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394551(37)

B. E. (Fifth Semester) Examination, April-May/Nov.-Dec. 2020

(New Scheme)

THEORY of MACHINES

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Part (a) of each question is compulsory and carry 2 marks each. Attempt any* ***one*** *from (b) and (c) and carry (14 marks) each.*

1. (a) What do you mean by Rubbing Velocity?

(b) The crank and connecting rod of theoretical steam engine are 0·5 m and 2 m long respectively. The

cranck 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 point E on the connecting rod 1·5 m from the gudgeon pin,

(iv) velocities of rubbing at the pins of the crank shaft, crank and crosshead when the diameters of their pins are 50 mm, 60 mm and 30 mm respectively,

(v) position and linear velocity of any point G on the connecting rod which has the least velocity relative relative to crank shaft.

(c) Locate all the instantaneous centres of the slider crank mechanism as shown in Fig. 1, c. The lengths of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s, find : 1. Velocity of the slider A, and 2. Angular velocity of the connecting rod AB.

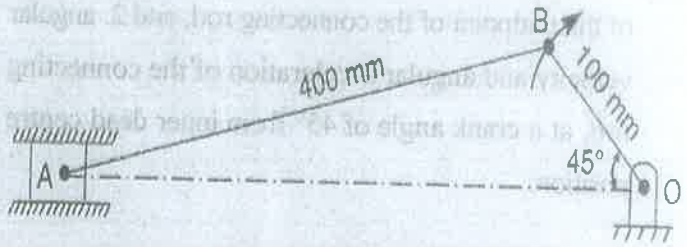

Fig. 1. c

2. (a) What do you mean by Pantograph?

(b) $PQRS$ is a four-bar chain with link PS fixed. The lengths of the links are $PQ = 62 \cdot 5$ mm ; $QR = 175$ mm ; $RS = 112 \cdot 5$ mm and $PS = 200$ mm .

The crank PQ rotates at 10 rad/s clockwise. Draw the velocity and acceleration diagram when angle $QPS = 60°$ and Q and R lie on the same side of PS. Find the angular velocity and angular acceleration of links QR and RS.

(c) The crank of a slider crank mechanism rotates clockwise at a constant speed of 300 r.p.m. The crank is 150 mm and the connecting rod is 600 mm long. Determine : 1. linear velocity and acceleration

of the midpoint of the connecting rod, and 2. angular velocity and angular acceleration of the connecting rod, at a crank angle of 45° from inner dead centre position.

3. (a) What do you mean by Prime Circle of a Cam?

(b) A cam with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion described below :

1. To raise the valve through 50 mm during 120° rotation of the cam ;
2. To keep the valve fully raised through next 30° ;
3. To lower the valve during next 60° ; and
4. To keep the valve closed during rest of the revolution i.e. 150° ;

The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm.

Draw the profile of the cam when (a) the line of stroke of the valve rod passes through the axis of the cam shaft, and (b) the line of the stroke is offset 15 mm from the axis of the cam shaft.

The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion. Determine the maximum acceleration of the valve rod when the cam shaft rotates at 100 r.p.m.

Draw the displacement, the velocity and acceleration diagrams for one complete revolution of the cam.

(c) A cam, with a minimum radius of 50 mm, rotating clockwise at a uniform speed, is required to give a Knife edge follower the motion as described below :

1. To move outwards through 40 mm during 100° rotation of the cam ;
2. To dwell for next 80° ;
3. To return to its starting position during next 90° and
4. To dwell for the rest period of a revolution i. e. 90°.

Draw the profile of the cam

(i) when the line of stroke of the follower passes through the centre of the cam shaft, and

(ii) when the line of stroke of the follower is off-set by 15 mm.

The displacement of the follower is to take place with uniform acceleration and uniform retardation. Determine the maximum velocity and acceleration of the follower when the cam shaft rotates at 900 r.p.m.

Draw the displacement, velocity and acceleration diagrams for one complete revolution of the cam.

4. (a) What do you mean by Addendum and Addendum circle?

(b) (i) Explain Law of gearing.

(ii) A pair of gears, having 40 and 20 teeth respectively, are rotating in mesh, the speed of the smaller being 2000 r.p.m. Determine the velocity of sliding between the gear teeth faces at the point of engagement, at the pitch point, and at the point of disengagement if the smaller gear is the driver. Assume that the gear teeth are 20° involute form, addendum length is 5 mm and the module is 5 mm.

Also, find the angle through which the pinion turns while any pairs of teeth are in contact.

(c) (i) Derive a relation for finding the minimum number of Teeth on the Wheel in Order to Avoid Interference.

(ii) In a reverted epicyclic gear train, the arm *A* carries two gears *B* and *C* and a compound gear *D* - *E*. The gear *B* meshes with gear E and the gear *C* meshes with gear *D*. The number of theeth on gears *B*, *C* and *D* are 75, 30 and 90 respectively. Find the speed and direction of gear *C* when gear B is fixed and the arm *A* makes 100 r.p.m. clockwise.

5. (a) What do you mean by self-energizing brakes?

(b) (i) Derive the expression for finding the Ratio of Driving Tensions for Flat Belt Drive.

(ii) The thrust of a propeller shaft in a marine engine is taken up by a number of collars integral with the shaft which is 300 mm in diameter. The thrust on the shaft is 200 kN and the speed is 75 r.p.m. Taking μ constant and equal to 0·05 and assuming intensity of pressure as uniform and equal to 0·3 N/mm^2, find the external

diameter of the collars and the number of collars required, if the power lost in friction is not to exceed 16 kW.

(c) (i) Explain with diagram Prony Brake Dynamometer.

(ii) A band and block brake, having 14 blocks each of which subtends an angle of 15° at the centre, is applied to a drum of 1 m effective diameter. The drum and flywheel mounted on the same shaft has a mass of 2000 kg and a combined radius of gyration of 500 mm. The two ends of the band are attached to pins on opposite sides of the brake lever at distances of 30 mm and 120 mm from the fulcrum. If a force of 200 N is applied at a distance of 750 mm from the fulcrum, find :

1. maximum braking torque,
2. angular retardation of the drum, and
3. time taken by the system to come to rest from the rated speed of 360 r.p.m.

The coefficient of friction between blocks and drum may be taken as 0·25.