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B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 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. State the difference between machine and mechanism with examples.

2. Name any four inversions of double slider crank chain mechanism.

3. How interference can be prevented in gears ?

4. Define velocity ratio in compound train of wheels.

5. Define coefficient of friction and angle of repose with respect to screw threads.

6. Write the expression for torque transmitted by a single plate clutch with both sides effective at uniform wear condition.

7. With suitable example explain the concept of Inertia torque.

8. Define D-Alembert's principle.

9. Why balancing is necessary of rotating parts necessary for high speed engines?

10. What is the meaning of vibration isolation?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain any three inversions of Single Slider crank chain mechanism. (6)

(ii) In a Single Slider Crank Chain mechanism, the crank and connecting rod lengths of an engine are 125 mm and 500 mm respectively. The mass of the connecting rod is 60 kg and its centre of gravity is 275 mm from the crosshead pin centre, the radius of gyration about centre of gravity being 150 mm. If the engine speed is 600 r.p.m. for a crank position of 45° from the inner dead centre, determine, (7)

(1) Velocity of the Piston

(2) Angular Velocity of the connecting rod.

Or

(b) A cam is rotating clockwise at a constant speed of 1200 rpm. It is proposed to give a roller follower with the following defined motion given below: (13)

(i) Follower to move outwards through 45 mm during 120° of cam rotation

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

(iii) Follower to return to its starting position during next 120° of cam rotation

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

The minimum radius of the cam is 30 mm and the diameter of the roller is 20 mm. The line of the stroke of the follower is off-set by 15 mm from the axis of the cam shaft. The displacement of the follower takes place with simple harmonic motion.

Draw the cam profile for the given conditions.

12. (a) A pair of involute spur gears with 16° pressure angle and pitch of module 6 mm is in mesh. The number of teeth on pinion is 16 and its rotational speed is 240 r.p.m. When the gear ratio is 1.75, find in order that the interference is just avoided;

(i) the addendum on pinion and gear wheel; (4)

(ii) the length of path of contact; and (4)

(iii) the maximum velocity of sliding of teeth on either side of the pitch point. (5)

Or

(b) An epicyclic gear consists of three gears A, B and C as shown in Figure 1. The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre of A at 18 rpm. If the gear A is fixed, determine the speed of gears B and C. (13)

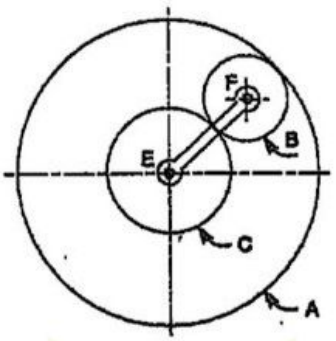


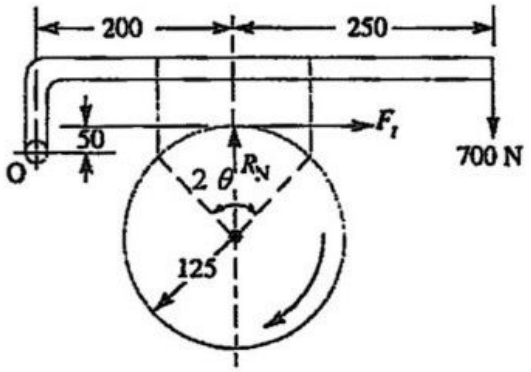
Figure 1

13. (a) (i) A vertical screw with single start square threads of 50 mm mean diameter and 12.5 mm pitch is raised against a load of 10 kN by means of a hand wheel, the boss of which is threaded to act as a nut. The axial load is taken up by a thrust collar which supports the wheel boss and has a mean diameter of 60 mm. The coefficient of friction is 0.15 for the screw and 0.18 for the collar. If the tangential force applied by each hand to the wheel is 100 N, find suitable diameter of the hand wheel. (6)

(ii) A single plate clutch, both sides are effective, is required to transmit 35 kW at 200 rpm, the pressure being applied axially by means of springs and limited to 150 N/cm^2. If the outer diameter of the plate is to be 300 mm, find the required inner diameter of the clutch ring and the total force exerted by the springs. Assume the wear to be uniform and a co-efficient of friction of 0.3. (7)

Or

(b) (i) A single block brake is shown in Fig. 2. The diameter of the drum is 250 mm and the angle of contact is 90°. If the operating force of 700 N is applied at the end of a lever and the coefficient of friction between the drum and the lining is 0.35, determine the torque that may be transmitted by the block brake. (6)



All dimensions in mm

Figure 2

(ii) An open belt 100 mm wide connects two pulleys mounted on parallel shafts with their centres 2.4 m apart. The diameter of the larger pulley is 450 mm and that of the smaller pulley 300 mm. The coefficient of friction between the belt and the pulley is 0.3 and the maximum stress in the belt is limited to 14 N/mm widths. If the larger pulley rotates at 120 r.p.m., find the maximum power that can be transmitted. (7)

14. (a) A four-link mechanism with the following dimensions is acted upon by a force 80 N at angle 150° on link DC (Figure.3): AD = 50 mm, AB = 40 mm, BC = 100 mm, DC = 75 mm, DE = 35 mm. Determine the input torque T on the link AB for the static equilibrium of the mechanism for the given configuration. (13)

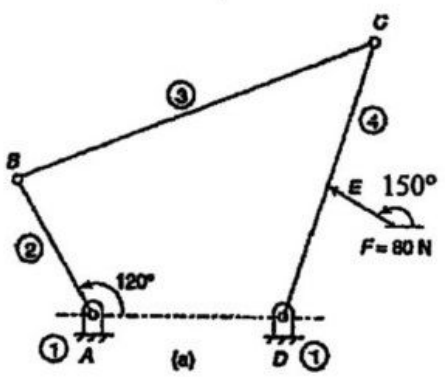


Figure 3

Or

(b) Static-force analysis of a slider crank mechanism is discussed. Consider the slider crank linkage shown in Figure 4 representing a compressor, which is operating at so low a speed that inertia effects are negligible. The dimensions are OB = 30 mm and BC = 70 mm, we wish to find the required crankshaft torque T and the bearing forces for a total gas pressure force P = 40N at the instant when the crank angle is 45°. (13)

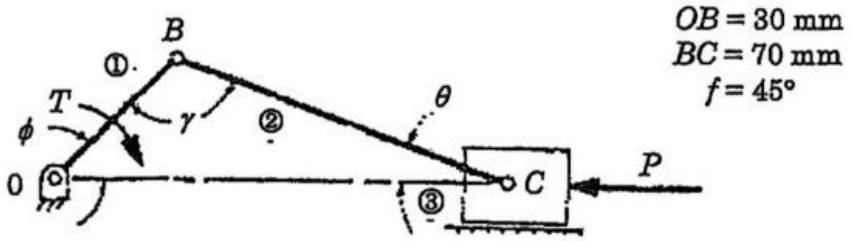


Figure 4

15. (a) A rotating shaft carries four unbalanced masses 18 kg, 14 kg, 16 kg and 12 kg at radii 50 mm, 60 mm, 70 mm and 60 mm respectively. The 2nd, 3rd and 4th masses revolve in planes 80 mm, 160 mm and 280 mm respectively from the plane of first mass and are angularly located at 60°, 135° and 270° respectively measured clockwise from the first mass looking from the end of the shaft. The shaft is dynamically balanced by two masses, both located at 50 mm radii and revolving in planes mid-way between those of 1st and 2nd masses and midway between those of 3rd and 4th masses. Determine the magnitudes of their masses and their respective angular positions. (13)

Or

(b) (i) In a single-degree damped vibrating system; a suspended mass of 3.75 kg makes 12 oscillations in 7 seconds when disturbed from its equilibrium position. The amplitude of vibration reduces to 0.33 of its initial value after four oscillations. (6)

Determine :

(1) stiffness of the spring

(2) logarithmic decrement and

(3) damping factor.

(ii) A shaft of 100 mm diameter and 1 meter long has one of its end fixed and the other end carries a disc of mass 500-kg. The modulus of elasticity for the shaft material is 200 GN/m². Determine the frequency of longitudinal vibrations. (7)

PART C — (1 × 15 = 15 marks)

16. (a) PQRS is a four bar chain with link PS fixed. The lengths of the links are PQ = 63 mm; QR = 175 mm; RS = 113 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. (15)

Or

(b) A single cylinder vertical petrol engine of total mass 300 kg is mounted upon a steel chassis frame and causes a vertical static deflection of 2 mm. The reciprocating parts of the engine have a mass of 20 kg and move through a vertical stroke of 150 mm with simple harmonic motion. A dashpot is provided whose damping resistance is directly proportional to the velocity and amounts to 1.5 kN per metre second. Considering that the steady state of vibration is reached; determine: (15)

(i) the amplitude of forced vibrations, when the driving shaft of the engine rotates at 480 rpm

(ii) the speed of the driving shaft at which resonance will occur.

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