普通高等学校测控技术与仪器专业规划教材

测控专业英语

Professional English for Measurement and Control

主编　王丽君　梁福平

华中科技大学出版社
http://www.hustp.com

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内容简介

本书从测控技术与仪器专业的角度，选编了关于机械、电子、测量、控制及计算机等方面的英文资料，基本上覆盖了和测控技术与仪器相关的各个领域，旨在使学生能够通过专业英语的学习，熟悉并掌握测控技术与仪器方面的基本英语词汇及用法，培养和提高学生阅读和翻译专业英语文献资料的能力。

本书分为9个部分，每个部分均由课文及阅读材料组成，供上课讲解和课后阅读使用。第一部分为概述，介绍了测量与控制技术；第二部分为机械部分，由机构、工程材料、机械设计、工程制图和加工等5课组成；第三部分为测量，由测量、传感器、通用仪器、虚拟仪器、激光技术和标定技术等6课组成；第四部分为信号调理，由数据采样、运算放大器、滤波器、D/A和A/D转换、仪表装置和接地等5课组成；第五部分为控制，由自动控制简介、开环和闭环控制、离散时间控制、过程控制、PID控制器和可编程控制器等6课组成；第六部分为计算机，由计算机硬件和软件、微处理器、总线网络技术、计算机网络和数字信号处理等5课组成；第七部分为执行机构，由电动执行机构、液压执行机构和气动执行机构等3课组成；第八部分为新技术，由机器人技术简介、分布式控制系统中的先进控制技术、遥感技术、机器视觉简介和21世纪的航空技术等5课组成；第九部分为翻译与写作，介绍了专业英语的特点、专业英语的翻译概论和科技论文的写作方法。

本书适合于高校测控技术与仪器相关专业的学生作为专业英语教材，也可供大专、职业大学、成人大学等相关专业选用，还可供研究生及从事相关专业的工程技术人员阅读参考。

普通高等学校测控技术与仪器专业规划教材

编委会

普通高等学校测控技术与仪器专业规划教材

总　序

测控技术与仪器专业是在合并原来的11个仪器仪表类专业的基础上新设立的专业，目前设有该专业的高校已经超过250所，是当前发展较快的本科专业之一。经过两届全国高等学校仪器科学与技术教学指导委员会的努力，形成了《测控技术与仪器专业本科教学规范》（以下简称《专业规范》）。《专业规范》颁布后，各高校开始构建面向21世纪的测控技术与仪器本科专业的课程体系，并进行教学改革，以更好地满足科学技术和国民经济发展的需要。

华中科技大学出版社邀请多位全国高等学校仪器科学与技术教学指导委员会委员和具有丰富教学经验的专家编写了这套“普通高等学校测控技术与仪器专业规划教材”，这对于满足各高校测控专业建设需要，加强高校测控专业的建设，进一步落实《专业规范》精神，具有积极的作用。

这套教材基本涵盖了测控技术与仪器专业的专业基础课程和部分专业课程，编写定位清晰，内容适应了加强工程教学的趋势，注重了教材的实用性和创新性教育的推进。这套教材的出版，是测控专业教学领域“百花齐放、百家争鸣”的一个体现，它为测控专业教学选用教材又提供了一个选择。

由于时间所限，这套教材可能存在这样那样的问题。随着这套教材投入教学使用和通过教学实践的检验，它将不断得到改进、完善和提高，为测控专业人才的培养做出积极的贡献。

谨为之序。

全国高等学校仪器科学与技术教学指导委员会主任委员

胡小唐

2009年7月

前　言

测控专业英语是测控技术与仪器专业及相关专业的一门专业课程，是本科英语教学中必不可少的一个教学环节。为了使学生熟悉和掌握本专业及相关专业的常用专业词汇、词组及相关的科技文献资料，培养学生顺利阅读专业文献、进行信息交流、完成专业翻译及写作的能力，了解当前国内外的一些新的测量技术及方法，特编写了《测控专业英语》一书。

本书的主要特点体现在：①选材力求丰富多样，内容和专业词汇的涵盖面广，选取的文章具有代表性、新颖性，既有利于培养学生学习兴趣，又有利于学生丰富专业知识并积累相关的专业词汇。②本书的大多数资料选自国外原版的教材、专著、论文或本专业相关网站提供的技术资料，保证了课文的实用性和可读性。③本书共提供课文 36 课，每课内容都由课文、生词和短语、重点和难点的翻译与解释及阅读材料组成，既便于各学校根据自己的特点机动地组织教学，也便于学生自学。

本书由华北水利水电学院王丽君副教授、北京信息科技大学梁福平教授任主编，具体编写分工为：华北电力大学的韩晓娟副教授编写第一部分和第六部分，华北水利水电学院的运红丽讲师编写第二部分，北京信息科技大学的梁福平教授编写第三部分和第九部分，北京信息科技大学的郭阳宽副教授编写第四部分，华北水利水电学院的王丽君副教授编写第五部分和第七部分，重庆大学的刘嘉敏副教授编写第八部分。全书由王丽君和梁福平统稿，由武汉大学的马志敏教授主审，郑州轻工业学院丁静老师、北京信息科技大学刁素坤老师、研究生马丽丽等为本书的编写提供了许多资料和帮助，参编的各个单位的领导也给予大力支持，在此一并表示感谢。

由于水平有限，书中错误和不当之处在所难免，欢迎广大读者多提宝贵意见。

编　者

2009 年 4 月

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PART ONE Overview

Lesson 1 An Introduction to Measurement & Control Technology

"Measurement & Control Technology and Instruments" is the unique major of instrument science and technology in China. Instrument and meter is an essential part of IT industry. Instrument and meter technology is a comprehensive subject which is based on mechanics, computer science and information technology. And it shows greater and greater power in the development of national economy, national defense and everyday life.

Understanding is a powerful aid to prediction. Models lead to understanding, and observations ground models. Instruments and measurement techniques extend direct observation to the benefit of understanding and prediction. Develop skill in utilization of instrumentation and learn to specify or invent new instrumentation and you will aid observation. Better techniques of measurement lead to greater and more accurate understanding of the natural system. The short term benefit of such understanding is the ability to predict response. In the long term, understanding is a general guard against blunders in our own behavior as a society. And understanding can lead to opportunities for human use and individual appreciation to social benefit.

1. Trends in Measurement and Control System Equipment and Future Outlook

The wave of digitization has become widely disseminated in many fields since 1975, encompassing power systems including nuclear and thermal power systems; industrial systems including petrochemicals, steel, foods, and pharmaceuticals; and infrastructure systems including water and sewage, road, and airport control systems. Substantial progress has been made in open system technologies, information technologies, and integration technologies, and methods of configuring control systems under total system optimization including information systems are now attracting global attention.

2. Industrial Controllers—Advances in Development of High-Speed and High-Reliability Controller Technologies

Technologies have been progressing for the standardization and realization of open architectures for programmable logic controllers (PLCs) and distributed control systems (DCS), both of which are representative industrial control equipment. Moreover, taking technical trends and the social environment into consideration, we have studied hardware and software technologies to improve management and applicability to factory automation (FA) and process automation (PA) systems, and proposed the development of products to be released in the future.

3. New Developments for Industrial Computers

The application of industrial computers has expanded to encompass not only factory automation systems but various other fields, including social infrastructure systems such as broadcasting and communication systems, transportation management systems, water supply and sewerage monitoring systems, electric power generation and supply systems, and building management systems; as well as automated equipment, inspection and analysis equipment, and so on. In monitoring and control systems, and equipment with embedded computers, there is an accelerating trend toward open systems and an increasing number of systems using PCs and PC servers. As a result, the requirements for industrial computers have expanded and diversified according to such factors as the purpose of use and the scale of application.

4. Latest Field Measurement Technologies

Various types of field measurement devices such as flowmeters, pressure transmitters, thermometers, and density meters are widely applied in manufacturing process systems.

5. Instrument and Control Products Contributing to Effective Operation of Water and Sewage Plants

Water and sewage systems are an important part of the social infrastructure and indispensable in people's daily lives. A water system must provide safe water at all times, while a sewage system must purify sewage and rainwater collected by sewerage pipes and transform them into clear water before discharge into a river or ocean. At the same time, reduction of electricity consumption by water and sewage plants is important to reduce greenhouse gas emissions, which lead to global warming. It is also necessary to prevent overdosing of chemicals in treated water from the standpoint of environmental protection. In addition, the reduction of chemical consumption is important from the viewpoint of reducing the operating and maintenance costs of plants.

6. Monitoring and Control of Building Automation System

The architecture of building automation and control systems is evolving into the Building Energy Management System (BEMS), including energy-saving control and energy management. BEMS measures the status of the building facilities and space environment, performs accurate control, and stores data for reporting and analysis.

7. Solutions for Measurement and Control Systems in Industrial Processing Fields

Thirty years have passed since digital technology was introduced in the field of measurement and control systems. On the one hand, investment in plant and equipment has been rising in raw material industries such as steel and petrochemicals due to the recent growth of the Chinese economy, and this in turn has promoted the renewal of instrument systems. On the other hand, the operators who have supported the high-growth period of the Japanese economy are now aging, and it is becoming increasingly difficult to maintain safe and stable operations as well as the uniformly high quality realized by the experience and skill of these expert operators up to now. In particular, problems are expected to arise from 2007 onward with regard to the renewal of distributed control systems (DCS).

8. Current Project Areas

Below is a list of current research projects in the Systems, Measurement and Control Areas:

Modeling and System Identification

- Modeling and controling of fuel cell power systems;
- Modeling of machining chatter;
- Autonomous modeling of complex manufacturing processes;
- Real-time predictive modeling and simulation for prognosis in smart ships;
- Real-time load and damage identification in filament wound rocket motor casings;
- Modeling and identification of seat head rest rattle in passenger bucket seat;
- Modeling and identification of morphing aircraft structure.

Measurements and Diagnostics

- Nonlinear observer design and neural networks for virtual sensing, modeling, fault detection, diagnostics, and adaptive robust fault-tolerant control;
- Diesel engine diagnostics and prognostics using information-rich input signals;
- Estimating particulate load in a diesel particulate filter for regeneration control;
- Vehicle health management technologies;
- Integrated diagnostics and reliability forecasting for heterogeneous structures;
- A facility for theoretical and experimental environmental conditioning, modeling and prognostics of advanced heterogeneous structures;
- Sensing and diagnostics of electrical machines;
- Autonomous selection of sensors and sensor features for intelligent monitoring and diagnostics for manufacturing processes;
- Integrated prognostics health management technologies for commercial and defense systems;
- Integrated sensing and diagnostics for life cycle health management of gas turbine engines: application to wire harnesses and connectors;
- Modeling and diagnostics of mechanically attached structural components;
- Diagnostics & prognostics for assessing vehicle products in real time with feedback for manufacturing to reduce conservatism.

Control Theory

- Nonlinear adaptive robust control theory;
- Multi-level fuzzy control;
- Multivariable intelligent control;
- Neural network-based adaptive control;
- Observer-based adaptive control.

Control Applications

- Engine controls;

- Energy-saving nonlinear control of electro-hydraulic systems;
- Intelligent and precision control of high-speed linear motor drive systems, machine tools, and piezo-electric actuators for precision manufacturing;
- Nonlinear control of high-density hard disk drives;
- Coordinated control of robot manipulators;
- Feedforward/feedback motion control for high-speed automation;
- High-speed motion control for flexible robotic manipulators;
- Precision control of piezo-electric actuators for scanning microscopes;
- Control of medical devices;
- Control of mechatronic devices.

Words and Expressions

pharmaceuticals [ˌfɑːməˈsjuːtikəlz] *n.* 医药品
infrastructure [ˈinfrəˈstrʌktʃə] *n.* 下部构造,下部组织,基础结构,基础设施
programmable logic controllers 可编程控制器
factory automation(FA) 工厂自动化
process automation(PA) 过程自动化
flowmeter [ˈfləumiːtə] *n.* 流量计
transmitter [trænzˈmitə] *n.* 发报机;发射机;发送器;话筒;变送器
sewage [ˈsju(ː)idʒ] *n.* 脏水,污水
Building Energy Management System 建筑节能管理系统
distributed control systems (DCS) 分布式控制系统
piezo-electric 压电的
energy-saving 节能的

Notes

1. The wave of digitization has become widely disseminated in many fields since 1975, encompassing power systems including nuclear and thermal power systems; industrial systems including petrochemicals, steel, foods, and pharmaceuticals; and infrastructure systems including water and sewage, road, and airport control systems.

(1) 句中的 encompassing 是现在分词作状语,它在句子中作一个伴随状语。including 是现在分词作定语。

(2) 全句可翻译为:1975 年以来,数字化浪潮已在许多领域广为传播,包含了核能和热力发电的电力系统;石化、钢铁、食品和药品的工业系统;以及供水、污水处理、道路和机场控制的基础设施系统。

2. Moreover, taking technical trends and the social environment into consideration, we have studied hardware and software technologies to improve management and applicability to factory automation (FA) and process automation (PA) systems, and proposed the development of products to be released in the future.

(1) 句中 taking... into consideration:考虑……。

(2) 全句可翻译为：此外，考虑到技术发展趋势和社会环境，我们研究了硬件和软件技术来改善工厂自动化和过程自动化系统的管理和应用，提出了未来产品的开发方案。

3. It is also necessary to prevent overdosing of chemicals in treated water from the standpoint of environmental preservation.

(1) 句中 from the standpoint of："从……角度"。overdosing 是动名词，这里翻译成"超(剂)量"。例如：He's been overdosing himself. 他用药一直过量。

(2) 全句可翻译为：从保护环境的角度来看，也必须防止用过量的化学品处理水。

Reading Material

A Workshop on Process Measurement and Control

In recognition of the recent growth and the perceived new opportunities in process measurement and control, a workshop on this topic was held at the Sheraton New Orleans on March 6-8, 1998. Sixteen invited speakers and discussants from academia, industry and national laboratories presented their perspectives on the current state-of-the-art applications in industry and future needs in various areas of process measurement and control. Thirty additional participants, also representing academia, industry and national laboratories, attended and participated in the workshop. Many of these individuals were invited; however, some were unsolicited applicants who learned of the workshop through colleagues and responded to a web-based call for participation located at the web site http://udel.edu/~fdoyle/V2020.html.

The goals of the workshop were five-fold:

- To identify the current state-of-the-art for process measurement and control, including their current impact on academic and industrial research and development;
- Project where these methods can be in 25 years, and the expected impact of these methods over that period;
- Identify the challenges and roadblocks that delay advancements in these technology areas;
- Identify strategic research investments that might facilitate the achievement of these latter capabilities and ensure their widespread utility to both academic and industrial communities;
- Produce a report to the research community served by the NSF, NIST, and NIST ATP concerning the findings of 1-4.

A unique feature of this workshop was that chemists andchemical engineers were brought together in a common forum to address the common interests in process measurements for control. Individual breakout groups were comprised of a mixed group from academia, industry, and the government labs. Furthermore, each group was split between measurement scientists and control engineers, and the groups each addressed one control topic and one measurement topic. In this manner, a "single track" was achieved. In the remainder of this preliminary report, the summary findings of the workshop will be discussed. Several speakers were asked to provide overviews of, and assess the state-of-the-art in, process measurement and control. Others were asked to describe successes of current methods in industry and academia, and to assess needs into the future. This was done around eight topical areas, and the balance of this report is organized around those areas:

- Nonlinear model predictive control;
- Performance monitoring;
- Estimation and inferential control;
- Identification and adaptive control;
- Molecular characterizations and separations;
- Process sensors;
- Micro-fabricated instrumentation;
- Information and data handling.

PART TWO Machinery

Lesson 1 Mechanism

A mechanism has been defined as "a combination of rigid or resistant bodies so formed and connected that they move upon each other with definite relative motion". That is the component of machinery. Activity connections between two members that have the relative motion are to be called the motion pairs. All motion pairs contacting with planes are called lower pairs and all motion pairs contacting with points or lines are called higher pairs. Lower pairs include revolute or pin connections, for example, a shaft in a bearing or the wrist pin joining a piston and connecting rod. Both elements joined by the pin may be considered to have the same motion at the pin center if clearance is neglected. Other basic lower pairs include the sphere, cylinder, prism, helix, and plane. The Hook-type universal joint is a combination of two lower pairs. Examples of higher pairs include a pair of gears or a disk cam and follower.

The motion specific property of mechanism chiefly depends on the relative size between the members, and the character of motion pairs, as well as the mutual disposition method etc. The member is used to support the member of motion in the mechanism to be called the machine frame and used as the reference coordinate to study the motion system. The member that possesses the independence motion is called motivity member. The members except machine frame and motivity member being compelled to move in the mechanism are called driven members. The independently parameter which is essential for description or definite mechanism motion is called the free degree of mechanism. For gaining the definite relative motion between the members of mechanism, it must make the number of driving parts of mechanism equal to the number of free degrees. An unconstrained rigid body has six degrees of freedom: translation in three coordinate directions and rotation about three coordinate axes. If the body is restricted to motion in a plane, there are three degrees of freedom: translation in two coordinate directions and rotation within the plane.

Mechanisms may be categorized in several different ways to emphasize their similarities and differences. One such grouping divides mechanisms into planar, spherical, and spatial categories. All three groups have many things in common; the criterion which distinguishes the groups, however, is to be found in the characteristics of the motions of the links.

A planar mechanism is one in which all particles describe plane curves in space and all these curves lie in parallel places, i. e. , the loci of all points are plane curves parallel to a single common plane. This characteristic makes it possible to represent the locus of any chosen point of a planar mechanism in its true size and shape on a single drawing or figure.

The motion transformation of any such mechanism is called coplanar. The plane four-bar linkage, the plate cam and follower, and the slider-crank mechanism are familiar examples of planar mechanism. The vast majority of mechanisms in use today are planar.

1. Four-Bar Mechanisms

When one of the members of a constrained linkage is fixed, the linkage becomes a mechanism capable of performing a useful mechanical function in a machine. On pin-connected linkages the input (driver) and output (follower) links are usually pivotally connected to the fixed link; the connecting links (couplers) are usually neither inputs nor outputs. Since any of the links can be fixed, if the links are of different lengths, four mechanisms, each with a different input-output relationship, can be obtained with a four-bar linkage. These four mechanisms are said to be inversions of the basic linkage, as shown in Figure 2. 1.

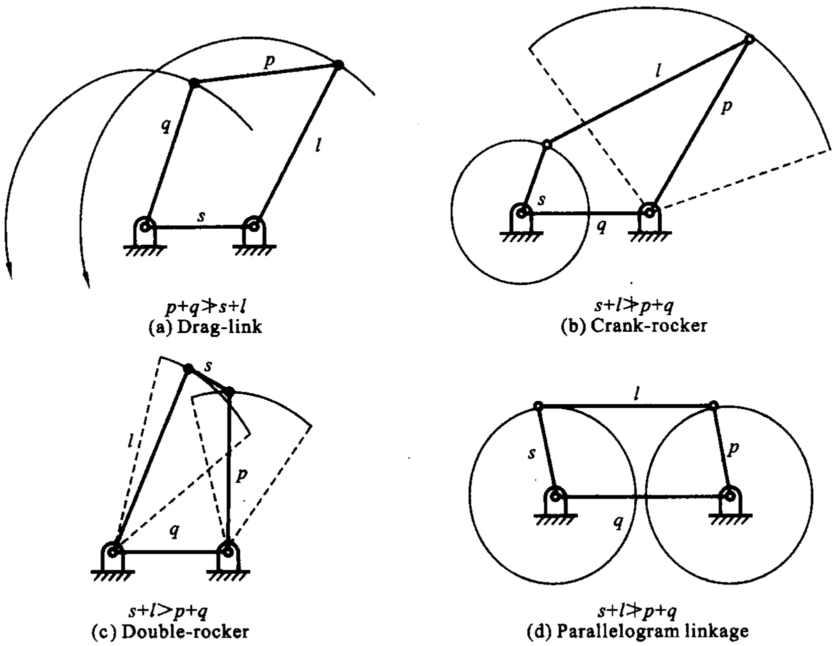

Figure 2. 1 The inversions of the four-bar mechanisms

2. Slider-Crank Mechanism

When one of the pinconnections in a four-bar linkage is replaced by a sliding joint, a number of useful mechanisms can be obtained from the resulting linkage. In Figure 2. 2, the connection between links 1 and 4 is a sliding joint that permits block 4 to slide in the slot in link 1. If link 1 is fixed, the resulting slider-crank mechanism is a reciprocating engine. The block 4 represents the piston; link 1 is the block that contains the crankshaft bearing at A and the cylinder; link 2 is the crankshaft and link 3 the connecting rod. The crankpin bearing is at B, the wrist pin bearing at C. The stroke of the piston is twice AB, the stroke of the crank.