**2-5520 Theory of Mechanisms**

Glossary

for bachelors study in 3rd year-classis, summer semester

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**Lecture 2: Theory of Mechanisms and structural parameters of MBS**

**Sections in Lecture 2:**

S1 The finite angle of slew

S2 Control curves

S3 Application

## S1 The finite angle of slew

Types of motions

In the slider crank mechanism on Fig.1 the PAR2 (crank) wrt PAR1 (ground) rotates 2/1, the PAR4 (piston) wrt PAR1 (ground) translates 4/1, and the PAR3 (coupler) moves wrt PAR1 (ground) via general planar motion 3/1 (it perform neither rotation, nor translation).

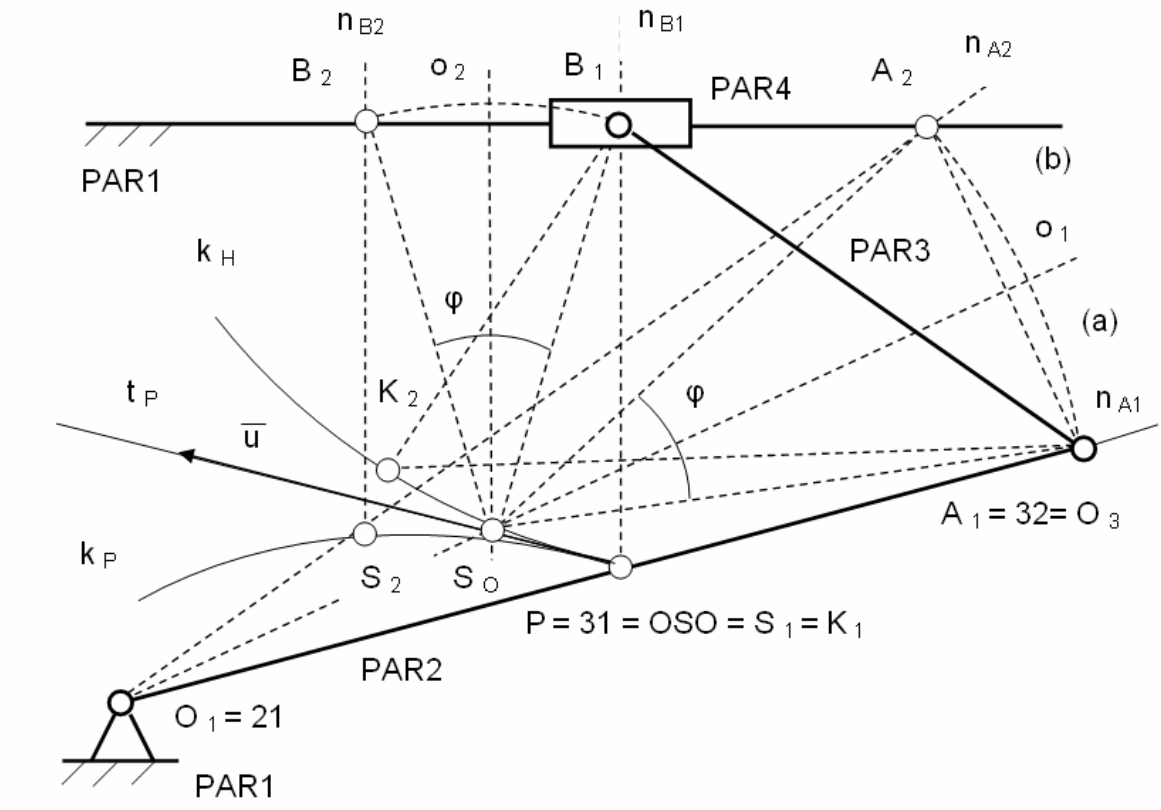


Fig.1 The slider crank mechanism in initial configuration ($O_1A_1B_1$) and final configuration ($O_1A_2B_2$).

Finite angle of slew

The lamina with coupler $\overset{uuuu}{AB}$ can be displaced from its initial position $\overset{uuuuuu}{A_1B_1}$ to the final position $\overset{uuuuuu}{A_2B_2}$ via slew about center $S_o = o_1 \times o_2$ (bisection of abscisses) with finite angle $j = \mathbf{S}(A_1S_oA_2) = \mathbf{S}(B_1S_oB_2)$.

Instantaneous centre

If the finite angle $j$ of slew will be reduced to become infinite small, then the lamina with coupler $\overset{uuuu}{AB}$ will be displaced from its initial position $\overset{uuuuuu}{A_1B_1}$ to the infinitesimal close position via slew about intersection point $S_1$ of normals $n_{A1}, n_{B1}$ to the actual paths (a),(b).

This intersection point $S_1$ is instantaneous slew center $S_1 = (OSO_{31})_1 = n_{A1} \times n_{B1} = P$ of zero velocity of coupler PAR3 wrt PAR1. For configuration of mechanism when coupler is in the position $\overset{uuuuuu}{A_2B_2}$ the adjacent intersection point $S_2 = (OSO_{31})_2 = n_{A2} \times n_{B2}$ is new instantaneous slew centre $S_2$.

**S2 Control curves**

Fixed centrode

The locus of the instantaneous slew centres $\{S_i\}$ of zero velocity traced on the fixed lamina during general planar motion 3/1 of the coupler PAR3 wrt PAR1 is called the fixed centrode $k_P$.

Movable centrode

When the triangle $\Delta(A_2B_2S_2)$ will be returned to the initial position $\overset{uuuuuu}{A_1B_1}$ the point $K_2$ from movable lamina of coupler PAR 3 will be obtained. After generalization of this procedure $\Delta(A_iB_iS_i) \rightarrow \Delta(A_1B_1K_i)$ the locus of the instantaneous slew centres $\{K_i\}$ in the movable plane is called the movable centrode $k_H$.

Control curves

The general planar motion 3/1 of the coupler PAR3 wrt PAR1 can be replaced by pure rolling of movable centrode $k_H$ against fixed centrode $k_P$ (control curves).

Center of curvature

The center $S_A$ of curvature of point $A$ trajectory (a) is the center of osculating circle, by which is trajectory (a) replaced in the neighborhood of point $A$. When trajectory (a) is a circle then center $S_A$ of curvature is coincident with center of this circle. When trajectory (a) is a straight line, then center $S_A$ of curvature is a step point. During steady rotation or translation is center $S_A$ of curvature identical with instantaneous slew centre $OSO$. In case of general plane motion center $S_A$ of curvature and instantaneous slew center $OSO$ are different points.

## S3 Application

Application

Hypocyclic gear train on Fig.2 is one of well known appliance of control curves, where the movable centrode $k_H$ is planet wheel circle with radius $R_P$ and the fixed centrode $k_P$ is sun wheel circle with radius $R_C$. If the transmission ratio $m_{PC}$ defined by ratio of pitch circles radii $m_{PC} = \frac{R_P}{R_C} = \frac{1}{3}$, then point $C_1$ on pitch circle of a planet generates trajectory named Steiner's hypocycloid which is approximately of circle shape. The piston in dwell mechanism is required to be in the rest during phase of coupler BC revolution about point B, when point C is moving from $C_1$ to the $C_2$.

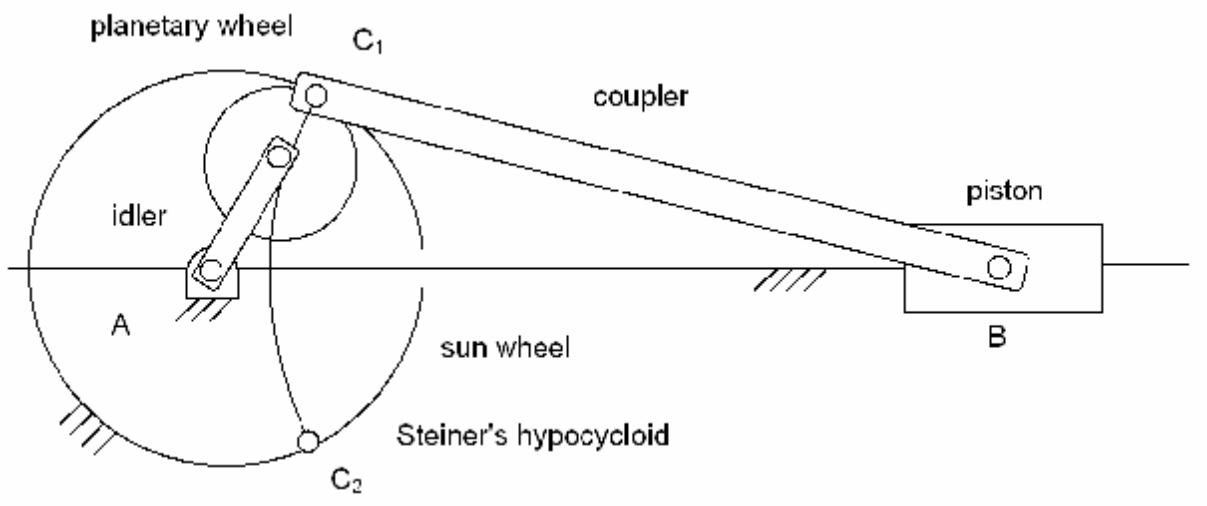


Fig 2. Dwell mechanism with hypocyclic gear train.