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Question Paper Code : 21298

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Third/Fourth Semester

Mechanical Engineering

ME 3491 – THEORY OF MACHINES

(Common to: Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering and Agricultural Engineering)

(Regulations – 2021)

Time : Three hours   Maximum : 100 marks

(Use of A3 Drawing sheet is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1.   State 'Grashoff's Law'.

2.   Classify different types of cams.

3.   State the 'law of gearing'.

4.   What do you understand by 'gear train'?

5.   What is centrifugal tension in a belt? How does it affect the power transmitted?

6.   Differentiate between self-locking and overhauling screws.

7.   Differentiate applied force from constrained force.

8.   State 'D'Alembert's principle'.

9.   Differentiate between static and dynamic balancing.

10. Differentiate between free and forced vibration with an example.

11. (a) Sketch and explain any four inversions of four bar mechanism with its applications.

Or

(b) In the mechanism, as shown in Figure. 1 the crank OA rotates at 20 r.p.m anticlockwise and gives motion to the sliding blocks B and D. The dimensions of the various links are OA = 300 mm; AB = 1200 mm; BC = 450 mm and CD = 450 mm.
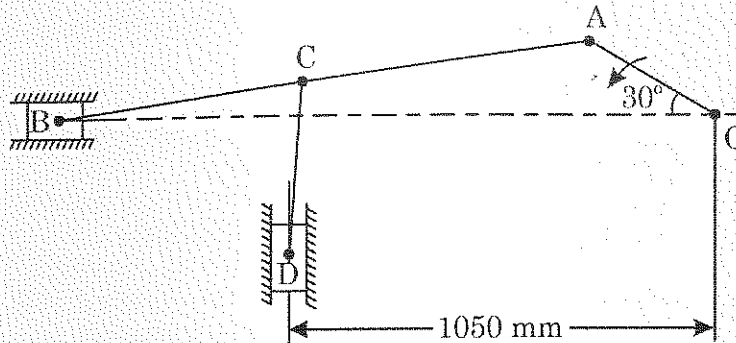

Figure. 1

For the given configuration, determine (i) velocity of sliding at B and D, (ii) Angular velocity of CD.

12. (a) Derive an expression for the minimum number of teeth required on the pinion in order to avoid interference in involute gear teeth when it meshes with wheel.

Or

(b) An epicyclic gear train, as shown in Figure.2, has a sun wheel S of 30 teeth and two planet wheels P-P of 50 teeth. The planet wheels mesh with the internal teeth of a fixed annulus A. The driving shaft carrying the sun wheel, transmits 4 kW at 300 r.p.m. The driven shaft is connected to an arm which carries the planet wheels. Determine the speed of the driven shaft and the torque transmitted, if the overall efficiency is 95%.
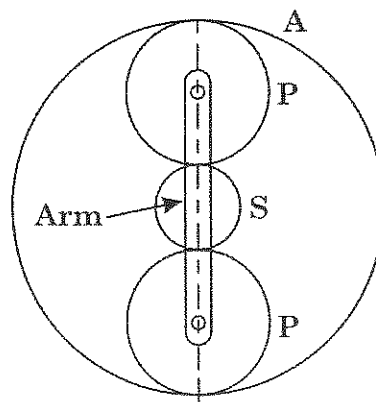

Figure. 2

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13. (a) (i) The pitch of 50 mm mean diameter threaded screw of a screw jack is 12.5mm. The coefficient of friction between the screw and the nut is 0.13. Determine the torque required on the screw to raise a load of 25 kN, assuming the load to rotate with the screw. Determine the ratio of the torque required to raise the load to the torque required to lower the load and also the efficiency of the machine.   (7)

      (ii) A single plate clutch (both sides effective) is required to transmit 26.5 kW at 1600 r.p.m. The outer diameter of the plate is limited to 300 mm and intensity of pressure between the plates is not to exceed 68.5 kN/m². Assuming uniform wear and a coefficient of friction 0.3, show that the inner diameter of the plates is approximately 90 mm.   (6)

Or

   (b) (i) A leather belt is required to transmit 7.5 kW from a pulley 1.2 m in diameter, running at 250 rpm the angle embraced is 165° and the coefficient of friction between the belt and pulley is 0.3, if the safe working stress for the leather belt is 1.5 MPa, density of leather 1 Mg/m³ and the thickness of bell 10 mm, determine the width of the belt taking centrifugal tension into account.   (7)

      (ii) Derive the expression for the length of belt in open belt drive.   (6)

14. (a) The Figure. 3 shows the four bar mechanism and external forces and torques are exerted on or by the mechanism. Sketch the free body diagram of each part of the each mechanism including frame. Neglect friction between the links/pairs.
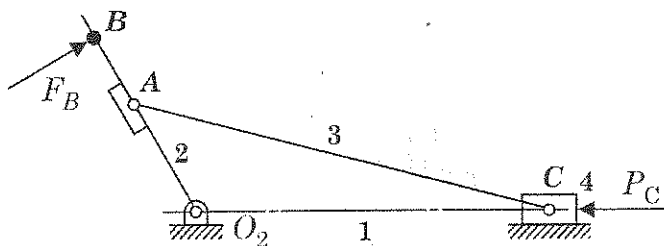

Figure. 3

Or

   (b) The crank pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from I.D.C, the difference between the driving and the back pressures is 0.35 N/mm². The connecting rod length between centres is 1.2m and the cylinder bore is 0.5 m. If the engine runs at 250 r.p.m and if the effect of piston rod diameter is neglected calculate (i) pressure on slide bars (ii) thrust in the connecting rod (iii) tangential force on the crank pin and (iv) Turning moment on the crank shaft.

15. (a) Four masses A, B, C and D are attached to a shaft and revolve in the same plane. The masses are 12 kg, 10 kg, 18 kg and 15 kg respectively and their radii of rotations are 40 mm, 50 mm, 60 mm and 30 mm. The angular position of the masses B, C and D are 60°, 135° and 270° from the mass A. Find the magnitude and position of the balancing mass at a radius of 100 mm.

Or

(b) The disc of torsional pendulum has a moment of inertia of $600 kg-cm^2$ and is immersed in a viscous fluid. The brass shaft is attached to it is of 10 cm diameter and 40 cm long. When the pendulum is vibrating, the observed amplitudes are 9°, 6° and 4°. Determine

   (i) Logarithmic decrement

   (ii) Damping torque at unit velocity

   (iii) Periodic time of vibration

   Assume for the brass shaft $G = 4.4 \times 10^{10} N/m^2$. What would be the frequency be if the disc is removed from the viscous fluid?

PART C — (1 × 15 = 15 marks)

16. (a) Sketch atleast one example of the use of a planar four bar linkage in practice in the workshop, in domestic applications, on vehicles and on agricultural machines.

Or

(b) Construct the profile of a cam to suit the following specifications:

Cam shaft diameter = 40 mm; Least radius of cam = 25 mm; Diameter of roller = 25 mm; Angle of lift = 120°; Angle of fall = 150°; Lift of the follower = 40 mm; Number of pauses are two of equal interval between motions.

During the lift, the motion is S.H.M. During the fall the motion is uniform acceleration and deceleration The speed of the cam shaft is uniform. The line of stroke of the follower is off-set 12.5 mm from the centre of the cam.

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