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Question Paper Code : 30258

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

Third/Fourth Semester

Mechanical Engineering

ME 3491 — THEORY OF MACHINES

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

(Regulations 2021)

Time : Three hours | Maximum : 100 marks

(Permitted : A3 drawing sheet)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between lower pair and higher pair.

2. Name the two methods of finding acceleration in a mechanism.

3. Two mating spur gears have 74 and 36 teeth. Their common module is 5 mm. Determine the centre to centre distance between the gear axis.

4. Where the epicyclic gear trains are used?

5. Define co-efficient of friction.

6. Infer the advantages of wire ropes over fabric ropes.

7. Give examples of applied forces.

8. State the D'Alembert's Principle.

9. Point out the necessity of balancing.

10. List the applications of damper.

(b) A body having a mass of 15 kg is suspended from a spring which deflects 12 mm under the weight of the mass. Determine the frequency of the free vibrations. What is the viscous damping force needed to make the motion aperiodic at a speed of 1 mm/s?

If, when damped to this extent, a disturbing force having a maximum value of 100 N and vibrating at 6 Hz is made to act on the body, determine the amplitude of the ultimate motion. (13)

PART C — (1 × 15 = 15 marks)

16. (a) A cam is to be designed for knife edge follower with the following data,

(i) Cam lift = 40 mm during 90° of cam rotation with the simple harmonic motion.

(ii) Dwell for the next 30°.

(iii) During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion.

(iv) dwell during the remaining 180°.

Draw the profile of the cam when the line of stroke of the follower passes through the axis of the cam shaft. The radius of the base circle of the cam is 40 mm. determine the maximum velocity and acceleration of the follower during its ascent and decent, if the came rotates at 240 rpm. (15)

Or

(b) A rotor is driven by a co-axial through a single plate clutch, both sides of the plate being effective. The external and internal diameters of the plate are respectively 220 mm and 160 mm and the total spring load spring load pressing the plates together is 570 N. The motor armature and shaft has a mass of 800 kg with an effective radius of gyration of 200 mm. The rotor has a mass of 1300 kg with an effective radius of gyration of 180 mm. The coefficient of friction for the clutch is 0.35.

The driving motor is brought up to speed of 1250 r.p.m. when the current is switched off and the clutch suddenly engaged. Determine;

(i) The final speed of motor and rotor

(ii) The time to reach this speed and

(iii) The kinetic energy lost during the period of slipping. (15)

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PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain the three inversions of double slider-crank chain with suitable example. (7)

(ii) The lengths of crank and connecting rod of a horizontal reciprocating engine are 125 mm and 500 mm respectively. The crank is rotating at 600 rpm. When the crank has turned 45° from inner dead centre, find analytically, (1) the velocity and acceleration of the slider and (2) the angular velocity and angular acceleration of the connecting rod. (6)

Or

(b) Derive expressions for displacement, velocity and acceleration for a tangent cam operating radial-translating roller follower;

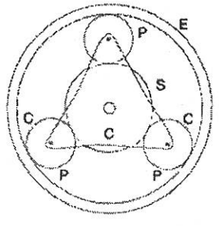
(i) When the contact is on straight flank, and

(ii) When the contact is on circular nose. (13)

12. (a) Two 20° involute spur gears have a module of 10 mm. the addendum is one module. The larger gear has 50 teeth and the pinion 13 teeth. Does the interference occur? If it occurs, to what value should the pressure angle be changed to eliminate interference? (13)

Or

(b) An epicyclic gear train consists of a sun wheel S, a stationary internal gear E and three identical planet wheels P carried on a star – shaped planet carrier C. The size of different toothed wheels are such that the planet carrier C rotates at 1/5th of the speed of the sun wheel S. The minimum numbers of teeth on any wheel is 16. The driving torque on the wheel is 100 N-m. Determine number of teeth on different wheels of the train and torque necessary to keep the internal gear stationary. (13)



13. (a) (i) An effort of 1500 N is required to just move a certain body up an inclined plane of angle 12°, force acting parallel to the plane. If the angle of inclination is increased to 15°, then the effort required is 1720 N. Find the weight of the body and the coefficient of friction.(7)

(ii) Pitch of 50 mm diameter threaded screw of a screw jack is 12.5 mm. Coefficient of friction between screw and nut is 0.10. Determine the torque to raise a load of 25 kN rotating with the screw. Also find the torque required to lower the load and efficiency of screw jack. (6)

Or

(b) An open belt drive connects two pulleys 1.2 m and 0.5 m diameter, on parallel shafts 4 meters apart. The mass of the belt is 0.9 kg per meter length and the maximum tension is not to exceed 2000 N. The coefficient of friction is 0.3. The 1.2 m pulley, which is the driver, runs at 200 r.p.m. Due to belt slip on one of the pulleys, the velocity of the driven shaft is only 450 r.p.m. Calculate the torque on ach of the two shafts, the power transmitted, and power lost in friction. What is the efficiency of the drive? (13)

14. (a) Enumerate the steps involved in determining the various forces on the links and torque applied, when a four-bar mechanism is subjected to an external force F on any one of its links. (13)

Or

(b) The length of crank and connecting rod of a horizontal engineer are 200 mm and 1 m respectively. The crank is rotating at 400 rpm. When the crank has turned through 30° from the inner dead centre, the difference of pressure between cover and piston rod is 0.4 N/mm^2. If the mass of the reciprocating parts is 100 kg and cylinder bore is 0.4 meters, then calculate;

(i) Inertia force
(ii) Force on piston
(iii) Piston effort
(iv) Thrust on the sides of the cylinder walls
(v) Thrust in the connecting rod
(vi) Crank effort. (13)

15. (a) A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm, the angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. if the balancing masses revolved at a radius of 100 mm, find their magnitudes and angular positions. (13)

Or