1. Details of Module and its structure

Module Detail	
Subject Name	Economics
Course Name	Economics 03 (Class XII, Semester - 1)
Module Name/Title	Demand and Elasticity of Demand – Part 4
Module Id	leec_10204
Pre-requisites	Budget Line and Indifference Curve
Objectives	After going through this lesson, the learners will be able to understand the following: • Consumer's Equilibrium • Idea of Demand • Normal and Inferior Goods • Law of demand and Demand Curve • Movement and shifts in the Demand Curve • Market Demand • Elasticity of Demand • Factors affecting Elasticity of Demand
Keywords	Consumer Equilibrium, Law of Demand, Inferior Goods, Shifts in Demand, Elasticity of demand

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Table of Contents :

In this module we shall explore the concept of 'demand'. We start with a recap of the consumer's equilibrium discussed in an earlier module. The consumer's equilibrium describes how much of each commodity a consumer will buy, given the following:

- Prices of the commodities
- The consumer's income
- The tastes and preferences of the consumer (described by his indifference curves)

The theory of demand explores how the quantity consumed changes when any of these parameters changes.

1. The Consumer's Equilibrium

We combine what we know about budget sets and indifference curves to figure out what the consumer consumes, and in what quantities. Figure 1 reproduces the budget set discussed in the earlier module. We assume that the two commodities the consumer is choosing between are books and movies. (Remember we do this only as a simplification. You can choose any two commodities you like. In principle, you can also extend this analysis to more than two commodities, but that would make the diagrams extremely complicated)

The budget set represents what the consumer can afford to buy, given a certain income (Rs 2000) and prices of commodities (Rs.50 for a movie and Rs. 100 for a book). Superimposed on this is a consumer's indifference map. This represents the consumer's preferences. The consumer will try to achieve the highest level of satisfaction he can achieve, given his budget, and the prices of commodities. Notice that the highest possible IC that the consumer can reach is the one that just touches, or is tangent to, the budget line. This occurs at the point E, where the consumer is consuming 16 movies and 12 books. This is the consumer's 'equilibrium'. At E, his utility is maximum, given his income and the prices of movies and books. The consumer can do no better than this, and has no incentive to change, unless prices change, or his income changes.

At E the slope of the budget line equals the slope of the indifference curve. Recall that the slope of the budget line is the ratio of prices of the commodity on the X-axis to that on the Y-axis; and the slope of the Indifference Curve is the MRS.

Thus, **at equilibrium, MRSx,y = PX/PY**

In our example:

MRS of movies for books = (Price of Movies)/(Price of Books)

=Rs.50/Rs.100

= 1/2

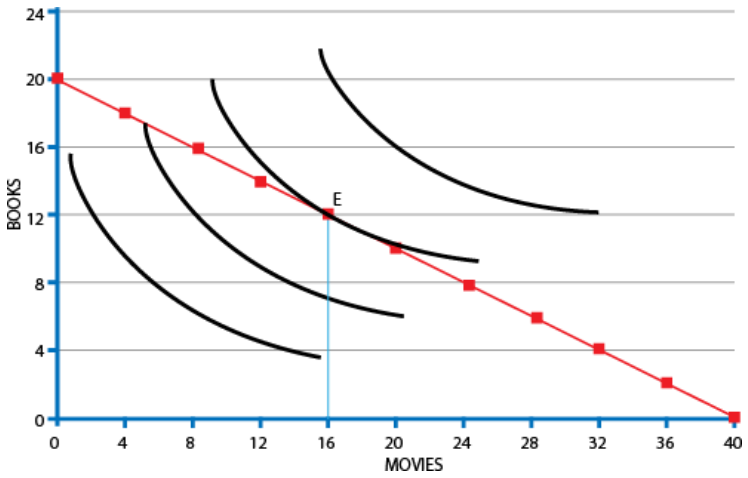

Figure 1

This answers the basic questions:

What does our consumer buy? Our consumer buys books and movies.

In what quantities? He buys 16 movies and 12 books.

What happens if the price of movies changes? Suppose the price of movies goes up to Rs.100.

We saw in the previous module how the budget line changes. This is depicted in figure 2 below. Superimposed on the budget lines is the consumer's indifference map. The consumer's old equilibrium, E1, is now beyond his new (green) budget line. He cannot afford it any more. His new equilibrium is where his *new* budget line is tangent to the highest indifference curve (E2). He now consumes only 10 movies and 10 books, rather than 16 and 12. Notice that the number of movies consumed has gone down as the price of movies has gone up.

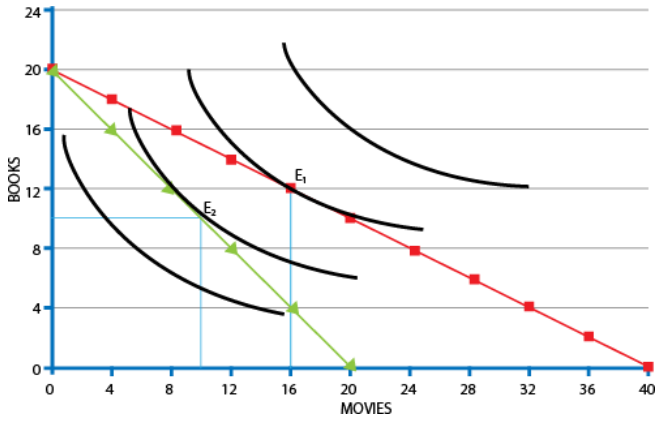

Figure 2

What would have happened if the consumer's income had gone up? Recall that an increase in income, keeping prices unchanged causes the consumer's budget line to shift out parallel to the original budget line. The consumer would therefore move to a new equilibrium, described by where an indifference curve touches this new budget line. In figure 3 below the consumer's income has gone up from Rs.2000 to Rs. 2500, the prices of books and movies remaining unchanged. At the new equilibrium, the consumer consumes 15 books and 20 movies.

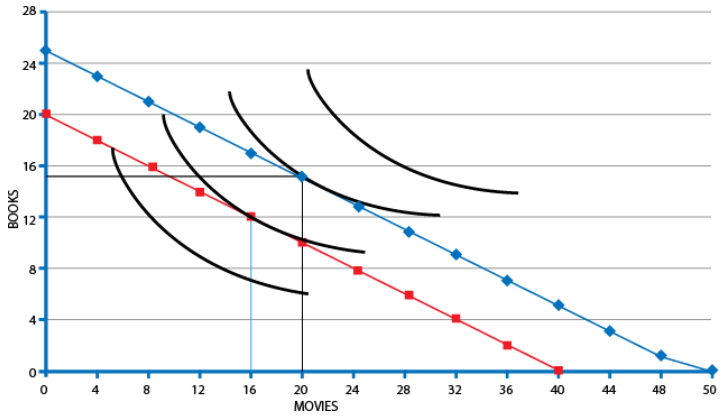

Figure 3

We use the above analysis to understand what determines how much of a particular commodity the consumer is buying, given her preferences, the prices of commodities and her income.

2. Idea of Demand

The **demand for a commodity** is the quantity of that commodity that a consumer purchases, given her preferences, prices, and her income. There are two aspects of demand that are useful to remember. First, demand reflects the amount of the commodity a consumer *wants* to buy. Her 'want' is captured by her indifference map. Second, she has to be *able to afford* it. This is captured by her budget line.

We can now list the determinants of demand for a commodity:

- Price of the commodity
- Price(s) of other commodities
- Income of the consumer
- Preferences of the consumer

A mathematical representation of this relationship is called a **demand function**. A general representation of a demand function is:

Qx = d(PX, PY, M, T)

Where

Qx is the demand for the commodity X

PX, is the price of the commodity X

PY is the price of the other commodity Y (there may be more than one 'other' commodities) M is the consumer's income

T is the consumer's tastes or preferences.

2.1 Effect of Price Change on Demand:

Price of the commodity:

Our analysis of the consumer's equilibrium allows us to predict how demand changes when any of these variables change. In order to achieve clarity on the matter, economists use a strategy to change only one variable at a time, keeping all other variables unchanged. We have already seen in the above example that when the price of movies increased, other things remaining the same,

the consumption of movies went down. **In other words, when price of a commodity increases, we expect the demand for the commodity to go down, other things remaining the same.** Conversely, **when price of a commodity decreases, we expect the demand for the commodity to go up, other things remaining the same.** So price of a commodity and its demand are said to be inversely related. What do we mean when we say 'other things remaining the same'? We mean that we are keeping other prices, income and tastes unchanged. The Latin phrase *ceteris paribus* is often used to denote this.

The graphical representation of the demand function is called the Demand Curve. While drawing the demand curve, price is measured on the Y-axis while quantity is measured on the X-axis. The demand curve is downward sloping displaying the inverse relationship between the price of the good and its quantity demanded. Figure 4 below shows demand curve showing inverse relationship between price and quantity of the good.

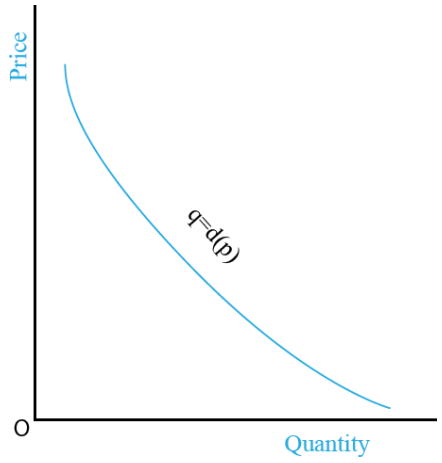

Figure 4: Demand curve showing inverse relationship between price and quantity of the good

Law of Demand: Usually, a consumer's demand for a good is inversely related to the price of the good.

We can illustrate this with a linear demand function which would simplify and help us understand the idea of demand. A linear demand function can be written as

$q(p) = a - bp$; when prices are in the range of 0 to a/b

$= 0$; when prices equal or are greater than a/b

Here q(p) denotes demand of the commodity as a function of the price of the commodity. One X-axis we have quantity demanded of the good and on Y-axis we have price of the good. Our X-

intercept here is *a* while *a/b* is our Y-intercept. Slope of the curve measures how much the quantity demanded changes following a change in price of the good. The slope here is –b (- sign denoting the inverse relationship), which suggests that for each unit increase in the price of the good, the quantity of the good demanded falls by b units. We have chosen to ignore the other determinants of demand for simplicity's sake. Figure 5 below depicts this linear demand function.

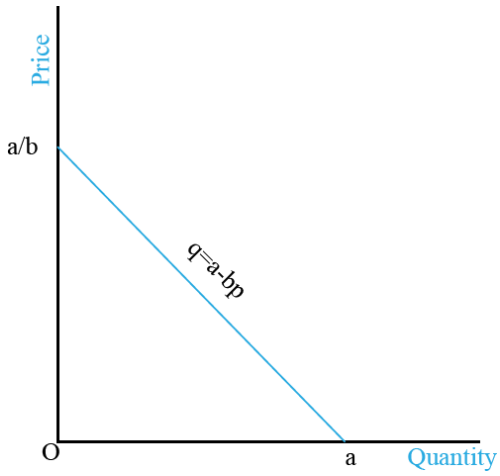

Figure 5: linear demand function

In all our analysis unless otherwise stated we shall proceed with the linear demand curve developed here for our understanding.

2.2 Prices of related commodities: The demand for a commodity may be related to the prices of other commodities depending upon whether they are complements or substitutes. Commodities which can be consumed in place of each other are called **substitutes**. Tea and coffee are substitutes for most people. Sugar and jaggery (gur) are also substitutes. If the price of coffee goes up what happens to the demand for tea? Typically, the demand for tea will go up because consumers will switch from coffee to tea. Commodities which are consumed together are called **complements**. Tea and sugar are complements. If the price of sugar goes up, what would happen to the demand for tea? People who like their tea sweet may cut back on their consumption of tea.

The demand for a commodity usually moves in the direction of the movement of the price of its substitutes. If the price of a substitute increases, demand for the commodity will go up, and vice versa. Demand for a commodity moves in the opposite direction of the movement of the price of

its complements. If the price of the complement increases, the demand for the commodity will fall and vice versa.

2.3 Income of the consumer : Typically, when a consumer's income increases, the demand for commodities will increase. If the consumer's demand moves in the same direction as change in his income, the commodity is said to be a **normal** commodity. So for a normal commodity, its demand would go up with rise in consumer's income, and fall with a fall in income.

If consumer's demand for a commodity moves opposite to the direction of change in income, the commodity is said to be an **inferior** commodity. So for an inferior commodity, its demand would go up when consumer's income falls and its demand would go down when his income rises. Usually these are commodities that are consumed at low levels of income. For example, people tend to consume more food grains at low levels of income. As incomes rise, they consume less food grains and switch to 'better' food such as milk, fruits and vegetables.

2.4 Movements and Shifts in the Demand Curve: The demand curves that we drew in figure 4 and 5 were drawn with the assumption that 'other things remained unchanged'. Each point on the demand curve indicates the quantity that a consumer would purchase at a particular price. So for changes in the price of the commodity, ceteris paribus you move along the demand curve. This is referred to as change in quantity demanded for a change in price. A downward movement along the curve shows increase in the quantity demanded, and is called an expansion of demand. An upward movement along the curve shows decrease in quantity demanded and is called a contraction of demand.

But if any factor other than the price of the commodity changes, then there is a shift in the demand curve. This is referred as change in demand. So a change in the income of consumer, taste and preference of the consumer, prices of other commodities would shift the demand curve of the commodity. The leftward shift shows decrease in demand of the commodity while rightward shift shows increase in demand of the commodity. Figure 6 below depicts these shifts.

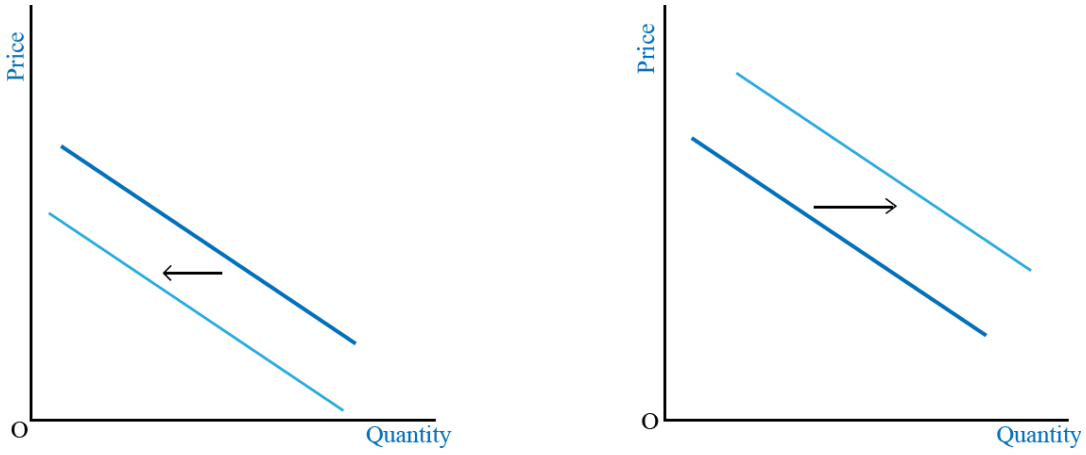

Figure 6: Leftward and Rightward Shift of Demand Curve

Market Demand: Market Demand for a commodity at some price is the sum of individual consumer demands at that price, taken together. Graphically the market demand curve is derived by horizontally adding all the individual demand curves. Assume there are only two consumers in the market and at price p′, the demand of first consumer is q1′ and that of second consumer is q2′. So the market demand of the commodity at price p′ is the sum of individual demands at price p′ which is q1′ + q2′. Similarly, at a different price pˆ, first consumer has the demand q1ˆ and second consumer has the demand q2ˆ, so the market demand of the commodity at pˆ is sum of individual consumer demands at price pˆ which is q1ˆ + q2ˆ. Thus, the market demand for the commodity at all prices can be derived by adding up the demands of the two consumers at all those prices. We carry the same exercise even if there are more than two consumers. Figure 7 below reproduces the above graphically.

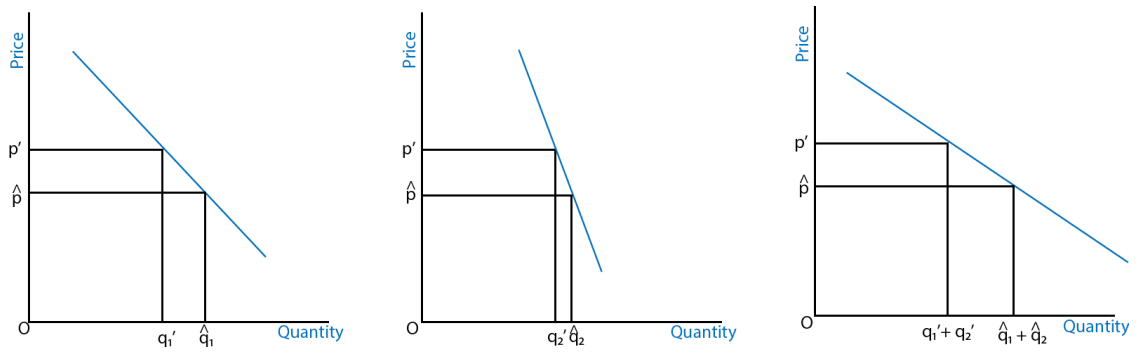

Figure 7: Derivation of Market Demand Curve from Individual Demand Curves

The rightmost graph is the resulting market demand curve from the horizontal summation of first two individual demand curves.

3. Elasticity of Demand

Recall that –b was the slope of the linear demand curve discussed earlier, which told us how much the quantity demanded of a commodity changes if price of the commodity changes. We introduce here *Price elasticity of demand* as a formal measure of the responsiveness of demand to price changes. It is defined as percentage change in quantity demanded of a commodity divided by percentage change in the price of the commodity. We denote it by ed, where

e_D = (percentage change in quantity demanded of commodity)/ (percentage change in the price of the commodity)

Since both numerator and denominator are percentage terms, price elasticity of demand is a pure number devoid of any units.

We can rewrite the above formula for elasticity as

$$\text{Price Elasticity of Demand} = \frac{\text{Percentage Change in Quantity Demanded}}{\text{Percentage Change in Price}}$$

or,

$e_D = \{ [(q_1 - q_0)/ q_0]X\ 100 \} / \{ [(p_1 - p_0)/ p_0]X\ 100 \}$ ------- Equation (i)

Where the subscript 1 denotes final value of the corresponding variable and subscript 0 denotes the initial value of that variable. Remember change is always final value minus initial value. Price elasticity of demand bears negative sign because of the inverse relationship between price of a commodity and its quantity demanded. We focus on the absolute value of the elasticity

denoted as $|e_D|$ (read as modulus of ed). When $|e_D| > 1$, the demand of the commodity at that price is said to be elastic, if $|e_D| < 1$, the demand of the commodity at that price is said to be inelastic, if $|e_D| = 1$, the demand of the commodity is said to be unitary elastic at that price.

A flatter demand curve is said to be more elastic than a steeper demand curve, provided they are both drawn to the same scale, because in a flatter demand curve change in quantity demanded is more for a unit change in price at a given price level than observed in a steeper demand curve. Thus absolute value of ed would be higher in case of the flatter demand curve than in a steeper demand curve.

3.1 Elasticity for a linear demand curve: As you noted earlier that we have a linear demand function of the form q(p) = a – bp. At all points on the demand curve, ratio of change in quantity demanded to that of change in price equals –b. Below we present equation (i) in a slightly altered manner. Make sure you understand it pretty well before advancing ahead.

$$e_D = \frac{\left(\Delta q/_{q_\circ}\right)\times 100}{\left(\Delta p/_{p_\circ}\right)\times 100} = \frac{\Delta q/_{q_\circ}}{\Delta p/_{p_\circ}} = \frac{(q_1 - q_\circ)/q_\circ}{(p_1 - p_\circ)/p_\circ}$$ ------Equation (ii)

where, $q_1 - q_0 = \Delta q$ and $p_1 - p_0 = \Delta p$.

Also,

$$\frac{\Delta q}{\Delta p} = -b$$

So we use the above expression in equation (ii) and obtain

$$e_D = -b\frac{p}{q} = \frac{bp}{a - bp}$$ --------- Equation (iii)

The last result that we derived presents elasticity as a function of price alone. So we can predict that for a demand function of the form q(p) = a – bp, elasticity of demand will vary across points on a linear demand function according to equation (iii). The table below presents the elasticity for various prices observed for this demand function.

Price	e_D
0	0

a/2b	1
0 > **p** > a/2b	<1
p > a/2b	>1
a/b	∞

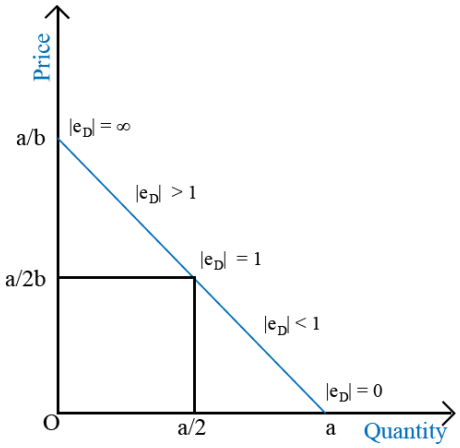

Figure 8

What is e_D, when q=0?

When a linear demand curve is drawn, it's easy to calculate elasticity at any point on it. Without giving proof, we tell you that the absolute value of elasticity at any point E on the demand curve is equal to the ratio of the length of the line segment which joins E to X-axis to that of length of line segment which joins E to Y-axis. We illustrate the same via a diagram below. Assume point E anywhere on this demand curve given in figure 6. The price elasticity of demand at the point E is given by ratio of length of line segment EQM to length of line segment ES.

Figure 9 below shows elasticity across various points on a linear demand curve of the form q(p) = a – bp. Figure 7 below represents the same.

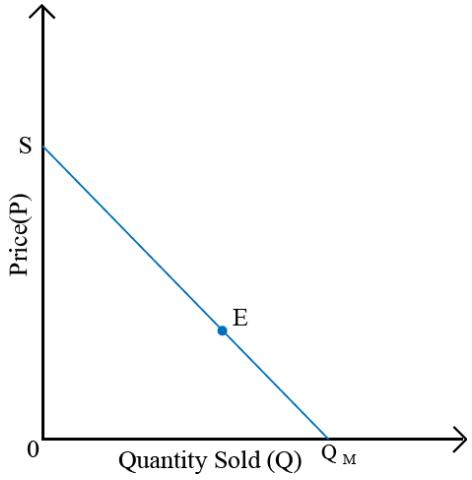

Figure 9

Make sure you understand the absolute values of elasticity written above intuitively and using the trick as well.

3.2 Additional topics in Elasticity: Elasticity associated with a demand function at various points can assume values ranging from zero to infinity. It may also happen that elasticity for a demand function remains constant for all prices. , A vertical demand curve will always have elasticity equal to zero. No matter what the price, the quantity demanded does not change. A horizontal demand curve will always have elasticity equal to infinity.. A curve with elasticity equal to infinity is said to be perfectly elastic while the one with zero elasticity is said to be perfectly inelastic. We can also have a curve called rectangular hyperbola which has a constant

elasticity of 1. The diagram below shows two such demand curves which have constant elasticity. The first graph represents vertical demand curve denoting perfectly inelastic demand and the second graph represents a rectangular hyperbola.

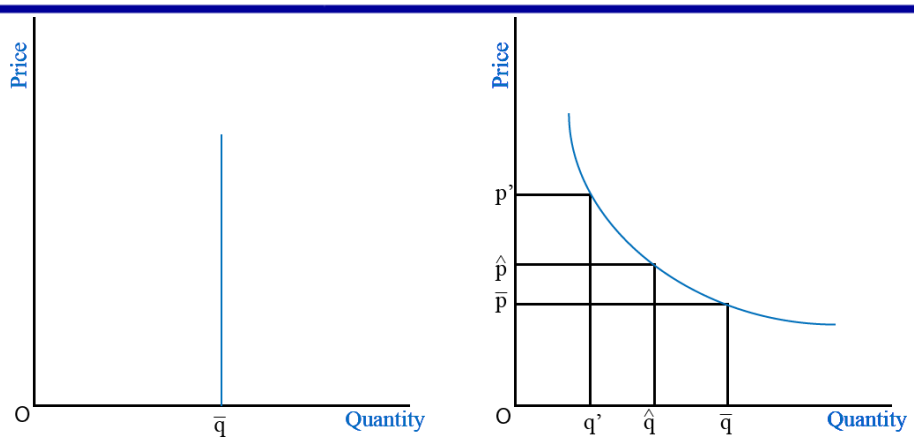

Figure 10: Perfectly Inelastic and Unitary Elasticity of Demand

Rectangular hyperbola are generally represented in the form of X*Y=K where K is non zero. In our context it becomes P*Q=K, which is analogous to saying, there is fixed expenditure by the consumer because the product of price and quantity demanded is nothing but the consumer's expenditure and it is remaining constant. This is also to say that for demand function with unitary elasticity, the consumer's expenditure on the commodities remains unchanged. *Why?*

The expenditure on a commodity depends on the price of the commodity and its quantity demanded.

Expenditure = Price x Quantity demanded.

Following a price change, the expenditure on the commodity may or may not change. It depends on how the quantity demanded of the commodity responds to the changes in its price.

3.2.1 When the demand is elastic, and there is an increase in the price of the commodity, quantity demanded falls more than proportionately and the total expenditure declines.

3.2.2 When the demand is inelastic, and there is an increase in the price of the commodity, quantity demanded falls less than proportionately. So total expenditure goes up.

3.2.3 When the demand is unitary elastic, a rise in the price of the commodity causes fall in the quantity of commodity demanded in equal proportion. So, total expenditure remains constant.

Factors affecting Elasticity: Price elasticity of demand of a commodity depends on the nature of the commodity, availability of substitutes, time horizon under consideration. For example, commodities which are necessities like medicines, or food grains have relatively inelastic demand because people cannot do without them, price changes are less likely to change the quantity

demanded. While commodities which are luxuries, , like holidaying in foreign countries, yacht travel, their demand is much responsive (elastic) to their prices. Similarly for commodities having lot of substitutes, we can expect their demand to be elastic, because any increase in their prices can make people shift to the substitute. Also for a shorter time horizon demand is relatively inelastic while compared to a longer time horizon. It is simply because in the longer time period people find alternate commodities , or learn to do without. If petrol becomes highly expensive, one would expect that over a longer time horizon the decline in quantity demanded would be much larger than in short run. Why? People would switch to other means of transport, companies would develop vehicles running on other fuels etc.

4. Summary:

In this module, you have learned to identify the point of Consumer Equilibrium, which is the point of maximum satisfaction, given the income of the consumer. It is the point where the slope of the budget line equals the slope of the indifference curve. You have also learned the determinants of demand, which are - price of a commodity, prices of other commodities, like - substitute and complementary commodities, income of the consumer, and his tastes and preferences and also, how changes in these determinants affect the quantity demanded by a consumer. The mathematical relationship and graphical representation of a demand function have also been explained in this module.

We have also derived the market demand curve by horizontally adding up the individual demand curves. Recall that price elasticity of demand is the percentage change in the quantity demanded to the percentage change in the price of a commodity. The elasticity is high for luxury goods, and low for necessary goods. The elasticity also varies over the period of time.