清华经济学系列英文版教材

PEARSON
Prentice Hall

工程经济学

第 12 版

(美) William G. Sullivan
Elin M. Wicks
James T. Luxhoj 著

Engineering Economy

Twelfth Edition

清华大学出版社

Engineering Economy Twelfth Edition

PEARSON
Prentice Hall

清华经济学系列英文版教材

工程经济学

第12版

Engineering Economy

Twelfth Edition

(美) William G. Sullivan
Elin M. Wicks
James T. Luxhoj 著

清华大学出版社
北京

出 版 说 明

为了适应经济全球化的发展趋势，满足国内广大读者了解、学习和借鉴国外先进的管理经验和掌握经济理论的前沿动态，清华大学出版社与国外著名出版公司合作影印出版一系列英文版经济管理方面的图书。我们所选择的图书，基本上是已再版多次、在国外深受欢迎、并被广泛采用的优秀教材，绝大部分是该领域中较具权威性的经典之作。在选书的过程中，我们得到了很多专家、学者的支持、帮助和鼓励，在此表示谢意！清华经济学系列英文版教材由清华大学经济管理学院和北京大学经济学院朱宝宪、杨炘、李明志、钟笑寒、姚志勇、刘群艺等老师审阅，在此一并致谢！

由于原作者所处国家的政治、经济和文化背景等与我国不同，对书中所持观点，敬请广大读者在阅读过程中注意加以分析和鉴别。

我们期望这套影印书的出版对我国经济科学的发展能有所帮助，对我国经济管理专业的教学能有所促进。

欢迎广大读者给我们提出宝贵的意见和建议；同时也欢迎有关的专业人士向我们推荐您所接触到的国外优秀图书。

清华大学出版社经管事业部

2004.9

总 序

世纪之交，中国与世界的发展呈现最显著的两大趋势——以网络为代表的信息技术的突飞猛进，以及经济全球化的激烈挑战。无论是无远弗界的因特网，还是日益密切的政治、经济、文化等方面的国际合作，都标示着21世纪的中国是一个更加开放的中国，也面临着一个更加开放的世界。

教育，特别是管理教育总是扮演着学习与合作的先行者的角色。改革开放以来，尤其是20世纪90年代之后，为了探寻中国国情与国际上一切优秀的管理教育思想、方法和手段的完美结合，为了更好地培养高层次的“面向国际市场竞争、具备国际经营头脑”的管理者，我国的教育机构与美国、欧洲、澳洲以及亚洲一些国家和地区的大量的著名管理学院和顶尖跨国企业建立了长期密切的合作关系。以清华大学经济管理学院为例，2000年，学院顾问委员会成立，并于10月举行了第一次会议，2001年4月又举行了第二次会议。这个顾问委员会包括了世界上最大的一些跨国公司和中国几家顶尖企业的最高领导人，其阵容之大、层次之高，超过了世界上任何一所商学院。在这样高层次、多样化、重实效的管理教育国际合作中，教师和学生与国外的交流机会大幅度增加，越来越深刻地融入到全球性的教育、文化和思想观念的时代变革中，我们的管理教育工作者和经济管理学习者，更加真切地体验到这个世界正发生着深刻的变化，也更主动地探寻和把握着世界经济发展和跨国企业运作的脉搏。

我国管理教育的发展，闭关锁国、闭门造车是绝对不行的，必须同国际接轨，按照国际一流的水准来要求自己。正如朱镕基总理在清华大学经济管理学院成立十周年时所发的贺信中指出的那样：“建设有中国特色的社会主义，需要一大批掌握市场经济的一般规律，熟悉其运行规则，而又了解中国企业实情的经济管理人才。清华大学经济管理学院就要敢于借鉴、引进世界上一切优秀的经济管理学院的教学内容、方法和手段，结合中国的国情，办成世界第一流的经管学院。”作为达到世界一流的一个重要基础，朱镕基总理多次建议清华的MBA教育要加强英语教学。我体会，这不仅因为英语是当今世界交往中重要的语言工具，是连接中国与世界的重要桥梁和媒介，而且更是中国经济管理人才参与国际竞争，加强国际合作，实现中国企业的国际战略的基石。推动和实行英文教学并不是目的，真正的目的在于培养学生——这些未来的企业家——能够具备同国际竞争对手、合作伙伴沟通和对抗的能力。按照这一要求，清华大学经济管理学院正在不断推动英语教学的步伐，使得英语不仅是一门需要学习的核心

课程，而且渗透到各门专业课程的学习当中。

课堂讲授之外，课前课后的大量英文原版著作、案例的阅读对于提高学生的英文水平也是非常关键的。这不仅是积累相当的专业词汇的重要手段，而且是对学习者思维方式的有效训练。

我们知道，就阅读而言，学习和借鉴国外先进的管理经验和掌握经济理论动态，或是阅读翻译作品，或是阅读原著。前者属于间接阅读，后者属于直接阅读。直接阅读取决于读者的外文阅读能力，有较高外语水平的读者当然喜欢直接阅读原著，这样不仅可以避免因译者的疏忽或水平所限而造成的纰漏，同时也可以尽享原作者思想的真实表达。而对于那些有一定外语基础，但又不能完全独立阅读国外原著的读者来说，外文的阅读能力是需要加强培养和训练的，尤其是专业外语的阅读能力更是如此。如果一个人永远不接触专业外版图书，他在获得国外学术信息方面就永远会比别人差半年甚至一年的时间，他就会在无形中减弱自己的竞争能力。因此，我们认为，有一定外语基础的读者，都应该尝试一下阅读外文原版，只要努力并坚持，就一定能过了这道关，到那时就能体验到直接阅读的妙处了。

在掌握大量术语的同时，我们更看重读者在阅读英文原版著作时对于西方管理者或研究者的思维方式的学习和体会。我认为，原汁原味的世界级大师富有特色的表达方式背后，反映了思维习惯，反映了思想精髓，反映了文化特征，也反映了战略偏好。知己知彼，对于跨文化的管理思想、方法的学习，一定要熟悉这些思想、方法所孕育、成长的文化土壤，这样，有朝一日才能真正“具备国际战略头脑”。

以往，普通读者购买和阅读英文原版还有一个书价的障碍。一本外版书少则几十美元，多则上百美元，一般读者只能望书兴叹。随着全球经济合作步伐的加快，目前在出版行业有了一种新的合作出版的方式，即外文影印版，其价格几乎与国内同类图书持平。这样一来，读者可以不必再为书价发愁。清华大学出版社这些年在这方面一直以独特的优势领先于同行。早在1997年，清华大学出版社敢为人先，在国内最早推出一批优秀商学英文版教材，规模宏大，在企业界和管理教育界引起不小的轰动，更使国内莘莘学子受益良多。

为了配合清华大学经济管理学院推动英文授课的急需，也为了向全国更多的MBA试点院校和更多的经济管理学院的教师和学生提供学习上的支持，清华大学出版社再次隆重推出与世界著名出版集团合作的英文原版影印商学教科书，也使广大工商界人士、经济管理类学生享用到最新最好质优价廉的国际教材。

祝愿我国的管理教育事业在社会各界的大力支持和关心下不断发展、日进日新；祝愿我国的经济建设在不断涌现的大批高层次的面向国际市场竞争、具备国际经营头脑的管理者的勉力经营下早日中兴。

赵纯均 教授

清华大学经济管理学院院长

全国工商管理硕士教育指导委员会副主任

Preface

About Engineering Economy

Engineering economy—what is it, and why is it important? The initial reaction of many engineering students to these questions is "Money matters will be handled by someone else. It is not something I need to worry about." In reality, any engineering project must be not only physically realizable, but also economically affordable. For example, a child's tricycle could be built with an aluminum frame or a composite frame. Some may argue that because the composite frame will be stronger and lighter, it is a better choice. However, there is not much of a market for thousand dollar tricycles! One might suggest that this argument is ridiculously simplistic and that common sense would dictate choosing aluminum for the framing material. Although the scenario is an exaggeration, it reinforces the idea that the economic factors of a design weigh heavily in the design process, and that engineering economy is an integral part of that process, regardless of the engineering discipline. *Engineering, without economy, makes no sense at all.*

In broad terms, for an engineering design to be successful, it must be technically sound and produce benefits. These benefits must exceed the costs associated with the design in order for the design to enhance net value. The field of engineering economy is concerned with the systematic evaluation of the benefits and costs of projects involving engineering design and analysis. In other words, engineering economy quantifies the benefits and costs associated with engineering projects to determine whether they make (or save) enough money to warrant their capital investments. Thus, engineering economy requires the application of engineering design and analysis principles to provide goods and services that satisfy the consumer at an affordable cost. As we shall see, engineering economy is as relevant to the design engineer who considers material selection as it is to the chief executive officer who approves capital expenditures for new ventures.

History of the Book

The original *Introduction to Engineering Economy*, authored by Woods and DeGarmo, appeared in 1942. The extensive use of this text for the past 60 years has encouraged the authors to continue building on the original purpose of the book—to teach lucidly the principles of engineering economy. In this spirit, the twelfth edition of *Engineering Economy* has built upon the rich and time-tested teaching materials of earlier editions, and its publication makes it the second-oldest book on the market that deals exclusively with engineering economy.

Twelfth Edition of *Engineering Economy*

New or Enhanced Features to This Edition

- Design economics problems are expanded in Chapter 2.
- Cost estimating has been clarified and given expanded coverage.
- A number of new and updated end-of-chapter problems are included.
- A Web site devoted to electronic media to support an engineering economy course is fully operational (and maintained by Prentice Hall).
- Spreadsheet templates appear throughout the text.
- An extra supplement dealing with development and use of spreadsheets is available.
- An Instructor's Manual containing full solutions to all problems in the book is available.
- Suggestions for using "student portfolios" to facilitate the integrated learning of topics in engineering economy are presented in this Preface.
- "Economic value added" by an engineering project is explained in terms of an after-tax cash-flow analysis.
- The cost of equity and debt capital and the weighted average cost of capital and its relationship to rate of return concepts are explained.
- Replacement Analysis (Chapter 9) has been rewritten to clarify concepts and principles of this important topic.
- Chapter 15, which deals with multiattributed decision making, has been added.

Pedagogy of this Book

This book has two primary purposes: (1) to provide students with a sound understanding of the principles, basic concepts, and methodology of engineering economy; and (2) to help them develop proficiency with these methods and with the process for making rational decisions regarding situations they are likely to encounter in professional practice. Consequently, *Engineering Economy* is intended to serve as a text for classroom instruction *and* as a basic reference for use by practicing

engineers in all specialty areas (e.g., chemical, civil, computer, electrical, industrial, and mechanical engineering). The book is also useful to persons engaged in the management of technical activities.

As a textbook, the twelfth edition is written principally for the first formal course in engineering economy. The contents of the book and the accompanying Instructor's Manual and Electronic Spreadsheets Supplement (both available from Prentice Hall) are organized for effective presentation and teaching of the subject matter. A three-credit-hour semester course should be able to cover the majority of topics in this edition, and there is sufficient depth and breadth to enable an instructor to arrange course content to suit individual needs. Representative syllabi for a three-credit and a two-credit semester course in engineering economy are provided in Table P-1. Moreover, because several advanced topics are included, this book can also be used for a second course in engineering economy.

Every chapter and the appendices have been revised and updated to reflect current trends and issues. Also, numerous exercises that involve open-ended problem statements and iterative problem-solving skills are included throughout the book. A large number of the 500+ end-of-chapter exercises are new, and many solved examples representing realistic problems that arise in various engineering disciplines are presented.

An engineering economy course may be classified, for Accreditation Board for Engineering and Technology (ABET) purposes, as part engineering science and part engineering design. It is generally advisable to develop and teach such a course at the upper division level. Here, an engineering economy course incorporates the accumulated knowledge students have acquired in other areas of the curriculum also dealing with iterative problem solving, open-ended exercises, creativity in formulating and evaluating feasible solutions to problems, and consideration of realistic constraints (economic, aesthetic, safety, etc.) in problem solving.

Internet Web Site Supplement

An engineering home page is accessible to instructors and students at:

http://www.prenhall.com/sullivan_engineering

This resource contains numerous teaching and learning aids, such as (1) sample Microsoft PowerPoint® slides for selected chapters in the book; (2) sample test/exam questions; (3) an engineering economy tutorial that includes green engineering examples; (4) electronic spreadsheet templates authored by James A. Alloway Jr.; and (5) case studies developed by engineering students working in interdisciplinary teams.

Our engineering economy home page is an apt resource for transitioning the teaching of engineering economy into the twenty-first century. Now instructors and students can electronically draw upon the Internet to "cut" and "paste" the desired learning supplements to suit their individual needs and interests. We are positive that this feature of the twelfth edition will motivate the curiosity, imagination, and learning of your students in engineering economy.

TABLE P-1 Typical Syllabi for Courses in Engineering Economy

Semester Course (Three Credit Hours)			Semester Course (Two Credit Hours)		
Chapter	Week of the semester	Topic(s)	Chapter(s)	No. of Class Periods	Topic(s)
1	1	Introduction to Engineering Economy	1	1	Introduction to Engineering Economy
2 App. A		Cost Concepts and Design Economics	2	4	Cost Concepts, Single Variable Tradeoff Analysis and Present Economy
3	2-3	Money–Time Relationships and Equivalence	3	5	Money–Time Relationships and Equivalence
4	4	Applications of Money–Time Relationships	1-3	1	**Test #1**
5	5	Comparing Alternatives	7	3	Developing Cash Flows and Cost Estimating Techniques
6	6	Depreciation and Income Taxes	4	2	Applications of Money-Time Relationshps
	7	**Midterm Examination**	5	4	Comparing Alternatives
11	8	Evaluating Projects with the Benefit–Cost-Ratio Method	4,5,7	1	**Test #2**
7	9	Cost Estimation Techniques	10	2	Dealing With Uncertainty
8	10	Price Changes and Exchange Rates	6	5	Depreciation and Income Taxes
10	11	Dealing with Uncertainity	15	1	Dealing with Multiattributed Decisions
9	12	Replacement Analysis	All the above	1	**Final Examination**
14–15	13–14	Capital Financing and Allocation, Dealing with Multiattributed Decisions			
	15	**Final Examination**			
Number of class periods: 45			Number of class periods: 30		

Instructional Features

The Instructor's Manual is designed as a comprehensive aid in teaching the text material. Full solutions of all problems at the end of each chapter are presented. Several *comprehensive examples (case studies)* have been included in the twelfth edition. These fairly complex examples and problems provide the instructor with essential material for teaching both the first formal course and a second, more advanced course in engineering economy. They also integrate the principles, basic concepts, and methodologies that are needed by engineers in typical real-world situations, and also serve as a bridge from the classroom to professional practice.

Spreadsheet Supplement

A second supplement entitled *Spreadsheet Modeling to Accompany Engineering Economy, Twelfth Edition* is authored by James A. Alloway, Jr. Electronic spreadsheets are a mainstay in many undergraduate engineering economy courses; the spreadsheet supplement ensures that the twelfth edition of *Engineering Economy* will maintain its leadership position by providing basic templates for all major topics in the text. In addition, it provides a concise summary of formulas and key concepts, which students will find invaluable for review and quick reference.

The greatest advantage is that it is no longer necessary to enter the spreadsheets by hand. The templates can be downloaded and opened directly in Excel for Windows. Most other spreadsheet software packages provide conversion utilities to convert these files into their respective native formats. Users can then modify the basic templates for the specific problem at hand. As a bonus, advanced templates have also been developed for such techniques as Monte Carlo simulation, three-factor simultaneous sensitivity analysis, and integer linear programming.

Engineering Economy Portfolio

In many engineering economy courses, students are required to design, develop, and maintain an "Engineering Economy Portfolio." The purpose of the portfolio is to demonstrate and integrate knowledge of engineering economy beyond the required assignments and tests. This is usually an individual assignment. Professional presentation, clarity, brevity, and creativity are important criteria that will be used to evaluate portfolios. Students are asked to keep the audience (i.e., the grader) in mind when constructing their portfolios.

The portfolio should contain a variety of content. To get credit for content, students must display their knowledge. Simply collecting articles in a folder demonstrates very little. To get credit for collected articles, students should read them and write a brief summary. The summary could explain how the article is relevant to engineering economy, it could critique the article, or it could check or extend any economic calculations in the article. The portfolio should include both the summary and the article itself. Annotating the article by writing comments in the margin is also a good idea. Other suggestions for portfolio content follows (note that students are encouraged to be creative):

- Describe and set up or solve an engineering economy problem from your own discipline (e.g., electrical engineering or building construction).
- Choose a project or problem in society or at your university and apply engineering economic analysis to one or more proposed solutions.
- Develop proposed homework or test problems for engineering economy. Include the complete solution. Additionally, state which course objective(s) this problem demonstrates (include text section).
- Reflect upon and write about your progress in the class. You might include a self-evaluation against the course objectives.
- Include a photo or graphic that illustrates some aspect of engineering economy. Include a caption that explains the relevance of the photo or graphic.
- Include completely worked out practice problems. Use a different color pen to show these were checked against the provided answers.
- Rework missed test problems, including an explanation of each mistake.

(The preceding list could reflect the relative value of the suggested items; that is, items at the top of the list are worth more than items at the bottom of the list.)

Develop an introductory section that explains the purpose and organization of the portfolio. A table of contents and clearly marked sections or headings are highly recommended. Cite the source (i.e., a complete bibliographic entry) of all material other than your own work. Remember, portfolios provide evidence that students know more about engineering economy than what is reflected in the assignments and exams. Focus on quality of evidence, not quantity.

WILLIAM G. SULLIVAN
ELIN M. WICKS
JAMES T. LUXHOJ

简明目录

Contents

CHAPTER 6

CHAPTER 7

CHAPTER 8