JI XIE GONG CHENG ZHUAN YE YING YU JIAO CHENG

机械工程专业英语教程

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内 容 简 介

本书系统地论述了机械制图、机械原理、机械设计、公差、液压、金属材料、热处理、铸造、锻压、焊接、金属切削机床、刀具、夹具、计算机辅助设计、计算机辅助制造、柔性制造系统、计算机辅助编程、电火花加工、质量控制、数控原理与加工、设备维护等方面的专业英语知识和术语。全书分5部分，共42个单元，每个单元包括课文、单词、注释、练习。

本书可作为高等院校的机械类专业英语教材，也可以作为工程技术人员的参考资料。

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前　言

随着我国加入世界贸易组织，我国和国外的技术交流越来越广，企业的技术人员不仅要具备专业的知识，而且要具备阅读英文技术资料、文献、产品使用说明书的能力。为使工科类学生适应现今社会技术的发展，以及满足企业对技术人才知识广而博的要求，我们编写了本教材。

全书分5部分，共42个单元，每个单元包括课文、单词、注释、练习。本书内容包括机械制图、机械原理、机械设计、公差、液压、金属材料、热处理、铸造、锻压、焊接、金属切削机床、刀具、夹具、计算机辅助设计、计算机辅助制造、柔性制造系统、计算机辅助编程、电火花加工、质量控制、数控原理与加工、设备维护等方面的专业英语知识和术语。本书各单元的内容相互独立，各个学校可以根据具体情况自行选择教学内容。

参加本书编写工作的有高成秀（第三部分、第五部分和附录A），王珺（第二部分），杨永萍（第一部分），张红岩（第一部分中第12、13、14单元，第四部分，附录B及附录C），许萍（附录D），全书由高成秀担任主编，王珺、杨永萍、张红岩担任副主编，西安交通大学刘在德博士担任主审。

在编写过程中，兰州工业高等专科学校徐创文教授、王华栋教授给予了大力支持与热心指导，在此特向他们表示衷心的感谢。

由于编写水平有限，编写时间仓促，难免会有不妥之处，欢迎读者批评指导。

编　者

2004年10月于兰州

目　　录

PART I FOUNDATION OF MECHANICS

Unit 1 Engineering Drawings and Tolerance

Engineering Drawings

The result of a designer's efforts must be translated into a set of instructions to the shop in order that the part or parts can be fabricated and assembled. Thus, a set of engineering drawings are prepared showing the sizes, shapes, and dimensions to which parts are to be made. Unfortunately, many designers consider this phase of engineering design to be trivial. Realistically speaking, however, it may be of greater importance than the design solution itself.

Consider, for the moment, what an engineering drawing represents. It is a detailed set of instructions (that is, orders) that tells the machinist, molder, die caster, and so on, to "make this part in accordance with the information indicated and to the dimensions specified —any unauthorized deviations or errors made in fabrication are your responsibility." This statement is, of course, exaggerated. Nevertheless, it is meant to convey the importance of the complete and proper dimensioning of engineering drawings —the responsibility for which rests with the designer. Careless dimensioning can lead to increase production costs and/or outright waste as a result of errors.

Due to the fact that no part can be manufactured to an "exact" dimension, shop drawings are prepared in accordance with a system of tolerances and allowances. Many companies, by reason of their shop facilities and experience, rely on their own standards for dimensioning drawings. We all base our discussion on the widely used ANSI (American National Standards Institute) "Preferred limits and fits for cylindrical parts" (Standard B4. 1-1967) published by the American Society of Mechanical Engineers.

When closer fits than those indicated by the tables are required, the designer may reduce the tolerance of the mating parts. However, taking such action could result in increased fabrication costs. In order to avoid any increased cost, the designer would of necessity have to resort to selective assembly. The idea behind selective assembly is to specify large tolerances for the mating parts, and then grade them by gaging in small, medium, and large fits. Thus, a small shaft mating with a small hole, a medium shaft mating with a medium hole, and a large shaft mating with a large hole will all possess the same fit allowance. One should, nevertheless, keep in mind that the additional cost of purchasing the gages as well as the labor required for gaging may offset any saving achieved by selective assembly.

Dimensions

1. *Definitions of Dimensioning Terms*

For a thorough understanding of fits and tolerances, the following term must be clearly understood.

Allowance. The allowance is the tightest fit between mating parts. For interference fits, the allowance is negative.

Nominal Size. The nominal size is the designation used for the purpose of general identification. For example, a 21/2-in. diameter nominal pipe is actually 2.875 in. in diameter.

Tolerance. A tolerance is the total permissible variation in the size of a part.

Basic Size. The basic size is that size from which limits of size are derived by the application of allowances and tolerances.

Unilateral Tolerancing. Unilateral tolerancing is a system of dimensioning where the tolerance (that is, variation) is shown in only one direction from the nominal size. Unilateral tolerancing allows the changing of tolerance on a hole or shaft without seriously affecting the fit.

Bilateral Tolerancing. Bilateral tolerancing is a system of dimensioning where the tolerance is split and is shown on either side of the nominal size.

Limit Dimensioning. Limit dimensioning is a system of dimensioning where only the maximum and minimum dimensions are shown. Thus, the tolerance is the difference between these two dimensions. Two methods of designating limit dimensions are considered as standard. One method is the maximum material method in which the large dimensions is placed above the smaller dimension for male parts, and the reverse is true for female parts. This method is well suited for small lot quantities because it is likely that the machinist himself may check the dimensions of the parts. In so doing, he will be verifying initially the larger dimension of the male part and the smaller dimension of the female part. The other method is the maximum number method and is preferred by production and quality control departments. In this method of designating a dimension, the larger number is always placed above the smaller number, regardless of whether the part is male or female.

Clearance Fit. A clearance fit is one having limits of size so prescribed that a clearance always results when mating parts are assembled.

Interference Fit. An interference fit is one having limits of size so prescribed that an interference always results when mating parts are assembled.

Transition Fit. A transition fit is one having limits of size so prescribed that either a clearance or an interference may result when mating parts are assembled.

Basic Hole System. A basic hole system is a system of fits in which the design size of the hole is the basic size from which the allowance is subtracted to obtain the diameter of the shaft. The basic hole is the preferred system because standard drills, reamers, broaches, plug gages, and so on can be used and shafts can then easily be machined to fits.

Basic Shaft System. A basic shaft system is a system of fits in which the design size of the shaft is the basic size from which the allowance is added to obtain the diameter of the hole.

2. *Classes of Fits*

The ANSI Standard B4. 1-1967 is widely used for establishing tolerances for various classes of fits. The letter symbols appearing in this standard represent the following classes: RC (running or sliding fit), LC (locational clearance fit), LT (transition fit), LN (locational interference fit), and FN (force or shrink fit).

Running or sliding fits. Running or sliding fits provide a similar running performance with suitable lubrication allowance throughout the range of sizes. The clearance for the first two classes, used chiefly as slide fits, increases more slowly with diameter than the other classes, in order that accurate location is maintained even at the expense of free relative motion. There are nine types of RC fits which are defined as follows:

- RC1. Close sliding fits are intended to locate accurately parts that must assemble without perceptible play.
- RC2. Sliding fits are intended for accurate location, but with greater maximum clearance than class RC1. Parts made to this fit move and turn easily but are not intended to run freely and, in the larger sizes, may seize with small temperature changes.
- RC3. Precision running fits are the closest fits that can be expected to run freely and are intended for precision work at slow speeds and light journal pressures. However, they are not suitable where appreciable temperature changes are likely to be encountered.
- RC4. Close running fits are intended chiefly for running fits on accurate machinery with moderate surface speeds and journal pressures where accurate location and minimum play is desired.
- RC5. and RC6. Medium running fits are intended for higher running speeds or heavy journal pressures or both.
- RC7. Free running fits are intended for use where accuracy is not essential or where large temperature variations are likely to be encountered, or under both of these conditions.
- RC8 and RC9. Loose running fits are intended for use where materials such as cold-rolled shafting and tubing made to commercial tolerances are involved.

Location fits. Location fits are intended to determine only the location of the mating parts, they may provide rigid or accurate location, as with interference fits, or some freedom of location, as with clearance fits. Accordingly, They are divided into three groups: clearance fits, transition fits, and interference fits. These fits are more fully described as follows:

- LC. Locational clearance fits are intended for parts that are normally stationary but can be freely assembled or disassembled. They run from snug fits for parts requiring accuracy of location, through the medium clearance fits for parts such as spigots, to the looser fastener fits where freedom of assembly is of prime importance.
- LT. Transition fits are a compromise between clearance and interference fits for application where accuracy of location is important, but either a small amount of clearance or interference is permissible.
- LN. Locatinal interference fits are used where accuracy of location is of prime importance and for parts requiring an alignment with special requirements for bore pressure. Such fits are not intended for parts designed to transmit frictional loads from one part to another by virtue of the tightness of fit, as these conditions are covered by force fits.

Force fits. Force fits(1) or shrink fits(2) constitute a special type of interference fits normally characterized by maintenance of constant bore pressures through the range of sizes. The interference, therefore, varies almost directly with diameter, and the difference between its minimum and maximum values is small to maintain the resulting pressures within reasonable limits. There are five types of force fits, which are described as follows:

- FN1. Light drive fits are those requiting light assembly pressures and produce more or less permanent assemblies. They are suitable for thin sections or long fits or in cast iron external members.
- FN2. Medium drive fits are suitable for ordinary steel parts or for shrink fits on light sections. They are about the tightest that can be used with high grade, cast iron external members.
- FN3. Heavy drive fits are suitable for heavier steel parts or for shrink fits in medium sections.
- FN4. And FN5. Force fits are suitable for parts that can be highly stressed or for shrink fits where the heavy pressing forces are impractical.

Technical words

tolerance	*n*. 公差,容许间隙,允许限度
dimension	*n*. 尺寸,尺度
allowance	*n*. 加工余量,容许误差

Technical phrases

engineering drawing	工程制图
force fit	压力配合
shrink fit	热压配合
running fit	松动配合
clearance fit	间隙配合

interference fit	过盈配合
transition fit	过渡配合
nominal size	公称尺寸
basic hole system	基孔制
basic shaft system	基轴制
limit dimensioning	极限尺寸标注
unilateral tolerance	单向公差
bilateral tolerance	双向公差

Notes

(1) Force Fit: A means for holding mating mechanical parts in fixed position relative to each other. In a force fit of cylindrical parts, the inner member has a greater diameter than the hole of the outer member.

压力配合:对相互间位置固定的机械配合间的一种装配法。在圆柱件的压力配合中,里面的零件的直径总是比外面的零件的直径要大。

(2) Shrink Fit: A fit has considerable negative allowance so that the diameter of a hole is less than the diameter of a shaft that is passed through the hole, also called a heavy force fit.

热压配合:有相当大的负余量的配合,因此孔的直径比穿过该孔的轴的直径要小,也叫重压紧配合。

Exercises

A. True or false (point to the following sentences are true or false)

1) A tolerance is the total reliable variation in the size of a part. (　)

2) Medium running fits are intended for higher running speeds or heavy journal stress or both. (　)

3) Light drive fits are those requiting light assembly pressures and produce more or less permanent assemblies. (　)

4) Heavy drive fits are suitable for heavier steel parts or for shrink fits in middle sections. (　)

B. Answer the following questions

1) What is Basic Hole System?

2) What is Basic Shaft System?

3) What is meaning tolerance?

C. Translate the following passage into Chinese

Two methods of designating limit dimensions are considered as standard. One method is the maximum material method in which the large dimensions is placed above the smaller dimension for male parts, and the reverse is true for female parts. This method is well suited for small lot quantities because it is likely that the machinist himself may check the dimensions of the parts. In so doing, he will be verifying initially the larger dimension of the male part and the smaller dimension of the female part. The other method is the maximum number method and is preferred by production and quality control departments. In this method of designating a dimension, the larger number is always placed above the smaller number, regardless of whether the part is male or female.

Unit 2 Dimensional Tolerances and Surface Roughness

Because of the highly competitive nature of most manufacturing businesses, the question of finding ways to reduce cost is ever present. A good starting point for cost reduction is in the design of the product. The design engineer should always keep in mind the possible alternatives available to him in making his design. It is often impossible to determine the best alternatives without a careful analysis of the probable production cost. Designing for function, interchangeability, quality, and economy requires a careful study of tolerances, surface finishes, processes, materials, and equipents.

To assure sound and economical design from a producibility standpoint, careful consideration of the following general design rules, both separately and together, is of paramount importance. The order of importance may vary according to design requirements, or factors, but the overall importance always remains the same.

Seek simplicity. Design for maximum simplicity in functional and physical characteristics.

Determine the best production method. Seek the help of a production engineer to design for the most economical production methods.

Analyze materials. Select materials that will lend themselves to low-cost production as well as to design requirements.

Eliminate fixturing and handling problems. Design for ease of locating, setting up, and holding parts(1).

Employ maximum acceptable tolerances and finishes. Specify surface roughness and accuracy no greater than that which is commensurate with the type of part or mechanism being designed, and the production method or methods contemplated(2).

Tolerances on finish and dimensions play an important role in the final achievement or absence of practical production design.

A comprehensive study of the principles of interchangeability is essential for a thorough understanding and full appreciation of low-cost production techniques. Interchangeability is the key to successful production regardless of quantity. Details of all parts should be surveyed carefully to assure not only inexpensive processing but also rapid, easy assembly and maintenance. It must be remembered that each production method has a well-established level of precision which can be maintained in continuous production without exceeding normal basic cost.

Economic manufacturing does not "just happen." It starts with design and considers practical limits of machine tools, processes, tolerances, and finishes. Neither dimensional tolerances nor surface roughness should be specified to limits of accuracy closer than those which the actual function or design necessitate. This is done to assure the advantages of lowest possible cost and fastest possible production.

Without needing to know how to operate a particular machine to attain the desired degree of surface roughness, there are certain aspects of all these methods which should be understood by the design engineer. Knowledge of such facts as degree of roughness obtained by any operation, and the economics of attaining a smoother surface with each operation, will aid him in deciding just which surface roughness to specify.

Because of its simplicity, the arithmetical average R_a has been adopted internationally and is widely used. The applications of surface roughness R_a are described in the following paragraphs.

0.2μm The finish is used for the interior surface of hydraulic struts, for hydraulic cylinders, pistons and piston rods for O-ring packings, for journals operating in plain bearings, for cam faces, and for rolls of antifriction bearings when loads are normal.

0.4μm The finish is used for rapidly rotating shaft bearings, for heavily loaded bearings, for rolls in bearings of ordinary commercial grades, for hydraulic applications, for static sealing rings, for the bottom of sealing-rings grooves, for journals operating in plain bearings, and for extreme tension members.

0.8μm The finish is normally found on parts subject to stress concentrations and vibrations, for broached holes, gear teeth, and other precision machined parts.

1.6μm This finish is suitable for ordinary bearings, for ordinary machine parts where fairly close dimensional tolerances must be held, and for highly stressed parts that are not subject to severe stress reversals.

3.2μm The finish should not be used on sliding surfaces, but can be used for rough bearing surface where loads are light and infrequent, or for moderately stressed machine parts.

6.3μm The appearance of this finish is not objectionable, and can be used on non-critical component surface, and for mounting surfaces for brackets, etc.

Technical words

locating	*n*. 工件定位,放样
accuracy	*n*. 精度,准确度
sealing	*n*. 密封,绝缘
packing	*n*. 密封垫,密封件
journal	*n*. 轴颈,辊颈
bracket	*n*. 支座,轴承架
piston	*n*. 活塞
commensurate	*adj*. 同等大小的,相称的

Technical phrases

surface roughness	表面粗糙度
shaft bearing	轴承
antifriction bearing	滚动轴承
bearing surface	承压面,支承面
stress concentration	应力集中

Notes

(1) **Eliminate fixturing and handling problems.** Design for ease of locating, setting up, and holding parts.

消除固定与操作问题。设计容易定位、安装与调整的工件。

(2) **Employ maximum acceptable tolerances and finishes.** Specify surface roughness and accuracy no greater than that which is commensurate with the type of part or mechanism being designed, and the production method or methods contemplated.

采用最大可接受的公差与表面粗糙度。在确定零件的表面粗糙度和尺寸精度时,不要对零件或机构的设计还有需要采用的生产方法提出过高的要求。

Exercises

A. True or false (point to the following sentences are true or false)

1) 0.2μm surface roughness can be used in valves. (　)

2) 1.6μm surface roughness can be used in ordinary bearing. (　)

3) 0.8μm surface roughness can be used in gear teeth. (　)

B. Answer the following questions

1) How many rules should be considered to assure sound and economical design from a producibility standpoint? What are they?

2) How many kinds of surface roughness have there?

C. Translate the following sentences into Chinese

0.4μm The finish is used for rapidly rotating shaft bearings, for heavily loaded bearings, for rolls in bearings of ordinary commercial grades, for hydraulic applications, for static sealing rings, for the bottom of sealing-rings grooves, for journals operating in plain bearings, and for extreme tension members.

Unit 3 Basic Concepts in Mechanics

Introduction

In its original sense, mechanics refers to the study of the behavior of systems under the action of forces. Statics deals with cases where the forces either produce no motion or the motion is not of interest. Dynamics deals properly with motions under forces. Mechanics is subdivided according to the types of systems and phenomena involved.

An important distinction is based on the size of the system. Those systems are large enough and can be adequately described by the Newtonian law of classical mechanics. In this category, for example, are celestial mechanics, the study of the motions of planets, stars, and other heavenly bodies, and fluid mechanics, which treats liquids and gases on a macroscopic scale(1). Fluid mechanics is a part of a larger field called continuum mechanics or (by some physicists) classical held theory, involving any essentially continuous distribution of matter, whether rigid, elastic, plastic, or fluid. On the other hand, the behavior of microscopic systems such as molecules, atoms, and nuclei can be interpreted only by the concepts and mathematical methods of quantum mechanics. From its inception, quantum mechanics had two apparently different mathematical forms: the wave mechanics of E. Schrodinger, which emphasizes the spatial probability distributions in the quantum states, and the matrix mechanics of W. Heisenberg, which emphasizes the transitions between states. These are now known to be equivalent.

Mechanics may also be classified as nonrelativistic or relativistic mechanics, the latter applying to systems with material velocities comparable to the velocity of light. This distinction pertains to both classical and quantum mechanics.

Finally, statistical mechanics uses the methods of statistics for both classical and quantum systems containing very large numbers of similar subsystems to obtain their large-scale properties.

Basic concepts in mechanics

That branch of scientific analysis which deals with motions, time, and forces is called mechanics and is made up of two parts, static's and dynamics. Static's deals with the analysis of stationary systems, i.e., those in which time is not a factor, and dynamics deals with systems which change with time.

Forces are transmitted into machine members through mating surfaces, e.g., from a gear to a shaft or from one gear through meshing teeth to another gear, from a connecting rod through a bearing to a lever, from a V belt to a pulley, or from a cam to a follower. It is necessary to know the magnitudes of these forces for a variety of reasons. The distribution of the forces at the boundaries or mating surfaces must be reasonable, and their intensities must be within the working limits of the materials composing the surfaces. For example, if the force operating on a sleeve bearing becomes too high, it will squeeze out the oil film and cause metal-to-metal contact, overheating, and rapid failure of the bearing. If the forces between gear teeth are too large, the oil film may be squeezed out from between them. This could result in flaking and spalling of the metal, noise, rough motion, and eventual failure. In the study of dynamics we are principally interested in determining the magnitude, direction, and location of the forces.

Some of the terms used in this phase of our studies are defined below.

Force. Our earliest ideas concerning forces arose because of our desire to push, lift, or pull various objects. So force is the action of one body acting on another. Our intuitive concept of force includes such ideas as place of application, direction, and magnitude, and these are called the characteristics of a force.

Matter. Matter is any material or substance; if it is completely enclosed, it is called a body.

Mass. Newton defined mass as the quantity of matter of a body as measured by its volume and density. This is not a very satisfactory definition because density is the mass of a unit volume. We can excuse Newton by surmising that he perhaps did not mean it to be a definition. Nevertheless, he recognized the fact that all bodies possess some inherent property that is different from weight. Thus, a moon rock has a certain constant amount of substance, even though its moon weight is different from its earth weight. This constant of substance, or quantity of matter, is called the mass of the rock.

Inertia. Inertia is the property of mass that causes it to resist any effort to change its motion.

Weight. Weight is the force of gravity acting upon a mass. The following quotation is pertinent:

The great advantage of SI units is that there is one, and only one unit for each physical quantity —the meter for length, the kilogram for mass, the Newton for force, the second for time, etc. To be consistent with this unique feature, it follows that a given unit or word should not be used as an accepted technical name for two physical quantities. However, for generations the term "weight" has been used in both technical and non-technical fields to mean either the force of gravity acting on a body or the mass of a body itself.

Particle. A particle is a body whose dimensions are so small that they may be neglected.

Rigid body. All bodies are either elastic or plastic and will be deformed if acted upon by forces. When the deformation of such bodies is small, they are frequently assumed to be rigid, i.e., incapable of deformation, in order to simplify the analysis.

Deformable Body. The rigid-body assumption cannot be used when internal stresses and