2-5520 Theory of Mechanisms

Glossary

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

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Lecture 12: Synthesis of planar mechanisms

Sections in Lecture 12:

S1 Task categories. Four-bar linkage. Positioning.

S2 Function generator.

S3 Path generator.

S4 Motion generator.

S5 Six-bar linkages.

S6 Showtimes of computer aided analysis and synthesis of mechanisms.

S1 Task categories. Four-bar linkage.

Task categories

A great variety of mechanisms are used in machines and devices. Even though these applications are quite different, all mechanisms can be clasified into three task categories depending on the mission that mechanisms perform:

- Function generation (positioning of output link LCS axes)
- Path generation (positioning of output link LCS origin)
- Motion generation (positioning of output link LCS origin and axes, too)

Four-bar linkage

A large majority of mechanisms exibit planar motion. A four-bar linkage has the most basic chain of pin-connected links. It consist from input link (crank, or slider), coupler (floating link) with path tracer points which generaly trace out six-order algebraic coupler curves, and ouput link (follower).

Positioning

Under term positioning of the rigid body (PART2 on Fig.1) we understand the PART2 guidance through prescribed subsequent positions of its local coordinate system (LCS) origin O_2 coincident with reference point A and angular orientation (position) of axes of its (LCS) wrt global coordinate system (GCS) $O_1(x_1,y_1)$. This description is according to Poissont´s theorem of decomposition of rigid body general motion into translational motion of body, represented by reference point (origin O_2) displacement, and rotational displacement of rigid body about this reference point (origin O_2).

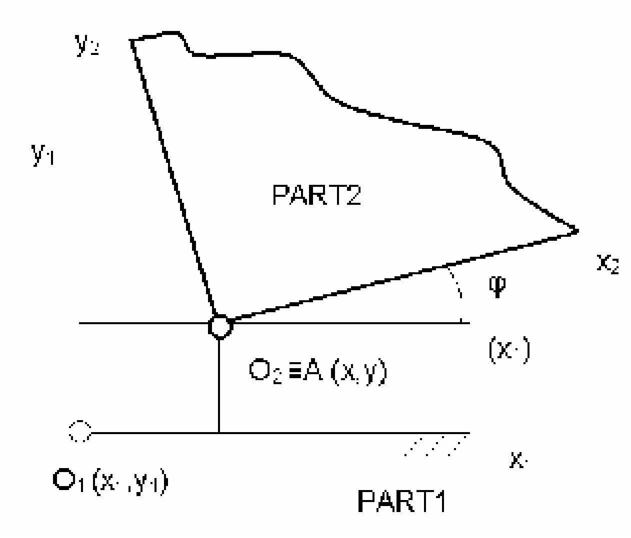

Fig.1 Position of PAR2 wrt PAR1 in plane

Position in plane

Unique position of PAR2 wrt PAR1 in plane (Fig.1) is given by two Cartesian position coordinates (x,y) of reference point A(x,y) identical with origin O_2 wrt origin O_1 of GCS (global coordinate system) and by variable (floating) angle $j = j_{12} = <(x_1, x_2)$ for angular displacement of PAR2 LCS (local coordinate system) axis x_2 wrt axis x_1 of GCS, because free body (PAR2) has mobility $n_v = 3$ in the plane.

S2 Function generator.

Function generator

Function generator is a linkage (for example on Fig.2) in which a positioning of output link (PART4) LCS axes, or relative displacement of output link connected to ground is of interest. Such mechanism should be designed to transform displacement q_{12} or forces from input link (PART2) to desired range $q_{14} = f(q_{12})$ of the ouput link (PART4) displacement q_{14}. Present formula is called the first transform function (stroke function). This task does not require control a path tracer point on the coupler link.

Lawn sprinkler

Drive linkage on Fig.2 for a lawn sprinkler, which is adjustable to obtain desired range of oscillation of the sprinkler head. Mechanism is designed to transform displacement j_{12} of input link (PART2) to desired range of the ouput link (PART4) angular displacement. $j_{14} = f(j_{12})$.

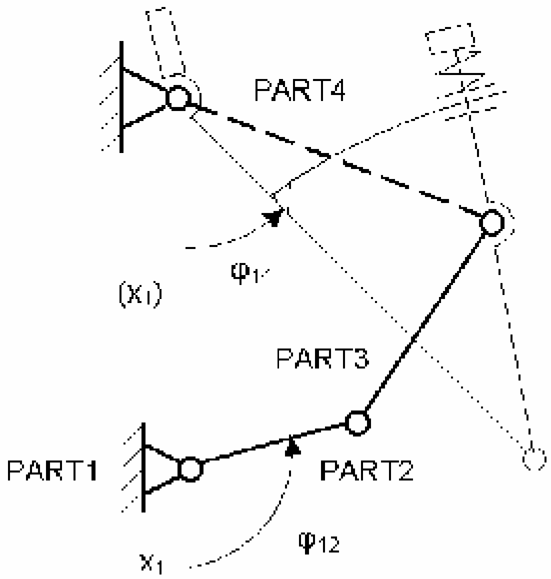

Fig.2 Drive linkage for a lawn sprinkler

S3 Path generator

Path generator

A path generator mechanism (for example on Fig.3) is positioning the proper selected path tracer point A (from output coupler link PART3) which should exibit displacement along prescribed curve (path), while angular position of coupler link is arbitrary.

Level luffing crane

This level luffing crane on Fig.3 generates approximate straight-line trajectory (a) of the path tracer point A. Since a hook at the path tracer point A holds a wire rope which is allways hanging vertically, the orientation (angular position) of the coupler link (PART3) can be arbitrary.

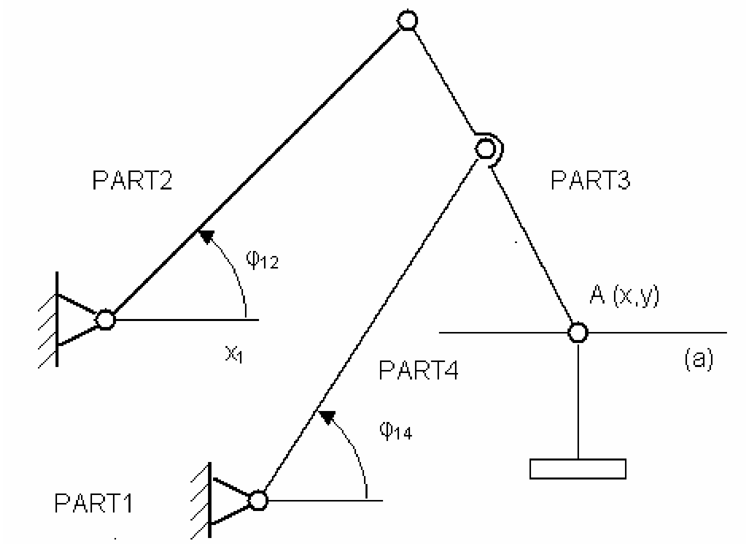

Fig.3 A level luffing crane.

S4 Motion generator.

Motion generator

Motion generator is a linkage (for example on Fig.4) in which a positioning of output link LCS origin and also its axes is of concern. So both, path tracer point A(x,y) coordinates and global angular position $y_{13} = f(y_{12})$ of coupler link PART3 wrt GCS should vary according to prescribed requirements on output link LCS displacement.

In-line skater

A skater on Fig.4 with in-line wheels has braking mechanism which input link is boot cuff (PART2) joined with boot (PART1) by revolute ankle joint C. Output coupler link (PART3) with braking pad is designed to lenghten and adjust the response of the linkage as the brake pad wears down.The path tracer point A from braking pad should conduct its displacement along prescribed curve (a) and maintain parallel position wrt skating surface (PART5).

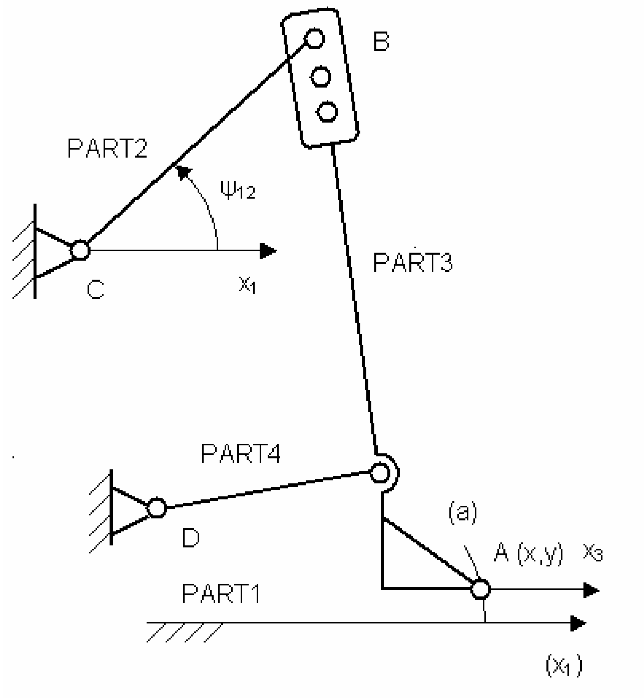

Fig.4 A braking mechanism for skater with in-line wheels

S5 Six-bar linkages.

Six-bar linkages

Six-bar linkages with seven revolute joints and mobility $n = 1$ are more suitable to meet requirements on type of performance like four-bar linkages, because there is more variables for process of optimisation and robust design. Such six-bar linkages can be classified according placement of ternary links in their structure. In a schemes of structures of a Watt six-bar chanes are ternary links adjacent, while Stephenson six-bar chanes have ternary links separated by binary links in corresponding schemes of structure.

Watt chain

In a scheme of structure on Fig.5 of a Watt six-bar chain W1 are ternary links PART3 and PART6 adjacent.

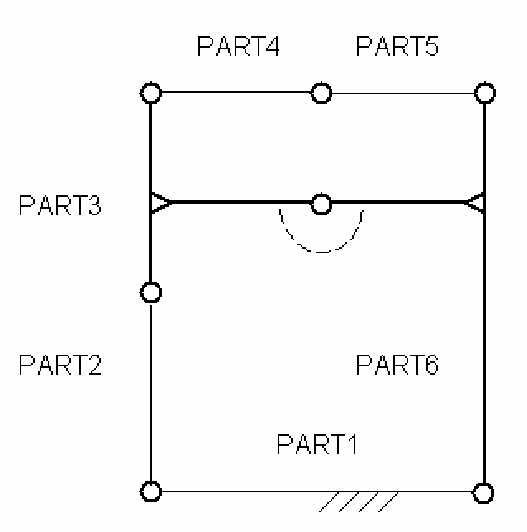

Fig.5 A Watt six-bar W1 scheme of structure.

In a scheme of structure of a Watt six-bar chain W2 on Fig.6 there are adjacent ternary links PART1 and PART4.

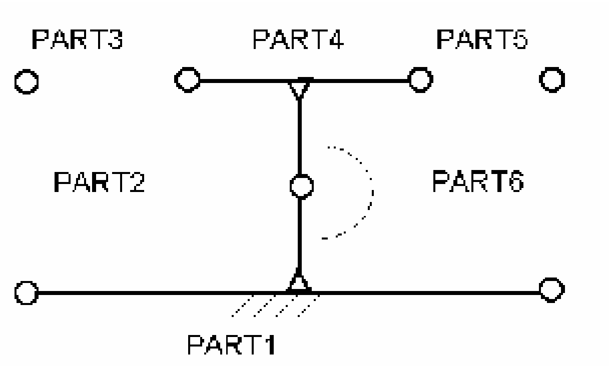

Fig.6 A Watt six-bar chain W2 scheme of structure.

Stephenson chains

In a scheme of structure of Stephenson six-bar chain S1 on Fig.7 are ternary links PART2 and PART4 separated by binary link PART3.

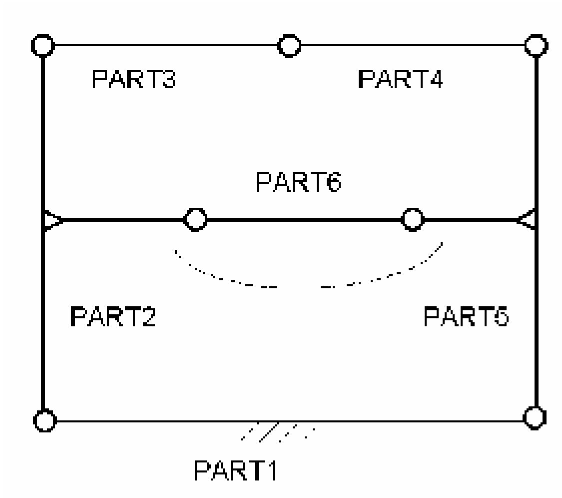

Fig.7 Stephenson six-bar chain S1 scheme of structure

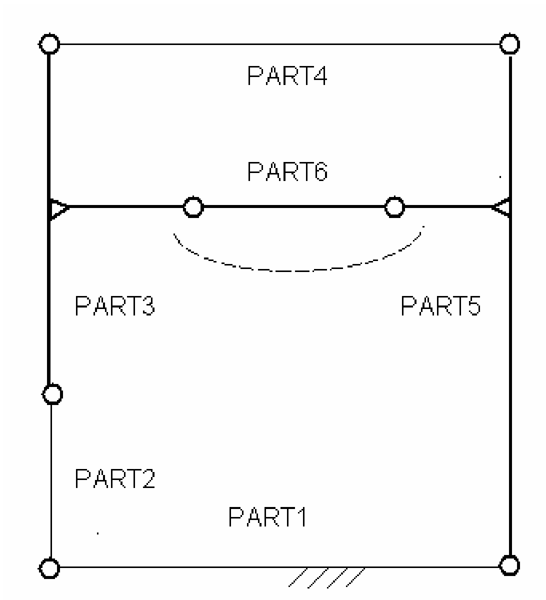

Fig.8 Stephenson six-bar chain S2 scheme of structure.

In a scheme of structure of Stephenson six-bar chain S2 on Fig.8 are ternary links PART3 and PART5 separated by binary link PART6.

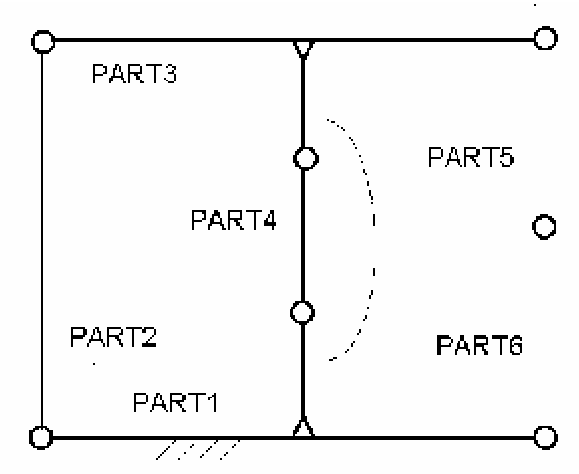

Fig.9 Stephenson six-bar chain S3 scheme of structure.

In a scheme of structure of Stephenson six-bar chain S3 on Fig.9 are ternary links PART1 and PART3 separated by binary link PART4.

S6 Showtimes of computer aided analysis and synthesis of mechanisms.