

CHAPTER STRUCTURE

1.1 DEFINITIONS AND CONCEPTS OF ECONOMICS

- 1.1.1 Microeconomics
- 1.1.2 Macroeconomics
- 1.1.3 Gross Domestic Product (GDP)
- 1.1.4 Managerial Economics
- 1.1.5 Law of Demand and Supply
- 1.1.6 Market Equilibrium

1.2 INTRODUCTION TO ENGINEERING ECONOMY

- 1.2.1 Introduction to Engineering Economy
- 1.2.2 Principles of Engineering Economy
- 1.2.3 Engineering Economy and The Design Process

1.1 DEFINITIONS AND CONCEPTS OF ECONOMICS

In general, Economics is the study of how individuals and societies choose to utilize scarce resources to satisfy their unlimited wants. Different economists have defined economics in their own words. There is no consensus among the economists about a precise definition of economics. Therefore, it is said that whenever six economists are gathered, there are seven opinions. Adam Smith, the father of modern economics, defined economics as a science of wealth. He also assumed that economics is the subject that tells us how to make a nation wealthy. There are several branches of economics. Of these, two are the most important. These are microeconomics and macroeconomics. Both of these terms have been derived from Greek words “mikros” and “makros” respectively meaning “small” and “big” respectively.

1.1.1 MICROECONOMICS

Microeconomics is defined as the branch of economics which deals with the individual parts of an economy. In other words, it is the part of economic analysis which is concerned with the behavior of individual units: consumers, households, and firms. It examines how consumers choose between goods and services, how workers choose between jobs and business firms decide what to produce, how to produce and for whom to produce.

According to K.E. Boulding, "Microeconomics is the study of particular firms, particular households, individual prices, wages, incomes, individual industries, particular commodities.

Thus, microeconomics is the branch of economics which deals with the decision making of individual units in an economy. It studies individual units of the economy rather than the economy as a whole. The main objective of microeconomics is the study of price determination in the market. Therefore, it is also called price theory. Microeconomics is based on the assumptions like existence of full employment, free market economy, perfect competition and partial equilibrium analysis. Microeconomics is also known as the microscopic analysis because it is concerned with microscopic study of various elements of the economy. The scope of microeconomics includes the topics like consumption, production, exchange, distribution and welfare economics.

The concept of microeconomics can be summarized as follows:

- Microeconomics studies the individual parts of an economy.
- Microeconomics is concerned with individual firms and consumers.
- Microeconomics is based on the assumptions of full employment, partial equilibrium analysis and perfect competition.
- Microeconomics is applicable only in the free market economy.
- Microeconomics is also known as the price theory.
- The major variables of microeconomics are individual demand and supply, relative price, output of an individual firm, etc.

The main usages of microeconomics are

- Helpful to formulate economics policies
- Helpful to study human behavior
- Helpful in efficient allocation of resources
- Useful to study international trade

1.1.2 MACROECONOMICS

Macroeconomics is defined as the branch of economics which deals with the economy as a whole. In other words, macroeconomics is the study of very large, economy-wide aggregate variable like national income, money, price level, unemployment, economic growth, etc. Therefore, it is also known as aggregative economics. It examines how price level is determined and how resources are allocated at the economic system as a whole. The concept of macroeconomics can be cleared by the following definitions:

According to N. G. Mankiw, "Macroeconomics is the study of economy wide phenomena including inflation, unemployment and economic growth."

Thus, macroeconomics is the study of behavior and performance of the economy as a whole. It explains how equilibrium national income and employment are determined in the economy. Therefore, it is also known as the 'Theory of Income and Employment'. The scope of macroeconomics is large and includes the theory of national income, theory of employment, theory of money, and theory of general price level. Theory of economic growth and theory of international trade.

The concept of macroeconomics can be summarized as follows:

- Macroeconomics studies economy as a whole.
- Macroeconomics is an aggregate economics.
- Macroeconomics is called theory of income and employment.
- The objectives of macroeconomics are to determine aggregate output, employment and general price level and their rate of change.
- The major variables of macroeconomics are national income, total consumption, total saving, total investment, etc.

The main uses or importance of macroeconomics are

- Helpful to understand the working of the economy.
- Helpful in formulating economic policies.
- Helpful in international comparisons.
- Evaluate performance of the economy.

1.1.3 GROSS DOMESTIC PRODUCT (GDP)

Gross domestic product is defined as the market value of all the final goods and services produced within the domestic territory of a country in a year. In order to calculate the gross domestic product, all the goods and services produced within the country are multiplied by their respective prices and summed up. Symbolically,

$$GDP = P_1Q_1 + P_2Q_2 + \dots + P_nQ_n$$

Where

P = Market price of final goods and services

Q = Quantity of goods and services

GDP consist of private consumption + gross private investment + government investment + government spending + (exports – imports). GDP is usually calculated by the national statistical agency of the country following the international standard. The world's GDP was 94,935. USD Billion in 2021. The US had 22,939.58 USD Billion by the end of 2021 and GDP in Nepal is expected to reach 29.30 USD Billion by the end of 2021.

GDP includes only the final goods and services. All the intermediate goods and services are excluded from the measurement of GDP. The expression “final goods and services” refers to the goods and services produced for final use whereas “intermediate goods are the goods produced by one firm which are used in further processing by another. For example, flour is an intermediate product because it is used to produce bread and bread is the final product as it is used for final consumption.

The features of GDP are as follows:

- GDP is the money value or marker value of all the final goods and services produced within a country.
- GDP includes the money value of only final goods and services produced in a year.
- GDP is calculated at the current market prices.
- GDP includes only those goods which have market value and brought in the market for sale.
- Transfer payments like pension, unemployment allowance, etc. are not included in GDP because these payments do not contribute in any way to the production.
- GDP does not include capital gains.
- Whether the resources are domestically-owned or foreign-owned does not matter. As long as the resources are located within the country, the value of the output they produce is included in GDP.

1.1.4 MANAGERIAL ECONOMICS

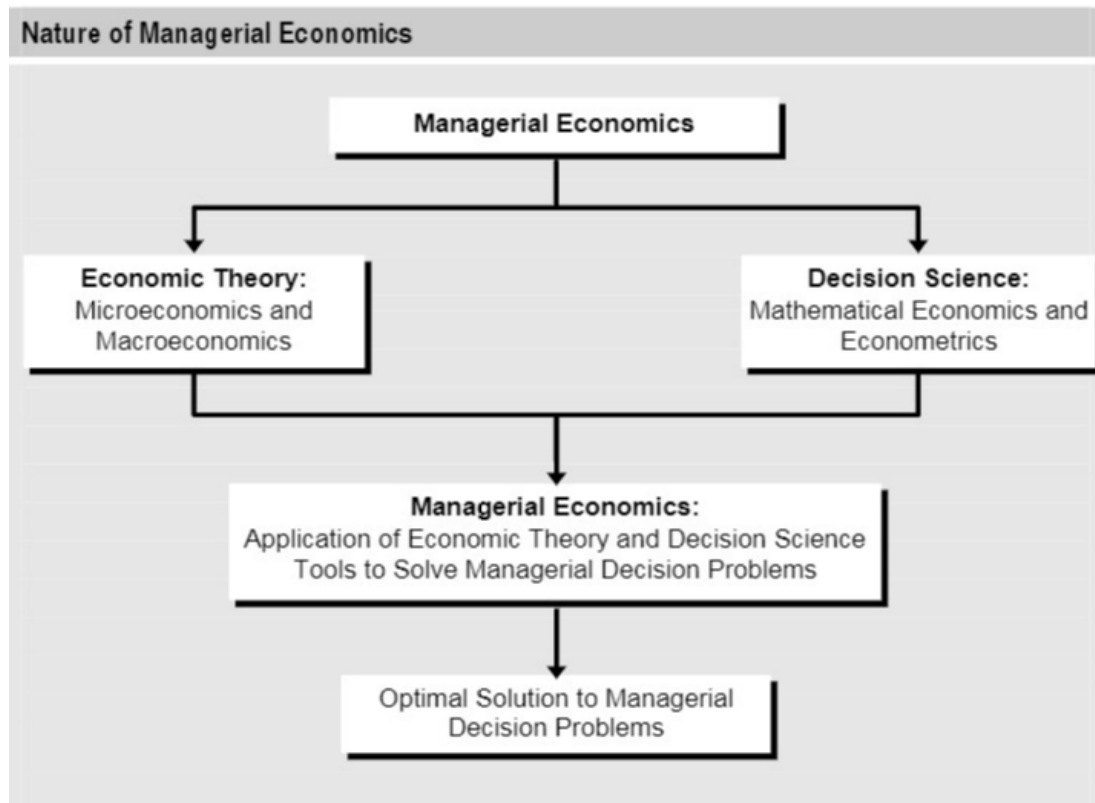
Managerial economics is a special branch of economics. It is the application of economic principles and methods to business practices. In other words, it is an application of economic theory to the business practice for decision making and forward planning. Decision making is the process of selecting one action out of several alternative actions and forward planning is the process of thinking in advance or it implies planning in advance for the future.

According to Edwin Mansfield, "Managerial economics is concerned with ways in which business executives and other policy makers should make decisions"

Thus, managerial economics is based on both microeconomics and macroeconomics since it is concerned with the study of problems and principles of an individual firm or an individual industry and it uses the monetary policy, trade cycle, industrial policy of the government for the successful management of a firm. Managerial economics gives knowledge to the manger of the firm regarding best use of the resources and achieving goal of the firms.

The scope of managerial economics is

- Demand analysis and forecasting
- Theory of Production and cost analysis
- Price theory or theory of exchange
- Theory of profit
- Theory of capital and investment



1.1.5 LAW OF DEMAND AND SUPPLY

The demand and supply are most important factors or forces determining price and quantity in the free market economy. Demand is related with the economic activities of the consumers and supply is related with the economic activities of the producers or the suppliers. These two factors are like two blades of a scissors. It means that as only one blade of a scissors does not function. likewise one force of the market either demand or supply also cannot function without another. The integration of these two forces of the market is necessary to determine the equilibrium price and quantity of output. In this context, this part of the unit deals with the demand, supply and market equilibrium.

1. Law of Demand

In general, the demand for a commodity is its quantity which consumers are able and willing to purchase at each possible price during a given period of time, other things remaining the same. And, the law of demand states the inverse relationship between the quantity demanded and price of a commodity. According to this law, the demand for a commodity increases with a fall in its price and decreases with a rise in its price, other things remaining the same. Thus, this law implies that price and quantity demanded are inversely related.

According to Prof. Alfred Marshall, "Demand refers to the quantities of a commodity that the consumers are able and willing to buy at each possible price during a given period of time, other things being equal".

Marshall states the law of demand as "other things remaining the same, the amount demanded increases with a fall in price and diminishes with a rise in price".

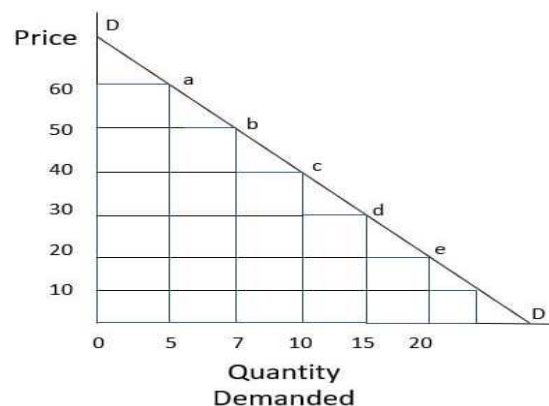
The law of demand is based on the following assumptions:

- No change in income of the consumer
- No change in price of related goods
- No change in tastes and preferences of the consumers
- No change in fashion and habit of the consumer
- No changes in size and composition of population
- No expectations of change in the future price of the commodity.

Based on these assumptions, the law of demand can be explained with the help of a demand schedule and demand curve.

A demand schedule is a tabular presentation of different prices of a commodity and its corresponding quantity demanded per-unit of time. In other words, it is a table, which shows the relationship between the price of a commodity and the quantity demanded. And, a demand schedule is a tabular presentation of different prices of a commodity and its corresponding quantity demanded per-unit of time. In other words, it is a table, which shows the relationship between the price of a commodity and the quantity demanded. A hypothetical demand schedule and demand curve is given below.

SN.	Price (Rs)	Demand (Qty)
a	60	5
b	50	7
c	40	10
d	30	15
e	20	20
f	10	25



2. Law of Supply

The quantities of a good that individual firm is willing and able to offer in sale over a given time period is defined as supply. In general, more goods are offered for sale at higher price, i.e. supply increases with the increase in price. Therefore, the relation between price and quantity supplied is positive and direct. The functional relationship between price and quantity supplied gives the law of supply. According to this law, other things remaining the same, the quantity supplied of a commodity is directly related to the price of the commodity. It means that when price rises, the quantity supplied increases, and when price falls, the quantity supplied decreases.

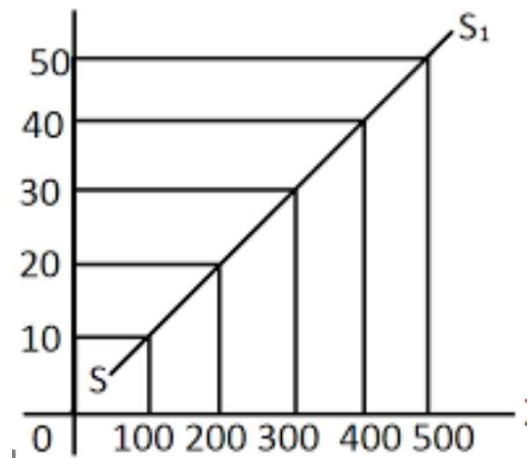
The law of supply is based on the following assumptions:

- No change in price of inputs or factors of production.
- No change in state of technology.
- No change in goal of producers.
- No change in number of producers.
- No change in price of other goods.
- No change in tax and subsidy policy of the government.

On the basis of these assumptions, the law of supply can be explained with the help of supply schedule and supply curve.

A supply schedule is a tabular presentation of the various quantities of a commodity offered for sale at various prices at given period of time.

SN.	Price (Rs)	Supply (Qty)
a	10	100
b	20	200
c	30	300
d	40	400
e	50	500

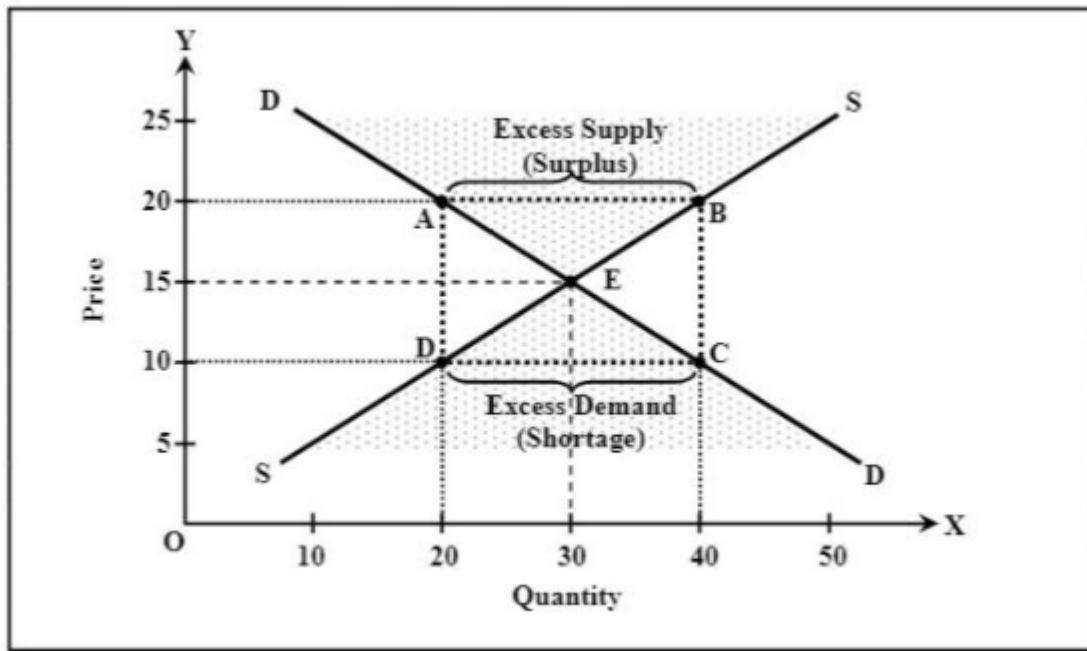


1.1.6 MARKET EQUILIBRIUM

In the ordinary sense, equilibrium means balance in opposite forces. In the context of market analysis, equilibrium refers to a state of market in which quantity demanded for a commodity equals to the quantity supplied of the commodity. The equality of demand and supply gives an equilibrium price. It means that equilibrium price is the price at which quantity demanded equals to quantity supplied. Similarly, equilibrium quantity is the quantity demanded and supplied at the equilibrium price.

In order to analyze how equilibrium price is determined, we need to integrate the demand and supply curves. For this purpose, let us use the example of potato. The hypothetical market demand and supply schedules for potato are given below.

Price (Rs/kg)	Quantity Demanded (Kgs)	Quantity Supplied (KGs)	Surplus (+) or Shortage (-)	Pressure on Price
5	50	10	-40	Upward Curve (disequilibrium)
10	40	20	-20	
15	30	30	0	Equilibrium
20	20	40	20	Downward Curve (disequilibrium)
25	10	50	40	



In Figure, DD and SS are the demand and supply curves respectively. These two curves are intersecting each other at point E, which is the equilibrium point. Hence, equilibrium price is Rs. 15 and equilibrium quantity of output is 30 units. When price exceeds equilibrium price Rs. 15, quantity supplied exceeds quantity demanded. This is known as the excess supply or surplus, Let us suppose, price increases to Rs. 20. When price increases to Rs. 20, quantity demanded decreases to 20 units and quantity supplied increases 40 units. In this situation, there is an excess supply equal to 20 units. On the other hand, if price is below equilibrium price Rs. 15, quantity demanded exceeds quantity supplied. This is known as the excess demand or Shortage. Let us suppose, price decreases to Rs. 10. When price decreases to Rs. 10, quantity demanded is 40 units and quantity supplied is 20 units.

1.2.1 INTRODUCTION TO ENGINEERING ECONOMY

The Accreditation Board for Engineering and Technology states that engineering “is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.” In this definition, the economic aspects of engineering are emphasized, as well as the physical aspects. Clearly, it is essential that the economic part of engineering practice be accomplished well. Thus, engineers use knowledge to find new ways of doing things economically.

In general, engineering economy deals with the concepts and techniques of analysis useful in evaluating the worth of systems, products, and services in relation to their costs. Fundamentally, engineering economy involves formulating, estimating, and evaluating the economic outcomes when alternatives to accomplish a defined purpose are available. Another way to define engineering economy is as a collection of mathematical techniques that simplify economic comparison. Engineering economy is a collection of techniques that simplify comparisons of alternatives on an economic basis. In defining what engineering economy is, it might also be helpful to define what it is not.

Engineering economy is not a method or process for determining what the alternatives are. On the contrary, engineering economy begins only after the alternatives have been identified. If the best alternative is actually one that the engineer has not even recognized as an alternative, then all of the engineering economic analysis

tools in will not result in its selection. Real-world decisions usually include many other factors in the decision making process. For example, in determining whether to build a nuclear-powered, gas-fired, or coal-fired power plant, factors such as safety, air pollution, public acceptance, water demand, waste disposal, global warming, and many others would be considered in identifying the best alternative.

Objectives and Basis of Engineering Economy

In addition to the economic aspects of decision making, nonmonetary factors (attributes) often play a significant role in the final recommendation. Examples of objectives other than profit maximization or cost minimization that can be important to an organization include the following:

1. Meeting or exceeding customer expectations
2. Safety to employees and to the public
3. Improving employee satisfaction
4. Maintaining production flexibility to meet changing demands
5. Meeting or exceeding all environmental requirements
6. Achieving good public relations or being an exemplary member of the community

Why Engineering Economy is important to Engineers?

Decisions made by engineers, managers, corporation presidents, and individuals are commonly the result of choosing one alternative over another. Decisions often reflect a person's educated choice of how to best invest funds. The decision of how to invest capital will invariably change the future, hopefully for the better; that is, it will be value adding. Engineers play a major role in capital investment decisions based on their analysis, synthesis, and design efforts. The factors considered in making the decision are a combination of economic and noneconomic factors.

For many corporations, especially larger ones, many of the projects and services are international in scope. They may be developed in one country for application in another. People and plants located in sites around the world routinely separate product design and manufacturing from each other, and from the customers who utilize the product. The approaches presented here are easily implemented in multinational settings or within a single country or location. Correct use of the techniques of engineering economy is especially important, since virtually any project-local, national, or international-will affect costs and/or revenues.

It is used to answer many different questions

1. Which engineering projects are worthwhile?
 - Has the mining or petroleum engineer shown that the mineral or oil deposits is worth developing?
2. Which engineering projects should have a higher priority?
 - Has the industrial engineer shown which factory improvement projects should be funded with the available dollars?
3. How should the engineering project be designed?
 - Has civil or mechanical engineer chosen the best thickness for insulation?

Some typical applications of engineering economy are listed below

Manufacturing Company

- Addition (expansion) to an existing plant.
- Improvements to a material handling system.
- Selecting between numerical controlled milling machines produced by different manufacturers.

- Selecting the preferred conceptual (preliminary) design for a new consumer product.
- Selecting the preferred detailed design for an application.

Service Company

- Selecting the best type (and model) of light truck for use in a service fleet.
- Determining the preferred location of a distribution center.
- Selecting an upgraded computer system to integrate and improve the accomplishment of a number of present functions in an organization.
- Selecting the preferred conceptual (preliminary) design for a new consumer service and its basic delivery process.
- Selecting the preferred detailed design for a service (e.g., a home health care service involving professional nursing care to meet the periodic needs of patients).

Government Organization

- Evaluating the contracting of garbage pickup and disposal versus continued accomplishment by a city work force.
- Analyzing the significant repair and upgrading of a highway bridge versus its replacement with a new structure.
- Selecting the preferred conceptual (preliminary) design for a new elementary school.
- Evaluating the life cycle cost for a new major weapon system.
- Determining the preferred replacement cycle for medium sized backhoes in the highway department equipment fleet.

1.2.2 PRINCIPLES OF ENGINEERING ECONOMY

The development, study, and application of any discipline must begin with a basic foundation. We define the foundation for engineering economy to be a set of principles that provide a comprehensive doctrine for developing the methodology. Once a problem or need has been clearly defined, the foundation of the discipline can be discussed in terms of seven principles.

1. Develop the Alternatives

Carefully define the problem! Then the choice (decision) is among alternatives. The alternatives need to be identified and then defined for subsequent analysis.

2. Focus on the Differences

Only the differences in expected future outcomes among the alternatives are relevant to their comparison and should be considered in the decision.

3. Use a Consistent Viewpoint

The prospective outcomes of the alternatives, economic and other, should be consistently developed from a defined viewpoint (perspective).

4. Use a Common Unit of Measure

Using a common unit of measurement to enumerate as many of the prospective outcomes as possible will simplify the analysis of the alternatives.

5. Consider All Relevant Criteria

Selection of a preferred alternative (decision making) requires the use of a criterion (or several criteria). The decision process should consider both the outcomes enumerated in the monetary unit and those expressed in some other unit of measurement or made explicit in a descriptive manner.

6. Make Risk and Uncertainty Explicit

Risk and uncertainty are inherent in estimating the future outcomes of the alternatives and should be recognized in their analysis and comparison.

7. Revisit Your Decisions

Improved decision making results from an adaptive process; to the extent practicable, the initial projected outcomes of the selected alternative should be subsequently compared with actual results achieved.

1.2.3 ENGINEERING ECONOMY AND DESIGN PROCESS

An engineering economy study is accomplished using a structured procedure and mathematical modeling techniques. The economic results are then used in a decision situation that normally includes other engineering knowledge and input. A sound engineering economic analysis procedure incorporates on the basic of principles discussed as above and involves several steps. We represent the procedure in terms of the seven steps listed below.

1. Problem definition

The first step of the engineering economic analysis procedure (problem definition) is particularly important, since it provides the basis for the rest of the analysis. A problem must be well understood and stated in an explicit form before the project team proceeds with the rest of the analysis.

The term problem is used here generically. It includes all decision situations for which an engineering economy analysis is required. Recognition of the problem is normally stimulated by internal or external organizational needs or requirements. Operating problems within a company (internal need) or a customer expectation about a product or service (external requirement) are examples.

Once the problem is recognized, its formulation should be viewed from a systems perspective. Evaluation of the problem includes refinement of needs and requirements, and information from the evaluation phase may change the original formulation of the problem. In fact, redefining the problem until a consensus is reached may be the most important part of the problem-solving process!

2. Development of the alternatives.

The second step of the engineering economic analysis procedure is development of the alternatives. To development of the alternatives, two factors should be considers, (1) searching for potential alternatives and (2) screening them to select a smaller group of feasible alternatives for detailed analysis. The difference between good alternatives and great alternatives depends largely on an individual's or group's problem-solving efficiency.

3. Development of the outcomes and cash flows for each alternative

Step 3 of the engineering economic analysis procedure incorporates Principles 2, 3, and 4 and uses the basic cash-flow approach employed in engineering economy. A cash flow occurs when money is

transferred from one organization or individual to another. Thus, a cash flow represents the economic effects of an alternative in terms of money spent and received.

4. Selection of a Decision criterion

The selection of a decision criterion (Step 4 of the analysis procedure) incorporates Principle 5 (consider all relevant criteria). The decision maker will normally select the alternative that will best serve the long-term interests of the owners of the organization. It is also true that the economic decision criterion should reflect a consistent and proper viewpoint (Principle 3) to be maintained throughout an engineering economy study.

5. Analysis and comparison of the alternatives.

Analysis of the economic aspects of an engineering problem (Step 5) is largely based on cash-flow estimates for the feasible alternatives selected for detailed study. A substantial effort is normally required to obtain reasonably accurate forecasts of cash flows and other factors in view of, for example, inflationary (or deflationary) pressures, exchange rate movements, and regulatory (legal) mandates that often occur. Clearly, the consideration of future uncertainties (Principle 6) is an essential part of an engineering economy study. When cash flow and other required estimates are eventually determined, alternatives can be compared based on their differences as called for by Principle 2. Usually, these differences will be quantified in terms of a monetary unit such as dollars.

6. Selection of the preferred alternative.

When the first five steps of the engineering economic analysis procedure have been done properly, the preferred alternative (Step 6) is simply a result of the total effort. Thus, the soundness of the technical-economic modeling and analysis techniques dictates the quality of the results obtained and the recommended course of action. Step 6 is included in Activity 5 of the engineering design process (specification of the preferred alternative) when done as part of a design effort.

7. Performance monitoring and post evaluation of results.

This final step implements Principle 7 and is accomplished during and after the time that the results achieved from the selected alternative are collected. Monitoring project performance during its operational phase improves the achievement of related goals and objectives and reduces the variability in desired results. Step 7 is also the follow-up step to a previous analysis, comparing actual results achieved with the previously estimated outcomes.