Introduction
to
Engineering Economics and Financial Management

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Introduction

- What is Engineering?
  - an activity in which forces of nature act upon resources (materials) to get something beneficial for mankind.
- Purpose of Engineering?
  - to satisfy human wants (e.g.: timber, iron ore, etc.)
- Importance of Economics in Engineering in the current scenario
  - In earlier days of industrialization, the motto was to get something new, to do something innovative to satisfy human needs.
  - Resources getting depleted led to resource constraints; engineers had to think about how to economize.
  - Basically, there is a resource crisis all over the world. A stiff competition is in the market. Without considering economics, any engineering activity will fail from an economic point of view because any activity that any organization starts has to be sustained. So, economics cannot be sidelined.

Continue…

- Economics is a continuous process; must be discussed again and again. So, the importance of economics in engineering is quite high.

➢ Defining Engineering (with an Economics perspective)

  ➢ An activity that deals with materials and forces of nature in an economical way for the benefit of mankind

➢ Without economics, the engineering activity will be a failure.

➢ Ultimately the objective is to earn profit for the company and give good satisfaction to the customers. So, this is how both the parties are satisfied and this deal goes on.

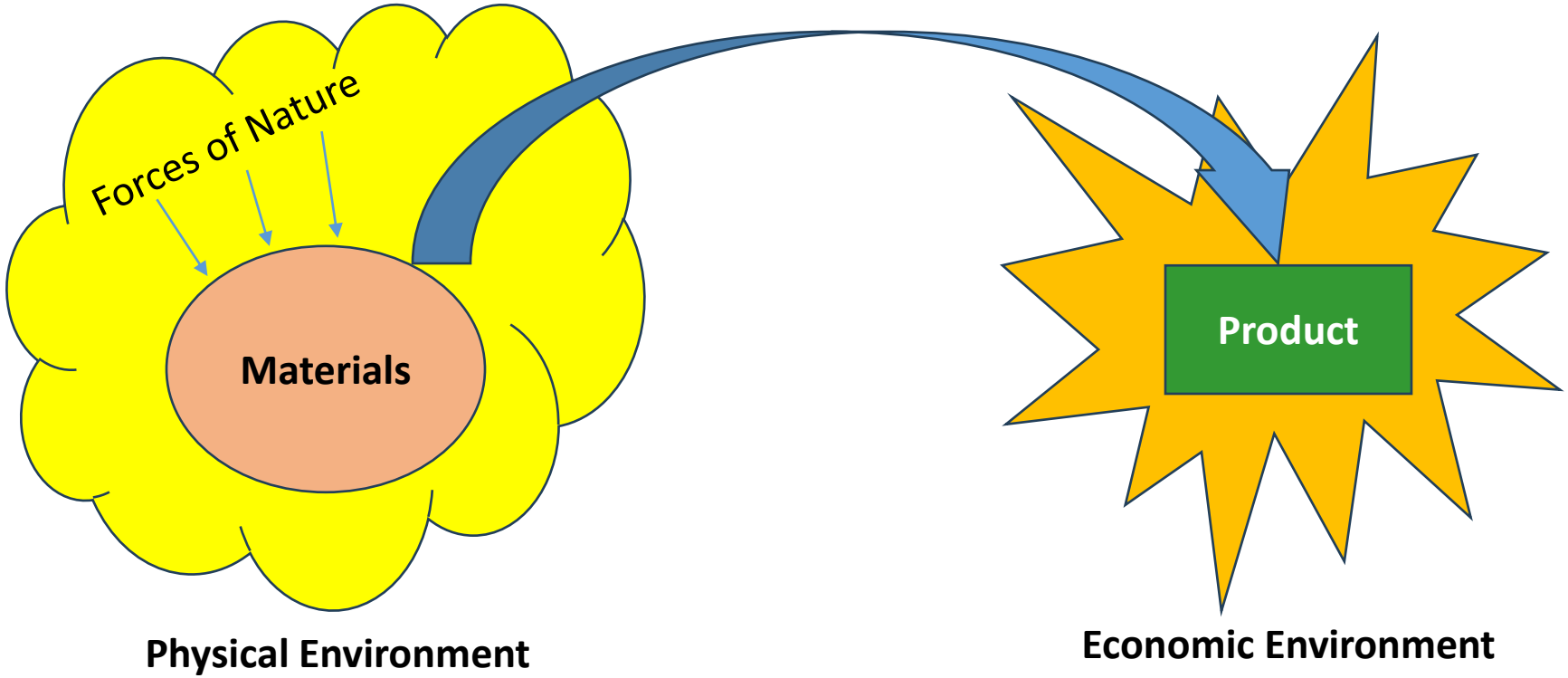
What is Economics?

The Science of useful application of wealth or natural resources

Economics is the study of the administration of scarce resources and the determinants of income and employment

Nature of Engineering

- Environments in which engineers have to work and correlation between them
  - 2 environments: Physical and Economic
  - Materials → Forces of Nature → Product
  - So the material is subjected to a number of operations using the laws of science; and from there a product is found which is the realization of the company.
  - This product goes into the market. It satisfies the customer's needs.



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- Two things are to be kept in mind:
  i. the physical laws are applied on the material and it is converted into a certain form. So, this kind of environment is known as the **physical environment**.
     - Engineers are typically concerned with this environment.
     - Their main job is to see how they can utilize the different laws, alter the physical environment and give a product. So, this is the physical environment.
  ii. Once the product comes into the market and it is used. It is used because it has some value. This value is added to it because of the alteration of the physical environment.
     - Hence, the product's value and utility increase, and due to this, there will be many buyers. This environment is nothing but an **economic environment**.
- In earlier days, engineers were confining themselves to the physical environment. The mindset was that their main job is to alter the physical environment and the economic environment belongs to sales and marketing personnel or the administration of the firm.
- But in the current scenario, an engineer must be aware of this. In fact, the economic environment has to be kept in mind prior to the physical environment.

Continue…

- As an engineer, you must know:
  - What are you going to produce?
  - What is the overall economy?
  - What is its life?
  - Who are their end-users?
  - What do they want? So that you can alter the physical environment.
- **The physical environment is expressed in terms of physical units**. You apply certain forces on certain volumes. So all these physical units are there to basically say how much physically you are changing the environment.
- **The economic environment**, which concerns the product's value and utility, **is expressed in terms of economic units**. It is **mostly in terms of the medium of exchange** such as **money.**
- Working on the economic environment has taken precedence over working on the physical environment for the firm/product to be successful.

Efficiency in Economics

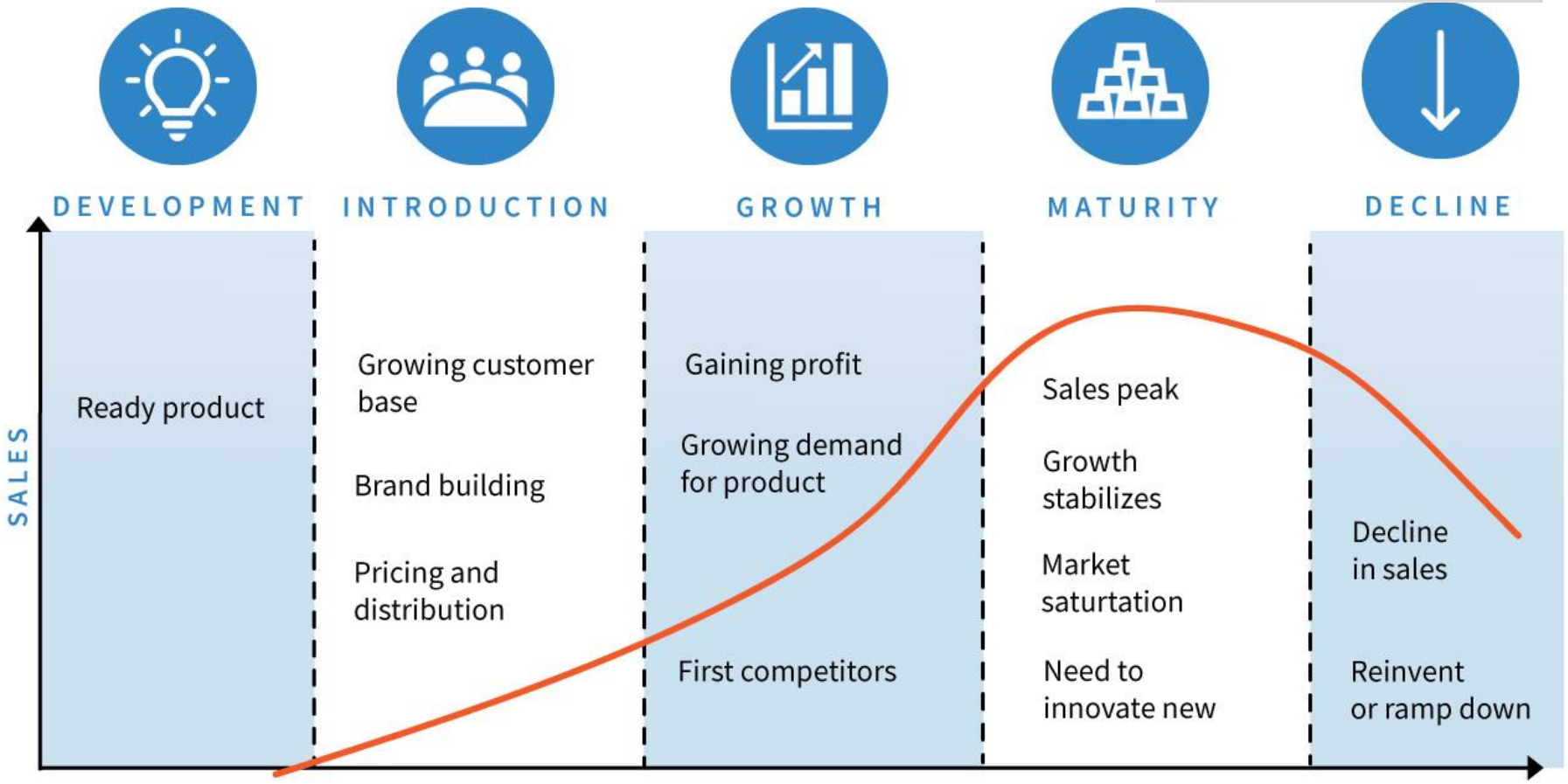
- **Physical efficiency**
  - Physical efficiency will be expressed in physical units; defined as output by input.
  - As engineers deal with the altering of the physical environment, they have the outputs and inputs in terms of physical units. E.g.: watts, joules, velocity, volume, etc.
  - Once the physical units are divided (Output/Input), it is known as physical efficiency and it is less than '1'.
- **Economic efficiency**
  - Economic efficiency is the ratio worth to cost..
  - It should be more than 100% for the firm/product to be successful.
- For example, In a power plant we burn the coal (Physical Environment) and get the steam. Thus the physical efficiency will be quite less than 100%.
- However, the generated steam is used for electricity production (Economic Environment). Here, we can see that at what price and in how much quantity the coal has been bought. And at what price the electricity is sold, which is economic efficiency more than 100% so that we could run our plant.

Phases in Engineering Analysis (economic perspective)

- **In economic analysis terms, it is better to know:**
  - What is the objective? : People's needs, Market size, selection of land, resources
  - How to meet the objectives? : Identify the factors
  - Limiting Factors: some factors which are coming in the way of obtaining the objective
  - Strategic Factors: the factor on which you can work so that you can overcome the limiting factors; these factors can be altered as per desired objective,

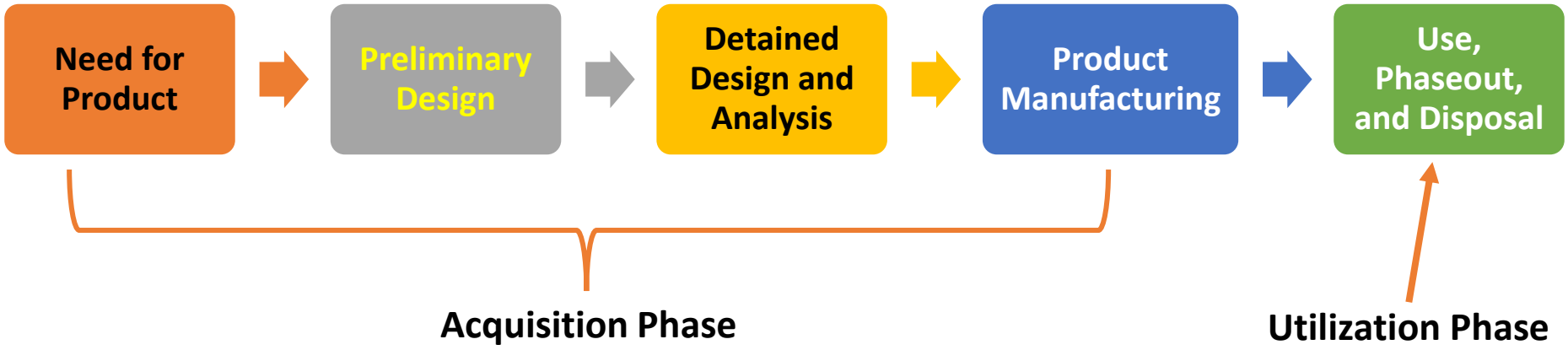
- Now there are many ways by which the strategic factors can be worked upon.
- One of them is known as Engineering Proposal, governed by the principles of engineering or they apply the laws of science
- So, as an engineer, one has to:
  - Identify the ways or means (Engineering Proposals)
  - Compare different engineering proposals (while keeping cost in mind)
  - Use decision-making tools/algorithms to choose the best proposal
- The selected engineering proposal will help attain the objective at a minimal cost.

The Product Life Cycle



Engineering using Life Cycle Approach

- PLC is a management tool that evaluates a product's journey from development to withdrawal from the market.
- PLC consists of various stages through which a product passes from development to decline in the market.
- It measures the total lifespan of a product.



Common Types of Engineering Economic Decisions

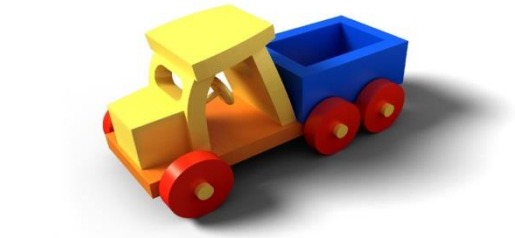
- Equipment or process selection
- Equipment replacement
- New product or product expansion
- Cost reduction
- Improvement in Service and Quality

The Decision-Making Process

1. Understand the Problem
2. Identify the decision criterion
3. Allocating Weights to the Criteria
4. Developing Alternatives
5. Analyzing alternatives
6. Select the “best” alternative
7. Implementing
8. Monitoring

Value

- Value is a measure of the worth that a person ascribes to a good or service.
- Value of the object is inherent not in the object but in the regard that a person has for it.
- Value is independent of its utility.
  - Gold has a high value in exchange but smaller utility when compared with water or food.
  - Air has high utility but no value in exchange.
- Value in exchange depends on the degree of scarcity.



Utility

- Utility is a measure of the power of the good or a service to satisfy human wants.
- The utility that an object has for a person is the satisfaction he/she derives from it.
- Utility of the object, like its value, inheres not in the object itself but in the regard the person has for it.

Value and Utility

Feature	Value	Utility
Definition	The worth of something, often expressed in monetary terms or relative importance.	The usefulness or ability to satisfy a need or want.
Focus	External and objective	Internal and subjective
Measurement	Can be measured in monetary units, social status, emotional significance, etc.	Can be measured through satisfaction levels, preferences, and choices.
Examples	- Price of a product	- Comfort of a chair
	- Rarity of a collectible gem	- Taste of a meal
	- Prestige of a brand	- Functionality of a tool
	- Sentimental value of a family heirloom	- Entertainment value of a movie
Relationship	Value can influence utility, but they are not always directly proportional.	High utility can lead to high value, but not always.
Context	Can vary depending on the individual, society, or market.	Can vary depending on individual needs, preferences, and circumstances.

Value and Utility

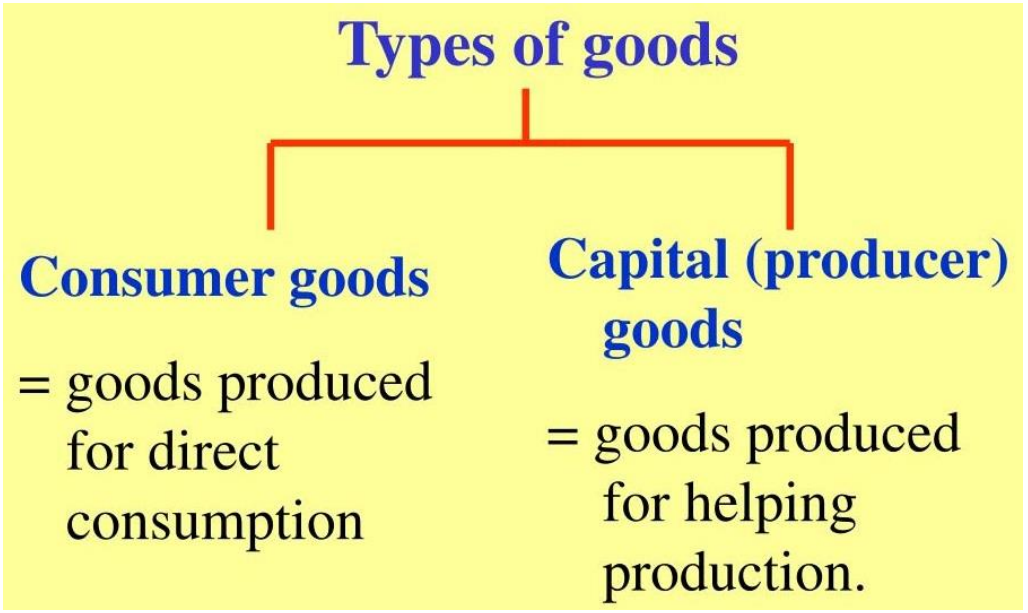
- While value can be objectively quantified (in most ways), utility is the perceived benefit attained from a product's value—one that is entirely subjective.
- **Value is an appraisal of utility in terms of the medium of exchange.** So if you have more utility for a product you try to give more money for it. And this happens in terms of the medium of exchange such as money.
- Evaluation of the utility of various items is not ordinarily constant, but it may be expected to change. Basically, the utility of an item keeps on changing.
- Further, the same goods and services can be having different utility by different person.
- Utility can be increased by altering physical condition.

How engineering relates to utility?

- The purpose of engineering effort is to determine how physical factors may be altered to create the most utility for the least cost.

Consumer and Producer Goods

- **In economic analysis, there are two types of goods and services:**
  - Consumer goods and services: directly satisfy your wants. E.g.: Washing Machine
  - Producer goods and services: satisfy human wants indirectly as part of the production or construction process. E.g.: parts that are used to make the washing machine
- Consumer goods are primarily determined subjectively, while producer goods are objectively determined. We have to objectively define what we want then only we will get the consumer goods.



Economic Aspects of Exchange

- Economy of exchange occurs when utilities are exchanged by two or more people.
- Exchange occurs because of:
  - Mutual benefits in exchange
    - From the buyer's and seller's perspective
    - Both must believe that they benefit

Exchange Perspective and Mutual Benefits

- The buyer and seller have different perspectives in the exchange process.
- There should be a mutual benefit in the exchange. Both must feel that they are benefitting.

From the buyer's perspective:

- The utility of money paid is lesser than the utility of the object. The buyer will go for exchange only when this condition is satisfied.

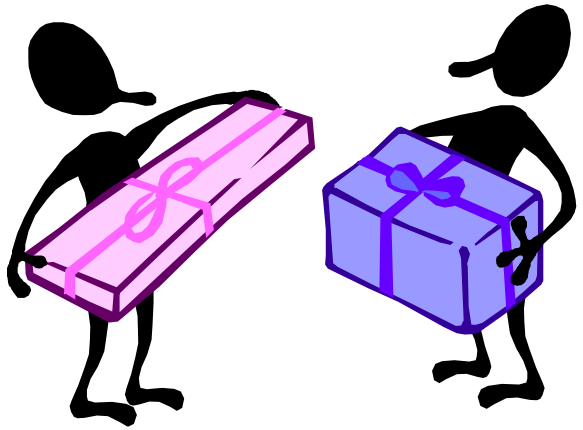
From the seller's perspective:

- The utility of the object/product is lesser/smaller than the money received from the buyer.

Mutual benefit in exchange

A buyer will purchase an object when

- Money is available
- Good has = or > utility than ____.



A seller will sell an object

- Amount of money has _____ utility than the object.

Persuasion in Exchange

- **How to increase the possibility in exchange?**
- To increase the exchange possibility, there should be **persuasion.**
- Persuasion means convincing customers to buy something even beyond their capabilities.

Thus, persuasion in exchange:

- consists of taking a person on an excursion into the future in an attempt to show or demonstrate the consequences if the person acts in accordance.
- So, the **purpose of economic analysis is to estimate the consequences of a decision**. It means, if we try to exchange, what will be the consequences, are we going to be benefited or not?

Players in an Economic Systems

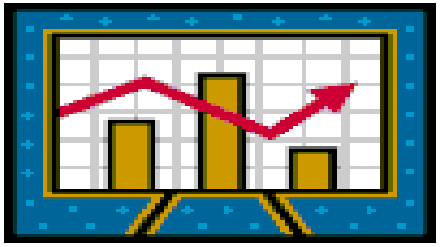
- An economic system is any system of allocating scarce resources.
- Economic systems answer three basic questions:
  - what will be produced,
  - how will it be produced, and
  - how will the output society produces be distributed?
- Complex and multidimensional, with the decisions made on production, produced goods, and those who would benefit from them having a moral and political context

Key Players:

1. Government
2. Firms/ Businesses/ Corporates
3. Household/ citizens
4. Financial system/ Central banks

Macroeconomics

- Macroeconomics examines the aggregate behavior of the economy (i.e. how the actions of all the players in the economic system interact to produce a particular level of economic performance as a whole).



- It focuses on issues such as:
  - ✓ Economic policies
  - ✓ GDP
  - ✓ Inflation
  - ✓ Deficit
  - ✓ Unemployment
  - ✓ Economic growth and
  - ✓ other related issues, which affect the economy as a whole.
- These concepts are not simple.

Microeconomics

- *Microeconomics* is the study of individuals, households, and firms' behavior in decision-making and allocation of resources.
- Microeconomic study deals with issues like:
  - ✓ what choices do people make,
  - ✓ what factors influence their choices
  - ✓ how their decisions affect the goods markets by affecting the price, supply, and demand.
- Microeconomic concepts are simple & easy to understand.
- Ex.: How much it would cost for a university or college to offer a new course?

Feature	Macroeconomics	Microeconomics
Focus	Overall economy; behavior of aggregate variables	Individual markets, firms, and consumers
Scale	National, regional, or global	Individual markets, firms, and households
Key Concepts	GDP, inflation, unemployment, economic growth, interest rates	Supply and demand, market equilibrium, price theory, competition, market efficiency
Key Questions	"What affects overall economic performance?"	"How do individuals and firms behave in markets?"
Data	Aggregate economic indicators like GDP, inflation, unemployment	Prices, quantities, market shares, firm profits
Policy Focus	Government fiscal and monetary policy, international trade agreements	Firm pricing and production decisions, consumer behavior, regulation
Tools and Models	Aggregate economic models, Keynesian and Neoclassical theory	Supply and demand curves, game theory, welfare economics
Examples	Analyzing how a change in interest rates affects inflation and economic growth	Studying how a new online grocery delivery service affects competition and prices in the local supermarket industry

Concepts of Demand and Supply

DEMAND

The willingness of buyers to purchase a given amount of goods or services, over a range of prices, over a given period of time.

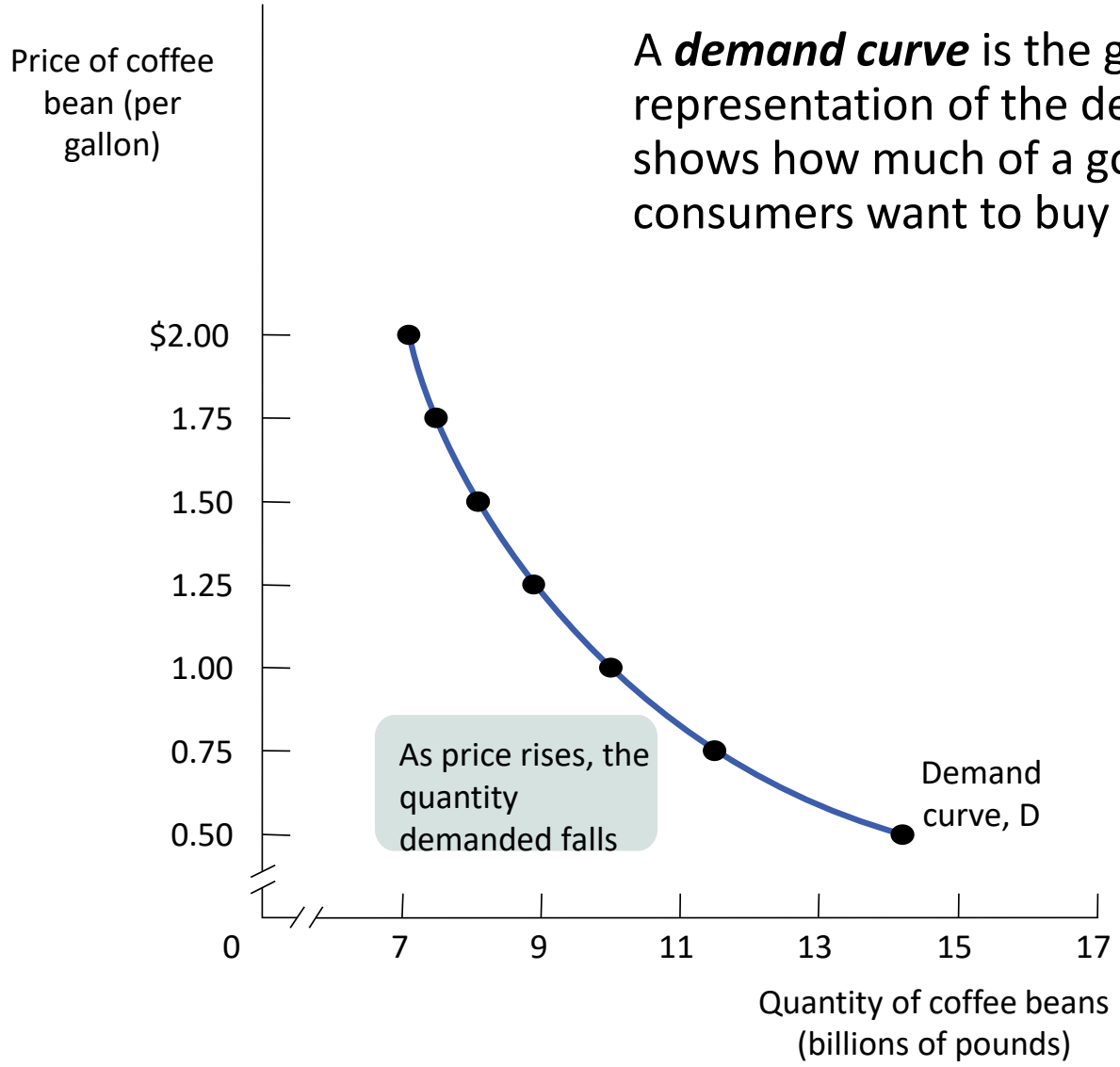
The relationship of the quantity of a good that will be bought at various prices can be presented in the form of a demand schedule or portrayed graphically as a demand curve.

Demand Schedule

- A demand schedule shows how much of a good or service consumers will want to buy at different prices.

Demand Schedule for Coffee Beans	
Price of coffee beans (per pound)	Quantity of coffee beans demanded (billions of pounds)
$2.00	7.1
1.75	7.5
1.50	8.1
1.25	8.9
1.00	10.0
0.75	11.5
0.50	14.2

A ***demand curve*** is the graphical representation of the demand schedule; it shows how much of a good or service consumers want to buy at any given price.



LAW OF DEMAND

Principle stating that as the price of a commodity increases, the less consumers will purchase the commodity, and vice-versa, provided all other factors that affect buyers' decisions are unchanged.

As price decreases, the quantity demanded increases and vice versa, other things remaining constant.

The law of demand operates due to the following underlying effects:

1. **Substitution effect** of price change:

The substitution effect specifically refers to the **shift in consumer preferences towards substitute goods** when the price of a particular good increases. This happens because the higher-priced good becomes relatively less attractive compared to its cheaper substitutes. As a result, consumers tend to switch to substitutes to maintain their overall level of utility or satisfaction.

1. **Income effect** of a price change:

It explores how a change in **a good's price impacts consumer demand by essentially altering their purchasing power**. This effect comes into play because when price changes, a good's affordability relative to the consumer's income changes, triggering adjustments in their consumption patterns.

DETERMINANTS OF DEMAND

General Factors:

1. Price of the product itself
2. Income of the consumer
3. Prices of related goods

Additional Factors:

1. Consumer's expectations of future prices
2. Consumer's expectations of future income.

- **Changes in the Prices of Related Goods**
  - **Substitutes**: *Two goods are **substitutes** if a fall in the price of one of the goods makes consumers less willing to buy the other good*.
    - A decrease in the price of tea (a substitute for coffee) can lead to a decrease in the demand for coffee, as consumers switch to the cheaper alternative.
  - **Complements**: *Two goods are **complements** if a fall in the price of one good makes people more willing to buy the other good.*
    - *An increase in the price of milk (a complement to coffee) can lead to a decrease in the demand for coffee, as consumers are less likely to buy coffee if milk is more expensive.*

Exceptions to Law of Demand

1. **GIFFEN GOODS:** (Refers to inferior good)

   Reduction in price of the commodity made reduce it's demand.

   Example: Inferior goods consumed by the poor.

2. **STATUS GOODS:**

   The more expensive these commodities become, greater will be their demand.

   Example: Luxury cars, diamonds etc.

SUPPLY

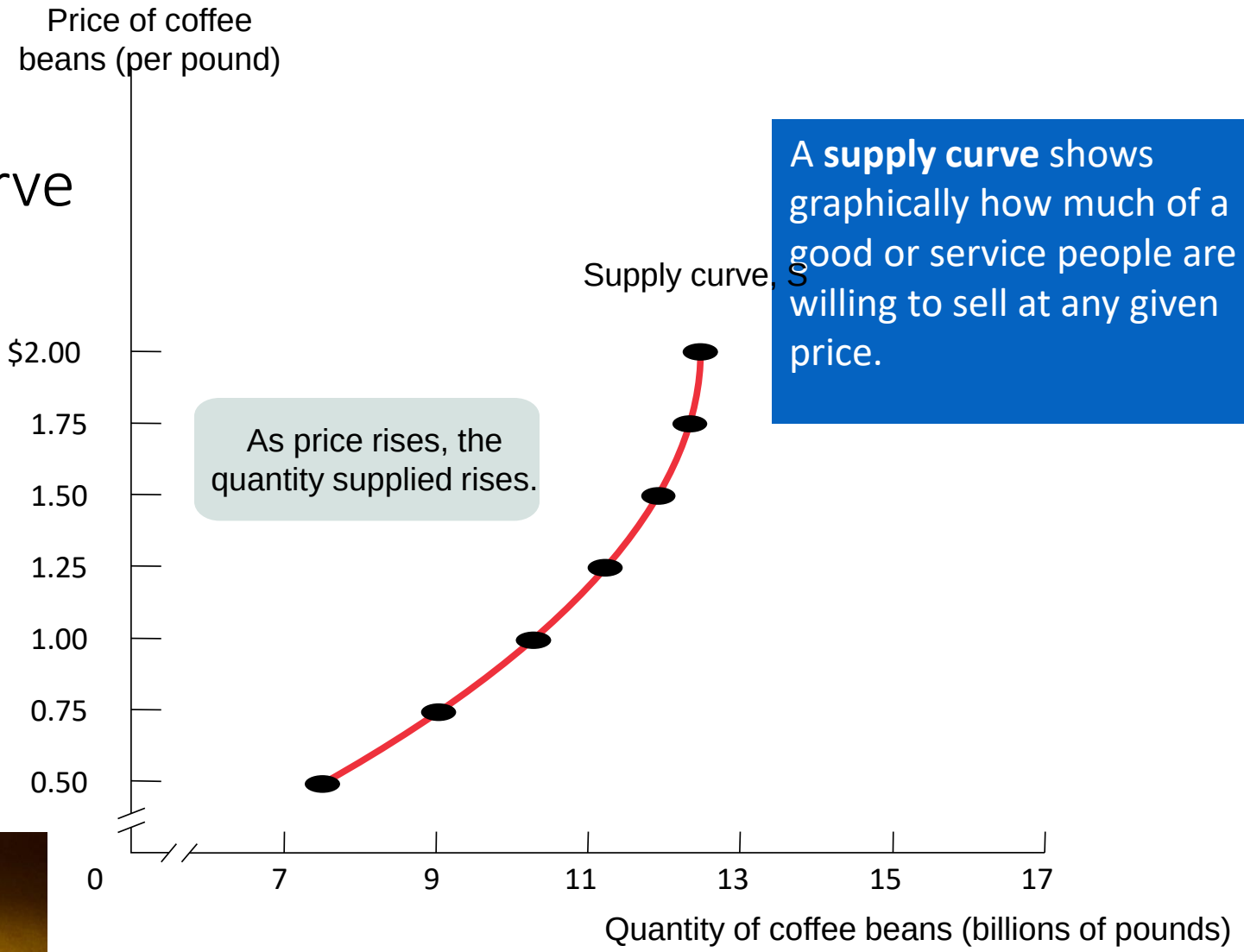
The willingness of producers to supply the good, over a range of prices, over a given period of time, other things remaining the same.

Supply Schedule

- A supply schedule shows how much of a good or service would be supplied at different prices.

Supply Schedule for Coffee Beans	
Price of coffee beans (per pound)	Quantity of coffee beans supplied (billions of pounds)
$2.00	**11.6**
1.75	**11.5**
1.50	**11.2**
1.25	**10.7**
1.00	**10.0**
0.75	**9.1**
0.50	**8.0**

Supply Curve



A **supply curve** shows graphically how much of a good or service people are willing to sell at any given price.

As price rises, the quantity supplied rises.

LAW OF SUPPLY

- The *law of supply* states that, **the quantity supplied of a good rises when the price of the good rises**, and vice-versa, as long as all other factors that affect suppliers' decisions are unchanged

DETERMINANTS OF SUPPLY

1. Price of the product
2. Input/production prices
3. Number of suppliers
4. State of technology used
5. Suppliers expectations about future prices

Supply and Demand Equilibrium

- **Equilibrium** : when the quantity demanded of a good equals the quantity supplied of that good.

- The price at which this takes place is the **equilibrium price**
  - Every buyer finds a seller and vice versa.

- The quantity of the good bought and sold at that price is the **equilibrium quantity.**

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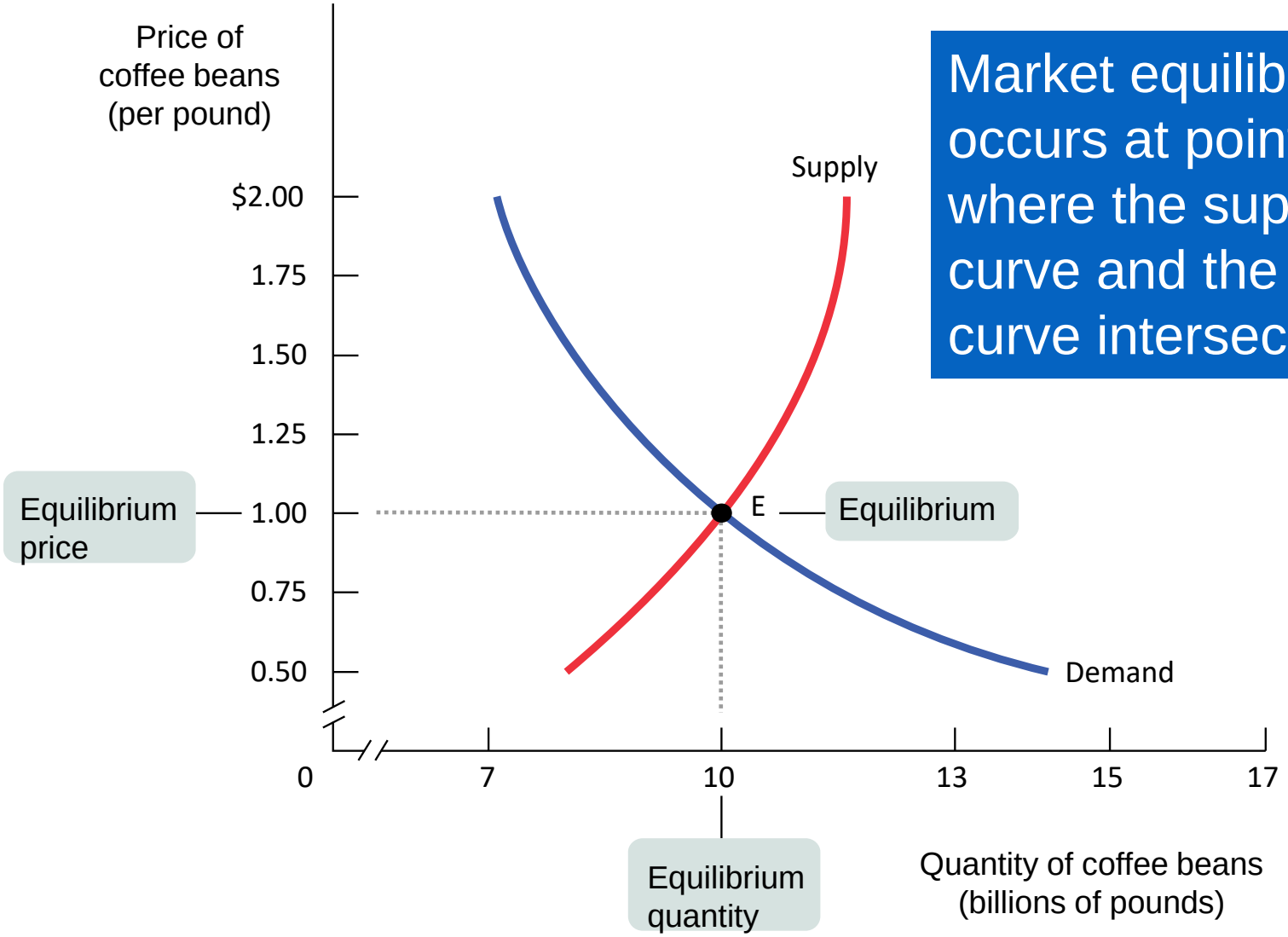
Market Equilibrium



Market equilibrium occurs at point E, where the supply curve and the demand curve intersect.

Elasticity of Demand

- *It refers to the shift in demand for an item or service when a change occurs in one of the variables that buyers consider as part of their purchase decisions.*
- *It's a relationship between demand and another variable, such as price, availability of substitutes, advertising pressure, and customer income.*
- $E_d = \frac{Percentage\ change\ in\ quantity\ demanded\ of\ good\ (X)}{Percentage\ change\ in\ determinant\ (factors\ or\ variables)(Z)}$
- $E_d = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta Z}{Z}}$

where, $E_d = Elasticity\ of\ demand$

$\Delta = Change$

$Q = Quantity$

$Z = Determinant\ or\ factor\ or\ variable$

Types of Elasticity of Demand

- *Price EoD*
- *Income EoD*
- *Cross EoD*
- *Promotional EoD*
- *Substitutional EoD*

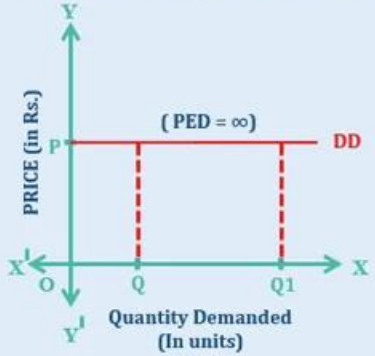
Price Elasticity of Demand

- *When customers are highly sensitive to changes in price, there is a high PEoD.*
- *This means, for example, that if inflation causes prices to increase, customers will reduce the quantity they purchase by switching, substituting or skipping.*
- *It can also indicate, conversely, that price reductions may spur additional sales.*
- $E_p = \frac{Proportionate\ change\ in\ quantity\ demanded\ of\ good}{Proportionate\ change\ in\ price\ of\ good}$
- $E_d = \frac{\frac{Q_2 - Q_1}{Q_1}}{\frac{P_2 - P_1}{P_1}}$

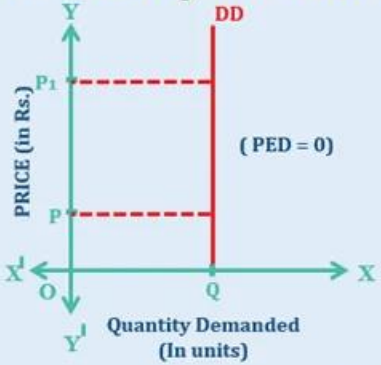
Types of Price Elasticity of Demand

Price Elasticity of Demand

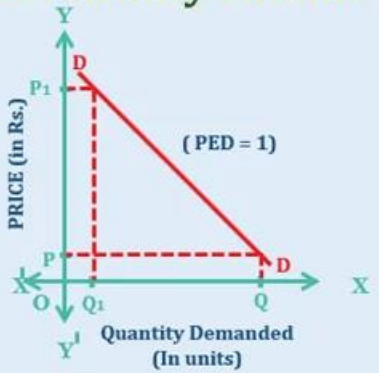
1. Perfectly elastic



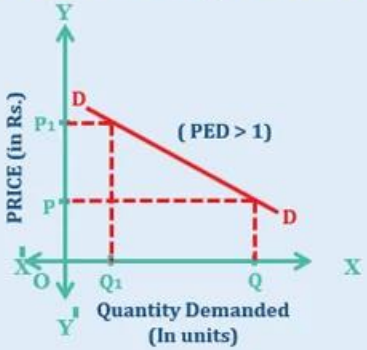
2. Perfectly inelastic



3. Unitary elastic



4. Relatively elastic



5. Relatively inelastic

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Types of Price Elasticity of Demand

Table-4: Price Elasticity of Demand

Numerical Value	Type of Price Elasticity	Description
$e_p = \infty$	Perfectly elastic demand	There is a greater change in demand in response to percentage or smaller change in the price. For example, the demand for a product decreases or completely stops, with a little change in its price and vice versa.
$e_p = 0$	Perfectly inelastic demand	Consumers do not respond to the demand for a product with increase or decreases in its price. This implies that the demand remains the same with change in the price.
$e_p > 1$	Relatively elastic demand	The percentage change in the quantity demanded of a product is greater than percentage change in its price. In such a case, consumers generally switch to new brands when the price of a particular brand increases. However, some consumers are loyal to the same brand.
$e_p < 1$	Relatively inelastic demand	The change in the demand of a product is less than that of change in its price.
$e_p = 1$	Unitary elastic demand	The change in the demand and change in the price of a product is same.

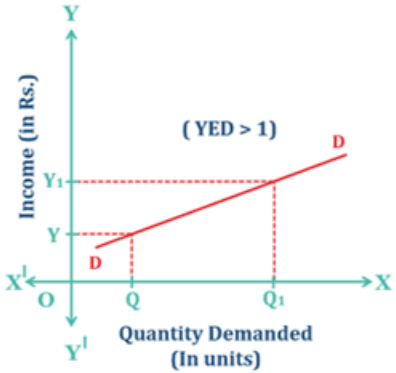
Income Elasticity of Demand

- *It is the relationship between demand and a customer's income.*
- *As income decreases, quantity of demand tends to decline, even if all other factors remain the same, including price.*
- *YEoD tends to differ according to the priority of a product, meaning that what economists refer to as "normal goods," like food, clothes and other necessities, are likely to be prioritized over luxury goods when customers' income declines.*
- $E_Y = \frac{Percentage\ change\ in\ quantity\ demanded\ of\ good}{Percentage\ change\ in\ the\ income\ of\ consumer}$
- $E_Y = \frac{\frac{Q_2 - Q_1}{Q_1}}{\frac{Y_2 - Y_1}{Y_1}}$

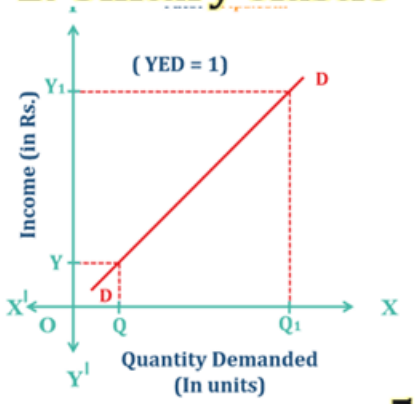
Types of Income Elasticity of Demand

Income Elasticity of Demand

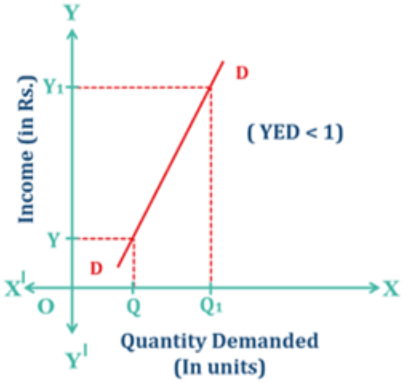
1. High elastic



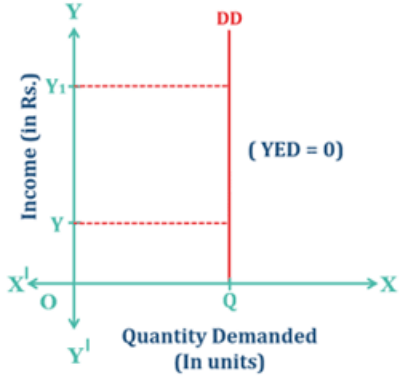
2. Unitary elastic



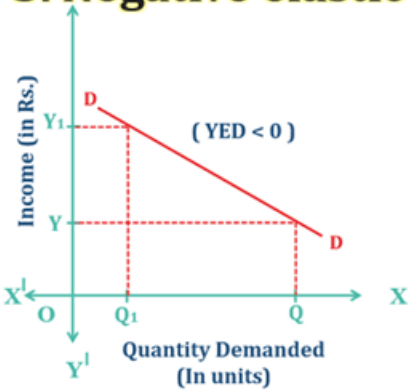
3. Low elastic



4. Zero elastic



5. Negative elastic



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Cross Elasticity of Demand

- *Cross elasticity (X) happens when changes in the price of one product prompt changes in demand for another.*
- *The two products must be related, either as complements or substitutes for each other.*
- *When products are substitutes for each other, a rise in the price of one will usually cause a rise in demand for the other.*
  - *For example, if coffee prices rise, then demand for breakfast tea is likely to increase as customers substitute tea for coffee.*
- *When two products are complementary, a rise in the price of one will usually cause a decrease in the demand for the other.*
  - *For example, if milk prices rise, demand for coffee will likely decline.*
- *XED does not apply to unrelated products, such as airline tickets and oranges.*
- $E_{PY} = \frac{Percentage\ change\ in\ quantity\ demanded\ of\ good\ A}{Percentage\ change\ in\ the\ price\ of\ good\ B}$
- $E_{PY} = \frac{\frac{Q_2 - Q_1}{Q_2 + Q_1}}{\frac{P_2 - P_1}{P_2 + P_1}}$

Advertising (Promotional) Elasticity of Demand

- *It is a measure of the response of quantity demanded to change in expenditure on advertising and other promotion activities*
- *Mathematically,*

$$E_A = -\frac{\Delta Q}{\Delta A} \cdot \frac{A_1}{Q_1} \quad \text{- Point Elasticity}$$

$$E_A = \frac{(Q_2 - Q_1)}{(Q_2 + Q_1)} \times \frac{(A_2 + A_1)}{(A_2 - A_1)} \quad \text{- Arc elasticity}$$

Substitutional Elasticity of Demand

- *The degree to which one good can be substituted for another as a consequence of a given change in their price ratio if the consumer is to enjoy the same satisfaction.*
- *Mathematically,*

$$E_S = \frac{Proportionate\ change\ in\ quantity\ ratios\ of\ X\ \&\ Y}{Proportionate\ change\ in\ the\ price\ ratios\ of\ the\ X\ \&\ Y}$$

$$E_S = \frac{\Delta(Q_x/Q_y)}{(Q_x/Q_y)} \div \frac{\Delta(P_x/P_y)}{(P_x/P_y)}$$


Any
Suggestions?


Thank you!