 20 r.p.m. in a clockwise sense and the arm P rotates at 100 r.p.m. in the anticlockwise direction and the wheel C has 24 teeth, determiner r.p.m and sense of rotation of the wheel c.

8 A proell governor has equal arms of length 300 mm. The upper and lower ends of the arms are pivoted on the axis of the governor. The extension arms of the lower links are each 80 mm long and parallel to the axis when the radii of rotation of the balls are 150 mm and 200 mm. The mass of each ball is 10 kg and the mass of the central load is 100 kg. Determine the range of speed of the governor.

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(Mechatronics)

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1 (a) Explain the classification of the kinematic pairs with the help of examples.
(b) Explain the inversion of single slider crank mechanism which is used in whitworth quick return motion mechanism.

2 (a) Sketch and describe the Peaucellier straight line mechanism indicating clearly the conditions under which the point P on the corners of the rhombus of the mechanism generates a straight line.
(b) Prove geometrically that the above mechanism is capable of production straight line.

3 (a) Write the relation between the number of instantaneous centres and the number of links in a mechanism and discuss the three types of instantaneous centres for a mechanism.
(b) The crank and connecting rod of a horizontal steam engine are 0.5 m and 2 m long respectively. The crank makes 180 r.p.m in the clockwise direction. When is has turned 45 from the inner dead centre position, determine:
(i) Velocity of piston,
(ii) Angular velocity of connecting rod.
(iii) Velocity of points E on connecting rod 1.5 m from the gudgeon pin,
(iv) Velocity of rubbing at the pins of the cranks shaft, crank and cross-head when the diameters of their pins are 5 cm, 3 cm, and 6 cm respectively.
(v) Position and linear velocity of any point G on the connecting rod which has the least velocity relative to crank-shaft.

4 (a) In a Davis steering gear, the distance between the pivots of the front axle is 1.2 meters and the wheel base is 2.7 meters. Find the inclination of the track arm to the longitudinal axis of the car, when it is moving along a straight path.
(b) Two shafts are connected by a Hooke's joint. The driving shaft revolves uniformly at 500 r.p.m. If the total permissible variation in speed of the driven shaft is not to exceed $\pm$ 6% of the mean speed, find the greatest permissible angle between the centre lines of the shafts. Calculate also the maximum and minimum speeds of the driven shaft.

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5 A flat ended valve tappet is operated by a symmetrical cam with circular arcs for flank and nose profiles. The total angle of action is 150^0, base circle diameter 125 mm and the lift 25 mm. During the lift, the period of acceleration is half that of the retardation. Speed of cam shaft is 1250 r.p.m. The straight line path of the tappet passes through the cam axis. Find
(i) Radii of the nose and flank, and
(ii) Maximum acceleration and retardation during the lift.

6 (a) Find an expression for the length of the path of contact between two mating spur gears.
(b) What do you mean by 'interference' between two mating gears? Explain.

7 (a) What are the advantages of epicyclic gearing?
(b) An internal wheel B has 80 teeth and is keyed to a shaft F. A fixed internal wheel C with 82 teeth is concentric with B.A compound wheel DE gears with two internal wheels, D having 28 teeth and gears with C, while E gears with B. The compound wheel revolves freely on a pin which projects from a disc keyed to a shaft A, co-axial with F. If all the wheels have the same pitch and the shaft A makes 800 r.p.m., what is the speed of F?

8 (a) How does a porter governor differ from that of a Watt governor?
(b) In a governor of the Hartnell type, the mass of each ball is 1.5 kg and the length of the vertical and horizontal arms of the bell crank lever are 100 mm and 50 mm respectively. The fulcrum of the bell crank lever is at a distance of 90 mm from the axis of rotation. The maximum and minimum radii of rotation of balls are 120 mm and 80 mm and the corresponding equilibrium speeds are 325 and 300 rpm. Find the stiffness of the spring and the equilibrium speed when the radius of rotation is 100 mm.

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1 (a) Sketch and explain any two inversions of a double slider crank chain.
(b) In a crank and slotted lever quick return motion mechanism, the distance between the fixed centre's 0 and C is 200 mm. The driving crank CP is 75 mm long. The pin Q on the slotted lever, 360 mm from the fulcrum O, is connected by a link QR 100 mm long, to a pin R on the ram. The line of stroke of R is perpendicular to OC and intersects OC produced at a point 150 mm from C. Determine the ratio of times taken on the cutting and return strokes.

2 (a) Name the different mechanisms which are used for approximate straight line motion.
(b) Describe the Watt's parallel mechanism for straight line motion and derive the condition under which the straight line is traced.

3 (a) State and prove the 'Aronhold Kennedy's theorem' of three instantaneous centres.
(b) A four bar kinematic chain is represented by a quadrilateral ABCD in which AD is fixed and is 400 mm long. The crank AB 75 mm long rotates in a clockwise direction at 120 r.p.m, and drives the link CD 125 mm long by means of the connecting link BC 350 mm long. Determine the angle through which CD oscillates and find the angular velocities of the links BC and CD in one of the positions when BC is perpendicular to AB.

4 The driving shaft of a Hooke's joint runs at a uniform speed of 240 r.p.m. and the angle α between the shafts is 20^0. The driven shaft with attached masses has a mass of 55 kg at a radius of gyration of 150 mm:
(a) If a steady torque of 200 N-m resists rotation of the driven shaft. Find the torque required at the driving shaft when $\theta = 45^0$.
(b) At what value of 'α' will the total fluctuation of the driven shaft be limited to 24 r.p.m.

5 Differentiate between:
(a) Pitch point and trace point and
(b) Period of ascent and period of decent.
(c) Draw the profile of a cam which raises a value with S.H.M. through 3.cm in 1/3 of revolution, keep it fully raised through 1/12 revolution and it is closed in next 1/3 revolution with S.H.M. the value remains closed during the rest of the revolution. The diameter of the roller is 1 cm and minimum radius of the cam is to 2 cm. The axis of the value rod is offset by 1.0 cm from the axis of cam shaft.

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6 (a) Define and explain the terms: path of approach, path of recess and path of contact between two mating gears.

(b) The number of teeth on each of two equal spur gears in mesh is 30. The teeth have 20^0 in volute profile and the module is 8 mm. If arc of contact is 1.3125 times the circular pitch, find the addendum.

7 An arm A carries 4 gear wheels B, C, D and E. Gear wheel B meshes with gear wheel C and gear wheel D meshes with gear wheel E. Gear wheels C and D form a compound gear. The number of teeth on gear wheel B = 20, that on gear wheel C = 15, that of gear wheel D = 35 and gear wheel E has 20 teeth. If the speed of arm is 100 r.p.m. clockwise and gear wheel E is fixed, calculate the speed of gear wheel B. Draw the sketch of the gear train.

8 (a) Define and explain the following terms relating to governors:
(i) Sensitiveness and
(ii) Isochronism.

(b) The arms of a Porter governor are 300 mm long. The upper arms are pivoted on the axis of rotation and the lower arms are attached to the sleeve at a distance of 35 mm from the axis of rotation. The load on the sleeve is 54 kg and the mass of each ball is 7 kg determine the equilibrium speed when the radius of the balls is 225 mm. What will be the range of speed for this position if the frictional resistance to the motion of the sleeve are equivalent to a force of 30 N.

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THEORY OF MACHINES

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1 (a) Define the term "Kinematic pair". Explain its classification with the help of examples.
(b) The whit worth quick return motion mechanism has the driving crank 150 mm long. The distance between fixed centres is 100 mm. The line of stroke of the ram passes through the centre of rotation of the slotted lever shoes free end is connected to the ram by a connecting link. Find the ration of time of cutting to time of return.

2 (a) What do you mean by straight line mechanism? Name the different mechanisms which are used for exact straight line motion.
(b) Describe any one type of exact straight line motion mechanism with the help of a sketch.

3 What do you mean by Coriolis component of acceleration? When it will exist? Prove that this component of acceleration is equal to 2 x v x ω. Where v = liner velocity of the slider along the link and ω = Angular velocity of the rotating link.

4 (a) Sketch the Davis gear and show that it satisfies the condition for correct steering. Also, explain, why Ackermann steering gear is preferred to Davis gear in actual practice.
(b) The driving shaft of a Hooke's join has a uniform angular speed of 300 r.p.m. Determine the maximum permissible angle between the axes of the shafts to permit a maximum variation in speed of the driven shaft by 6% of the mean speed.

5 Draw the profile of a cam to raise a value with harmonic motion through 5 cm in 1/3 of a revolution. Keep it fully raised through 1/12 revolution and to lower it with harmonic motion in 1/6 revolution. The value remains closed during the rest of the revolution. The diameter of the roller is 2 cm and the minimum radius of the cam to be 2.5 cm. the diameter of the cam shaft is 2.5 cm. the axis of the valve rod passes through the axis of the cam shaft. Assume the shaft to rotate with a uniform velocity.

6 (a) What do you mean by pitch point; circular pitch; module, addendum and dedendum of a gear?
(b) Calculate: (i) Length of path of contact, (ii) arc of contact and
(iii) Contact ratio when a pinion having 17 teeth drives a gear having 49 teeth. The profile of the gear is in volute with pressure angle 20^0, module = 6 mm and addenda on pinion and gear wheel = 1 module.

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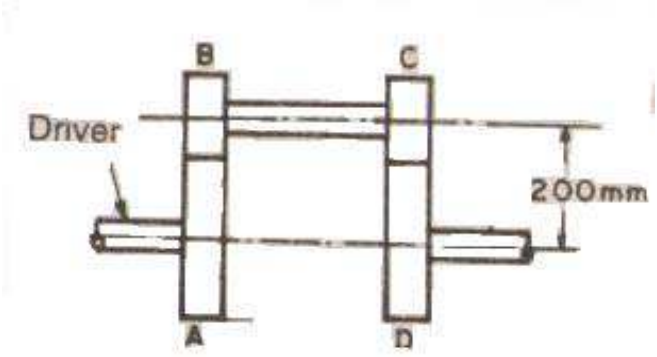
7 (a) What do you understand by epicyclic gear train? What are the merits and demerits of an epicyclic gear train as compared to reverted gear train and compound gear train.

(b) The speed ratio of the reverted gear train shown in figure is to be 12. The module pitch of gears A and B is 3.125 mm and of gears C and D is 2.5 mm. Calculate the suitable numbers of teeth for the gears. No gear is to have less than 24 teeth.



8 (a) Define and explain the following terms relating to governors: (i) Stability and (ii) Hunting.

(b) In a Porter governor, the mass of the central load is 18 kg and the mass of each ball is 2 kg. The top arms are 250 mm while the bottom arms are each 300 mm long. The friction of the sleeve is 14 N. If the top arms make 45^0 with the axis of rotation in the equilibrium position, find the range of speed of the governor in that position.

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