高职高专"十二五"规划教材·专业英语系列

# 机械工程专业英语

■ 高成秀 主编
■ 徐创文 主审

# Mechanical Engineering English

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北京·BEIJING

## 内 容 简 介

本书系统地介绍了机械制图、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、制造管理等方面的专业英语知识和术语。全书分 5 部分，共 45 单元，每个单元包括课文、生词及专业词汇注释、长难句解析、课后练习题、趣味阅读等内容。本书配有精彩课件、习题答案等教学资源，以方便教学、提高教学质量。

本书可作为高职高专院校相关专业的专业英语教材，也可以作为工程技术人员的学习参考资料。



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# 前　言

随着我国加入世界贸易组织，成为制造业大国，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。为了使工科学生适应现今社会技术的发展，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（5个部分的划分参见目录），共45单元，每个单元包括课文、生词及专业词汇注释、长难句解析、课后练习题、趣味阅读等内容。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、制造管理等方面的专业英语知识和术语。本书各单元的内容既有系统性的编排，又相互独立，各个学校可以根据具体情况自行选择教学内容。

本书由高成秀担任主编，徐创文担任主审。参加编写工作的有：高成秀（PartⅢ、PartⅤ、各单元名人名言、各单元单词注音），王珺（PartⅡ），杨永萍（PartⅠ中第1～11单元），张红岩（PartⅠ中第12～14单元，PartⅣ），许萍（每单元后的趣味阅读）。全书由高成秀统稿。

通过本书，希望读者能够对有关机械零件及其加工方法和过程的知识，以及有关机械零件及其加工方法和过程的专业英语有一个全面的认识，希望本书能够帮助读者学到知识，并且从中获得学习的动力和乐趣。

本书在编写过程中，得到了多位老师和同仁的大力支持，在此向他们表示衷心的感谢。

由于编者水平有限，难免会有不妥之处，欢迎读者批评指导。

编　者

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## Part Ⅰ　Foundation of Mechanics



## Part Ⅱ　Mass-Reducing Processes



## Part Ⅲ　Numerically Controlled Machine Tools

# Part Ⅰ Foundation of Mechanics

# Unit 1 Engineering Drawings and Tolerance

*Ask yourself:*

*Do you have a clearly defined purpose?*

*Do you have a plan of action?*

*Do you want to put more effort into preparation?*

*Do you want to pay more prices?*

*Do you have the patience to withstand the gestation period?*

*Do you have pride in performance?*

## 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. Locational 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 ['tɔlərəns] | *n.* 公差，容许间隙，允许限度 |
| dimension [dimenʃən] | *n.* 尺寸，尺度 |
| allowance ['əlauəns] | *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（过盈量）的配合，孔的直径比穿过该孔（与其配合）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.

**The story of science**

## Albert Einstein ( I )

Albert Einstein was born into a Jewish family in 1879. His father was a salesman and engineer. As a youngster, he showed very few signs that he would one day become a scientific genius. He was very slow in learning to talk. He did so poorly at school that his teachers called him "dull and backward". But that was one time the teacher was wrong.

Actually, Einstein was extremely intelligent. By the age of 12 he had taught himself geometry and calculus — two difficult subjects usually taught in high school and college.

When he was 16 his father urged him to work in the family's electrical factory. But he wanted to continue his studies, especially mathematics and physics. He planed to become a physics teacher. He went to Zurich, Switzerland and enrolled in the Polytechnic Academy. There he made good grades and a teaching certificate.

After graduation, he was unable to find a position as a teacher. He found a few tutoring jobs, but they paid very little. For months he had barely enough to eat. Finally, in 1902, he became a clerk at a patent office（专利局）.This was a poorly paid job too, but it was just right for him. He had time to devote to his thought. For the next three years he spent every free minute working on formulas that would give the world a new mathematical explanation of time and space. When he was free at the patent office, he bent over his desk, filling notebook after notebook with equations and figures. In 1905, when he was only 26 years old, he published the theory that made him famous. It was called "Theory of Relativity", the most important document in history. His theory answered many questions that puzzled mathematicians and physicists for years.

Soon the clerk became a world-famous figure. He was invited to give lectures at leading European universities. Many excellent teaching positions were offered to him. In 1914 he became physics professor at the University of Berlin, where he stayed for nineteen years. In 1921 he was awarded Nobel Prize for physics.

Suddenly, in1933, his whole life changed. Hilter came into power and they persecuted(迫害)the Jews. Einstein was quick to speak out gainst Hilter. Hilter took revenge by destroying his house, seizing all his property and offering a large reward for his arrest. Now the world's most brilliant scientist, honored and admired by millions, was a refugee without a home.

But then he received an invitation from America. He went to Princeton University. For the next 22 years, he lived and worked there. He became a familiar figure on the college campus a small man with bushy white hair who walked from his home to his office every day, no matter what the weather. The famous professor lived a quiet life in America. In the evenings he enjoyed chatting and playing his violin. He deeply loved America, where he had found peace and freedom, and in 1940 he became an American citizen.

In 1945 America exploded an atom bomb, which was based on some of his earliest conclusions: matter could be changed into energy and energy could be changed into matter. Einstein himself wrote a letter to President Roosevelt because he didn't want his work to lead to destruction and death. He greatly regretted that science had used atomic energy as a weapon, instead of using it to benefit mankind. He urged all nations to unite in a peaceful world government to prevent further atomic wars and terrible sufferings.

# Unit 2 Dimensional Tolerances and Surface Roughness

*What characteristics do good classroom learners share?*
*A willingness to listen.*
*A willingness to ask questions.*
*A willingness to think about how to learn.*
*A willingness to accept correction.*
*A willingness to experiment.*

## Engineering Drawings

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 equipment.

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 [ləu'keitiŋ] | *n.* | 工件定位，放样 |
| accuracy ['ækjurəsi] | *n.* | 精度，准确度 |
| sealing ['si:liŋ] | *n.* | 密封，绝缘 |
| packing ['pækiŋ] | *n.* | 密封垫，密封件 |
| journal ['dʒə:nl] | *n.* | 轴颈，辊颈 |
| bracket ['brækit] | *n.* | 支座，轴承架 |
| piston ['pistən] | *n.* | 活塞 |
| commensurate [kə'menʃərit] | *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、安装与调整的零件。

(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，不要对与其匹配的零件或机构的设计和生产方法提出过高的要求。