21st CENTURY
实用规划教材 21世纪全国应用型本科 大机械系列 实用规划教材

English in Mechanical and Electrical Engineering

机电工程专业英语

主　编　赵运才　何法江
副主编　王丽君　杨春杰

北京大学出版社
PEKING UNIVERSITY PRESS

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参　编　方晓丽　匡江红　朱　林
　　钟利萍　石玉祥　田宏宇　么永强
主　审　严珩志

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内 容 简 介

本书从机械设计制造及自动化、汽车工程专业的要求出发，以机、电、液相结合的整体原则组织编写。内容包括力学、机械零件与机构、机械设计、汽车构造和工作性能、机械加工及成型技术、自动化技术及现代设计制造。全书共有29篇课文，全部课文均附有参考译文和作业(翻译)。

本书可以作为机械设计及自动化、汽车工程、机电工程等专业英语教材，也可以供从事相关专业的科技人员参考使用。

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丛书总序

殷国富*/文

机械是人类生产和生活的基本要素之一，是人类物质文明最重要的一个组成部分。机械工业担负着向国民经济各部门，包括工业、农业和社会生活各个方面提供各种性能先进、使用安全可靠的技术装备的任务，在国家现代化建设中占有举足轻重的地位。20 世纪 80 年代以来，以微电子、信息、新材料、系统科学等为代表的新一代科学技术的发展及其在机械工程领域中的广泛渗透、应用和衍生，极大地拓展了机械产品设计制造活动的深度和广度，改变了现代制造业的产品设计方法、产品结构、生产方式、生产工艺和设备以及生产组织模式，产生一大批新的机械设计制造方法和制造系统。这些机械方面的新方法和系统的主要技术特征表现在以下几方面：

(1) 信息技术在机械行业的广泛渗透和应用，使得现代机电产品已不再是单纯的机械构件，而是由机械、电子、信息、计算机与自动控制等集成的机电一体化产品，其功能不仅限于加强、延伸或取代人的体力劳动，而且扩大到加强、延伸或取代人的某些感官功能与大脑功能。

(2) 随着设计手段的计算机化和数字化，CAD/CAM/CAE/PDM 集成技术和软件系统得到广泛使用，促进了产品创新设计、并行设计、快速设计、虚拟设计、智能设计、反求设计、广义优化设计、绿色产品设计、面向全寿命周期设计等现代设计理论和技术方法的不断发展。机械产品的设计不只是单纯追求某项性能指标的先进和高低、而是注意考虑质量、市场、价格、安全、美学、资源、环境等方面的影响。

(3) 传统机械制造技术在不断吸收电子、信息、材料、能源和现代管理等方面成果的基础上形成了先进制造技术，并将其综合应用于机械产品设计、制造、检测、管理、销售、使用、服务的机械产品制造全过程，以实现优质、高效、低耗、清洁、灵活的生产，提高对动态多变的市场的适应能力和竞争能力。

(4) 机械产品加工制造的精密化、快速化，制造过程的网络化、全球化得到很大的发展，涌现出 CIMS、并行工程、敏捷制造、绿色制造、网络制造、虚拟制造、智能制造、大规模定制等先进生产模式，制造装备和制造系统的柔性与可重组已成为 21 世纪制造技术的显著特征。

(5) 机械工程的理论基础不再局限于力学，制造过程的基础也不只是设计与制造经验及技艺的总结。今天的机械工程学科比以往任何时候都更紧密地依赖诸如现代数学、材料科学、微电子技术、计算机信息科学、生命科学、系统论与控制论等多门学科及其最新成就。

上述机械科学与工程技术特征和发展趋势表明，现代机械工程学科越来越多地体现着知识经济的特征。因此，加快培养适应我国国民经济建设所需要的高综合素质的机械工程学科人才的意义十分重大、任务十分繁重。我们必须通过各种层次和形式的教育，培养出适应世界机械工业发展潮流与我国机械制造业实际需要的技术人才与管理人才，不断推动我国机械科学与工程技术的进步。

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*殷国富教授：现为教育部机械学科教学指导委员会委员，现任四川大学机械学院院长

为使机械工程学科毕业生的知识结构由较专、较深、适应性差向较通用、较广泛、适应性强方向转化，在教育部的领导与组织下，1998 年对本科专业目录进行了第 3 次大的修订。调整后的机械大类专业变成 4 类 8 个专业，它们是：机械类 4 个专业(机械设计制造及其自动化、材料成型及控制工程、过程装备与控制、工业设计)；仪器仪表类 1 个专业(测控技术与仪器)；能源动力类 2 个专业(热能与动力工程、核工程与核技术)；工程力学类 1 个专业(工程力学)。此外还提出了面向更宽的引导性专业，即机械工程及自动化。因此，建立现代“大机械、全过程、多学科”的观点，探讨机械科学与工程技术学科专业创新人才的培养模式，是高校从事制造学科教学的教育工作者的责任；建立培养富有创新能力人才的教学体系和教材资源环境，是我们努力的目标。

要达到这一目标，进行适应现代机械学科发展要求的教材建设是十分重要的基础工作之一。因此，组织编写出版面向大机械学科的系列教材就显得很有意义和十分必要。北京大学出版社的领导和编辑们通过对国内大学机械工程学科教材实际情况的调研，在与众多专家学者讨论的基础上，决定面向机械工程学科类专业的学生出版一套系列教材，这是促进高校教学改革发展的重要决策。按照教材编审委员会的规划，本套教材将逐步出版。

本套机械工程系列教材是按照高等学校机械学科本科专业规范、培养方案和课程教学大纲的要求，合理定位，由长期在教学第一线从事教学工作的教师立足于 21 世纪机械工程学科发展的需要，以科学性、先进性、系统性和实用性为目标进行编写，以适应不同类型、不同层次的学校结合学校实际情况的需要。本系列教材编写的特色体现以下几方面：

(1) 关注全球机械科学与工程技术学科发展的大背景，建立现代大机械工程学科的新理念，拓宽理论基础和专业知识，特别是突出创造能力和创新意识。

(2) 重视强基础与宽专业知识面的要求。在保持较宽学科基础的前提下，在产品设计、制造、管理、市场、环境等方面，具有较为综合的内在联系，突出重点，有利于建立系统性的知识体系结构。

(3) 学科交叉与综合的观念。现代力学、信息科学、生命科学、材料科学、系统科学等新兴学科与机械学科结合的内容在系列教材编写中得到一定的体现。

(4) 注重能力的培养，力求做到不断强化自我的自学能力、思维能力、创造性地解决问题的能力以及不断自我更新知识的能力，促进学生向着富有鲜明个性的方向发展。

总之，本套系列教材注意了调整课程结构，加强学科基础，反映系列教材各门课程之间的联系和衔接，内容合理分配，既相互联系又避免不必要的重复，努力拓宽知识面，在培养学生的创新能力方面进行了初步的探索。当然本系列教材还需在内容的精选、音像电子课件、网络多媒体教学等方面需要进一步加强，使之成为能满足普通高等院校本科教学的需要，在众多的机械类教材中形成自己的特色。

最后，我要感谢参加本系列教材编著和审稿的各位老师所付出的大量卓有成效的辛勤劳动，也要感谢北京大学出版社的领导和编辑们对本系列教材的支持和编审工作。由于编写的时间紧、相互协调难度大等原因，本系列教材还存在一些不足和错漏。我相信，在使用本系列教材的教师和学生的关心和帮助下，不断改进和完善这套教材，使之在我国机械工程类学科专业的教学改革和课程体系建设中起到应有的促进作用。

2006 年 1 月

前　言

机电工程专业英语是机械设计制造及自动化、汽车工程专业的一门重要的基础课，对于机电工程专业的本科、专科学生以及从事相关专业工作的科技人员来说，熟练掌握专业英语对于促进国际交流，了解国内外本专业的最新发展动态是十分必要的，并且有着越来越重要的意义。随着我国加入 WTO，与国外的技术交流越来越多，专业英语的学习更为迫切，为了满足机械设计制造及自动化、汽车工程专业教学需求，我们编写了《机电工程专业英语》一书。

机电工程是一门交叉学科，内涵丰富，涉及面广。本教材内容包括力学、机械零件与机构、机械设计、机器人技术、汽车构造和工作性能、机械加工及成型技术、自动化技术及现代设计制造。本教材围绕这个特点展开编写工作，其主要特色有：

1. 作者用较为全面的语言设计和编写了本教材。本教材由浅入深，由简到繁，循序渐进，同时本教材选材广泛，内容丰富，语言规范，难度适中，便于自学。

2. 本书由基础知识篇、综合提高篇两部分组成。课文“原型”均选用国外原版报纸、杂志、教材、论著、会议论文和实用文件，从而使学生从不同角度、不同层次、不同侧面、不同渠道接触和吸收专业英语知识；使专业英语语言的语料具有“原汁原味”的真实性；使学生现在所学的专业英语知识和所获取的专业英语技能在将来更具有实用性。通过本教材的学习，学生们不仅可以熟练地掌握本专业常用的及本专业相关的英语单词、词组及其用法，而且可以深化本专业的知识，从而为今后的学习和工作打下良好的基础。

3. 在本教材所有的课文后附有参考译文。参考译文的目的在于“帮助学生理解和掌握专业英语的词汇、句式和功能意念等方面的知识”。翻译时注意采取尽可能使译文在词语含义、词语顺序和句子结构等方面与原文保持一致的翻译方法，以便学生预习和自学。

4. 本教材的编写过程中注意以学生为中心，以自主学习为主，让学生课内与课外结合、学习和应用结合，在课文中插入了一些示意图或构造图，以便学生通俗易懂，同时训练学生把基础阶段学到的语言知识在机电专业领域中得到应用、巩固、扩展和提高，更好地适应未来的工作需求。

本书由赵运才教授、何法江教授任主编，王丽君、杨春杰任副主编，参加编写的有方晓丽、石玉祥、朱林、田宏宇、匡江红、钟利萍、么永强，由严珩志教授担任主审。由于时间和水平有限，书中错误和不当之处在所难免，欢迎广大读者不吝指正。

编　者

2006.2

21世纪全国应用型本科大机械系列实用规划教材

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55 中南林学院
56 株洲工学院

目　录

PART ONE

PART TWO

PART ONE

Lesson 1 Machine Parts (I)

1.1 Text

Gears

[1]Gears are direct contact bodies,operating in pairs,that transmit motion and force from one rotating shaft to another,or from a shaft to a slide (rack),by means of successively engaging projections called teeth.

Tooth profiles. The contacting surfaces of gear teeth must be aligned in such a way that the drive is positive;i.e.,the load transmitted must not depend on frictional contact. As shown in the treatment of direct contact bodies,this requires that the common normal to the surfaces not to pass through the pivotal axis of either the driver or the follower.

As it is known as direct contact bodies,cycloidal and involute profiles provide both a positive drive and a uniform velocity ratio;i.e.,conjugate action.

Basic relations. The smaller of a gear pair is called the pinion and the larger is the gear. When the pinion is on the driving shaft the pair acts as a speed reducer;When the gear drives,the pair is a speed increaser. Gears are more frequently used to reduce speed than to increase it.

If a gear having N teeth rotates at n revolutions per minute, the product $N*n$ has the dimension "teeth per minute". This product must be the same for both members of a mating pair if each tooth acquires a partner from the mating gear as it passes through the region of tooth engagement.

For conjugate gears of all types, the gear ratio and the speed ratio are both given by the ratio of the number of teeth on the gear to the number of teeth on the pinion.If a gear has 100 teeth and a mating pinion has 20, the ratio is 100/20=5. Thus the pinion rotates five times as fast as the gear, regardless of the speed of the gear.Their point of tangency is called the pitch point,and since it lies on the line of centers,it is the only point at which the tooth profiles have pure rolling contact.Gears on nonparallel,non-intersecting shafts also have pitch circles,but the rolling-pitch -circle concept is not valid.

Gear types are determined largely by the disposition of the shafts;in addition,certain types are better suited than others for large speed changes. This means that if a specific disposition of the shafts is required,the type of gear will more or less be fixed.On the other hand,if a required

speed change demands a certain type,the shaft positions will also be fixed.

Spur gears and helical gears. A gear having tooth elements that are straight and parallel to its axis is known as a spur gear. A spur pair can be used to connect parallel shafts only.

[2]If an involute spur pinion were made of rubber and twisted uniformly so that the ends rotated about the axis relative to one another,the elements of the teeth,initially straight and parallel to the axis,would become helices. The pinion then in effect would become a helical gear.

Worm and bevel gears. In order to achieve line contact and improve the load carrying capacity of the crossed axis helical gears,the gear can be made to curve partially around the pinion,in somewhat the same way that a nut envelops a screw. The result would be a cylindrical worm and gear. Worms are also made in the shape of an hourglass, instead of cylindrical, so that they partially envelop the gear. This results in a further increase in load-carrying capacity.

Worm gears provide the simplest means of obtaining large ratios in a single pair. They are usually less efficient than parallel-shaft gears,however,because of an additional sliding movement along the teeth.

V-belt

The rayon and rubber V-belt are widely used for power transmission. Such belts are made in two series: the standard V-belt and the high capacity V-belt. The belts can be used with short center distances and are made endless so that difficulty with splicing devices is avoided.

First, cost is low, and power output may be increased by operating several belts side by side. All belts in the drive should stretch at the same rate in order to keep the load equally divided among them. When one of the belts breaks, the group must usually be replaced. The drive may be inclined at any angle with tight side either top or bottom. Since belts can operate on relatively small pulleys, large reductions of speed in a single drive are possible.

Second, the included angle for the belt groove is usually from 34° to 38° . The wedging action of the belt in the groove gives a large increase in the tractive force developed by the belt.

Third, pulley may be made of cast iron, sheet steel, or die-cast metal. [3]Sufficient clearance must be provided at the bottom of the groove to prevent the belt from bottoming as it becomes narrower from wear. Sometimes the larger pulley is not grooved when it is possible to develop the required tractive force by running on the inner surface of the belt. The cost of cutting the grooves is thereby eliminated. Pulleys are on the market that permit an adjustment in the width of the groove. The effective pitch diameter of the pulley is thus varied, and moderate changes in the speed ratio can be secured.

Chain Drives

The first chain-driven or "safety" bicycle appeared in 1874, and chains were used for driving the rear wheels on early automobiles. [4]Today, as the result of modern design and production methods, chain drives that are much superior to their prototypes are available, and these have contributed greatly to the development of efficient agricultural machinery, well-drilling equipment, and mining and construction machinery. Since about 1930 chain drives

have become increasingly popular, especially for power saws, motorcycle, and escalators etc..

There are at least six types of power-transmission chains; three of these will be covered in this article, namely the roller chain, the inverted tooth, or silent chain, and the bead chain. The essential elements in a roller-chain drive are a chain with side plates, pins, bushings (sleeves), and rollers, and two or more sprocket wheels with teeth that look like gear teeth. Roller chains are assembled from pin links and roller links. A pin link consists of two side plates connected by two pins inserted into holes in the side plates. The pins fit tightly into the holes, forming what is known as a press fit. A roller link consists of two side plates connected by two press-fitted bushings, on which two hardened steel rollers are free to rotate. When assembled, the pins are a free fit in the bushings and rotate slightly, relative to the bushings when the chain goes on and leaves a sprocket.

Standard roller chains are available in single strands or in multiple strands. In the latter type, two or more chains are joined by common pins that keep the rollers in the separate strands in proper alignment. The speed ratio for a single drive should be limited to about 10 ∶ 1; the preferred shaft center distance is from 30 to 35 times the distance between the rollers and chain speeds greater than about 2500 feet (800 meters) per minute are not recommended. Where several parallel shafts are to be driven without slip from a single shaft, roller chains are particularly well suited.

An inverted tooth, or silent chain is essentially an assemblage of gear racks, each with two teeth, pivotally connected to form a closed chain with the teeth on the inside, and meshing with conjugate teeth on the sprocket wheels. The links are pin-connected flat steel plates usually having straight-sided teeth with an included angle of 60 degrees. As many links are necessary to transmit the power and are connected side by side. Compared with roller-chain drives, silent-chain drives are quieter, operate successfully at higher speeds, and can transmit more load for the same width. Some automobiles have silent-chain camshaft drives.

Bead chains provide an inexpensive and versatile means for connecting parallel or nonparallel shafts when the speed and power transmitted are low. The sprocket wheels contain hemispherical or conical recesses into which the beads fit. The chains look like key chains and are available in plain carbon and stainless steel and also in the form of solid plastic beads molded on a cord. Bead chains are used on computers, air conditioners, television tuners, and Venetian blinds. The sprockets may be steel, die-cast zinc or aluminum, or molded nylon.

1.2 Words and Phrases

projection [prə'dʒekʃən] *n.* 凸出
cycloidal [sai'klɔidəl] *adj.* 摆线的
cycloidal profile 摆线轮廓
involute ['invəlu:t] *adj.* 渐开线的

involute profile 渐开线轮廓
conjugate ['kɔndʒugit] *adj.* 共轭的
pinion ['pinjən] *n.* 小齿轮
dimension [di'menʃən] *n.* 量纲
mate [meit] *v.* 啮合
engagement [in'geidʒmənt] *n.* 啮合
tangency ['tændʒənsi] *n.* 接触
pitch [pitʃ] *n.* 齿节
intersect [ˌintə'sekt] *v.* 交叉
disposition [dispə'ziʃən] *n.* 排列，配置
helical gear 螺旋齿轮
spur gear 正齿轮
worm [wə:m] *n.* 蜗轮，蜗杆
bevel gear 伞形齿轮
hourglass ['auəglɑ:s] *n.* 沙漏
V-belt V 型带
splice [splais] *n.* 连接
pulley ['puli] *n.* (皮带)轮
groove [gru:v] *n.* 沟，槽
tractive ['træktiv] *adj.* 牵引的，曳引的
clearance ['kliərəns] *n.* 间隙
chain drive 链传动
prototype ['prəutətaip] *n.* 模型，标准
saw [sɔ:] *n.* 锯
escalator ['eskəleitə] *n.* 自动扶梯
roller chain 滚柱链条
bead chain 滚子链条
bushing ['buʃiŋ] *n.* 套筒
sprocket ['sprɔkit] *n.* 链轮
strand [strænd] *n.* 排，列

1.3 Complex Sentence Analysis

[1] Gears are direct contact bodies, operating in pairs, that transmit motion and force from one rotating shaft to another, or from a shaft to a slide (rack), by means of successively engaging projections called teeth.

① operating in pairs：分词短语，修饰前面的 Gears。

② that 引导的从句，修饰前面的 Gears。

③ by means of 表示“借助”、“通过”的意思。

[2] If an involute spur pinion were made of rubber and twisted uniformly so that the ends rotated about the axis relative to one another, the elements of the teeth, initially straight and parallel to the axis, would become helices.

① were made of: “由……组成”

② so that 引导结果状语从句

③ parallel to: “平行于……”

[3] Sufficient clearance must be provided at the bottom of the groove to prevent the belt from bottoming as it becomes narrower from wear.

① at the bottom of… “在……的底部”

② prevent…from wear “防止磨损”

[4] Today, as the result of modern design and production methods, chain drives that are much superior to their prototypes are available, and these have contributed greatly to the development of efficient agricultural machinery, well-drilling equipment, and mining and construction machinery.

① superior to 表示“优于”的意思。

② and 引导的是一并列句。

1.4 Exercise: Translate the Following Paragraphs

A gear having tooth elements that are straight and parallel to its axis is known as a spur gear. A spur pair can be used to connect parallel shafts only. Parallel shafts, however, can also be connected by gears of another type, and a spur gear can be mated with a gear of a different type.

Helical gears have certain advantages; for example, when connecting parallel shafts they have a higher load-carrying capacity than spur gears with the same tooth numbers and cut with the same cutter. Helical gears can be also be used to connect nonparallel, non-intersecting shafts at any angle to one another. Ninety degrees is the most common angle at which such gears are used.

Worm gears provide the simplest means of obtaining large ratios in a single pair. They are usually less efficient than parallel shaft gears, however, because of an additional sliding movement along the teeth. Because of their similarity, the efficiency of a worm and gear depends on the same factors as the efficiency of a screw.

Lesson 2 Machine Parts (II)

2.1 Text

Fastener

[1]Fasteners are devices which permit one part to be joined to a second part and, hence, they are involved in almost all designs.

There are three main classifications of fasteners, which are described as follows:

(1) Removable. This type permits the parts to be readily disconnected without damaging the fastener. An example is the ordinary nut-and-bolt fastener.

(2) Semi permanent. For this type, the parts can be disconnected, but some damage usually occurs to the fastener. One such example is a cotter pin.

(3) Permanent. When this type of fastener is used, it is intended that the parts will never be disassembled. Examples are riveted joints and welded joints.

The importance of fasteners can be realized when referring to any complex product. In the case of the automobile, there are literally thousands of parts which are fastened together to produce the total product. The failure or loosening of a single fastener could result in a simple nuisance such as a door rattle or in a serious situation such as a wheel coming off. Such possibilities must be taken into account in the selection of the type of fastener for the specific application.

Nuts, bolts, and screws are undoubtedly the most common means of joining materials. Since they are so widely used, it is essential that these fasteners attain maximum effectiveness at the lowest possible cost. Bolts are, in reality, carefully engineered products with a practically infinite use over a wide range of services.

An ordinary nut loosens when the forces of vibration overcome those of friction. In a nut and lock washer combination, the lock washer supplies an independent locking feature preventing the nut from loosening. The lock washer is useful only when the bolt might loosen because of a relative change between the length of the bolt and the parts assembled by it.[2]This change in the length of the bolt can be caused by a number of factors-creep in the bolt, loss of resilience, difference in thermal expansion between the bolt and the bolted members, or wear. In the above static cases, the expanding lock washer holds the nut under axial load and keeps the assembly tight. When relative changes are caused by vibration forces, the lock washer is not nearly as effective.

Rivets are permanent fasteners. They depend on deformation of their structure for their holding action. Rivets are usually stronger than the thread-type fastener and are more economical

on a first-cost basis. Rivets are driven either hot or cold, depending upon the mechanical properties of the rivet material. Aluminum rivets, for instance, are cold-driven,since cold working improves the strength of aluminum. Most large rivets are hot-driven, however.

Shaft

Virtually all machines contain shafts. The most common shape for shafts is circular and the cross section can be either solid or hollow (hollow shafts can result in weight savings).

Shafts are mounted in bearings and transmit power through such devices as gears, pulleys, cams and clutches. These devices introduce forces which attempt to bend the shaft; hence, the shaft must be rigid enough to prevent overloading of the supporting bearings.[3] In general, the bending deflection of a shaft should not exceed 0.01 in. per ft. of length between bearing supports.

For diameters less than 3 in., the usual shaft material is cold-rolled steel containing about 0.4 percent carbon. Shafts are either cold-rolled or forged in sizes from 3 in. to 5 in. .For sizes above 5 in. , shafts are forged and machined to size. Plastic shafts are widely used for light load applications. One advantage of using plastic is safety in electrical applications, since plastic is a poor conductor of electricity.

Another important aspect of shaft design is the method of directly connecting one shaft to another. This is accomplished by devices such as rigid and flexible couplings.

Bearing

A bearing can be defined as a member specifically designed to support moving machine components. The most common bearing application is the support of a rotating shaft that is transmitting power from one location to another. Since there is always relative motion between a bearing and its mating surface, friction is involved. In many instances, such as the design of pulleys, brakes, and clutches, friction is desirable. However, in the case of bearings, the reduction of friction is one of the prime considerations: Friction results in loss of power, the generation of heat, and increased wear of mating surfaces.

The concern of a machine designer with ball bearings and roller bearings is fivefold as follows: (1) Life in relation to load; (2) stiffness, i.e. deflections under load; (3) friction; (4) wear; (5) noise. For moderate loads and speeds the correct selection of a standard bearing on the basis of load rating will usually secure satisfactory performance. The deflection of the bearing elements will become important where loads are high, although this is usually of less magnitude than that of the shafts or other components associated with the bearing. [4] Where speeds are high special cooling arrangements become necessary which may increase frictional drag. Wear is primarily associated with the introduction of contaminants, and sealing arrangements must be chosen with regard to the hostility of the environment.

Notwithstanding the fact that responsibility for the basic design of ball bearings and roller bearings rests with the bearing manufacturer, the machine designer must form a correct appreciation of the duty to be performed by the bearing and be concerned not only with bearing selection but with the conditions for correct installation.