Code: 9A14402

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II B. Tech II Semester (R09) Regular Examinations, April/May 2012

THEORY OF MACHINES

(Mechatronics)

Time: 3 hours Max Marks: 70

Answer any FIVE questions
All questions carry equal marks
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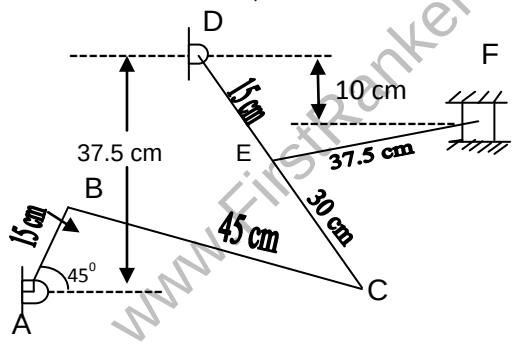
1 (a) Write a short note on the classification of kinematic pair.
(b) In a quick return motion mechanism of crank and slotted level type, the ratio of maximum velocities is 2. If the length of stroke is 25 cm, find: (i) the length of the slotted lever, (ii) the ratio of times of cutting and return strokes, (iii) the maximum cutting velocity per second if the crank rotates at 30 r.p.m.

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 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 inks 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 the 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.p.m. 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 periods 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) Find an expression for the length of the path of contact between two mating spur gears.

(b) Two mating involute spur gears have 28 and 45 teeth and a standard addendum of one module. Find the length of path of contact and length of arc of contact in terms of module when pressure angle is 20^0.

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 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) What is meant by effort and power of a governor? Find the expressions for the same in a porter governor.

(b) The following data relate to a Hartnell governor M = 1.5 kg; a =100 mm; b = 40 mm; r_1 = 70 mm; r_2 = 110 mm; N_1 = 260 rpm; and N_2 = 275 rpm. The axis of rotation is 80 mm form the fulcrum. Calculate the rate of the spring and the equilibrium speed when the radius of the balls is 80 mm.

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1 (a) Define and explain the terms; mechanism, machine, link and kinematic pair.
(b) Show that the locus of the midpoint of the link connecting the two sliders in an elliptical trammel is a circle.

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 producing 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 it 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, 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) What is the use of double Hooke's joint? Explain why two Hooke's joints are used to transmit motion from the engine to the differential of an automobile.
(b) The angle between the axes of two shafts connected by universal joint is 20^0 the driving shaft rotates at uniform speed of 240 r.p.m. the driven shaft carries a steady load of 9 kW. Calculate the radius of gyration of the flywheel off the driven shaft having mass 50 kg and the output torque of the driven shaft does not vary by more than 20% of the input shaft.

5 (a) Differentiate between:
(i) Pitch point and trace point and (ii) Period of ascent and period of descent.
(b) 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 valve remains closed during the rest of the revolution. The diameter of the roller is 1 cm and minimum radius of the cam is to be 2 cm. The axis of the valve rod is offset by 1.0 cm from the axis of cam shaft.

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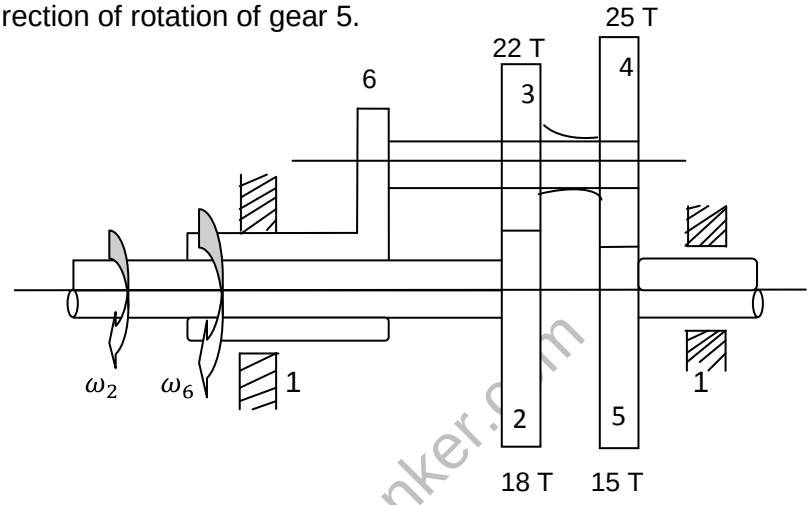
6 (a) What are the different forms of a tooth? Explain.

(b) Two 20^0 in volute spur gears mesh externally and have a gear ratio equal to 2. The number of teeth on smaller gear (i.e. pinion) is 20. The module is 10 mm the addendum on each wheel is to be made of such a length that the line of contact on each side of the pitch point has half the maximum possible length. Determine: (i) the addendum height for each gear wheel, (ii) length of path of contact (iii) arc of contact and (iv) contact ratio.

7 (a) With the help of a neat sketch, explain the working of a reverted gear train. Give at least two applications of the same.

(b) Figure shows a planetary gear train that has two inputs, spur gear 2 rotates at 500 r.p.m and arm 6 rotates at 750 r.p.m both clock wise, as viewed from left. Determine the speed and direction of rotation of gear 5.



8 (a) Explain the terms sensitiveness and stability relating to governors.

(b) In Hartnell governor, the radius of rotation of the balls is 60 mm at the minimum speed of 240 r.p.m. The length of the ball arm is 130 mm and of the sleeve arm 80 mm the mass of each ball is 3 kg and of the sleeve 4 kg the stiffness of the spring is 20 N/mm. Determine: (i) the speed when the sleeve is lifted by 50 mm
(ii) the initial compression of the spring
(iii) the governor effort
(iv) the power.

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1 (a) Differentiate between: (i) Lower pair and higher pair, (ii) Turning pair and sliding pair, (iii) Screw pair and spherical pair. (iv) Closed pair and unclosed pair.
(b) With a neat sketch explain the 'Whitworth Quick Return Mechanism.

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 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 = linear velocity of the slider along the link and ω = Angular velocity of the rotating link.

4 (a) In a Davis steering gear, the distance between the pivots of the front axle is I metre and the wheel base is 2.5 metres. 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 shafts revolves uniformly at 500 r.p.m. if the total permissible variation on speed of the driven shaft is not to exceed $\pm$ 6% of the speed, find the greatest permissible angle between the centre lines of the shafts. Also determine the maximum and minimum speeds of the driven shaft.

5 From the following data draw the profile of a cam in which the follower moves with S.H.M during ascent while it moves with uniformly accelerated motion during descent:
Lift of follower = 4 cm, least radius of cam = 5 cm, angle of descent = 48^0; angle of dwell between ascent and descent = 42^0; angle of descent = 60^0; the diameter of roller = 3 cm; distance between line of action of the follower and the axes of cam = 2 cm. If the cam rotates at 360 r.p.m. anticlockwise, find the maximum velocity and acceleration of the follower during desent.

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 the 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.

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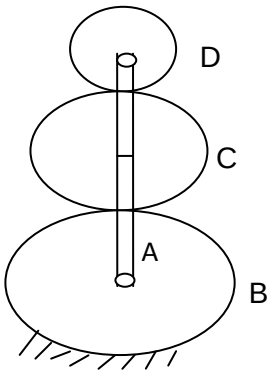
7 (a) Describe the procedure of calculating the fixing torque in case of fixed wheel in case of an epicyclic gear train.

(b) An epicyclic gear train is shown in figure. Find out the r.p.m of pinion D if the arm A rotates at 60 r.p.m in anticlockwise direction. Number of teeth on wheels are given below: $T_B = 12$; $T_C = 60$; $T_D = 40$



8 (a) What are centrifugal governors? How do they differ from inertia governors?

(b) The mass of each ball of a proell governor is 3 kg and the weight on the sleeve is 20 kg each arm is 220 mm long and the pivots of the upper and the lower arms are 20 mm form the axis. For the midposition of the sleeve the extension links of the lower arms are vertical, the height of the governor 180 mm and the speed 150 rpm. Determine the lengths of the extension links and the tension in the upper arms.

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1 (a) Define and explain the term kinematic chain. For a kinematic chain, what is the relation between number of pairs and number of links. Also write the equation, showing the relation between number of links and numbers of joints.

(b) What do you mean by constrained motion? What are the different types of constrained motions? Explain each type with examples neat sketches?

2 (a) What do you mean by a pantograph and what are its uses? Describe with a neat sketch the principal and working of the pantograph.

(b) Explain with the help of a line diagram the working of Tchebicheff's mechanism. What should be the proportion of different links of the mechanism in order to generate an approximate straight line motion?

3 In a Whitworth quick return motion, a crank AB rotates about the fixed centre A. The end B operates a slider reciprocating in a slotted link, rotating about a fixed centre D, and 5 cm vertically above A. The crank AB which is 10 cm long rotates in a clockwise direction at speed of 100 r.p.m. Find the angular acceleration of a slotted link for the configuration in which AB has turned through an angle of 45 degree past its lowest position.

4 (a) Describe with a neat sketch the working of Davis Steering gear mechanism. Also prove that for Davis steering gear tan α = w/2L.

(b) Two shafts with an inclined angle of 160^0 are connected by a Hooke's joint. The driving shaft runs at a uniform speed of 1500 r.p.m. The driven shaft carries a flywheel of mass of 12 kg and 100 mm radius of gyration, find the maximum angular acceleration of the driven shaft and the maximum torque required.

5 A cam rotating clockwise with a uniform speed is to give the roller – follower of 20 mm diameter the following motion; (i) Follower to move outwards through a distance of 45 mm during 90^0 of cam rotation, (ii) Follower to dwell for 60^0 of cam rotation. (iii) Follower to return to its original position during 120^0 of cam rotation. (iv) Follower to dwell for the remaining 90^0 of cam rotation. The minimum radius of the cam is 50 mm and the line of stroke of the follower is offset by 20 mm from the axis of the cam and the displacement of the follower is to take place with simple harmonic motion on both the outward and return stroke. Draw the cam profile.

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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.

7 Two shafts A and B are coaxial. A gear C (50 teeth) is rigidly mounted on shaft A. A compound gear D-E gear with C and an internal gear G. D has 20 teeth and gears with C and E has 35 teeth and gear with an internal gear G is fixed and is concentric with the shaft axis. The compound gear D-E is mounted on a pin which projects from an arm keyed to the shaft B. (i) Sketch the arrangement. (ii) Find the number of teeth on internal gear G assuming that all gears have the same module. (iii) If shaft A rotates at 110 r.p.m find the speed of shaft B.

8 (a) Describe the function of a simple watt governor. What is its limitation?

(b) Each ball of a Porter governor has a mass of 6 kg and the mass of the sleeve is 40 kg. The upper arms are 300 mm long and are pivoted on the axis of rotation whereas the lower arms are 250 mm long and are attached to the sleeve at a distance of 40 mm from the axis. Determine the equilibrium speed of the governor for a radius of rotation of 150 mm for 1% change in speed. Also find the effort and the power for the same speed change.

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