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Question Paper Code : 11661

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2026.

Fourth Semester

Mechanical Engineering

ME3491 – THEORY OF MACHINES

(Common to Mechanical Engineering (Sandwich) Mechanical Engineering
(Specialised in Automobile) /Mechanical Engineering (Specialised in Smart
Manufacturing)/Mechanical and Automation 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 the significance of velocity and acceleration polygons.
2. Sketch any two inversions of a double slider crank chain.
3. Distinguish between a simple gear train and an epicyclic gear train.
4. Sketch out the configuration of a reverted gear train.
5. What are the various types of belts used for the transmission of power?
6. Give two examples for antifriction bearings.
7. List any two examples for applied and constrained forces.
8. State D' Alembert's principle.
9. What do you mean by dynamic balancing?
10. What are the causes and effects of vibrations?

PART B — (5 × 13 = 65 marks)

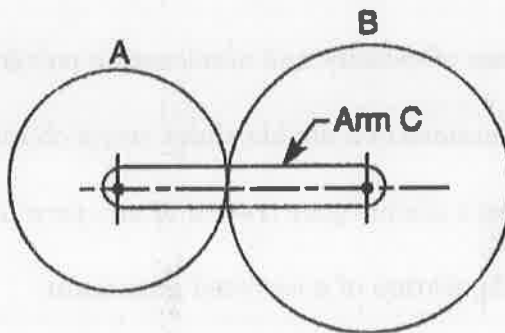
11. (a) PQRS is a four-bar chain with link PS fixed. The lengths of the links are $PQ = 62.5 \text{ mm}$; $QR = 175 \text{ mm}$, $RS = 112.5 \text{ mm}$,; and $PS = 200 \text{ mm}$. The crank PQ rotates at 10 rad/s clockwise. Draw the velocity and acceleration diagram when angle $\angle QPS = 60^\circ$ and Q and R lie on the same side of PS. Find the angular velocity and angular acceleration of links QR and RS.

Or

- (b) Sketch and explain any four inversions of a four-bar mechanism with its applications.
12. (a) A pair of gears, having 40 and 20 teeth respectively, are rotating in mesh, the speed of the smaller being 2000 r.p.m. 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, the 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.

Or

- (b) In an epicyclic gear train, an arm carries two gears, A and B having 36 and 45 teeth, respectively. If the arm rotates at 150 r.p.m. in the anticlockwise direction about the centre of gear A, which is fixed, determine the speed of gear B. If gear A instead of being fixed, makes 300 r.p.m. in the clockwise direction, what will be the speed of gear B?



13. (a) An engine, running at 150 r.p.m. , drives a line shaft by means of a belt. The engine pulley is 750 mm in diameter, and the pulley on the line shaft is 450 mm . A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Find the speed of the dynamo shaft when
- (i) there is no slip, and (7)
- (ii) there is a slip of 2% at each drive. (6)

Or

- (b) (i) Derive the expression for torque required to raise and lower a load in a square threaded screw. (7)
- (ii) A block brake has a drum of radius 300 mm. If $\mu=0.3$ and normal force is 1500 N. Calculate braking torque. (6)
14. (a) A slider-crank mechanism is used in a piston engine. The crank rotates at a constant angular velocity. Explain how you would calculate the inertia force due to the reciprocating piston mass. Using D'Alembert's principle, show the forces and the equivalent inertia force on a free body diagram of the connecting rod.

Or

- (b) Explain the graphical and analytical method of finding the inertia torque on the crankshaft in the reciprocating parts, of slider crank mechanism considering the weight of the connecting rod.
15. (a) A machine of mass 75 kg is mounted on springs and is fitted with a dashpot to damp out vibrations. There are three springs, each of stiffness 10 N/mm, and it is found that the amplitude of vibration diminishes from 38.4 mm to 6.4 mm in two complete oscillations. Determine:
- (i) the resistance of the dashpot at unit velocity and (6)
- (ii) the ratio of the frequency of the damped vibration to the frequency of the undamped vibration, and (4)
- (iii) the periodic time of the damped vibration. (3)

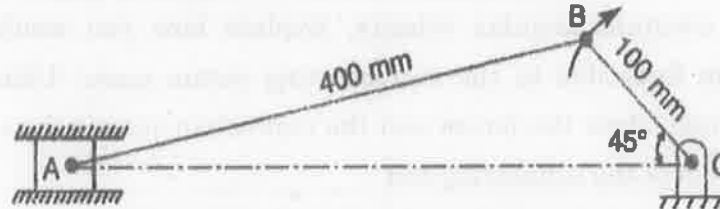
Or

- (b) In an in-line six-cylinder engine working on a two-stroke cycle, the cylinder centre lines are spaced at 600 mm. In the end view, the cranks are 60° apart and in the order 1-4-5-2-3-6. The stroke of each piston is 400 mm, and the connecting rod length is 1 metre. The mass of the reciprocating parts is 200 kg per cylinder, and that of the rotating parts is 100 kg per crank. The engine rotates at 300 r.p.m. Examine the engine for the balance of primary and secondary forces and couples. Find the maximum unbalanced forces and couples.

PART C — ($1 \times 15 = 15$ marks)

16. (a) Locate all the instantaneous centres of the slider crank mechanism as shown in the figure. The lengths of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s, find (8+4+3)

- (i) Velocity of the slider A. and
(ii) Angular velocity of the connecting rod AB



Or

- (b) (i) 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 the intensity of pressure between the plates is not to exceed 68.5 kN/m². Assuming uniform wear and a coefficient of friction of 0.3, show that the inner diameter of the plates is approximately 90 mm. (6)
- (ii) A shaft rotating at 200 r.p.m. drives another shaft at 300 r.p.m. and transmit 6 kW through a belt. The belt is 100 mm wide and 10 mm thick. The diameter between the shaft is 4 m. The smaller pulley is 0.5 m in diameter. Calculate the stress in the belt if it is
- (1) an open belt drive and
(2) a cross belt drive. Take $\mu = 0.3$. (9)