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**Question Paper Code : 91381**

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

Fourth Semester

Mechanical Engineering

ME 3491 — THEORY OF MACHINES

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

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between machine and structure.
2. Classify cams.
3. The following data relate to two meshing gears Velocity ratio =  $1/3$ , Module = 4 mm, pressure angle =  $20^\circ$ , centre distance = 200 mm. Determine the number of teeth.
4. Differentiate simple gear train and compound gear train.
5. Name the various types of friction.
6. Differentiate 'Dry friction' and 'Greasy friction'.
7. Outline the principle of superposition.
8. State D'Alembert's principle.
9. Infer the effects of partial balancing of locomotives.
10. Outline the importance of vibration isolation.

PART B — ( $5 \times 13 = 65$  marks)

11. (a) Explain the working principle of four bar and slider crank chains with neat sketch.

Or

- (b) Classify different types of followers, sketch them along with cam and label the parts.
12. (a) Two  $20^\circ$  involute spur gears mesh externally and give a velocity ratio of 3. The module is 3 mm and the addendum is equal to 1.1 module. If the pinion rotates at 120 rpm, determine
- Minimum number of teeth on each wheel to avoid interference. (7)
  - Contact ratio (6)

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.

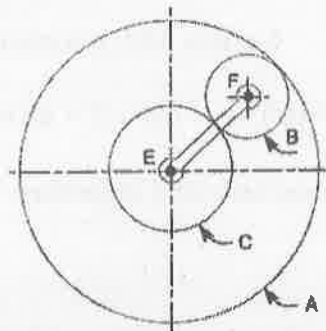


Fig 1

13. (a) An electric motor driven power screw moves a nut in a horizontal plane against a force of 75 kN at a speed of 300 mm/min. The screw has a single thread of 6 mm pitch on a major diameter of 40 mm. The coefficient of friction at the screw threads is 0.1. Estimate the power of the motor.

Or

- (b) A single-plate clutch transmit 25 kW at 900 rpm. The maximum pressure intensity between the plates is  $85 \text{ kN/m}^2$ . The outer diameter of the plate is 360 mm. Both the sides of the plate are effective and coefficient of friction is 0.25. Determine the
- Inner diameter of the plate (7)
  - Axial force to engage the clutch (6)

14. (a) A slider-crank mechanism with the following dimensions is acted upon by a force  $F = 2 \text{ kN}$  at B as shown in figure 2.  $OA = 100 \text{ mm}$ ,  $AB = 450 \text{ mm}$ . Determine the input torque  $T$  on the link OA for static equilibrium of the mechanism for the given configuration.

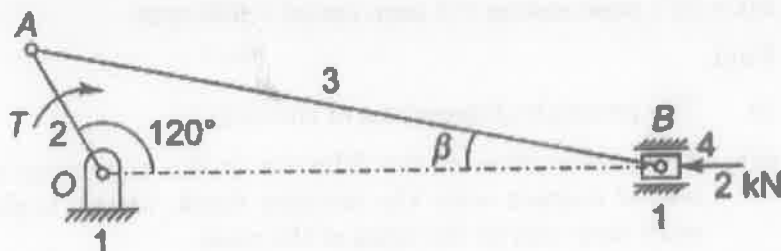


Fig 2

Or

- (b) A horizontal gas engine running at 210 rpm has a bore of 220 mm and a stroke of 440 mm. The connecting rod is 924 mm long and the reciprocating parts weigh 20 kg. When the crank has turned through an angle of  $30^\circ$  from the inner dead centre, the gas pressures on the cover and the crank sides are  $500 \text{ kN/m}^2$  and  $60 \text{ kN/m}^2$  respectively. Diameter of the piston rod is 40 mm. Determine
- Tuning moment on the crank shaft (4)
  - Thrust on the bearings (4)
  - Acceleration of the flywheel which has a mass of 8 kg and radius of gyration of 600 mm while the power of the engine is 22 kW. (5)
15. (a) A, B, C and D are four masses carried by a rotating shaft at radii 100 mm, 125 mm, 200 mm and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B, C and D are 10 kg, 5 kg, and 4 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance.

Or

- (b) A cantilever shaft 50 mm diameter and 300 mm long has a disc of mass 100 kg at its free end. The Young's modulus for the shaft material is  $200 \text{ GN/m}^2$ . Determine the frequency of longitudinal and transverse vibrations of the shaft.

PART C — ( $1 \times 15 = 15$  marks)

16. (a) A symmetrical circular cam operating a flat – faced follower has the following particulars.

Minimum radius of the cam = 30 mm; total lift = 20 mm; angle of lift =  $75^\circ$ ; nose radius = 5 mm; speed = 600 rpm.

Find,

- (i) The principle dimensions of the cam. (8)
- (ii) The acceleration of the follower at the beginning of the lift at the end of contact with the circular flank, at the beginning of contact with nose and at the apex of the nose. (7)

Or

- (b) Two involute gears in a mesh have a module of 8 mm and a pressure angle of  $20^\circ$ . The larger gear has 57 while the pinion and wheels are equal to one module, find

- (i) the contact ratio (the number of pairs of teeth in contact) (5)
- (ii) angle of action of the pinion and the gear wheel (5)
- (iii) ratio of the sliding to rolling velocity at the (1) beginning of contact, (2) pitch point and (3) end of contact. (5)