

GUJARAT TECHNOLOGICAL UNIVERSITY

BACHELOR OF ENGINEERING – SEMESTER 3 – EXAMINATION – SUMMER 2026

Subject Code: 3131906

Date: 02/07/2026

Subject Name: Kinematics and Theory of Machines

Time: 02:30 PM TO 05:00 PM

Total Marks: 70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

Q.1 (a) Find the degree of freedom for the given configurations. Fig. 1.

03

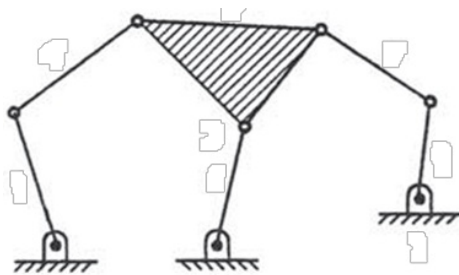
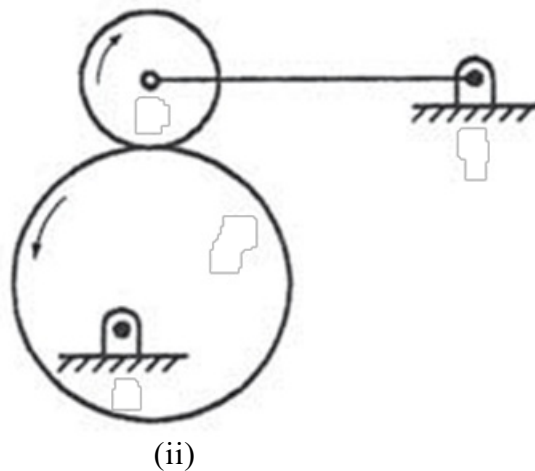
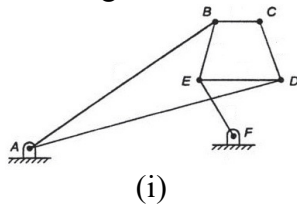


Fig. 1

- (b) Explain the terms: (i) Lower Pair; (ii) Degree of freedom; (iii) Kinematic Link; (iv) Mechanism **04**
- (c) What do you know about inversion? Explain inversion of four bar chain mechanism with neat sketch. **07**

Q.2 (a) Define Type, Number and Dimensional synthesis. **03**

(b) Describe angular velocity ratio theorem. **04**

(c) Derive Freudenstein's equation for the four-bar chain mechanism for three different positions. **07**

OR

Q.2 (c) Determine the Chebyshev spacing for the function $y = 2x^3 - x$ for the range $0 \leq x \leq 4$, where four precision points are required. For these precision points, determine $\theta_2, \theta_3, \theta_4$ and ϕ_2, ϕ_3, ϕ_4 . If $\Delta\theta = 45^\circ$ and $\Delta\phi = 90^\circ$. **07**

- Q.3** (a) Describe the types of instantaneous centres with a neat sketch. 03
- (b) Explain the following terminologies in the context of cam profile with a neat sketch: 04
 (i) Base Circle (ii) Trace Point (iii) Pressure Angle (iv) Lift or Stroke
- (c) A single slider crank chain mechanism is shown in Fig. 2. Given: $OA = 20$ cm, $AP = 70$ cm and angular velocity of crank OA is 10 radians per second. Find the velocity of piston P , angular velocity of link PA and the velocity of point B at a distance of 20 cm from A on the link AP when angle $\theta = 45^\circ$. 07

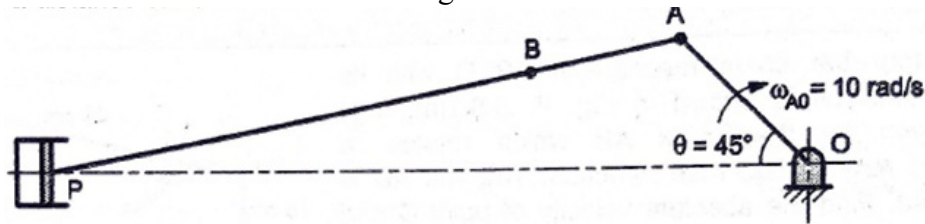


Fig. 2

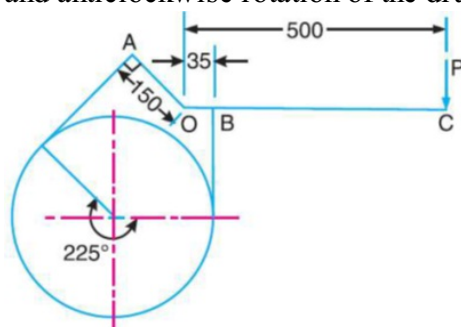
OR

- Q.3** (a) Classify different types of chains. 03
- (b) Describe the advantages and disadvantages of the chain drive over a belt drive. 04
- (c) A disc cam is to give SHM to a knife edge follower during out stroke of 50 mm. The angle of ascent is 120° , dwell 60° , and angle of descent 90° . The minimum radius of cam is 50 mm. Draw the profile of the cam when the axis of the follower passes through the axis of the camshaft. Also calculate the maximum velocity and acceleration during ascent and descent when the camshaft revolves at 240 rpm. 07

- Q.4** (a) Describe the creep of the belt. 03
- (b) Explain the condition of the self-energizing and self-locking brake. 04
- (c) Derive an expression for the tension ratios of a flat belt drive. 07

OR

- Q.4** (a) Explain following gear terminologies: 03
 (i) Module (ii) Tooth thickness (iii) Backlash
- (b) Explain different types of cams with neat sketches. 04
- (c) A differential band brake, as shown in Fig. 3, has an angle of contact 225° . The band has a compressed woven lining and bears against a cast iron drum of 350 mm diameter. The brake is to sustain a torque of 350 N-m and the coefficient of friction between the band and the drum is 0.3. Find the necessary force (P) for the clockwise and anticlockwise rotation of the drum. 07



All dimensions in mm.

Fig. 3

- Q.5** (a) Explain the jump phenomenon in the context of cam and follower. 03
- (b) A single plate clutch, with both sides effective, has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of pressure at any point in the contact surface is not to exceed 0.1 N/mm^2 . If the coefficient of friction is 0.3, determine the power transmitted by a clutch at a speed 2500 rpm. 04
- (c) What is interference in involute gears? Explain various methods to avoid interference. 07

OR

- Q.5** **(a)** Differentiate between Involute and Cycloidal tooth gears. **03**
- (b)** Explain Body centrode and Space centrode with neat sketches. **04**
- (c)** An epicyclic gear train of Sun and Planet type has the fixed outer annular A, Sun Wheel S rotating at a speed of 720 revolutions per minute in clockwise direction and the Arm E carrying three planet wheels P needed to be driven. If diametral pitch is same for all mating gears and Sun wheel S and Planet wheels P have 15 and 45 teeth respectively, Determine: (i) Number of teeth of Annular A; (ii) Speed and direction of rotation of planets. **07**
