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Question Paper Code : 30019

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fourth Semester

Aeronautical Engineering

AE 3491 – MECHANICS OF MACHINES

(Common to Aerospace Engineering/Industrial Engineering/
Industrial Engineering and Management)

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Show few Applications of the Kutzbach criterion.
2. Define the term, pressure angle.
3. State the fundamental law of toothed gearing.
4. What do you mean by undercutting in gears?
5. What is centrifugal tension? Write its relationship with the mass per unit length of the belt and the velocity of the belt.
6. What is meant by a self-energising brake?
7. Give a brief note on constrained forces.
8. State the D'Alembert's principle.
9. What do you understand by 'damping ratio'?
10. Write the equilibrium equations for (a) Static Balancing and (b) Dynamic Balancing.

PART B — (5 × 13 = 65 marks)

11. (a) For the four-bar linkage in the arbitrary posture shown in Fig. 1, derive expressions for the relationships between the angular velocity of the input link 2 and the angular velocities of the coupler link 3 and the output link 4.

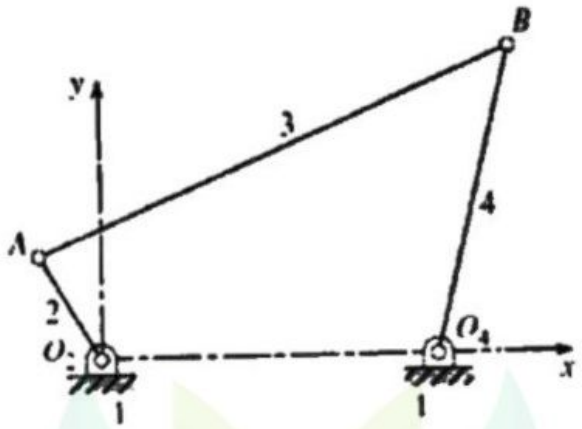

Fig. 1

Or

(b) A cam rotating clockwise at a uniform speed of 1000 p.m. is required to give a roller follower the motion defined below :

(i) Follower to move outwards though 50mm during 120° of cam rotation,

(ii) Follower to dwell for next 60° of cam rotation,

(iii) Follower to return to its starting position during next 90° of cam rotation,

(iv) Follower to dwell for the rest of the cam rotation.

The minimum radius of the cam is 50 mm and the diameter of roller is 10 mm. The line of stroke of the follower is off-set by 20 mm from the axis of the cam shaft. If the displacement of the follower takes place with uniform and equal acceleration and retardation on both the outward and return strokes, draw profile of the cam and find the maximum velocity and acceleration during out stroke and return stroke.

12. (a) (i) With suitable illustration, explain the concept of interference in gear tooth action. (5)

(ii) Fig. 2 shows a reverted planetary train. Gear 2 is fastened to its shaft and is driven at 250 rpm in a clockwise direction. Gears 4 and 5 are planet gears which are joined but are free to turns on the shaft carried by the arm. Gear 6 is stationary. Find the speed and direction of the arm. (8)

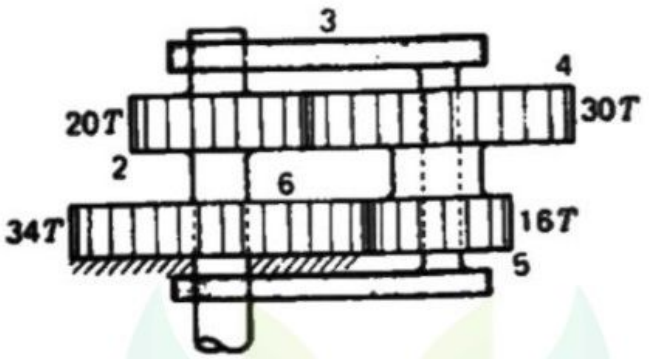

Fig. 2

Or

(b) (i) A pair of gears, having 40 and 20 teeth respectively, are rotating in mesh, the speed of the smaller being 2000 rpm. 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. (8)

(ii) Classify the gear trains. (5)

13. (a) Determine the width of a 9.75 mm thick leather belt required to transmit 25 KW from a motor running at 900 r.p.m. The diameter of the driving pulley of the motor is 300 mm. The driven pulley runs at 300 r.p.m. and the distance between the Centre of two pulleys is 3 metres. The density of the leather is 1000 kg/m^3. The maximum allowable stress is the leather is 2.5 MPa. The coefficient of friction between the leather and pulley is 0.3. Assume open belt drive and neglect the sag and slip of the belt.

Or

(b) The brake shown in Fig. 3 requires an actuating force of 2000 N at the end of the lever. Coefficient of friction is 0.3 and maximum pressure intensity = 1 MPa. Determine the width of the shoe and the braking capacity.

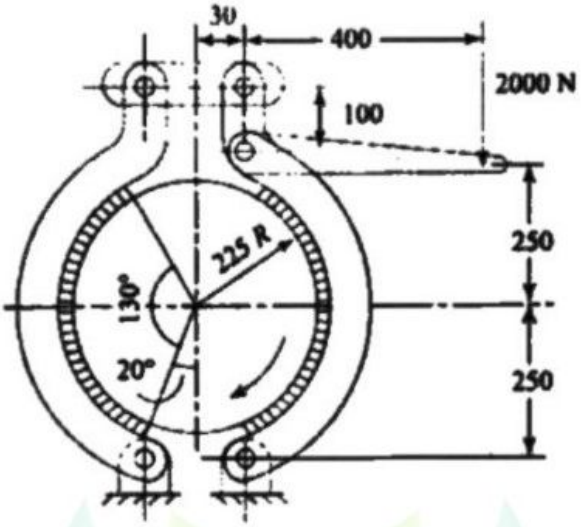

Fig. 3

14. (a) Determine the torque required to be applied at the crank shaft of a slider-crank mechanism to bring it in equilibrium. The slider is subjected to a horizontal force of 5000 N and a force of magnitude 1000 N is applied on the connecting rod as shown in Fig 4. The dimensions of various links are as follows :

OA = 250 mm, AB = 750 mm and AC = 250 mm, <BOA = 40°

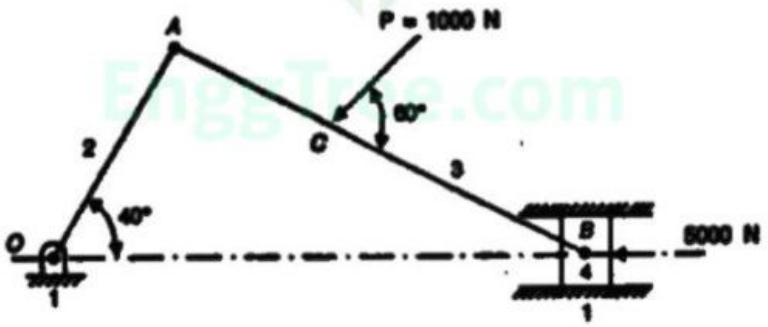

Fig. 4

Or

(b) In a slider-crank mechanism, the length of stroke is 120 mm and connecting rod is 250 mm long. When the crank rotates at 2000 rpm and has travelled 60° from dead centre, find ;

(i) displacement of piston (5)

(ii) velocity and acceleration of the piston (4)

(iii) angular velocity and acceleration of connecting rod. (4)

15. (a) Four mases m_1, m_2, m_3 and m_4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 respectively and the angles between successive masses are 45°, 75° and 135°. Find the position and magnitude of the balance mass required if its radius of rotation is 0.2 m.

Or

(b) A block of mass 1 kg moves over a flat surface, the coefficient of friction being 0.3. A spring of stiffness 150 N/m connects the block to a wall as shown in Fig. 5. The block is pulled through a distance of 50 mm away from the wall and is released with a velocity of 0.6 m/s towards the wall. Find out the period for which the block will oscillate before coming to rest and also the position of the block when it comes to rest.

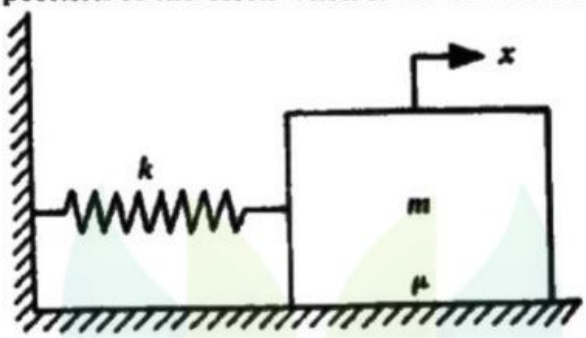

Fig. 5

PART C — (1 × 15 = 15 marks)

16. (a) (i) A uniform solid cylinder of radius r and mass *m* rolls without slipping on a cylindrical cavity of radius R. Determine the natural frequency of oscillation of the cylinder about its lowest position shown in Fig. 6. (8)

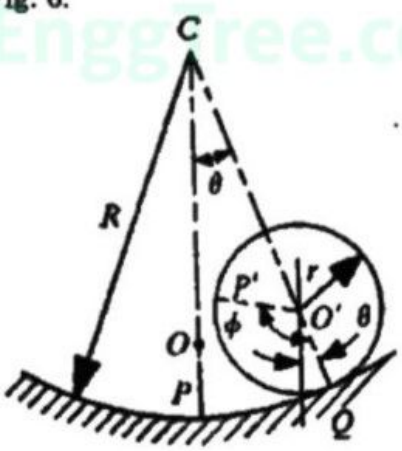

Fig. 6

(ii) A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio. (7)

Or

(b) (i) The vibrating system Fig. 7 has $k_1 = k_3 = 875$ N/m, $k_2 = 1750$ N/m, and W = 40 N. (7)

what is the natural frequency is hertz?

Fig. 7

(ii) Determine the mechanical advantage of the four-bar linkage in the posture shown in Fig. 8. Assume the lengths of the links; AB = 60 mm, BC = 210 mm, CD = 120 mm and DA = 180 mm. (8)

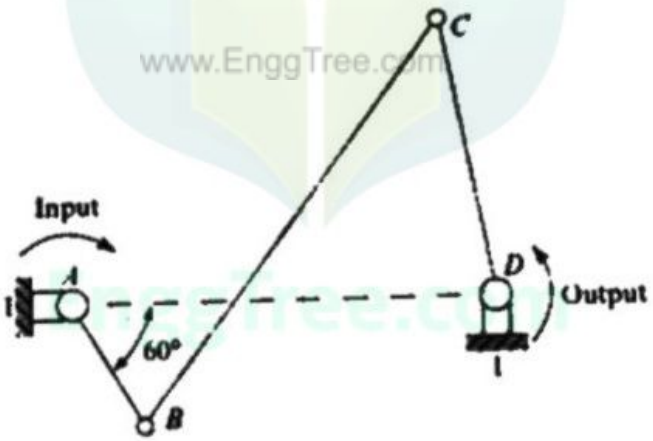

Fig. 8