CHAPTER-1

NATURE AND SCOPE OF ENGINEERING ECONOMICS

INTRODUCTION

- Over the past four decades, the importance of engineering economics as a disciple has grown tremendously. The growing importance of engineering economics can be attributed to at least three factors: (i) growing complexity of business environment and decision making process; (ii) increasing application of economic concepts, logics, theories and tools of economic analysis in the process of business decision-making; and (iii) rapid increase in demand for professionally trained engineering manpower with good knowledge of economics and economic behaviour of the people.
- The growing complexity of the business world can be attributed to such factors as rapid growth of large scale industries, increasing number of business firms, rapid innovation and introduction of new products, globalization and growth of multinational corporations, merger and acquisition of business firms, and large scale diversification of business activities and so on. These factors have created a good deal of the inter-firm, inter-industry and inter-country business competition enhancing the uncertainty and risk in the real business world.

WHAT IS ECONOMICS?

- The economists of different generations have defined economics in different ways according to their own perception and subject matter of economics.
- For example, Adam Smith—the 'father of economics'—had defined economics as "an inquiry into the nature and causes of the wealth of nations" (1776).
- According to Alfred Marshall, an eminent economist of the neo-classical era, "Economics is the study of mankind in the ordinary business of life; it examines that part of individual and social actions which is most closely connected with the attainment and with the use of the material requisites of well being" (1922).
- Another neo-classical economist, Lionel Robbins defined economics more specifically: "Economics is the science which studies human behaviour as relationship between ends and scarce means which have alternative uses" (1935)4.
- One can find a number of other definitions of economics in economics literature. However, none of the definitions reveal the entire subject matter of the modern economics. Nevertheless, these definitions do reveal the essence of economics, i.e., 'what economics is about'.

Why do people economize?

- People tend to adopt economizing behaviour because of the following facts of economic life.
- 1. Human wants, desires and aspirations are endless. Human wants, desires and aspirations are endless in the sense that they go on increasing with the availability of new kinds of goods and services and increase in ability to pay.
- 2. Resources available to the people are scarce. Resources (land, labour, capital, money, time and knowledge, etc.) available to the people at any point of time are scarce and limited, though they have alternative uses.
- 3. People are economizers by nature. Economizing is a natural behaviour of the people. For example, given the gain, i.e., distance to be travelled, if metro service is easily available, one would not like to hire a taxi, and if a pizza is available at `50 in college canteen and for `100 in a nearby restaurant, students would prefer to eat pizza in the canteen. This is economizing behaviour.

Economics Has Two Major Branches:

Microeconomics and Macroeconomics

- Microeconomics is the study of economic behaviour of the individual economic entities of individuals, households, firms, industries and factor-owners. For example, microeconomics studies how individuals and households with limited income decide ‘what to consume’ and ‘how much to consume’ so that their total utility is maximized. In other words, microeconomics studies how individual consumers make choice of goods and services they want to consume and how they allocate their limited income between the goods and services of their choice to maximize their total utility. In regard to business firms, microeconomics studies how individual firms decide what to produce, how to produce, how much to produce, and what price to charge, to maximize their profit. In addition, microeconomics studies how demand for a product and its supply are affected by the change in price of the product and how price of a product is determined in the market. It studies also how factor prices, viz., wages and rent, are determined.

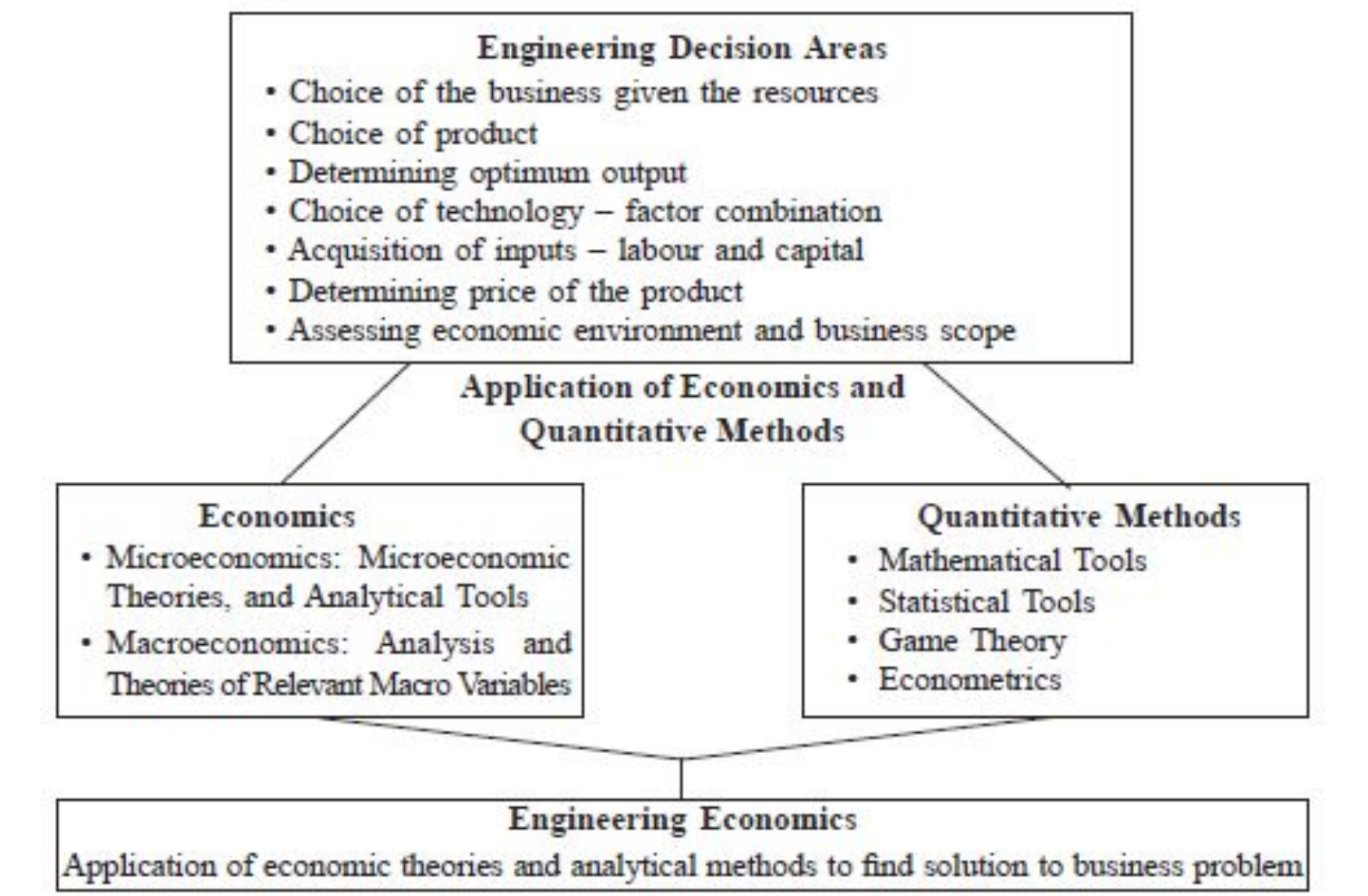
- Macroeconomics, on the other hand, is the study of economy as a whole, i.e., the economic phenomena at the aggregate level of the country. Specifically, macroeconomics is the study of working and performance of the economy as a whole. It studies the factors and forces that determine the level of national output, national income, factors and rate of economic growth, employment and the general price level. Besides, macroeconomics studies also the nature and scope of economic policies of the government, viz., taxation and public expenditure policies (the fiscal policy), monetary policy, price policy, employment policy, foreign trade policy, etc. and how these policies affect the economy. From business management point of view, macroeconomics provides the method of encapsulating the economic environment of the country, the trend in the economy – whether rising or declining – and the opportunity to judge whether or not to take a business decisions with long-term perspective.

WHAT IS ENGINEERING ECONOMICS?

- As the definitions of economics reveal, engineering economics is integration of economic theories and tools of analysis with decision-making process of business management. The integration of economics with the managerial decision-making has become inevitable because application of economic theories and tools of economic analysis in making business decisions provides guidance to arrive at appropriate managerial decisions.
- In fact, the basic functions of the business firms consist of planning, organizing, staffing, and controlling. The ultimate objective of all these functions is to ensure maximum return from the utilization of firm's limited resources. To this end, managers have to take decisions at each stage of their functions by taking in view the engineering issues and they have to implement their decisions effectively in order to achieve the goals of the organization. Also in fact, almost entire engineering decisions involve the application of economic concepts, theories and analytical techniques. Therefore, economic theories and analytical tools are applied to find out a reasonable solution to the engineering issues. This is how economics gets integrated to engineering functions giving emergence to engineering economics as a branch of economics.

INTEGRATION OF ECONOMICS TO ENGINEERING DECISIONS

- As mentioned above, integration of economic theories and tools of analysis combined with mathematical and statistical tools with engineering decisions gives the emergence of engineering economics.


Engineering Decision Areas
• Choice of the business given the resources
• Choice of product
• Determining optimum output
• Choice of technology – factor combination
• Acquisition of inputs – labour and capital
• Determining price of the product
• Assessing economic environment and business scope
Application of Economics and Quantitative Methods
Economics
• Microeconomics: Microeconomic Theories, and Analytical Tools
• Macroeconomics: Analysis and Theories of Relevant Macro Variables
Quantitative Methods
• Mathematical Tools
• Statistical Tools
• Game Theory
• Econometrics
Engineering Economics
Application of economic theories and analytical methods to find solution to business problem

HOW ECONOMICS CONTRIBUTES TO ENGINEERING DECISIONS?

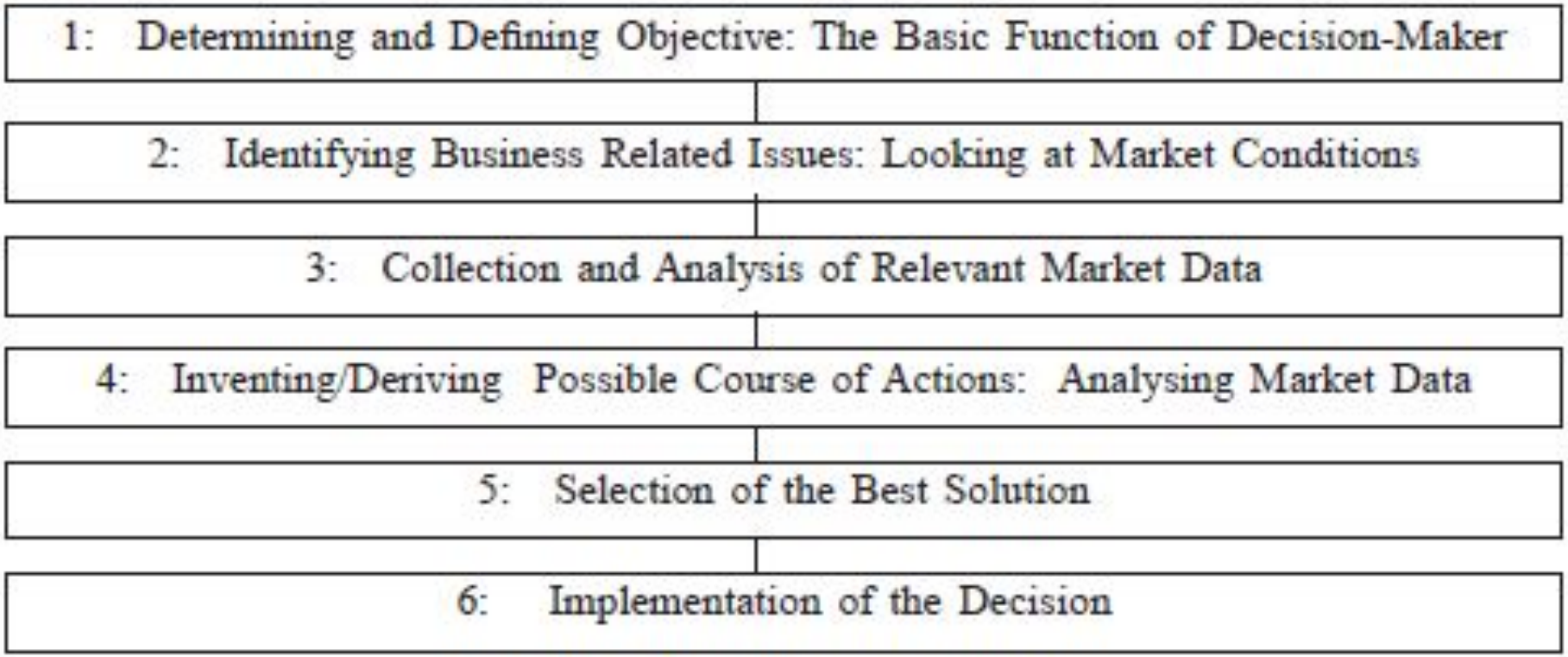
- Engineering economics is basically the study of the application of economic theories and tools of economic analysis applied to engineering decisions. Economic theories and analytical tools are applied greatly to the process of engineering decision-making because they contribute a great deal to engineering decisions.

Application and Contribution of Economics to Business Decisions

- All business activities are essentially economic activity. Economic activities are performed with the purpose of deriving maximum return from the given resources.
- Economic theories provide analytical framework and guidance for deriving maximum gain from the limited resources. Therefore, engineering decisions do necessarily involve application of economics, particularly microeconomic theories that provide guidance to minimize the cost or to maximize the return from the given cost.
- It is for this reason that engineers have to apply economic concepts and theories to their business decisions. For instance, given the financial resources and business objectives, engineers have to decide what to produce, how much to produce, how to produce, and what price to charge. Economics provides solution to all these decision problems under different conditions. For example, answer to the issue 'what to produce' is provided by the theory of demand, and solution to the issue 'how much to produce' is provided by the theory of production and cost, and so on.
- Application of economics contributes significantly to engineering decisions as it provides guidance for finding out an appropriate solution of the real life problems.

Application of Economics in Decision-Making Process: An Illustration

- Suppose a mobile phone company plans to introduce a new brand with the facility of talking without hand-holding of mobile phone. In order to take the final decision, the company will have to go through a process of decision making.
- In general, the decision making process6 is comprised of first four main stages


1: Determining and Defining Objective: The Basic Function of Decision-Maker
2: Identifying Business Related Issues: Looking at Market Conditions
3: Collection and Analysis of Relevant Market Data
4: Inventing/Deriving Possible Course of Actions: Analysing Market Data
5: Selection of the Best Solution
6: Implementation of the Decision

THE SCOPE OF ENGINEERING ECONOMICS

Specifically, the scope of engineering economics consists of the concepts, theories and analytical methods of microeconomics and macroeconomics that are applied in the process of engineering decision-making7.

Micro and macro economic concepts, theories, and analytical tools are applied to analyse business problems, to evaluate engineering options, to assess the business prospects, with the purpose of finding appropriate solution to business problems and formulating business policies for future.

In practice, however, the scope of engineering economics includes also some other disciplines, particularly mathematics, statistics, management science and operation research, applied to make appropriate business decision. As such, the scope of engineering economics can be specified as follows.

- Microeconomics applied to engineering decision-making.
- Macroeconomics aspects giving view of business environment, and
- Other disciplines applied to engineering decisions

Microeconomics Applied to Internal Engineering Issues

- For analytical purpose, the scope of managerial decisions can be divided under two categories, viz., internal issues – issues related to internal engineering problems of the firm, and external issues pertain to the economic environment of the country.
- Microeconomic concepts, theories and analytical tools are applied to making decision on internal issues and macroeconomic theories and analytical techniques are applied to assess the business environmental issues.

Internal engineering issues include the problems that arise in managing the business organisation. All internal engineering issues fall within the purview and the control of the managers. The basic internal engineering issues can be listed as follows.

- What to produce – choice of the product
- How much to produce – determining the size of the firm
- How to produce – choice of efficient and affordable technology
- How to price the product – determining the price of the product
- How to promote sale of the product
- How to face price competition from the competing firms
- How to enlarge the scale of production - planning new investment
- How to manage profit and capital

- **Theory of Consumer Demand:** Theory of consumer demand analyses the decision-making behaviour of the consumers. The decision-making behaviour of the consumer relates to such questions as how consumers decide what to consume; how much to consume; how much to buy, and how consumers react to change in price of the products they consume and price of their substitutes. Demand theory combined with quantitative tools helps in assessing the total demand for a product at different prices. Thus, the consumer demand theory helps in deciding 'what to produce'.
- **Theory of Production:** Theory of production analyses the nature of relationship between inputs and output. The production theory explains essentially how output changes with change in inputs – labour and capital – given the technology. It provides guidance for the choice of technology and for maximizing the output from the resources of the firm. Thus, the knowledge and application of the theory of production helps in determining the optimum level of production, the size of the firm, and the employment of labour and capital given the technology and the target production.

- **Theory of Cost:** Theory of cost analyses the nature and pattern of change in cost of production with change in output. The theory of cost reveals the change in total, marginal and average cost of production with increase in production. Application of cost theory helps in knowing the cost behaviour with increase in production and in determining the output that minimizes the average cost production. In view of profit-maximization objective, cost theory helps in determining the profit maximizing output, give the price of the product.

- **Theory of Price Determination:** The theory of price determination offers an analysis of how price of a product is determined under different kinds of market conditions. Market conditions are determined on the basis of degree of competition between the firms of the industry – perfect competition, monopolistic competition, oligopoly and monopoly.
- **Theory of capital and Investment Decisions:** Capital is the foundation-stone of the business firms. The efficient management of capital is one of the most important functions of the managers. The major issues in capital management are

(i) the choice of investment avenues,

(ii) assessing the efficiency and productivity of capital investment avenues, and (iii) making the choice of most efficient investment project. The theory of capital contributes a great deal in making appropriate investment decisions.

Macroeconomics Applied to Engineering Decision

- According to Weihrich and Koontz, the reputed management experts, "... managers cannot perform their task well unless they have an understanding of, and are responsive to, the elements of economic environment – economic, technological, social, political, and ethical factors that affect heir areas of operation"8. Their statement highlights the importance of macroeconomic aspects to be taken in view in engineering functions.
- The factors which, in general, determine the economic environment of a country are (i) the general trend in national income, saving and investment, prices, employment, etc., (ii) the structure and role of the financial institutions, (iii) the level and trend in foreign trade, (iii) economic policies of the government, (iv) socio-economic organizations like trade unions and consumer associations, and (v) political environment.
- It is far beyond the powers of a single firm, howsoever large it may be, to determine the course of economic, political and social conditions of the country. But the environmental factors have a far reaching bearing on the functioning and performance of the firms.

Macroeconomic Factors

- The macroeconomic factors that have to be taken in view while making engineering decisions, especially those related to forward planning, increasing scale of production, and formulation of business strategy, are the following ones.

1. The Current Status and the Predicted Future Course of the Economy: Both the current status and the future prospects of the economy, i.e., the overall trend in the economy, are determined on the basis of trend in certain important macroeconomic variables, viz., national income, rate of economic growth, rate of saving and investment, general price level, trend in employment, and investment climate.
2. Scope and the Trend in Foreign Trade: The status of and the trend in foreign trade matter a great deal for the business firms involved in foreign trade if the foreign sector of the economy is significantly large. Business corporations involved in foreign trade and financial transactions are affected directly and more heavily than the rest of the domestic economy by the fluctuations in the international economy. Fluctuations in the international trade, exchange rate and financial flows affect the economy of inter-related countries and, thereby, the prospects of the business corporations.

- The Nature and Objective of the Government Policies. Depending on the needs of the country, the government controls, regulates and promotes the economy by adopting some specific economic policies.
- Economic policies, especially monetary policy, fiscal policy, and industrial policy, applied by the government play a crucial role in determining the internal economic environment of the country. Economic policies affect functioning of the business firms adversely or favourably depending on policy objectives.

Other Disciplines of Engineering Economics

- In addition to micro- and macro-economic theories, concepts and tools of analysis, the scope of engineering economics includes some aspects of some other subjects also. Specifically, it includes analytical tools and techniques of mathematical economics, econometrics, statistics and operations research applied for analysing economic data in the process of engineering decision-making.
- The analytical methods and tools of these subjects are applied to analyse relevant economic data in order to derive appropriate engineering decisions. The application of mathematics, statistics, and operations analysis to engineering decisions is described here briefly.

- (i) Mathematics: Mathematical methods are applied extensively in different areas of managerial decisions. As is widely known, engineering decisions involve the analysis and measurement of a large number of economic variables, e.g., demand for product, supply of product, cost of production, price of the product, stock of capital, production input prices, wage rate, etc. The status and future course of these variables are analysed by applying economic data to economic theories and measured by applying different kinds of mathematical and statistical tools.
- The theoretical propositions and application of mathematics related to engineering decisions are discussed in the forthcoming Chapters. The application of mathematical and statistical tools in managerial decisions is illustrated here in a simple case of demand theory.

(ii) Statistics: Like mathematical methods, application of statistical tools also contributes a great deal to engineering decisions. Statistical methods are applied to process and analyse the business data, test the validity of economic laws, and to estimate the value of economic variables to be used in engineering decisions.

(iii) Operations Research (OR): Operation Research (OR) is an interdisciplinary discipline applied to resolve the complex engineering problems. The Operation Research is essentially a research method formulated with the combination of economics, mathematics and statistics. Under Operation Research, an analytical model is built by combining analytical tools of economics, mathematics and statistics and is applied to analyse the market conditions and to explore a practical solution to business problem.