



上海交通大学
SHANGHAI JIAO TONG UNIVERSITY

机构运动简图测绘

实验指导书

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机构运动简图测绘实验

一、实验目的

1. 通过实验，强化训练学生测绘机构运动简图的基本技能，熟练掌握机构运动简图测绘的方式与方法。
2. 通过实验，使学生进一步理解机构的组成方法、机构自由度的意义及机构自由度的计算。
3. 通过实验，让学生深刻理解机器机构系统中各执行机构运动协调配合的意义及其重要性。

二、实验设备与工具

1. 常用典型机械实物及机器机构模型若干套。
2. 钢直尺、游标卡尺、电子计算器、铅笔与草稿纸等。
3. 典型平面与空间机械机构运动展示与演示陈列柜等。

三、实验原理与方法

1. 机构运动简图与机构结构简图

在分析已有机械设备的机构运动情况时，应首先绘制出机构运动简图；而在设计新机械和新机构时，也要首先拟定它的运动简图。由此可见，了解机构运动简图的意义及其正确的绘制方法是非常重要的。

机构运动简图是能够反映机构的运动性质并便于对它的运动性能进行分析的一种图形。由于机构的运动性质不仅与机构中构件的数目及各运动副的种类有关，而且与机构的某些尺寸有关。因此机构运动简图必须把机构中的构件、运动副及有关尺寸等都反映清楚。机构运动简图能定量地分析机构的运动性质及运动情况。

为了简化分析过程，在不影响分析结果的前提下，可以不严格按照比例关系绘制机构的运动简图，这种简图称为机构结构简图。机构结构简图只能定性地研究机构的某些运动特性（如自由度），而不能定量地分析机构的运动情况。

2. 测绘方法

- (1) 缓慢驱动被测绘的机械机构模型，观察并判断各运动单元的运动情况，确定机构运动构件的数目。
- (2) 观察并判定各直接接触构件之间的接触情况及其相对运动性质，从而确定各运动副的种类。
- (3) 把（1）、（2）所得的结果整理并记录在稿纸上，并用 1、2、3……依次标注各运动构件，用 A、B、C……分别标注各运动副，画出机构结构简图（运动副应用规定的符号绘出）。
- (4) 认真测量各运动构件的相关尺寸，画出机构运动简图，同时标明长度比例尺。长度比例尺：

$$\mu_L = \frac{\text{实际长度 } (L_{AB} \text{ 米})}{\text{图上长度 } (AB \text{ 毫米})}$$

- (5) 完成正确的机构运动简图，并检查运动简图的各要素是否表示清楚。

四、实验步骤

1. 参观机械原理陈列室，了解常用机械设备的基本型式及用途，熟悉机构运动简图的绘制步骤及运动副的规定符号表达。
2. 每位同学至少测绘 4 个机构简图，其中一个简图要按比例尺绘制。不按比例的结构简图可应用目测法使各构件大致成比例，以利分析。
3. 计算机构自由度，按照实际机械的运动来验证计算结果是否正确。

机构运动简图测绘实验报告

一、 机构运动简图测绘

1. 机构名称:

长度比例尺: _____ 活动构件数目 n : _____

低副数目 P_L : _____ 高副数目 P_H : _____

机构的自由度 $F = 3n - 2P_L - P_H =$ _____

2. 机构名称:

活动构件数目 n : _____

低副数目 P_L : _____ 高副数目 P_H : _____

机构的自由度 $F = 3n - 2P_L - P_H =$ _____

3. 机构名称:

活动构件数目 n : _____

低副数目 P_L : _____ 高副数目 P_H : _____

机构的自由度 $F=3n-2P_L-P_H=$ _____

4. 机构名称:

活动构件数目 n : _____

低副数目 P_L : _____ 高副数目 P_H : _____

机构的自由度 $F=3n-2P_L-P_H=$ _____

二、 思考讨论题

1. 请阐述对自由度为 $F=2$ 的机构应如何测绘其运动简图?
2. 通过实验可知, 原动构件的位置是可以任意确定而不影响自由度的计算结果, 试说明原因。

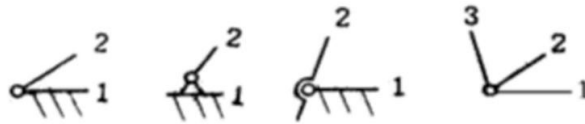
附件：部分构件及运动副的表示方法

1. 转动副

(1) 全为活动构件：

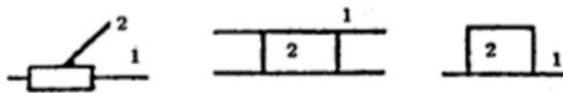


(2) 构件 1 为机架：

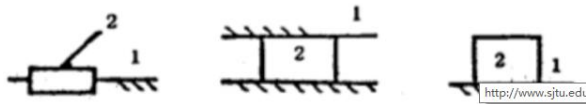


2. 移动副

(1) 全为活动构件：

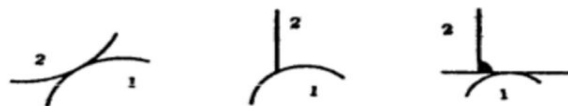


(2) 构件 1 为机架：



3. 高副

(1) 全为活动构件：



(2) 构件 1 为机架：



具体请参考标准GB4460-84《机械制图 机构运动简图符号》



上海交通大学
SHANGHAI JIAO TONG UNIVERSITY

Mechanism Diagram Drawing

Teacher: _____

Student Name: _____

Class: _____

Student ID: _____

**Learning Center in School of Mechanical Engineering
Shanghai Jiao Tong University**

Mechanism Kinematic Diagram Drawing

I、 Experimental objective:

1. Training basic skill in drawing mechanism motion diagram.
2. Through experiment, have a better understanding of the following: composition of mechanism, significance of degree of freedom, and how to calculate the degree of freedom.
3. Understand the significance and importance of the motion coordination of each actuator in automatic machine.

II、 Equipment and tools:

1. Mechanical objects and models
2. metallic tape、 pencil、 paper (provide for yourself)。

III、 Experimental principle and method:

1. Kinematic diagram of mechanism and structure diagram of mechanism

Before analyzing existing machinery, students should first draw the kinematic diagram of mechanism; when designing new machinery and mechanism, students should also determine and know its kinematic diagram. Therefore, knowing the significance of kinematic diagram and its correct drawing methods are very important.

Kinematic diagram is able to reflect the nature of mechanism and can help people analyze its movement performance better. As the movement of the mechanism is not only related to the number of the components

and kinematic pair, but also related to the size of the mechanism, kinematic diagram of mechanism must reflect kinematic pair and related dimensions clearly.

Diagrams drawn without plot scale are called mechanism structure diagram while diagrams drawn using plot scale are called mechanism kinematic diagram. The former can only be characterized by qualitative research on certain motion characteristics (such as degrees of freedom) of the mechanism, kinematic diagram of mechanism can be used to quantitatively analyze the motion of the mechanism.

2. Measuring and plotting methods

(1) Slowly drive the target mechanical model, carefully observe and distinguish the motion unit, so as to determine the number of components.

(2) Carefully observe and determine the contact condition and the relative motion character of each direct contact member, so as to determine the type of each kinematic pair.

(3) Record (1), (2) results in manuscript and use 1,2,3...to label each component in turn and use A, B, C... to label each kinematic pair and form the structure diagram. (kinematic pair should be marked with specified symbols)

(4) Measure the dimensions of each part carefully and mark it on the sketch.

(5) Make a formal kinematic diagram.

Assume one position for driving link and use appropriate plot scale to draw mechanism kinematic diagram.

$$\text{Scale of length: } \mu_L = \frac{\text{Actual length (L}_{AB} \text{ meters)}}{\text{Length on the diagram(AB millimeters)}}$$

The meaning of μ_L : 1 millimeter on the diagram represents μ_L meters.

IV、 Experimental procedure:

1. Visit the showroom of mechanical principle, understand the basic types and uses of common machinery, provisions of drawing steps and symbols of kinematic pair with the kinematic diagram.
2. Each of the students should measure and draw 4 diagrams, among which one should be drawn using plot scale. Other diagrams without plotting scale should be drawn roughly according to the proportion for further analysis.
3. Compute the mechanism's degree of freedom and test whether it is right according to the real machinery.
- 4* Draw the kinematic sketch of mechanism of household sewing machine: motion of needle, take-up-lever, feed dog, swinging shuttle mechanism. And regard sewing machine needle movement as the benchmark, record the phase relationship between the motion of each mechanism. (Figure 1 is a structure section of the household sewing machine).

Report of kinematic diagram drawing experiment

I、 kinematic diagram drawing

1. Mechanism name:

actual size:

degree of freedom(DOF):

2. Mechanism name:

degree of freedom(DOF):

3. Mechanism name:
degree of freedom(DOF):

4. Mechanism name:
degree of freedom(DOF):

II、 Points for Discussion

1. What content should the right kinematic diagram include? (please check whether your sketch painting includes these contents)
2. What is lower pair mechanism, higher pair mechanism, planar mechanism? And what is the meaning of degree of freedom
3. Please describe how to draw the kinematic scheme of mechanism whose DOF equals 2.
4. Through the experiment, what meaningful mechanism do you learn and what is helpful for your study.

III、 Experience and suggestions