GUJARAT TECHNOLOGICAL UNIVERSITY

BE-3 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

Subject Name & Code:
Kinematics and Theory of Machines- 3131906

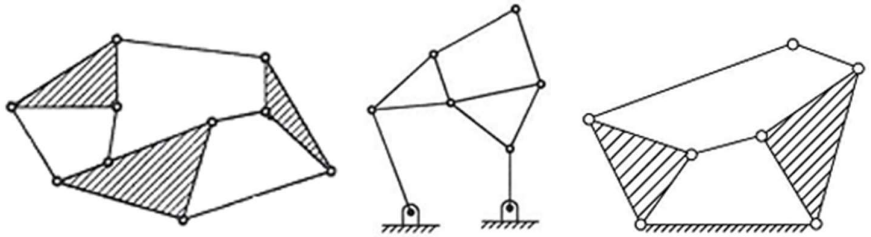
Unit 1: Introduction of Mechanisms and Machines

Repeated Questions:

1. Define/Explain/Differentiate between: Machine and Structure.
   - Appeared in: W25 (Q1a, 03 marks), W23 (Q1a, 03 marks).
2. Define/Explain: Degree of Freedom. Explain Kutzbach and Grubler's Criterion for Plane Mechanisms.
   - Appeared in: W25 (Q1c), S24 (Q4a, 03 marks - part of question), S23 (Q1c, 07 marks).
3. Define/Explain: Kinematic Link, Higher Pair, Lower Pair, Mechanism.
   - Appeared in: S24 (Q1a, 03 marks), S22 (Q1b, 04 marks), W25 (Q1b, 04 marks - includes Kinematics).
4. What is Inversion? Explain inversion of single slider crank mechanism.
   - Appeared in: S25 (Q1c), S24 (Q1c, 07 marks), W24 (Q1b, 04 marks).
5. State and explain Grashof's law.
   - Appeared in: S24 (Q1b, 04 marks).

Other Important Questions:

1. Find the degrees of freedom for the given configurations. (S25 - Q1a) - *(Figures are given in the paper)*.



2. How are the kinematic pairs classified? Explain with examples. (S25 - Q1b, 04 marks)
3. Compare and discuss: kinematic link, kinematic pair, and kinematic chain. (S22 - Q1c, 07 marks)
4. Sketch and describe four bar chain mechanism. (S22 - Q1a, 03 marks)
5. What is degree of freedom? Write Kutzbach and Grubler's criterion for plain mechanism. (S24 - Q4a, 03 marks)
6. Explain: Lower Pair, Degree of Freedom, Mechanical Advantage. (W24 - Q1a, 03 marks)
7. Explain Grubler criteria of determining degree of freedom for mechanisms & for plane mechanism prove that minimum number of binary links in constrained

mechanism with simple hinges is four. (W24 - Q1c, 07 marks)

8. Define the following terms: Link, Higher Pair, Mechanism, Machine. (S23 - Q1a, 03 marks)
9. What is degree of freedom in mechanism? Explain Grubler's criteria. (S23 - Q1c, 07 marks)
10. Write the inversion of double slider crank and explain any one inversion of double slider crank. (S23 - Q1b, 04 marks)
11. Differentiate Lower pair and Higher Pair. (W22 - Q1a, 03 marks)
12. Classify different types of constrained motions. (W22 - Q1b, 04 marks)
13. Draw and explain Peaucellier mechanism. (W22 - Q1c, 07 marks)
14. Explain the terms: 1. Higher Pair, 2. Inversion, 3. Constrained motion, 4. Degree of Freedom. (W23 - Q1b, 04 marks)
15. Sketch and explain any two inversions of a double slider crank chain. (W23 - Q1c, 07 marks)

Unit 2: Graphical and Analytical Linkage Synthesis

Repeated Questions:

1. Define/Explain: Type Synthesis, Number Synthesis, Dimensional Synthesis.
    - Appeared in: S25 (Q2a), W24 (Q3a, 03 marks).
2. Explain Function Generation.
    - Appeared in: W25 (Q2b, 04 marks), S22 (Q3a, 03 marks - part of question).
3. Design/Synthesize a four-bar mechanism to coordinate three input and output angles. (Using Freudenstein's Equation/Precision Points)
    - Appeared in: S24 (Q2c, 07 marks), W25 (Q2c, 07 marks - OR part).
4. Find three precision points using Chebyshev's spacing for a given function (e.g., y=x^1.5, y=x^2, y=1/x).
    - Appeared in: S25 (Q2c), S23 (Q3c, 07 marks - main), W24 (Q3c, 07 marks - OR part), W23 (Q3c, 07 marks - OR part), W22 (Q3c, 07 marks).

Other Important Questions:

1. Derive Freudenstein's Equation for Synthesis of four-bar mechanism. (W25 - Q2c, 07 marks)
2. Elaborate difference between type synthesis and number. (W25 - Q2a, 03 marks)
3. Explain the terms: Function Generation, Path Generation, Motion Generation. (S22 - Q3a, 03 marks)
4. Formulate Freudenstein's equation. (S22 - Q3b, 04 marks - OR part)
5. A four bar mechanism is to be synthesized by using three precision points from Chebyshev's spacing to generate the function $y = x^2$, for the range $0 \leq x \leq 1$. Input link is to start from 30° and $\Delta\theta = 90°$. The output link is to start at 30° and $\Delta\varphi = 90°$. Find out the values of corresponding θ and φ. (S25 - Q2c)
6. Design a slider crank mechanism to coordinate three positions of the input and of the slider for the following data by inversion method. Eccentricity = 20 mm. $\theta 12 = 30°$, $\theta 13 = 60°$, S12 = 40 mm, S13 = 96 mm. (S25 - Q2c - OR part)
7. Explain analytic synthesis for four bar mechanism. (S23 - Q3a, 03 marks)
8. State Chebyshev spacing for mechanism and find three precision points for the function $f(x) = x^{1.3}$ in the interval $0 \leq x \leq 6$, take $\theta c = 60°$, $\Phi 1 = 50°$ and $\Delta\Phi = 100°$. (S23 - Q3c, 07 marks - main)
9. What is synthesis? Explain type of synthesis. (S23 - Q3a, 03 marks - OR part)
10. Explain three position synthesis for four bar mechanism. (S23 - Q3b, 04 marks - OR part)
11. Describe the classification of synthesis problem. (W24 - Q3b, 04 marks)
12. Explain two position synthesis of four bar chain mechanism by pole method. (W23 - Q3c, 07 marks - main part)
13. Explain the term coupler curves. (W22 - Q3a, 03 marks)
14. Explain Chebyshev spacing method. (W22 - Q3b, 04 marks)

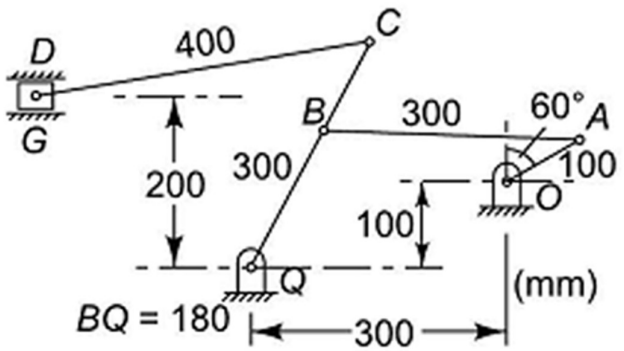
Unit 3: Velocity and Acceleration Analysis

Repeated Questions:

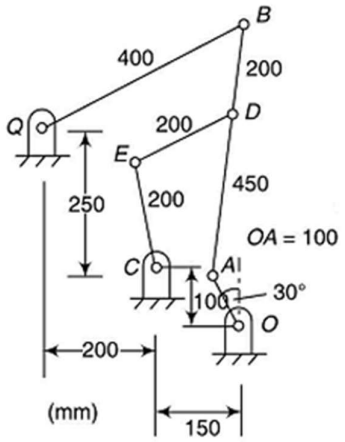
1. Explain/Define: Instantaneous Centre. State/Prove Kennedy's (Aronhold-Kennedy) Theorem.
    - Appeared in: S25 (Q3b - part of question), W25 (Q4a, 03 marks - OR part), W24 (Q2b, 04 marks), S22 (Q3a, 03 marks - OR part), W22 (Q4a, 03 marks - OR part).
2. Explain/Define Coriolis component of acceleration and derive its expression.
    - Appeared in: W24 (Q2c, 07 marks), W23 (Q2c, 07 marks).
3. Numerical on Velocity/Angular Velocity of links in Four-Bar/Slider-Crank/Quick Return Mechanism.
    - Appeared in: S25 (Q3a - numerical), S24 (Q2c - OR part, numerical), W25 (Q3c, 07 marks), W25 (Q4c, 07 marks - OR part, numerical), W22 (Q4c, 07 marks - numerical).
4. Explain Klein's construction / Relative velocity method.
    - Appeared in: W22 (Q4a, 03 marks), W25 (Q4b, 04 marks - OR part).

Other Important Questions:

1. In the mechanism shown in figure the crank OA rotates at 210 rpm clockwise. For the given configuration, determine (i) velocity and acceleration of slider D, (ii) angular velocity and angular acceleration of the link CD. (S25 - Q3a, 10 marks) - *(Figure given)*.



2. Figure shows a six link mechanism. The dimensions of the links are OA = 100 mm, AB = 450 mm, BD = 200 mm, QB = 400 mm, DE = 200 mm, CE = 200 mm. Find all the I-Centers for the given configuration. Also find velocity of point B and E and an angular velocity of links CE and BQ. Link OA rotates at 20 rad/s clockwise. (S25 - Q3b, 07 marks) - *(Figure given)*.



3. Explain the types of I-Centres. What is the use of Kennedy's theorem? (S25 - Q3b, part of question)
4. Explain how velocities of slider and connecting rod are obtained in slider crank mechanism. (S24 - Q2a, 03 marks)
5. The crank and connecting rod of a theoretical steam engine are 0.5 m and 2 m long respectively. The crank makes 180 r.p.m. in the clockwise direction. When it has turned 45° from the inner dead centre position, determine: 1. The velocity of the piston, 2. Angular velocity of connecting rod, 3. The velocity of point E on the connecting rod 1.5 m from the gudgeon pin, 4. Velocities of rubbing at the pins of the crankshaft, crank and crosshead when the diameters of their pins are 50 mm, 60 mm and 30 mm respectively, 5. Position and linear velocity of any point G on the connecting rod which has the least velocity relative to the crankshaft. (S24 - Q2c, 07 marks - OR part)
6. Define rubbing velocity at a pin joint. What will be the rubbing velocity at pin joint when the two links move in the same and opposite direction? (W23 - Q2a, 03 marks)
7. Prove that for three bodies moving relatively to each other, they have three instantaneous centres and lie on a straight line. (W23 - Q2b, 04 marks)
8. For the configuration of a slider crank mechanism shown in Fig.1. Determine: (i) the acceleration of the slider (ii) the acceleration of point E (iii) the angular acceleration of the link AB. The crank OA rotates at 200 r.p.m. clockwise. OA = 500 mm, AB = 1500 mm, AE = 450 mm. (W23 - Q2c, 07 marks - OR part) - *(Figure given)*.

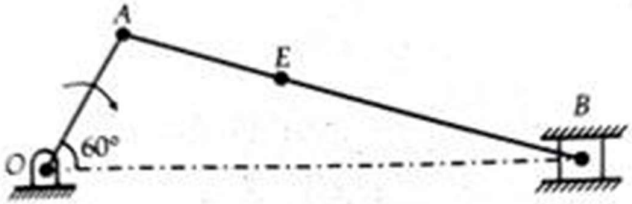


Fig.1

9. With neat sketch explain space centrode & body centrode. (W24 - Q2a, 03 marks)
10. A Whitworth quick return motion mechanism shown in figure c. OA is a crank rotating at 30 rpm in clockwise direction. OA is 150 mm, OC= 100 mm, CD= 125 mm, DR = 500 mm. Determine the acceleration of sliding block R and angular acceleration of slotted lever CA. (W24 - Q2c, 07 marks - OR part) - *(Figure given)*.

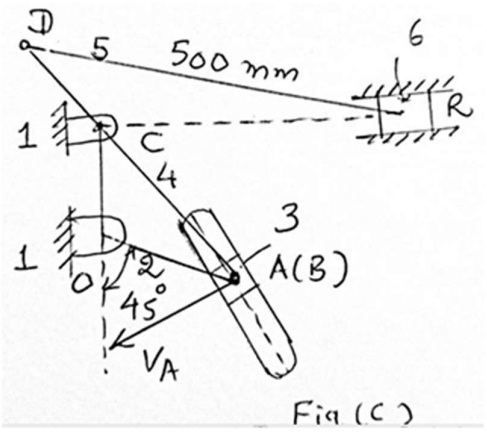
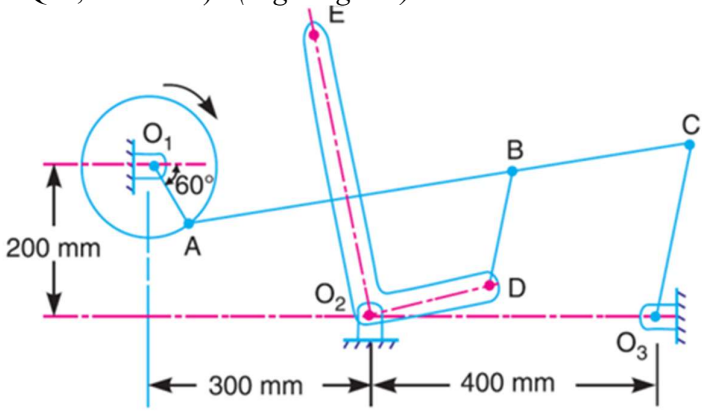
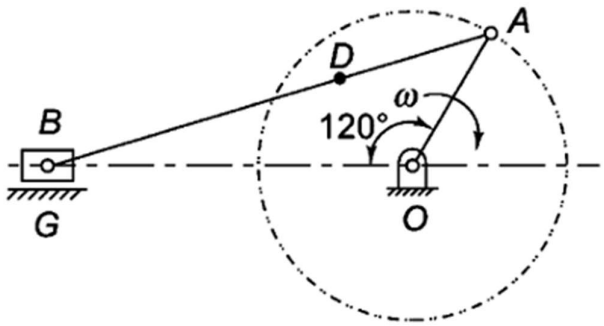


Fig (c)

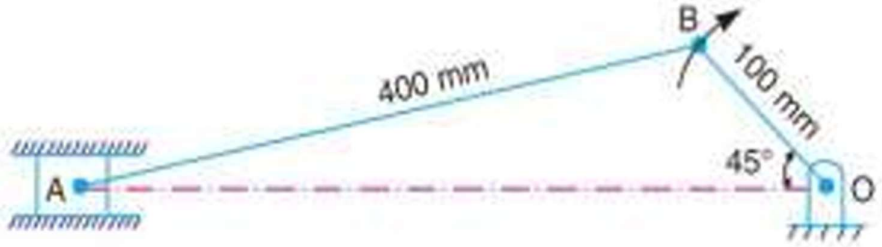
11. Summarize linear velocity, angular velocity and linear acceleration. (W25 - Q3a, 03 marks - OR part)
12. Explain angular velocity, linear velocity, angular acceleration and linear acceleration. (W22 - Q4b, 04 marks - OR part)
13. The mechanism of a machine, as shown in Figure, has the following dimensions: O1A = 100 mm, AC = 700 mm, BC = 200 mm, O3C = 200 mm, O2E = 400 mm, O2D = 200 mm and BD = 150 mm. The crank O1A rotates at a uniform speed of 100 rad/s. Find the velocity of the point E of the bell crank lever by instantaneous center method. (W22 - Q4c, 07 marks) - *(Figure given)*.



14. Figure shows configuration of an engine mechanism. The dimensions are the following: Crank OA = 200 mm; Connecting rod AB = 600 mm; distance of center of mass from crank end, AD = 200 mm. At the instant, the crank has an angular velocity of 50 rad/s clockwise and an angular acceleration of 800 rad/s2. Calculate the (i) velocity of D and angular velocity of AB (ii) acceleration of D and angular acceleration of AB. (W22 - Q4c, 07 marks - OR part) - *(Figure given)*.



15. Locate all the instantaneous centres of the slider crank mechanism as shown in Fig. 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: 1. Velocity of the slider A, and 2. Angular velocity of the connecting rod AB. (S22 - Q3c, 07 marks) - *(Figure given)*.



16. Explain briefly dimensional synthesis. (S22 - Q3b, 04 marks - OR part)
17. A four bar chain mechanism is to be designed, by using three precision point to generate the function Y = X^1.5 for the range $1 \leq x \leq 4$. Assuming 30° starting position and 120° finishing position for the input link and 90° starting position and 180° finishing position for the output link, find the value of x , y , θ and φ corresponding to three precision point. (S22 - Q3c, 07 marks - OR part)
18. Derive the equation of displacement, velocity and acceleration of slider in slider crank mechanism. (S23 - Q2c, 07 marks)
19. Following data relates to reciprocating steam engine having crank 14.5 cm, connecting rod 60 cm, uniform speed of crank 250 rpm, radius of pin circle 15 cm, length of connecting rod between centers 60 cm. Direction of rotation of crank is clockwise when crank has turned 30 degree from inner dead center. Find acceleration of piston, acceleration of center of gravity of connecting rod. The center of gravity being 22 cm from big end center(piston end connection). (S23 - Q2c, 07 marks - OR part)
20. Explain terms: relative velocity, Coriolis component in acceleration, peripheral velocity. (S23 - Q2a, 03 marks)

Unit 4: Cams

Repeated Questions:

1. Draw the cam profile for given data (Knife-edge/Roller Follower, SHM/UARM motion, Offset).
    - Appeared in: S25 (Q4c, 07 marks), S24 (Q3c, 07 marks), S23 (Q4c, 07 marks), W25 (Q5c, 07 marks), W23 (Q4c, 07 marks).
2. Classify types of followers.
    - Appeared in: S25 (Q4b, 04 marks - OR part), W23 (Q4c, 07 marks - OR part).
3. Explain various follower motions (SHM, Uniform Velocity, UARM).
    - Appeared in: S24 (Q3b, 04 marks - OR part), W25 (Q4a, 03 marks).
4. Define/Explain: Prime Circle, Pitch Circle, Pressure Angle.
    - Appeared in: S24 (Q3a, 03 marks), S22 (Q3a, 03 marks - OR part? Differs).

Other Important Questions:

1. What are the advantages of the V-belt drive? (S25 - Q4a, 03 marks)
2. A cam is to operate an offset roller follower. The least radius of the cam is 50 mm, roller diameter is 30 mm, and offset is 20 mm. The cam is to rotate at 360 rpm. The angle of ascent is 48°, angle of dwell is 42°, and angle of descent is 60°. The motion is to be SHM during ascent and uniform acceleration and deceleration during descent. Draw the cam profile. (S25 - Q4c, 07 marks)
3. Calculate the maximum velocity and acceleration during return for the data given in Q.4 (c) above. (S25 - Q4a, 03 marks - OR part)
4. How are the followers classified? Describe in detail. (S25 - Q4b, 04 marks - OR part)
5. Define for cam (1) Prime Circle (2) Pitch Circle (3) Pressure Angle. (S24 - Q3a, 03 marks)
6. Give classification of follower in different way. (S24 - Q3b, 04 marks)
7. A cam is to be designed for a knife-edge follower with the following data: 1.Cam lift = 40 mm during 90° of cam rotation with SHM. 2.Dwell for the next 30°. 3.During the next 60° of cam rotation, the follower returns to its original position with SHM. 4.Dwell during the remaining 180°. Draw the profile of the cam when the line of stroke is offset 20 mm from the axis of the camshaft. The radius of the base circle of the cam is 40 mm. (S24 - Q3c, 07 marks)
8. State advantages and disadvantages of chain drive. (S24 - Q3a, 03 marks - OR part)
9. Explain various motion of follower. (S24 - Q3b, 04 marks - OR part)
10. Explain path function generation and motion function generation. (S24 - Q3c, 07 marks - OR part)
11. Draw the cam profile for roller follower of 30 mm diameter having lift of follower (ascend) 50 mm during 90° of cam rotation with SHM, follower having 30° of dwell period, the follower with decent to its original position during 90° of cam rotation with uniform acceleration and deacceleration it remains rest for rest of the cam operation. Least radius of cam 50 mm, if it rotates 300 rpm find maximum velocity and acceleration during ascent and decent. (S23 - Q4c, 07 marks)
12. Write a short note on internal expanding shoe brake. (S23 - Q4a, 03 marks - OR part)
13. State the type of motion for follower. Explain any one type of motion with neat sketch. (S23 - Q4b, 04 marks - OR part)
14. Create displacement diagram for Simple Harmonic motion for desired dimensions. (S22 - Q2a, 03 marks)
15. Draw the displacement, velocity and acceleration diagrams for a follower when it

moves with Uniform acceleration and retardation. (S22 - Q2b, 04 marks)

16. A cam is to be designed for a knife edge follower with the following data : 1. Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion. 2. Dwell for the next 30°. 3. During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion. 4. Dwell during the remaining 180°. Draw the profile of the cam when the line of stroke is offset 20 mm from 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 descent, if the cam rotates at 240 r.p.m. (S22 - Q2c, 07 marks)
17. Draw the profile of the cam when the roller follower moves with cycloidal motion during out stroke and return stroke, as given below : 1. Out stroke with maximum displacement of 31.4 mm during 180° of cam rotation, 2. Return stroke for the next 150° of cam rotation, 3. Dwell for the remaining 30° of cam rotation. The minimum radius of the cam is 15 mm and the roller diameter of the follower is 10 mm. The axis of the roller follower is offset by 10 mm towards right from the axis of cam shaft. (S22 - Q2c, 07 marks - OR part)
18. Draw the cam profile for a cam in which moves with SHM during ascent while it moves with uniformly accelerated motion during descent. Lift of follower 40 mm, least radius of cam 60 mm, angle of ascent 48°, angle of dwell between ascent and descent 42°, angle of descent 60°, diameter of roller 40 mm. Distance between axis of follower and axis of cam 20 mm. If cam rotates at 360 rpm anticlockwise find maximum velocity and acceleration of follower during descent. (W24 - Q3c, 07 marks)
19. Explain the effect of pressure angle in cam design. (W24 - Q3a, 03 marks - OR part)
20. Classify follower motion in cam and explain SHM in cam. (W24 - Q3b, 04 marks - OR part)
21. From the following data draw the profile of a cam in which the follower moves with S.H.M. during ascent while it moves with uniform accelerated motion during descent: Lift of follower = 4 cm; Least radius of cam = 5 cm; Angle of ascent = 48°; Angle of dwell between ascent and descent = 42°; Angle of descent = 60°; The diameter of roller = 3 cm; Distance between line of action of the follower and the axis of cam = 2 cm. (W23 - Q4c, 07 marks)
22. Classify different types of cams according to types of shape. (W22 - Q2a, 03 marks)
23. Classify and draw different follower displacement diagram. (W22 - Q2b, 04 marks)
24. Construct cam profile for knife edge follower with offset to right by 15 mm. Minimum radius of the cam = 30 mm, stroke of the follower = 24 mm. angle of rise = 90°, dwell after rise = 60°, angle of return = 120°, dwell after return for the rest of the period. Follower move outward with uniform velocity and return back with simple harmonic motion. The cam is rotating in clockwise direction. (W22 - Q2c, 07 marks - OR part)
25. A cam, with a minimum radius of 50 mm, rotating clockwise at a uniform speed, is required to give a knife edge follower the motion as described below : 1. To move outwards through 40 mm during 100° rotation of the cam 2. To dwell for next 80° 3. To return to its starting position during next 90° and 4. To dwell for the rest period of a revolution i.e. 90°. Draw the profile of the cam when the line of stroke of the follower passes through the center of the cam shaft, and The displacement of the follower is to take place with uniform acceleration and uniform retardation. (W25 - Q5c, 07 marks)

Unit 5: Belt, Ropes and Chains

Repeated Questions:

1. Explain the phenomenon of Slip and Creep in belt drives.
    - Appeared in: S24 (Q4b, 04 marks), W25 (Q3b, 04 marks), W24 (Q4a, 03 marks), W23 (Q3a, 03 marks - OR part).
2. Derive the ratio of tensions (T1/T2 = e^μθ) for Flat Belt / V-Belt.
    - Appeared in: S25 (Q4b, 04 marks), W24 (Q4b, 04 marks).
3. Numerical on Open/Cross Belt Drive: Find Power transmitted / Belt width / Length / Initial Tension.
    - Appeared in: S25 (Q4c, 07 marks - OR part), S24 (Q4c, 07 marks - OR part), W24 (Q4c, 07 marks - OR part), W23 (Q3b, 04 marks - main part), W22 (Q5c, 07 marks).
4. Derive formula for length of belt for Open/Cross belt drive.
    - Appeared in: S24 (Q4c, 07 marks), W25 (Q5c, 07 marks - OR part).

Other Important Questions:

1. Derive the expression for the ratio of the friction tensions for a flat belt. (S25 - Q4b, 04 marks)
2. An open belt drive is required to transmit 10kW of power from a motor running at 600 rpm. Diameter of the driving pulley is 250 mm. The speed of the driven pulley is 220 rpm. The belt is 12 mm thick and has a mass density of 0.001 g/mm^2. Safe stress in the belt is not to exceed 2.5 N/mm^2. The two shafts are 1.25 m apart. The coefficient of friction is 0.25. Determine the width of the belt. (S25 - Q4c, 07 marks - OR part)
3. Explain what you know about initial tension in a belt. (S24 - Q4a, 03 marks)
4. Derive formula of length of belt for cross belt drive with usual notation. (S24 - Q4c, 07 marks)
5. Elaborate function of fast and loose pulley with neat sketch. (S24 - Q4b, 04 marks - OR part)
6. A 100 mm wide and 10 mm thick belt transmits 5 kW of power between two parallel shafts. The distance between the shaft centers is 1.5 m and the diameter of the smaller pulley is 440 mm. The driving and the driven shafts rotate at 60 rpm and 150 rpm respectively. The coefficient of friction is 0.22. Find the stress in the belt if the two pulleys are connected by an open belt drive. (S24 - Q4c, 07 marks - OR part)
7. Explain slip and creep in belt drive. (S24 - Q4b, 04 marks)
8. Explain limiting tension rate in flat belt drive and derive its equation. (S23 - Q3b, 04 marks)
9. How many V Belts required to transmit 30 kw from grooved pulley of 250 mm pitch diameter with groove angle 34° rotating at 1000 rpm to another grooved pulley of 1m pitch diameter. Maximum load per belt is 700 N, mass of 1 belt is 0.3 kg, coefficient of friction is 0.2 center distance is 1 meter. (S23 - Q3c, 07 marks - OR part)
10. For flat belt drive derive T_1/T_2 = e^{μθ}, where μ = coefficient of friction and θ is angle of contact. (W24 - Q4b, 04 marks)
11. Engine with 45 KW power at 1000 rpm is connected with cone clutch built inside the flywheel. Cone has face angle 12.5 and maximum mean diameter of 600 mm. The coefficient of friction is 0.2. The normal pressure on clutch face is not to exceed 0.1 N/mm². Find the axial spring force necessary to engage to clutch and face width required. (W24 - Q4c, 07 marks)
12. Explain limiting friction, angle of friction and coefficient of friction. (W24 - Q4a, 03

marks - OR part)

13. Derive expression for flat collar bearing Assume uniform intensity of pressure. Two pulleys are 450 mm diameter and other 200 mm diameter are on parallel shafts 1.95 m apart and are connected by cross belt. Find the length of belt required and angle of contact between the belt and each pulley. What power can be transmitted by belt when larger pulley rotates at 300 rpm. If the maximum permissible tension in belt is 1000 N and coefficient of friction between belt had pulley is 0.25? (W24 - Q4c, 07 marks - OR part)
14. The width of a belt is 15 cm and the maximum tension per cm width is not to be exceeded 140 N. the ratio of tensions on the two sides is 2.25, the diameter of the driver is 1.05 m and it makes 220 r.p.m, find the power that can be transmitted. (W23 - Q3b, 04 marks - main part)
15. Discuss relative merits and demerits of belt, rope and chain drive for transmission of power. (W23 - Q3b, 04 marks - OR part)
16. State the law of belting. (W22 - Q5a, 03 marks)
17. Compare belt drive, rope drive and chain drive. (W22 - Q5b, 04 marks)
18. In an open-belt drive, the diameters of the larger and the smaller pulleys are 1.2 m and 0.8 m respectively. The smaller pulley rotates at 320 rpm. The center distance between the shafts is 4 m. When stationary, the initial tension in the belt is 2.8 kN the mass of the belt is 1.8 kg/m and the coefficient of friction between the belt and the pulley is 0.25. Determine the power transmitted. (W22 - Q5c, 07 marks)
19. List advantages and disadvantages of chain drive over belt drive. (W25 - Q3a, 03 marks)
20. Power is transmitted using a V-belt drive. The included angle of V-groove is 30°. The belt is 20 mm deep and maximum width is 20 mm. If the mass of the belt is 0.35 kg per metre length and maximum allowable stress is 1.4 MPa, determine the maximum power transmitted when the angle of lap is 140°. $\mu = 0.15$. (S22 - Q4c, 07 marks - OR part)
21. Explain what do you understand by ‘initial tension in a belt’. (W23 - Q3a, 03 marks)

Unit 6: Friction, Clutch and Brake

Repeated Questions:

1. Explain/State the Laws of Friction (Static, Dynamic, Solid, Fluid).
    - Appeared in: S25 (Q5a, 03 marks), W25 (Q5a, 03 marks - OR part), W23 (Q4b, 04 marks).
2. Explain/Derive: Frictional torque transmitted in a Pivot/Collar Bearing (Uniform Pressure & Uniform Wear).
    - Appeared in: W25 (Q4c, 07 marks - OR part), S23 (Q4c, 07 marks - OR part, numerical).
3. Numerical on Block/Band Brake: Find Braking Torque/Braking Force.
    - Appeared in: S25 (Q5b, 04 marks), W22 (Q5c, 07 marks - OR part, Rope Brake).
4. Explain/Describe with sketch: Single Plate/Multi-Plate Clutch.
    - Appeared in: S25 (Q5c, 07 marks - OR part, numerical), W23 (Q4b, 04 marks - OR part, numerical), W22 (Q5b, 04 marks - OR part).
5. Write a short note on Internal Expanding Shoe Brake.
    - Appeared in: S23 (Q4a, 03 marks - OR part), W23 (Q4a, 03 marks).

Other Important Questions:

1. What are various kinds of friction? Discuss each in brief. (S25 - Q5a, 03 marks)
2. A differential band brake has a drum with a diameter of 800 mm. The two ends of the band are fixed to the pins on the opposite sides of the fulcrum of the lever at distances of 40 mm and 200 mm from the fulcrum. The angle of contact is 270° and the $\mu = 0.2$. Determine the brake torque when a force of 600 N is applied to the lever at a distance of 800 mm from the fulcrum. Consider clockwise rotation of the drum. (S25 - Q5b, 04 marks)
3. A single-plate clutch, with both sides effective, has inner and outer diameters of friction surface 250 mm and 350 mm, respectively. The maximum intensity of pressure is not to exceed 0.15 MPa. The coefficient of friction is 0.3. Determine the power transmitted by the clutch at a speed of 2400 rpm for (a) uniform wear and (b) uniform pressure. (S25 - Q5c, 07 marks - OR part)
4. Draw and label main components of cone clutch. (S24 - Q5a, 03 marks)
5. What you know about band brake? explain with neat sketch also state its advantages and disadvantages. (S24 - Q5c, 07 marks)
6. Explain laws of friction. (S24 - Q5a, 03 marks - OR part)
7. A conical pivot supports a load of 25 KN. The intensity of pressure is 0.5 MN/mm^2. Find the diameter of bearing surface and its cone angle if the face width is 0.75 times its diameter. If friction coefficient is 0.06 and shaft runs at 120 rpm find the power lost in friction. (S23 - Q4c, 07 marks - OR part)
8. Describe with neat sketch working of single friction clutch. (S23 - Q4b, 04 marks)
9. Distinguish between brakes and clutches. (W23 - Q4a, 03 marks - OR part)
10. A multiplate clutch has three pairs of contact surfaces. The outer and inner radii of the contact surfaces are 100 mm and 50 mm respectively. The axial spring force is limited to 1 kN. Assuming uniform wear, find the power transmitted at 1500 rpm. Take $\mu = 0.35$. (W23 - Q4b, 04 marks - OR part)
11. What is self locking in brakes? Explain it in shoe brake. (W24 - Q5a, 03 marks)
12. Explain simple, compound and reverted gear trains. (S25 - Q5b, 04 marks - OR part)
13. Explain single block or shoe brake with neat sketch. (W25 - Q5b, 04 marks - OR part)
14. Derive formula for frictional torque transmitted by flat pivot bearing considering (1)

uniform pressure distribution and (2) uniform wear condition with usual notations. (W25 - Q4c, 07 marks - OR part)

15. Classify the different type of brakes. (W22 - Q5a, 03 marks - OR part)
16. Explain the working of multi plate clutch with neat sketch. (W22 - Q5b, 04 marks - OR part)
17. A rope drive transmits 600 kW from a pulley of effective diameter 4 m, which runs at a speed of 90 r.p.m. The angle of lap is 160°; the angle of groove 45°; the coefficient of friction 0.28; the mass of rope 1.5 kg / m and the allowable tension in each rope 2400 N. Find the number of ropes required. (W22 - Q5c, 07 marks - OR part)

Unit 7: Gears and Gear Trains

Repeated Questions:

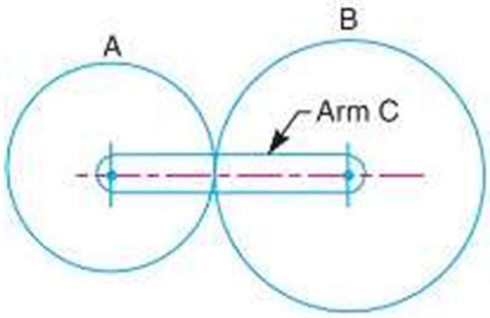
1. Define: Circular Pitch, Diametral Pitch, Module, Pressure Angle, Backlash, Addendum.
    - Appeared in: S25 (Q5a, 03 marks - OR part), W25 (Q5a, 03 marks), W23 (Q5a, 03 marks), W24 (Q5b, 04 marks - OR part).
2. Numerical on Minimum Number of Teeth to Avoid Interference.
    - Appeared in: S25 (Q5c, 07 marks), S23 (Q5c, 07 marks).
3. Explain/Differentiate between Involute and Cycloidal Gear Profiles.
    - Appeared in: S22 (Q3a, 03 marks), W24 (Q5b, 04 marks).
4. Numerical on Epicyclic Gear Train (Sun & Planet, Compound).
    - Appeared in: S22 (Q3c, 07 marks), S23 (Q5c, 07 marks - OR part), W22 (Q3c, 07 marks), W24 (Q5c, 07 marks - OR part).
5. Explain/Write Short Note on Epicyclic Gear Train / Automobile Differential.
    - Appeared in: S24 (Q5b, 04 marks - OR part), S23 (Q5a, 03 marks - OR part), W25 (Q4b, 04 marks - OR part).
6. Explain/State the Law of Gearing.
    - Appeared in: W24 (Q5c, 07 marks), W22 (Q3a, 03 marks).

Other Important Questions:

1. Two 20° 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 the (i) minimum number of teeth on each wheel to avoid interference, (ii) contact ratio. (S25 - Q5c, 07 marks)
2. Define Circular pitch, Diametral pitch and Module for gears. (S25 - Q5a, 03 marks - OR part)
3. Explain simple, compound and reverted gear trains. (S25 - Q5b, 04 marks - OR part)
4. What you know about sun and planet wheel? Explain with neat sketch. (S24 - Q4a, 03 marks)
5. State and explain types of gear train with sketch. (S24 - Q5b, 04 marks)
6. What are straight line mechanisms? Also explain watt's mechanism with line diagram. (S24 - Q5b, 04 marks - OR part)
7. Two involute gears in mesh have a 20° pressure angle. The gear ratio is 3 and the number of teeth on the pinion is 24. The teeth have a module of 6 mm. The pitch line velocity is 1.5 m/s and the addendum equal to one module. Determine the angle of action of a pinion (the angle turned by the pinion when one pair of teeth is in the mesh) and the maximum velocity of sliding. (S24 - Q5c, 07 marks - OR part)
8. What is interference in gears? How it can be avoided? (S23 - Q5a, 03 marks)
9. Write a short note on automobile differential gear box. (S23 - Q5b, 04 marks)
10. Determine minimum number of teeth required on pinion & wheel to avoid interference when gear ratio is 3 & when number of teeth on pinion and wheel is equal, consider pressure angle 20° and assume addendum of gear is 1.1 module. (S23 - Q5c, 07 marks)
11. Write a short note on Epicyclic Gear Train. (S23 - Q5a, 03 marks - OR part)
12. Derive the expression for velocity of sliding of the mating teeth. (S23 - Q5b, 04 marks - OR part)
13. An Epicyclic gear train of a sun and planet type has the fixed outer annular A. Sun wheel S rotating at a speed of 800 revolutions/minute. In clockwise direction and arm E carrying three planet wheels P needed to be driven. If the diametral pitch is same

for all mating gears and sun wheel S and planet wheel P have 15 and 45 teeth respectively. Determine number of teeth on annular A and speed of direction of rotation of planet. (S23 - Q5c, 07 marks - OR part)

14. Differentiate between Involute and Cycloidal profile of gear tooth. (S22 - Q3a, 03 marks)
15. Define the term: 1. Pitch circle 2. Pitch Diameter 3. Pitch Point 4. Module. (S22 - Q3b, 04 marks)
16. 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 the gear A which is fixed, determine the speed of gear B. If the gear A instead of being fixed makes 300 r.p.m. in the clockwise direction, what will be the speed of gear B? (S22 - Q3c, 07 marks)
17. Define the following terms: (1) Dry friction (2) Film friction (3) Limiting angle of friction. (S22 - Q4a, 03 marks - OR part)
18. Discuss the various types of the brakes. (S22 - Q4b, 04 marks - OR part)
19. A bicycle and rider of mass 100 kg are travelling at the rate of 16 km/h on a level road. A brake is applied to the rear wheel which is 0.9 m in diameter and this is the only resistance acting. How far will the bicycle travel and how many turns will it make before it comes to rest? The pressure applied on the brake is 100 N and μ = 0.05. (S22 - Q4c, 07 marks - OR part)
20. Illustrate with the neat sketch the “sun and planet wheel.” (S22 - Q5b, 04 marks - OR part)
21. Explain the condition for correct steering. Sketch and show the Davis steering mechanism and discuss their advantages. (S22 - Q5c, 07 marks - OR part)
22. Explain reverted gear train with neat sketch. (W25 - Q3b, 04 marks - OR part)
23. 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, 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. (W25 - Q3c, 07 marks - OR part)
24. What are epicyclic gear trains? state its special advantages. (W25 - Q4b, 04 marks - OR part)
25. What do you understand by the term ‘interference’ as applied to gears? (W25 - Q5b, 04 marks - OR part)
26. Differentiate between involute and cycloidal gear. (W24 - Q5b, 04 marks)
27. What is law of gearing? Derive the equation for sliding velocity in gear. (W24 - Q5c, 07 marks)
28. Explain Addendum, Module, Backlash in Gear. (W24 - Q5a, 03 marks - OR part)
29. Write short note on differential gear box. (W24 - Q5b, 04 marks - OR part)
30. In an epicyclic gear train arm carries two gears A and B having 30 and 45 teeth respectively. If arm rotates at 150 rpm in clockwise direction about center of gear A which is fixed, Determine speed of gear B. If the gear A instead of being fixed makes 300 rpm in clockwise direction what will be speed of gear B? (W24 - Q5c, 07 marks - OR part)



31. What do you understand by gear train? Discuss the various types of gear train. (W23 - Q5b, 04 marks)
32. Two gear wheels of 10 cm and 15 cm pitch diameters have involute teeth of 1.6 DP and pressure angle 20°. The addenda are 3 mm. Determine (i) length of path of contact (ii) contact ratio, and (iii) angle turned by the pinion, while any pair of teeth is in contact. (W23 - Q5c, 07 marks)
33. Prove that the velocity of sliding is proportional to the distance of the point of contact from the pitch point. (W23 - Q5a, 03 marks - OR part)
34. What do you understand by the term 'interference' as applied to gears? (W23 - Q5b, 04 marks - OR part)
35. In an epicyclic gear train as in Fig.2, the arm A is fixed to shaft S. The wheel B having 100 teeth rotates freely on the shaft S and wheel F with 150 teeth is separately driven. If the arm A runs at 200 rpm and wheel F at 100 rpm in the same direction, find (a) Number of teeth on wheel C, (b) speed of wheel B. (W23 - Q5c, 07 marks - OR part) - *(Figure given)*.

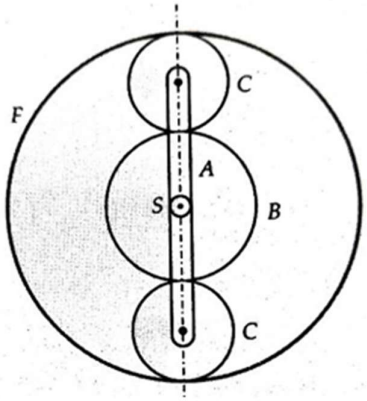
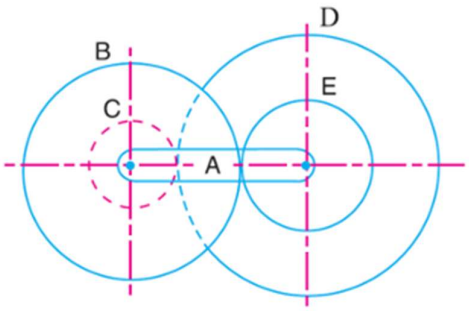


Fig.2

36. Two involute gears of 20° pressure angle are in mesh. The number of teeth on pinion is 20 and the gear ratio is 2. If the pitch expressed in module is 5 mm and the pitch line speed is 1.2 m/s, assuming addendum as standard and equal to one module, find the angle turned through by pinion when one pair of teeth is in mesh and the maximum velocity of sliding. (W22 - Q2c, 07 marks)
37. State the law of gearing. (W22 - Q3a, 03 marks)
38. Differentiate spur and helical gear. (W22 - Q3b, 04 marks)
39. In a reverted epicyclic gear train, the arm A carries two gears B and C and a compound gear D - E. The gear B meshes with gear E and the gear C meshes with gear D. The number of teeth on gears B, C and D are 75, 30 and 90 respectively. Find the speed and direction of gear C when gear B is fixed and the arm A makes 100 r.p.m. clockwise. (W22 - Q3c, 07 marks)


D
B
E
C
A

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