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978-1-108-45885-6 — Principles of Engineering Economics with Applications
Zahid A. Khan , Arshad N. Siddiquee , Brajesh Kumar , Mustufa H. Abidi
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Principles of Engineering Economics with Applications

Engineering economics is an essential subject for engineers. A sound understanding of this subject is required for analyzing complex economic decision-making problems in several core engineering disciplines. Adapted to meet the syllabi requirements of most universities, the text introduces the fundamental concepts of engineering economics. It shows ways to calculate time value of money using cash flow diagrams and it explains the procedure for making economy studies to select the best alternative. It also elaborates various methods to make replacement and retention decisions, calculate depreciation costs, evaluate public sector projects, perform economy studies considering inflation, arrive at make or buy decisions etc. It further explains project planning and scheduling through CPM and PERT. The concepts and applications of value engineering are also introduced. Various methods for making forecasts, cost estimation and analysis, and decision making under different environments are also discussed. The book is strong in its ability to relate abstract engineering and managerial concepts to real life situations.

Zahid A. Khan is a professor at the Department of Mechanical Engineering, Jamia Millia Islamia, New Delhi. He has published more than 100 articles in national and international journals. His research interests include optimization of design and manufacturing processes parameters, artificial neural network (ANN), fuzzy modelling, and environmental ergonomics.

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Principles of Engineering Economics with Applications

2nd edition

Zahid A. Khan
Arshad Noor Siddiquee
Brajesh Kumar
Mustufa H. Abidi

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Foreword

In the face of cut-throat competition of the present day, businesses the world over have become more and more technical. Alongside other professionals, engineers play a key role in running businesses successfully across the globe. They play an important role in decision-making, both in the manufacturing and service industries. Most of these decisions are made primarily on the basis of economic factors and their assessment. It is often seen that decision-makers do not possess the required knowledge and skills related to engineering, and thus, they frequently call upon engineers to make technical-economic analyses and suggest recommendations. Engineering Economy is an important subject for aspiring as well as practicing engineers today, as the techniques and models thus adopted assist engineers and managers in making well-thought-out decisions. They can use the knowledge of this subject to analyse and draw conclusions as they work on projects of all kinds of complexities.

The success of engineering and business projects is usually measured in terms of financial efficiency. A project would be able to achieve maximum financial efficiency if it is properly planned and operated with respect to its technical, social and financial requirements. Since it is the engineers who understand the technical requirements of a project, they are best placed to assimilate the technical details with their knowledge of engineering economy to do an effective economic analysis and arrive at a sound managerial decision.

The present volume, comprising 16 chapters, covers many such issues pertaining to economic analysis of projects. Chapter 1 summarizes the basic principles of engineering economy and its applications. Chapter 2 describes the fundamental concepts of mathematics and engineering economics, which will help readers learn the basic mathematical concepts required for economic analysis. The roles of factors involved in economic analysis have been discussed at length in Chapter 3. Chapter 4 describes the key concept of value of money, on which economic analyses are based. Topics such as simple and compound interests, cash flow diagrams, determination of equivalent cash flow at different points in time, nominal and effective interest rates have also been explained here. Chapter 5 describes the basic methods that can be used by engineers to perform economy-studies. The methods that can be used for selecting the best alternative out of many, have been presented in Chapter 6. Chapter 7 describes the procedure to be followed to decide whether an organization should continue to use existing physical assets (such as a machine) or whether if the asset should be replaced. The value of a physical asset depreciates, that is diminishes, with time; this concept of depreciation

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as well as the procedure for calculating depreciation costs have been described in Chapter 8. Chapter 9 describes different methods such as benefit-cost ratio for the economic evaluation of large public-sector projects. The concept of inflation and how it affects the worth of capital have been discussed in Chapter 10. Often organizations have to make decisions as to whether they should manufacture a component in-house or buy it from outside. The procedure of arriving at a make-or-buy-decision has been explained in Chapter 11. In Chapter 12, the focus is project management. Concepts such as CPM, PERT and project crashing have been described here to enable readers understand and apply these techniques for timely and economic completion of their projects. Chapter 13 presents a well-established technique, value engineering, adopted to reduce the cost of a product and increase its value. The success of an organization depends on how efficiently and effectively it can forecast the demand for its products.

Chapter 14, describes the underlying concepts, methods and models of forecasting. Chapter 15, explains the various types of costs and describes the different methods for cost estimation. The last chapter of the book, Chapter 16 discusses the various methods used for taking decisions under different decision-making environments. This book, highlights the principles and applications of economic analysis in a lucid manner, supported by a large number and wide range of engineering-oriented examples and end-of-chapter exercises. It covers the syllabi of undergraduate and postgraduate courses of major Indian and overseas universities. Special chapters such as Fundamentals of Mathematics and Engineering Economics, Elementary Economic Analysis, Project Management, Value Engineering, and Forecasting, covered in this book are rare in books of this kind, which makes it distinct from existing books.

Writing a book requires in-depth subject knowledge, dedication, sincere effort, sacrifices, and teaching and research experience. As head of the institution, I am aware that the first author of this volume, Dr Zahid Akhtar Khan, Professor in Mechanical Engineering, Jamia Millia Islamia, New Delhi, has more than 20 years of teaching and research experience. He has taught in overseas universities such as the University Sains Malaysia, Malaysia, and the King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia. Apart from teaching, he is actively involved in research and development activities. He has published more than 45 research papers in reputed national and international journals and over 20 papers in the proceedings of conferences held in India and abroad. In addition, he has also contributed chapters in three books related to Mechanical Engineering. VDM Verlag, a German publishing company, has published one of his monographs. Dr Khan has supervised several MTech dissertations and BTech projects. Presently he is supervising five PhD and three MTech. students. He and his colleague Mr Arshad Noor Siddiquee have been instrumental in developing quite a few laboratories, including the Metrology Lab, in the department and in preparing proposals for financial grants. This year they have submitted a proposal for SAP (worth ~75 lakh) to the University Grants Commission. They, along with their team of students, have filed a patent with the Controller General of Patents, Design and Trademarks, Government of India, for the designing and development of a convertible wheel chair.

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Dr Khan has been discharging additional duties as coordinator for the training and placement of postgraduate students; as member, sports committee of the faculty; in-charge of the faculty magazine 'Tech-Times'; in-charge of the Engineering workshop; member of the result analysis committee; member of the sub-purchase committee of the department; advisor of the students of Mechanical Engineering; and tabulator of the MTech and BTech results.

He has received international recognition: his biography has been published in 'Marqui's Who's Who in Science and Engineering, Tenth edition, 2008-09'. He has received the International Scientist of the Year 2008 award given by the International Biographical Centre, Cambridge, UK. He is a member of the Emerald Literati Network, UK, and is also on the panel of reviewers of international journals.

Arshad Noor Siddiquee, the second author of this book, has graduated from Government Engineering College, Jabalpur. He completed his MTech from the Indian Institute of Technology, Delhi, where he is currently pursuing this doctoral studies. He is presently working as an associate professor in the Department of Mechanical Engineering, Jamia Millia Islamia. He played a key role in the developmental phase of Glasgow University College in Oman during 1998-2001. He has had hands-on experience in the establishment and accreditation of technical institutions during his tenure at the All India Council for Technical Education (AICTE), New Delhi, in the capacity of an assistant director. Siddiquee has dexterously used his skills in making the Faculty of Engineering and Technology profile for ranking evaluation of institutions and also in making proposals for Petroleum Engineering and Aeronautical Engineering programmes. He has contributed chapters on engineering subjects to three books of reputed publishers and over 15 research papers to international journals. He is on the panel of reviewers for Elsevier and Springer journals.

Dr Brajesh Kumar, the third author, has worked in the Department of Expenditure, Ministry of Finance, Government of India, and is currently serving as an associate professor at the National Institute of Financial Management (NIFM), Faridabad. His areas of interest are managerial economics, financial econometrics and computer applications in economics. He has published several research works on managerial economics, and macro- and micro-economics. Dr Kumar is associated with various national and international organizations in different capacities; for instance, agro-expert, Federation of Indian Chambers of Commerce and Industry (FICCI); read group member, Centre for Trade and Development (CENTAD); and programme coordinator, civil servants from North-East Cadre.

I am extremely pleased to find that despite their most sincere involvement, commitment and dedication to teaching and research, the authors have put in so much effort in writing this extremely useful and timely book. This must have demanded of them time away from family, great sacrifices, pains and compromises. I have learnt that the range and content of the book has received excellent appreciation from its reviewers. It is an interesting fact that the market review of the publisher revealed that no single title in India is, so far, available to fulfill students' requirements in engineering economy. I have no doubt that this is a definitive text on the subject; that it would meet the genuine needs of students, teachers, and practising

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engineers and managers alike. I congratulate the authors for accomplishing this challenging task and wish them every success.

Najeeb Jung, IAS

Vice-Chancellor, Jamia Millia Islamia

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Zahid A. Khan , Arshad N. Siddiquee , Brajesh Kumar , Mustufa H. Abidi
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Preface

ABOUT ENGINEERING ECONOMICS WITH APPLICATIONS

Engineers are required to provide economically feasible solutions to existing problems. To achieve this, engineers must possess knowledge of economy to evaluate the monetary consequences of the products, projects and processes that they design. Engineering design solutions do not exist in a vacuum but within the context of a business opportunity. Since almost every problem has multiple solutions, so the issue is: how does one rationally select a design with the most favorable economic result? The answer to this question is provided by engineering economy. Engineering economy, the analysis of the economic consequences of engineering decisions, is said to have originated in A. M. Wellington's *The Economic Theory of Railway Location*, published in 1887. Engineering economy is now considered a part of the education of every engineer, as it provides a systematic framework for evaluating the economic aspects of competing design solutions. Just as engineers model the effect of temperature on cutting tools or the thermodynamic response of an air compressor, they must also model the economic impact of their recommendations. What is 'engineering economy' and why is it so important? The initial reaction of many engineering students to this question is, 'money matters will be handled by someone else and I need not worry about these matters'. In reality, any engineering project must be, not only physically realizable but also economically affordable. Understanding and applying economic principles to engineering have never been more important. Engineering is more than a problem-solving activity focusing on the development of products, systems, and processes to satisfy a need or demand. Beyond function and performance, solutions must also be economically viable. Design decisions affect limited resources such as time, material, labor, capital and natural resources, not only initially i.e. during conceptual design but also through the remaining phases of the life cycle i.e. during detailed design, manufacture and distribution, service, retirement and disposal. Engineers should realize that the solution provided by them does not make sense and will not be acceptable, if it is not profitable.

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EDUCATION LEVEL AND USE OF TEXT

The contents of this book have been designed in such a way that it serves two primary purposes: (i) to provide students with a sound understanding of the principles, basic concepts, and methodology of engineering economy; and (ii) to help students develop proficiency with these methods and with the processes for facilitating rational decisions they are likely to encounter in professional practice. Interestingly, an, engineering economics with applications, course may be a student's only college exposure to the systematic evaluation of alternative investment opportunities. In this respect, *Engineering Economics with Applications* is intended to serve as a basic text for classroom instruction and as well as a reference for use by practicing engineers in all areas (chemical, civil, computer, electrical, industrial, and mechanical engineering). The book is also useful for people engaged in the management of technical activities.

It is well suited for undergraduate as well as postgraduate courses in engineering economic analysis, project analysis, or engineering cost analysis. Additionally, because of its simple and easy to understand language, it is perfect for those who are studying the subject for the first time and on their own, and for those who simply want to review. The systematic approach used in the text design allows a practitioner unacquainted with economics and engineering principles to use the text to learn, understand, and correctly apply the principles and techniques for effective decision making.

SALIENT FEATURES OF THE BOOK

- Simple and easy to understand language.
- The concepts have been explained in a lucid manner.
- Numerous comprehensive real life examples appear throughout the book.
- Extended learning exercises in the end-of-chapter problem sets.
- A large number of figures and diagrams enrich the text.
- Some special chapters such as 'Chapter 2: Fundamental Concepts of Mathematics and Engineering Economics', 'Chapter 3: Basic Mathematical Concepts for Economic Analysis', 'Chapter 12: Project Management', 'Chapter 14: Forecasting', 'Chapter 15: Cost Estimation' and 'Chapter 16: Decision Making', that generally do not appear in engineering economy texts are included in this book.

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