考试教室　姓名　学号　年级　专业、班　学院

密　封　线

重庆大学《机械原理》课程试卷

A卷　B卷

20 20 — 20 21 学年 第 二 学期

开课学院：机械工程学院 课程号：ME31803 考试日期：2021.04.30

考试方式：开卷 闭卷 其他　　考试时间：120 分钟

题 号	一	二	三	四	五	六	七	八	九	十	总 分
得 分											

备注：

1. 使用试卷标准格式命题时，大标题一律采用四号宋体、小标题及正文用小四号宋体；

2. 每套试卷满分应该为 100 分；在每大题的题号后面括号内标明该题的分数值；

3. 打印试题时按 A4 纸缩小打印，制卷时再统一按比例放大；试卷原则上要求单面印刷，按份装订。

（以上红色字体为命题时参考内容，命题完成后打印前请删除掉）

考试提示

1.严禁随身携带通讯工具等电子设备参加考试；

2.考试作弊，留校察看，毕业当年不授学位；请人代考、替他人考试、两次及以上作弊等，属严重作弊，开除学籍。

TASK-1 (Mark: 15 points)

1) What are the properties of involute? Why can involute gears satisfy the basic law of tooth profile meshing? What are the conditions for correct engagement and continuous transmission of involute gears? (Mark: 8 points)

Solution:

1) (3 points)

a. The length of the segment on the generating line is equal to the length of the arc rolled across the base circle.

b. The normal of any point on the involute is tangent to the base circle.

c. The closer the involute is to the part of the base circle, the smaller the curvature radius is, and the curvature radius on the base circle is zero.

d. The shape of the involute depends on the size of the base circle.

e There are no involutes in the base circle.

2) (3 points)

It's determined by the involute properties. The involute normal line is tangent to the base circle. When the two gears engage, the normal line is also a meshing line. This line can divide the center line of the two wheels into a constant ratio line segment, which satisfies the tooth profile meshing law.

3) (2 points)

a Involute tooth profile can ensure constant transmission ratio and separability.

b The direction of positive pressure between involute tooth profiles remains unchanged, always along the direction of the meshing line, so the direction of force transmission remains unchanged, which is beneficial to the smoothness of gear transmission.

2) By learning CAM mechanism, please talk about what is rigid impact and flexible impact? (Mark: 7 points)

Solution:

Rigid impact:：The inertial force generated by acceleration changes to infinity, resulting in a strong mechanical impact. When the push rod of the CAM mechanism is at the beginning and the end of the movement of the moment, because of the sudden change in speed, the push rod will appear infinite acceleration and inertia force in theory, so the CAM mechanism will be subjected to great impact, this impact is called rigid impact. (3 points)

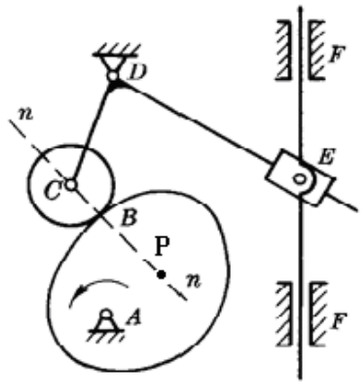
Flexible impact: the impact caused by the sudden change of finite value in the acceleration of a follower at a certain instant. Flexible impact is relative to rigid impact. At the beginning and end of the motion, there is no sudden change in velocity, so there is no rigid impact; But the acceleration has a sudden change, resulting in a larger inertia force, the impact caused by this is called the flexible impact. The motion of flexible impact can only be applied to medium speed situations. (3 points)

The low speed field is suitable for rigid impact. Flexible impact and rigid impact should be avoided in high speed situations. (1 points)

命题人：魏静　组题人：刘达斌　审题人：魏静　命题时间：20210411　教务处制

TASK-2 (Mark: 10 points)

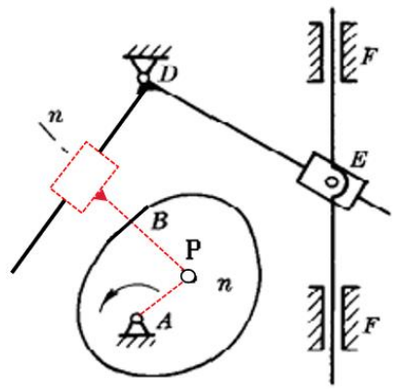
Try to calculate the DOF of the planar high pair mechanism as shown in the figure, and analyze the Assur Group that makes up the mechanism via replacing higher pair by lower pairs.

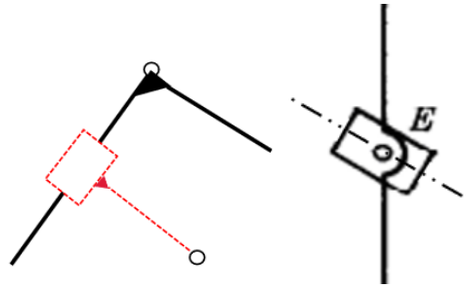


Solution:

1) $F=3n-(2p_1+p_h)-F'=3\times5-(2\times6+1)-1=1$ (4 points)

2) Schematic diagram of the mechanism after replacing higher pair by lower pairs. **(6 points)**





So two II link-group that make up the mechanism via replacing higher pair by lower pairs.

TASK-3 (Mark: 15 points)

Given: Dispense a missing spur gear. The number of teeth Z_2 =52 of the wheel meshing with it is now measured, tip diameter $d_{a2}=134.9mm$, center distance $a=112.55mm$, pressure angle $\alpha=20°$, system of normal tooth.

Determine: Try to find the main size parameters of the pinion.

Solution:

1) To calculate the module

$d_{a2}=(z_2+2h_a^*)m$, then $m=\dfrac{d_{a2}}{Z_2+2h_a^*}=\dfrac{134.9}{52+2\times1}=2.5$ **(2 points)**

2) number of teeth

$a=\dfrac{m}{2}(Z_1+Z_2)$, then $Z_1=\dfrac{2a}{m}-Z_2=\dfrac{2\times112.55}{2.5}-52=38$ **(2 points)**

3) reference diameter

$d_1=mZ_1=2.5\times38=95mm$ (2 points)

4) Tip diameter

$d_{a1}=d_1+2h_a^*m=95+2\times1\times2.5=100mm$ (3 points)

5) root diameter

$d_{f1}=d_1-2(h_a^*+C^*)m=95-2\times(1+0.25)\times2.5=88.75mm$ (3 points)

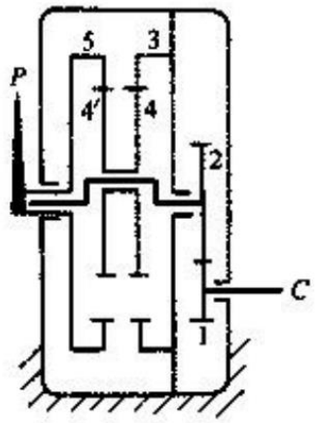
6) basic circle diameter

$d_b=d_1\cos\alpha=95\cdot\cos20=89.27mm$ (3 points)

TASK-4 (Mark: 15 points)

Given: In the bicycle odometer mechanism shown in the figure, C is the wheel axle and P is the odometer pointer. Given the number of teeth of each wheel is： $z_1=17$, $z_3=23$, $z_4=19$, $z_{4'}=20$, $z_5=24$. Suppose the effective diameter of the wheel after the tire is deformed under pressure is 0.7 m. When the bicycle travels 1 km, the pointer on the table just turns around once.

Determine: Try to calculate the number of the teeth for gear 2.



Solution:

When the bike travels 1 km, the number of turns of the tire is n_c, then $n_c = 1000/(0.7\pi)$, it is known that $n_5 = 1$, and the gear train is a compound gear train, 1and 2 constitute the fixed shaft gear train; 3, 4-4', 5 and 2(H) form the planetary gear train. Therefore: (5 points)

$i_{12} = n_1 / n_2 = -z_2 / z_1$

$i_{35}^{H} = \dfrac{n_3 \cdot n_h}{n_5 \cdot n_H} = (-1)^0 \dfrac{z_4 \cdot z_5}{z_3 \cdot z_{4'}}$ (5 points)

$n_2=n_H$, $n_3=0$

Together with the above equation, we can find $z_2 \approx 68$. (5 points)

TASK-5 (Mark: 15 points)

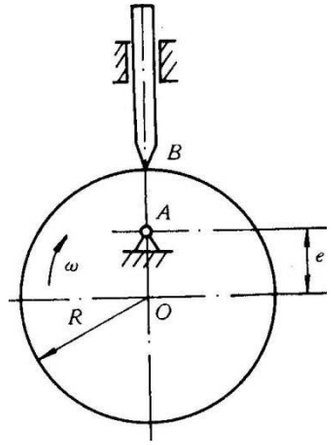
Given: The eccentric disc CAM mechanism is shown in the figure. The radius of the disc is R=50 mm and the eccentricity is e=25 mm. When CAM with Ω=25rad/s clockwise rotation 90°, The speed of push rod is v=50 mm/s.

Determine:

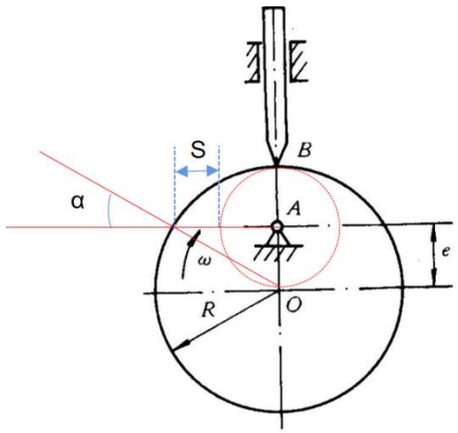
(1) What is the pressure Angle of the CAM mechanism at this position? (5 points)

(2) What is the displacement of the push rod at this position? (5 points)

(3) What is the stroke h of the push rod of the CAM mechanism? (5 points)



Solution:



1) $\tan\alpha = \dfrac{e}{\sqrt{R^2 - e^2}} = \dfrac{25}{\sqrt{50^2 - 25^2}} = \dfrac{\sqrt{3}}{3}$, then α=30° (5 points)

2) $S = \sqrt{R^2 - e^2} - \dfrac{R}{2} = \sqrt{50^2 - 25^2} - 25 \approx 18.30\text{mm}$ (5 points)

3) h=R=50 mm(5 points)

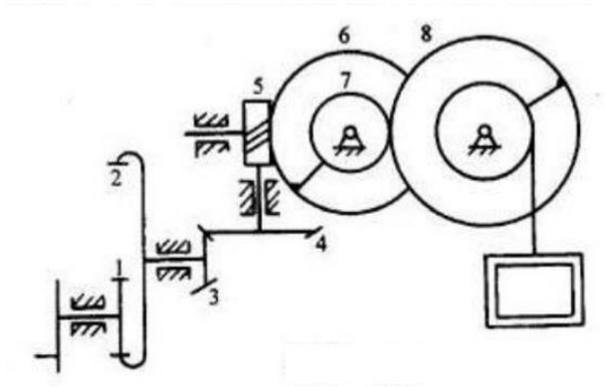
TASK-6 (Mark: 15 points)

Given: In the hand lifting device shown in the figure, the number of teeth of each gear is known as: $z_1 = 20$, $z_2 = 50$, $z_3 = 15$, $z_4 = 30$, $z_6 = 40$, $z_7 = 18$, $z_8 = 51$, The worm $z_5 = 1$ is right-handed.

Calculate:

(1) Try to find the transmission ratio i_{18} (8 points)

(2) Determine the turn of handle when lifting heavy objects. (7 points)

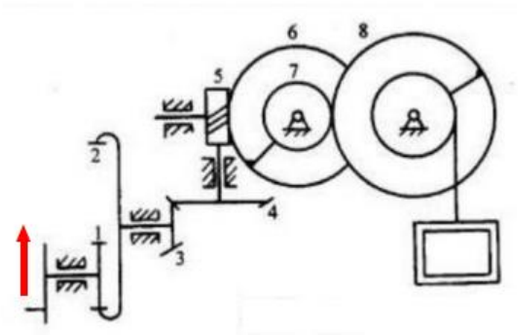


Solution:

(1) The gear train is a space fixed shaft gear train, then

$i_{18}=\frac{z_2z_4z_6z_8}{z_1z_3z_5z_7}=\frac{50\times30\times40\times51}{20\times15\times1\times18}\approx566.67$ (8 points)

(2) The handle direction when lifting heavy objects is shown in the figure. (7 points)



TASK-7 (Mark: 15 points)

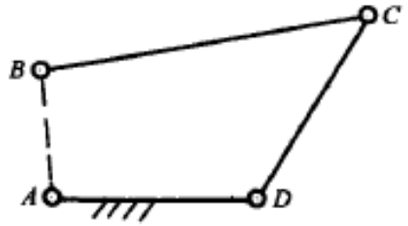
Given: The hinged four-bar mechanism ABCD as shown in the figure, $l_{BC}=50mm$, $l_{CD}=35mm$, $l_{AD}=30mm$, take AD as the frame.

Calculate:

(1) If the mechanism is a crank-rocker mechanism and AB is a crank, find the value range of $l_{AB.}$ (5 points)

(2) If the mechanism is a double crank mechanism, find the value range of $l_{AB.}$ (5 points)

(3) If the mechanism is a double rocker mechanism, find the value range of $l_{AB.}$ (5 points)



Solution:

1) If the mechanism can be a crank-rocker mechanism and AB is a crank, then AB shall be the shortest bar and BC is known to be the longest bar, according to the condition of the existence of an full rotation pair:

$l_{AB}+l_{BC}\le l_{AD}+l_{CD}$, then $l_{AB}\le l_{AD}+l_{CD}-l_{BC}=30+35-50=15\text{mm}$, then $l_{AB}\le15mm$ (5 points)

2) If the mechanism can become a double-crank mechanism, the conditions for the existence of full rotation pair should also be satisfied, and the shortest bar AD should be used as the frame, then respectively

When AB is the longest bar, $l_{AB}+l_{AD}\le l_{BC}+l_{CD}$,

then $l_{AB}\le l_{BC}+l_{CD}-l_{AD}=50+35-30=55\text{mm}$, then $l_{AB}\le55mm$

When BC is the longest bar, $l_{BC}+l_{AD}\le l_{AB}+l_{CD}$

$l_{AB}\ge l_{BC}+l_{AD}-l_{CD}=50+30-35=45\text{mm}$, $l_{AB}\ge45mm$

Then $45mm\le l_{AB}\le55mm$

(5 points)

3) If the mechanism can be a double rocker mechanism, the sum of the length of the shortest bar and the longest bar should be greater than the sum of the length of the other two bars.

When AB is the shortest bar, $l_{AB}+l_{BC}>+l_{CD}+l_{AD}$

Then $l_{AB}>l_{CD}+l_{AD}-l_{BC}=35+30-50=15\text{mm}$, then $l_{AB}\ge15mm$

When AB is neither the longest nor the shortest bar, $l_{BC}+l_{AD}>+l_{AB}+l_{CD}$

Then $l_{AB}<l_{BC}+l_{AD}-l_{CD}=50+30-35=45mm$, then $l_{AB}\le45mm$

When AB is the longest bar, $l_{AB}+l_{AD}>l_{BC}+l_{CD}$,

$l_{AB}>l_{BC}+l_{CD}-l_{AD}=50+35-30=55mm$, then $l_{AB}\ge55mm$

Because the maximum length of AB bar cannot be greater than the sum of the other three bar lengths, so $l_{AB}<l_{BC}+l_{CD}+l_{AD}=50+35+30=115mm$

Based on the above analysis, the length of AB bar is obtained as:

$15mm\le l_{AB}\le45mm$ or $55mm\le l_{AB}\le115mm$ (5 points)