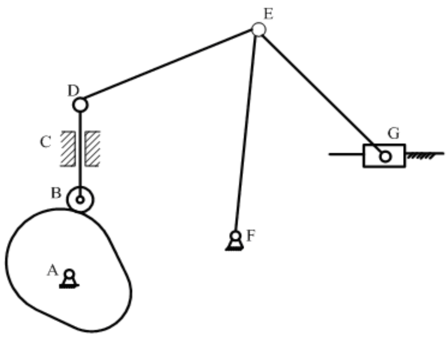
Chapter2

1.The mechanism is shown below.



1) Calculate the DOF;

2）If there are compound hinges, passive DOF and redundant constraints, please figure them out;

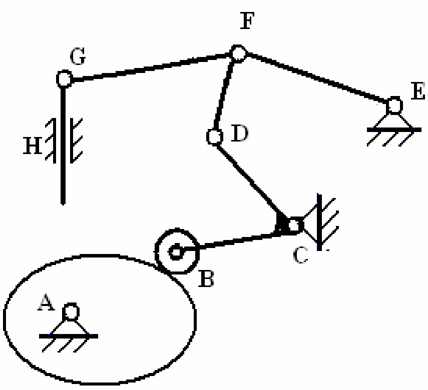
3) If the motion of the mechanism is determined, how many driving links should be there?

1) $F=3N-2P_l-P_h=3\times6-2\times8-1=1$

2) Point E compound hinges, point B passive DOF.

3) One driving link.

2.The mechanism is shown below.



1) Calculate the DOF;

2）If there are compound hinges, passive DOF and redundant constraints, please figure them out;

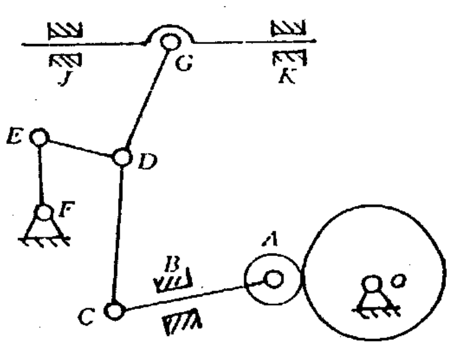
3) If the motion of the mechanism is determined, how many driving links should be there?

1) $F=3N-2P_l-P_h=3\times6-2\times8-1=1$

2) Point F compound hinges, point B passive DOF.

3) One driving link.

3.The mechanism is shown below.



1) Calculate the DOF;

2）If there are compound hinges, passive DOF and redundant constraints, please figure them out;

3) If the motion of the mechanism is determined, how many driving links should be there?

1) $F=3N-2P_l-P_h=3\times7-2\times9-1=2$

2) Point D compound hinges, point A passive DOF, point K or J redundant constraint.

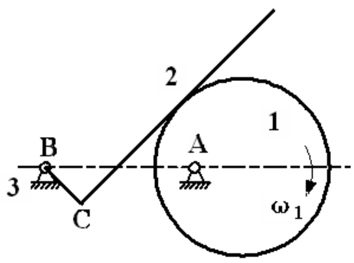
3) Two driving links.

Homework:

Ex.2-7: 48,51,54,57

Chapter3

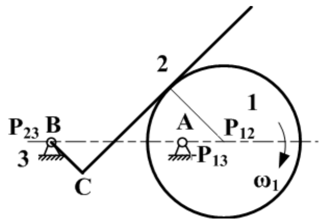
1.Exercise 1: The mechanism is shown below. The angular velocity ω_1 of link 1 is given. (1) locate all instant centers for the mechanism, (2) find the angular velocity ω_2 of link 2.



Solution:

$$\omega_1 l_{P13P12} = \omega_2 l_{P23P12}$$

$$\omega_2 = \frac{\omega_1 l_{P13P12}}{l_{P23P12}}$$

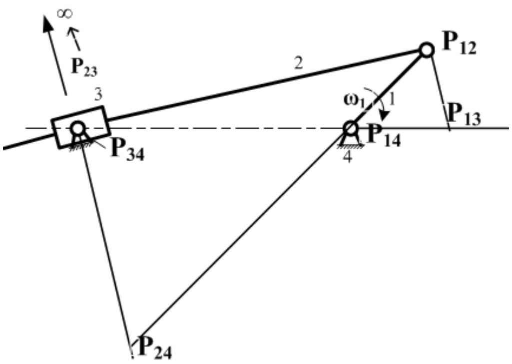


2.Exercise 2: The mechanism is shown below. The angular velocity ω_1 of link 1 is given. (1) locate all instant centers for the mechanism, (2) find the angular velocity ω_3 of link 3.

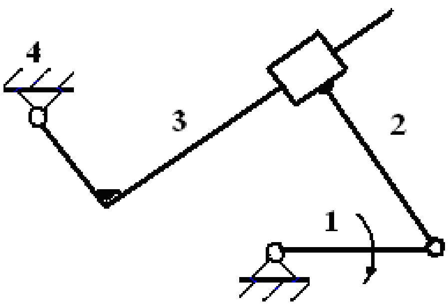
Solution:

$$\omega_1 l_{P14P13} = \omega_3 l_{P34P13}$$

$$\omega_3 = \frac{\omega_1 l_{P14P13}}{l_{P34P13}}$$



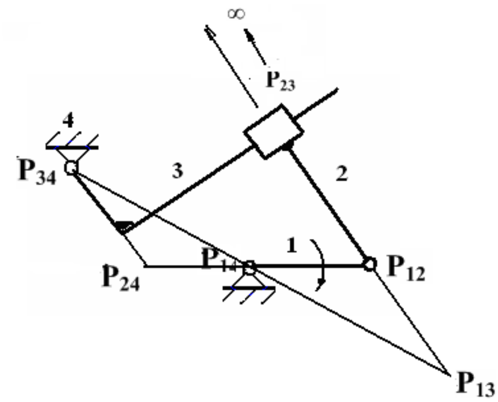
3. The mechanism is shown below. The angular velocity ω_1 of link 1 is given. (1) locate all instant centers for the mechanism, (2) find the angular velocity ω_3 of link 3.



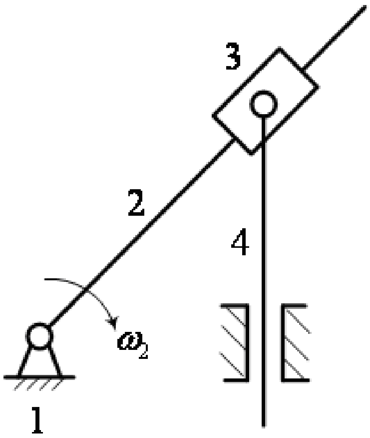
Solution:

$$\omega_1 l_{P14P13} = \omega_3 l_{P34P13}$$

$$\omega_3 = \frac{\omega_1 l_{P14P13}}{l_{P34P13}}$$



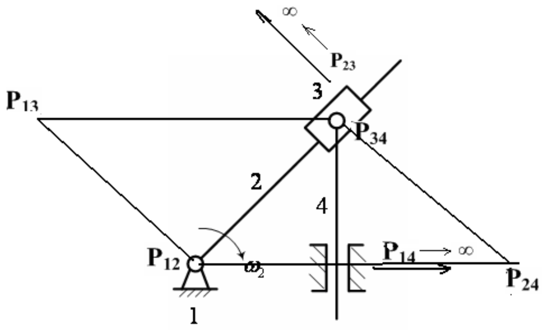
4.The mechanism is shown below. The angular velocity ω_2 of link 2 is given. (1) locate all instant centers for the mechanism, (2) find the velocity v_4 of link 4.



Solution:

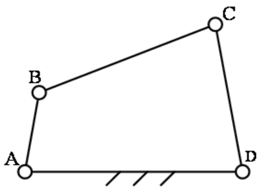
$$\omega_2 l_{P12P24} = \omega_4 l_{P14P24}$$

$$\omega_4 = \frac{\omega_2 l_{P12P24}}{l_{P14P24}}$$



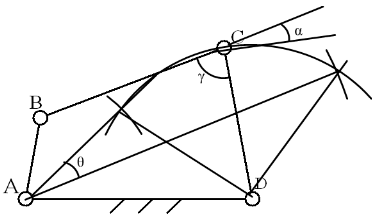
Chapter4

1.Exercise 1: The dimensions of a revolute four-bar linkage are given. AB＝30mm，BC＝70mm，CD=67mm, AD=80mm. Link AB is the driving link. 1) Determine the type of the linkage mechanism. 2) Draw the pressure angle α and transmission angle γ. 3) Draw the crank acute angle of two limiting positions θ. 4) Can this mechanism have dead points? Under what circumstance will it have dead points?

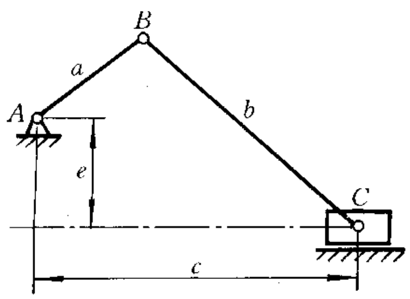


Solution:

1) Crank-rocker mechanism.
2) Pressure angle and transmission angle are shown.
3) Crank acute angle of two limiting position is shown.
4) No dead points. If we take rocker as the driving link, there are dead points.

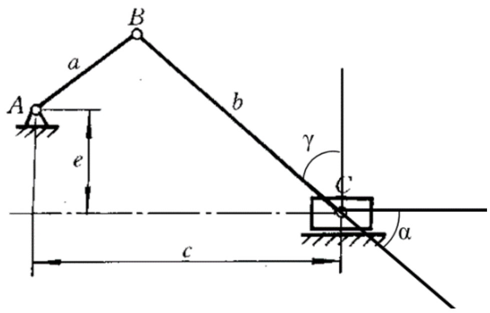


2.Exercise 2: One planar four-bar linkage are shown. Link AB is the driving link. 1) Name the linkage mechanism. 2) Write out the condition for having crank of the mechanism. 3) Draw the pressure angle α and transmission angle γ. 3) Determine if it has quick return characteristic. 4) Can this mechanism have dead points? Under what circumstance will it have dead points?

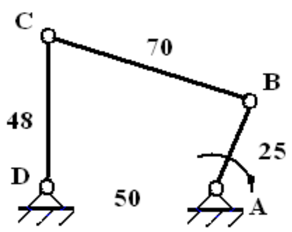


Solution:

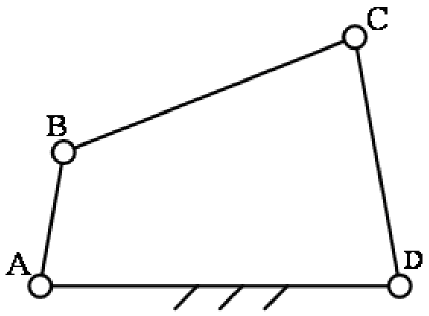
1) Offset slider-crank mechanism.
2) a+e≤b
3) There is quick return characteristic.
4) No dead points. If we take slider as the driving link, there are dead points.



3.Homework 1: The dimensions of a revolute four-bar linkage are given. Link AB is the driving link. 1) Determine the type of the linkage mechanism. 2) Draw the pressure angle α and transmission angle γ. 3) If the coefficient of travel speed variation K=1.7, calculate the crank acute angle of two limiting positions θ. 4) Can this mechanism have dead points? Under what circumstance will it have dead points?

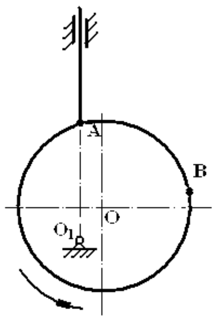


4.Homework 2: The dimensions of a revolute four-bar linkage are given. AB＝28mm，BC＝52mm，CD=50mm, AD=72mm. Link AB is the driving link. 1) Determine the type of the linkage mechanism. 2) Determine the types of revolutes A, B, C and D. 3) Draw the pressure angle α and transmission angle γ. 4) If the coefficient of travel speed variation K=1.2, calculate the crank acute angle of two limiting positions θ. 5) Can this mechanism have dead points? Under what circumstance will it have dead points?

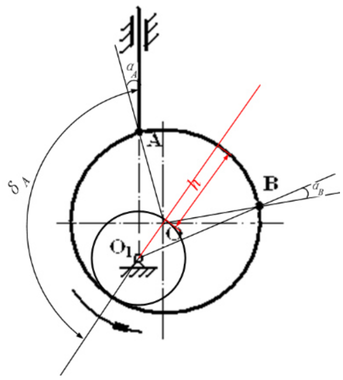


Chapter5

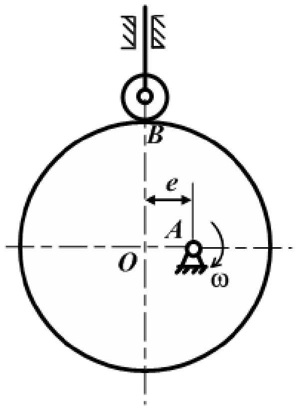
1.Exercise 1: The cam mechanism is shown in the figure.. 1) Draw the prime circle. 2) Draw the pressure angles of positions A and B. 3) Draw the displacements of positions A and B. 4) Draw the lift h of the follower. 5) Draw the rotation angle of position A.



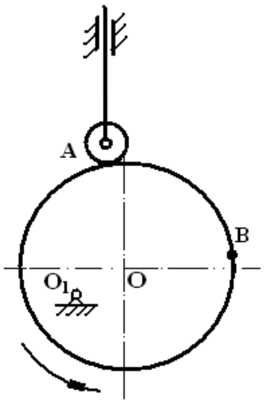
Solution:



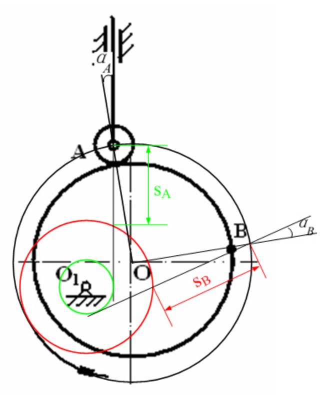
2.Exercise 2 : The cam mechanism is shown in the figure. 1) Draw the pitch curve. 2) Draw the prime circle and offset circle. 3) Draw the pressure angle of position B. 4) Draw the displacement of position B. 5) Draw the lift h of the follower.



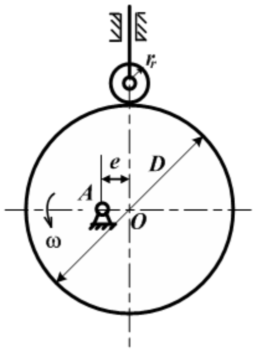
3.Homework 1 : The cam mechanism is shown in the figure. 1) Draw the pitch curve. 2) Draw the prime circle. 3) Draw the pressure angles of positions A and B. 4) Draw the displacements of positions A and B.



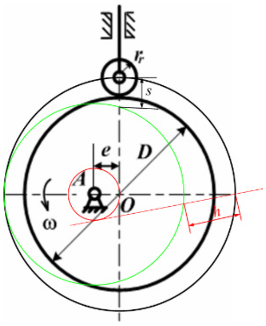
Solution:



4.Homework 2: The cam mechanism is shown in the figure. D=42mm, r_r=5mm, e=6mm.1) Draw the pitch curve. 2) Draw and calculate radius of the prime circle. 3) Draw the offset circle. 4) Draw the pressure angle of this position. 5) Draw the displacement of this position. 6) Draw the lift h of the follower.



Solution:



2)

$$r_p = D/2 + r_r - e = 21 + 5 - 6 = 20mm$$

3)

$$\alpha = 0°$$

Chapter6

1.Exercise 1: Suppose that a pair of standard involute spur external gears. m=5mm, z_1=20, z_2=40, α= 20°, h_a*=1, c*=0.25. Calculate: 1) Diameters of reference circles d_1, d_2. 2) Diameters of addendum circles d_{a1}, d_{a2}. 3) The pressure angles of addendum circles α_{a1}, α_{a2}. 4) Diameters of dedendum circles d_{f1}, d_{f2}. 5) Diameters of base circles d_{b1}, d_{b2}. 6) The reference center distance *a*. 7) If the actual center distance *a'*=155, calculate working pressure angle α'. 8) If helical gears are adapted instead of spur gears, the parameters are the same as spur ones, if center distance *a*=155, calculate the helix angle β.

Solution:

1)

$$d_1 = mz_1 = 100mm \ d_2 = mz_2 = 200mm$$

2)

$$d_{a1} = mz_1 + 2h_a{}^* m = 110mm$$

$$d_{a2} = mz_2 + 2h_a{}^* m = 210mm$$

3)

$$d_{b1} = d_{a1} \cos\alpha_{a1} = d_1 \cos\alpha$$

$$\alpha_{a1} = 31.32°$$

$$d_{b2} = d_{a2} \cos\alpha_{a2} = d_2 \cos\alpha$$

$$\alpha_{a1} = 26.5°$$

4)

$$d_{f1} = (z_1 - 2h_a^* - 2c^*)m = 87.5mm$$

$$d_{f2} = (z_2 - 2h_a^* - 2c^*)m = 187.5mm$$

5)

$$d_{b1} = mz_1 \cos\alpha = 93.97mm$$

$$d_{b2} = mz_2 \cos\alpha = 187.94mm$$

6)

$$a = \frac{m(z_1 + z_2)}{2} = 150mm$$

7)

$$a' \cos\alpha' = a \cos\alpha$$

$$\alpha' = 24.58°$$

8)

$$a = \frac{m_n(z_1 + z_2)}{2\cos\beta} = 155$$

$$\beta = 14.59°$$

2.Homework 1: Suppose that a pair of standard involute spur external gears. m=20mm, z_1=30, z_2=40, α= 20°, h_a*=1, c*=0.25. Calculate: 1) Diameters of reference circles d_1, d_2. 2) Diameters of addendum circles d_{a1}, d_{a2}. 3) The pressure angles of addendum circles α_{a1}, α_{a2}. 4) Diameters of dedendum circles d_{f1}, d_{f2}. 5) Diameters of base circles d_{b1}, d_{b2}. 6) The reference center distance a. 7) If the actual center distance a'=725, calculate working pressure angle α'. 8) If helical gears are adapted instead of spur gears, the parameters are the same as spur ones, if center distance a=725, calculate the helix angle β.

3.Homework 2: Suppose that a pair of standard involute spur external gears. The reference center distance is a=200mm, m=4mm, z_1=20, α= 20°, h_a*=1, c*=0.25. Calculate: 1) The tooth number of gear 2 z_2. 2) Diameters of reference circles d_1, d_2. 2) Diameters of addendum circles d_{a1}, d_{a2}. 3) Diameters of dedendum circles d_{f1}, d_{f2}. 4) Diameters of base circles d_{b1}, d_{b2}. 5) The tooth thickness s of reference circle. 7) If the actual center distance a'=205, calculate working pressure angle α' and bottom clearance c.

Solution:

1)

$$a = \frac{m(z_1 + z_2)}{2} = \frac{4\times(20+z_2)}{2} = 200mm$$

$$z_2 = 80$$

5)

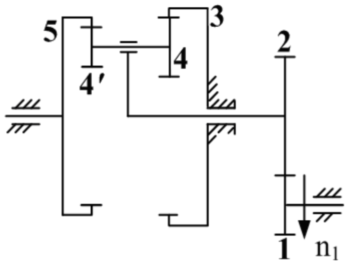
$$s = \frac{\pi m}{2} = 6.28$$

7)

$$c = c^* m + a' - a = 0.25\times 4 + 205 - 200 = 6mm$$

Chapter7

1.Exercise 1: In the combined gear train shown in figure. z_1=30, z_2=75, z_3=130，z_4=50，$z_{4'}$=40, z_5=120. n_1=750r/min and the rotating direction is shown in figure. Find out 1) Train ration of i_{15}. 2) The rotation magnitude and direction of gear 5.



Solution:

(a) In ordinary gear train 1-2

$$i_{12} = \frac{n_1}{n_2} = -\frac{Z_2}{Z_1} = -2.5$$

(b) In planetary gear train 3-4-4'-5-2

$$i_{53}^{2} = \frac{n_5 - n_2}{n_3 - n_2} = \frac{n_5 - n_2}{-n_2} = \frac{z_{4'} z_3}{z_5 z_4} = \frac{40\times 130}{120\times 50} = \frac{13}{15}$$

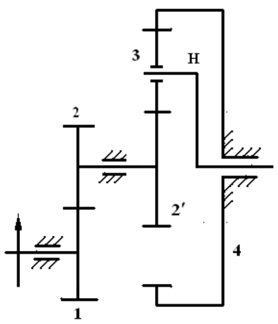
$$\frac{n_5}{n_2} = \frac{2}{15}$$

$$i_{15}=i_{12}/i_{52}=-\frac{75}{4}=-18.75$$

$$n_5=\frac{n_1}{i_{15}}=-40r/\min$$

The rotation direction of gear 5 is opposite to that of gear 1.

2.Exercise 2: In the combined gear train shown in figure. Z_1=20, Z_2=25, $Z_{2'}$=50, Z_3=20，Z_4=90. n_1=1450r/min and the rotating direction is shown in figure. Find out 1) Train ration of i_{1H}. 2) The rotation magnitude and direction of carrier, n_H.



Solution:

(a) In ordinary gear train 1-2

$$i_{12}=\frac{n_1}{n_2}=-\frac{Z_2}{Z_1}=-\frac{5}{4}$$

(b) In planetary gear train 2’-3-4-H

$$i_{2'4}^{H}=\frac{n_{2'}-n_H}{n_4-n_H}=\frac{n_2-n_H}{-n_H}=-\frac{Z_3Z_4}{Z_{2'}Z_3}=-\frac{Z_4}{Z_{2'}}=-\frac{9}{5}$$

$$\frac{n_2}{n_H}=\frac{14}{5}$$

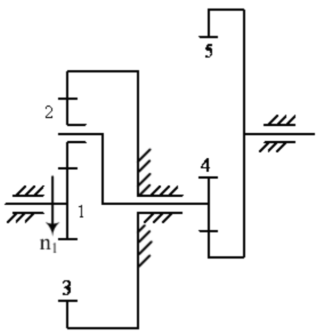
$$i_{1H}=\frac{n_1}{n_H}=(\frac{n_1}{n_2})(\frac{n_2}{n_H})=-3.5$$

$$n_H=\frac{n_1}{i_{1H}}=\frac{1450}{-3.5}=-414.3$$

The rotation direction of carrier H is opposite to that of gear 1.

3.Homework 1: In the combined gear train shown in figure. Z_1=Z_2=20, Z_3=60，Z_4=18，

Z_5=54. n_1=960r/min and the rotating direction is shown in figure. Find out 1) Train ration of i_{15}. 2) The rotation magnitude and direction of gear 5, n_5.



Solution:

(a) In planetary gear train 1-2-3-4

$$i_{13}^{4} = \frac{n_1 - n_4}{n_3 - n_4} = \frac{n_1 - n_4}{-n_4} = -\frac{z_3}{z_1} = -\frac{60}{20} = -3$$

$$i_{14} = \frac{n_1}{n_4} = 4$$

(b) In ordinary gear train 4-5

$$i_{45} = \frac{n_4}{n_5} = \frac{Z_5}{Z_4} = 3$$

$$i_{15} = i_{14} \cdot i_{45} = 12$$

$$n_5 = \frac{n_1}{i_{15}} = 80r/\min$$

The rotation direction of gear 5 is the same as that of gear 1.

4.Homework 2: In the planetary gear train shown in figure. Z_1=50, Z_2=30, Z_3=100. n_1=750r/min and the rotating direction is shown in figure. Find out 1) Train ration of i_{1H}. 2) The rotation magnitude and direction of carrier, n_H.