Managerial Economics
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Lecture - 21
Theory of Cost (Contd...)

We will continue our discussion on theory of production cost. So if you remember in the last class, we were discussing about the short-run and long-run cost analysis. We just introduced the short-run cost analysis. In today's class we will talk about the long-run cost analysis, how long-run cost curves are derived from the short-run cost curve. Then we will talk about the break even analysis and learning curve.

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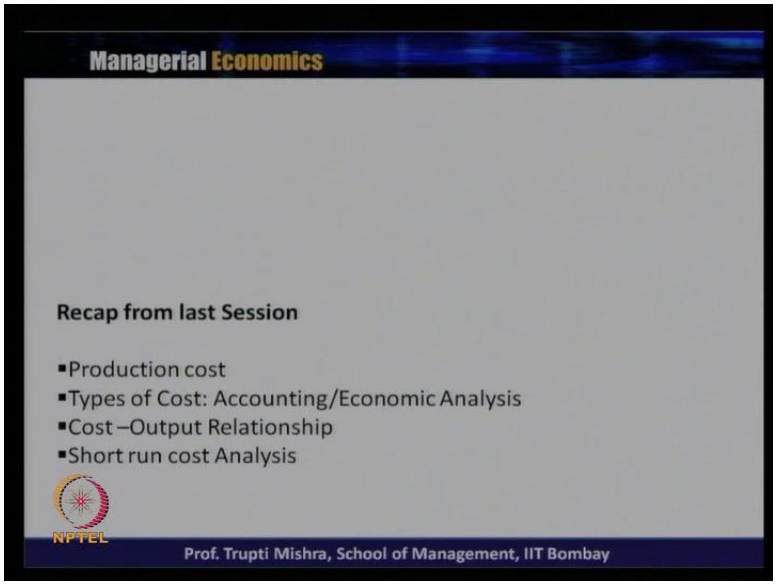

So, if you remember this is the topic what we discussed in the last class; like we introduce the production cost, different type of cost in both accounting sense and economic analysis sense. Then we discussed about the cost and output relationship, specifically in the context of short-run cost analysis.

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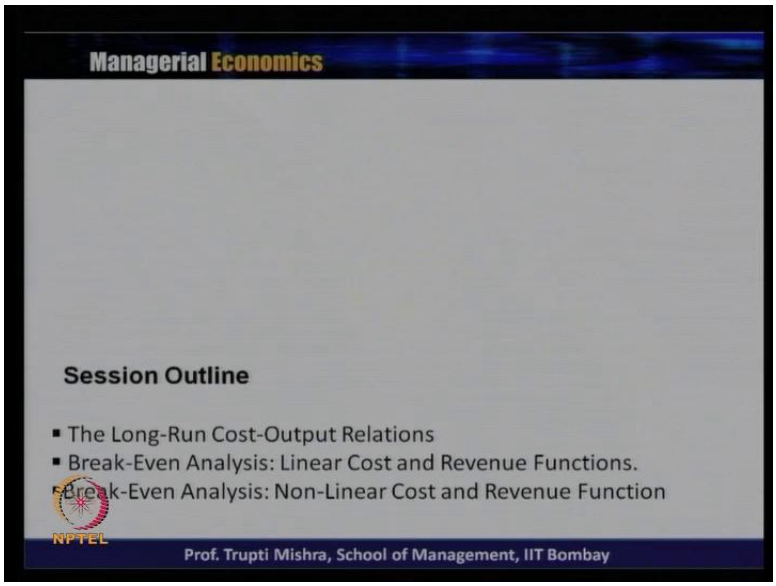

In today's class we will talk about the long-run cost-output relationship, breakeven analysis in case of linear cost and revenue function, and breakeven analysis in case of non-linear cost and revenue function.

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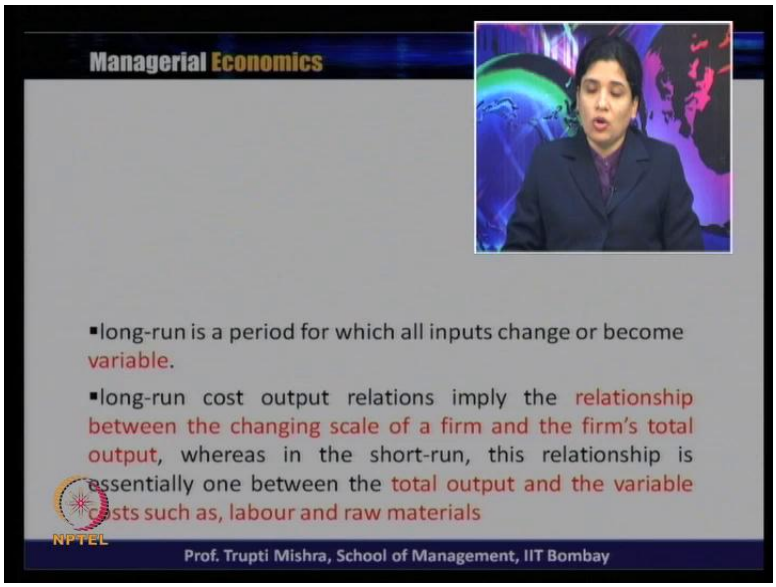

So as you know, I think we have already differentiated the difference between the short-run and long-run; one is the time specific and second in case of typically in case of production analysis; short-run, long-run is on the basis of classification of the how the inputs behave, whether the inputs they are fix or whether they are the variable input. In

case of short-run, at least there is one input has to be fixed; but in case of long-run, all input has to be variable which implies that when the output increases it, and there is a requirement to change all the inputs or may be in the other, to put it in the other way, when all inputs changes then only the output changes or maybe we can take another implication of this that the change in the output is large. So, it cannot be change; only by changing few inputs all input has to be change.

So, long-run is a period for which all inputs change or become variable, and long-run cost-output relation implies the relationship between the changing scale of firm's and firm's total output. So if it is comes to a cost-output relationship in case of long-run, it is basically a relationship between the changing scale of firm and the firm's total output.

Whereas if you look at in case of short-run generally the relationship is not the scale relationship, rather it is the change in the output or change in the input with respect to change in the output. So, it is one between the total output and in the specifically the variable cost. So in case of long-run it is a scale relationship and in case of short-run this is a one-to-one relationship between the total output and the variable constant. The variable constant includes the raw material and the labor.

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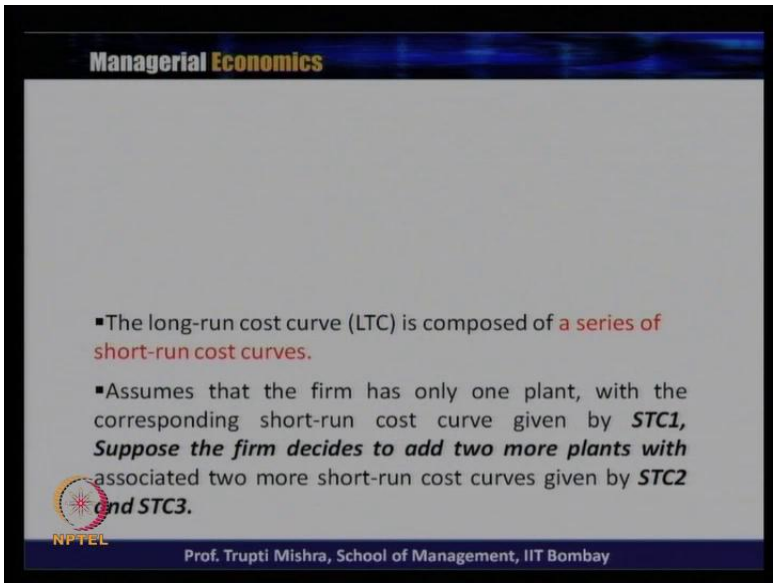

Then when it is coming to the cost curve of the long-run total cost or may be the long-run cost and altogether, this is composed of a series of short-run cost curve. So, when you take a series or when you take a more than may be two, three, short-run cost curve

that gives us the long-run cost curve. Assume that firm has only one plant with a corresponding short-run cost curve given by suppose STC1 that is short-run cost curve in one period, and suppose the firm decides to add two more plants with associated two more short-run cost curve given by STC2 and STC3.

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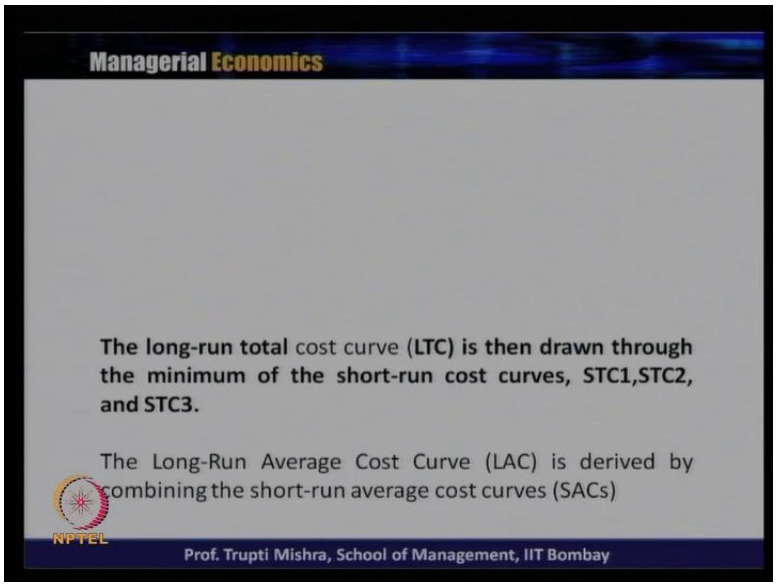

If you now take all these STC1 that is cost curve in one short-run, STC2 that is cost curve in the second short-run, and STC3 that is cost curve in the third short-run. And altogether STC1, STC2, and STC3, they will come they will then leads to the long-run total cost curve and similarly, the long-run average cost curve is also derived from the combining the short-run average cost curve. So, this is the long-run total cost and if you look at how this has been derived this long-run total cost curve.

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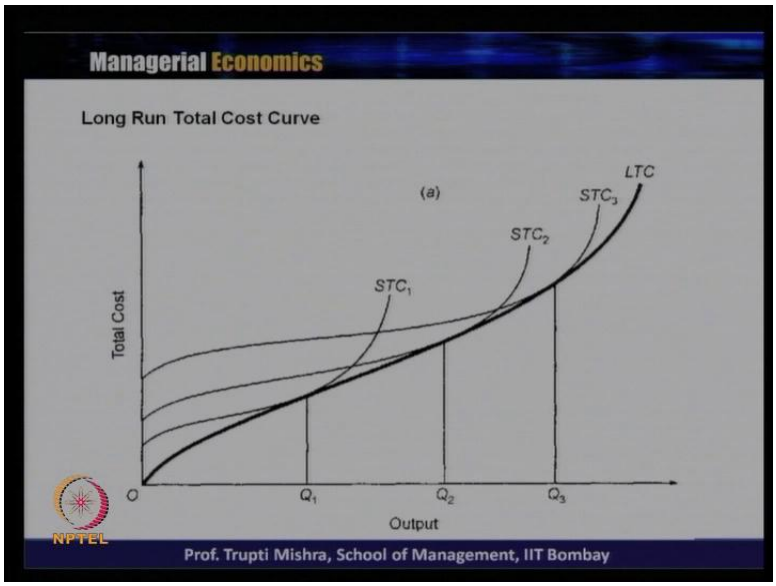

This is as we say that this is the combination of or may be this is the combination of a series of short-run cost curve and how this short-run cost curve is derived. Suppose the output is 100 units. So by changing variable unit, only the output can achieve up to 100 units. So, this is one short-run cost curve. When the output which can be maximum changed by 200 unit by changing the variable, that is another short-run cost curve or may be when the output can be changed by 500 unit of output.

By changing only the variable unit that is another short-run cost curve. So for a specific output level, keeping the fixed input only the changing variable input, how much a maximum output can be increased that consist of one short-run cost curve. So, taking a series of short-run cost curve at different level of output that gives us the long-run total cost curve.

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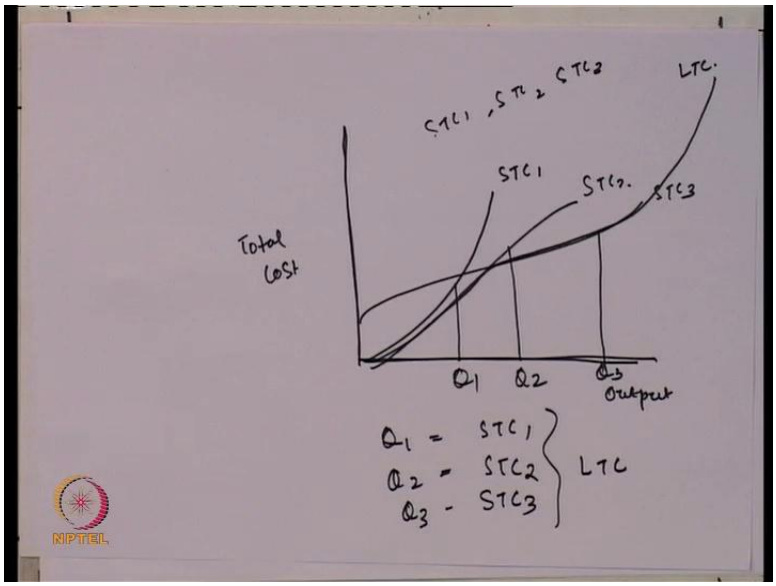

Now, we will see how the long-run total cost can be derived from the short-run cost curve at the different level of output. So, here we can say the output. Here we can say the total cost. So, maybe we have one short-run cost curve that is STC1. May be we have another short-run cost curve that is STC2 or maybe we have one more short-run cost curve that is STC3. So when you join or sum together of all, this short-run cost curve that gives us the long-run total cost curve; so STC1, STC2, and STC3.

So, if you look at this is corresponding to maybe this is Q1 level of output; this is Q2 level of output, and this is Q3 level of output. So, corresponding to Q1 level of output, the cost curve is STC1. Corresponding to Q2 level of output, the short-run cost curve is STC2, and corresponding to Q3 level of output, the short-run cost curve is STC3. Taking altogether all these three, we get the long-run total cost curve.

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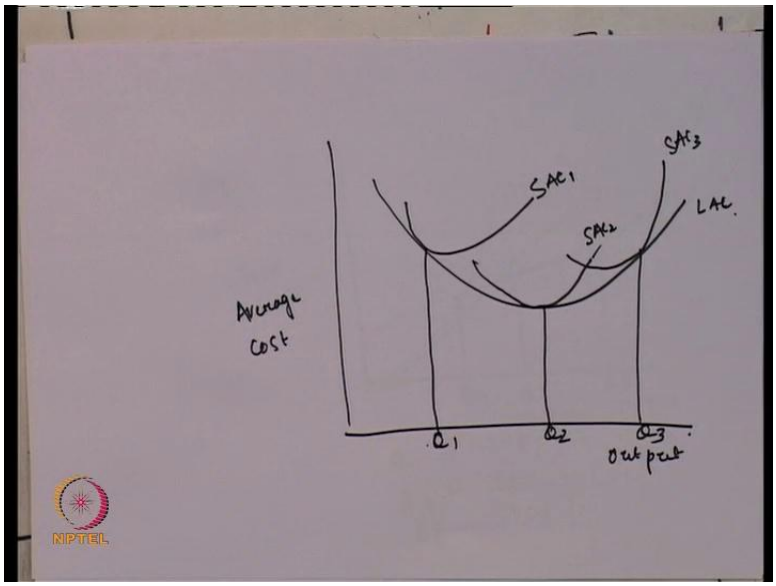

So, long-run total cost curve is the series of short-run cost curve at the different level of output. Similarly if you look at we can also derive the long-run average cost curve taking the series of the short-run average cost curve. This is x-axis will take the output; y-axis we will take the average cost since we are drawing the long-run average cost curve. So, similarly we get a short-run average cost curve here.

Then short-run average cost curve 2, and similarly the short-run average cost curve 3; so corresponding to that we get three level of output because that leads to three level of cost curve. So, this is SAC1, SAC2, SAC3 and this is long-run average cost curve. So, hence we can derive the long-run total cost curve from the series of total short-run total cost curve.

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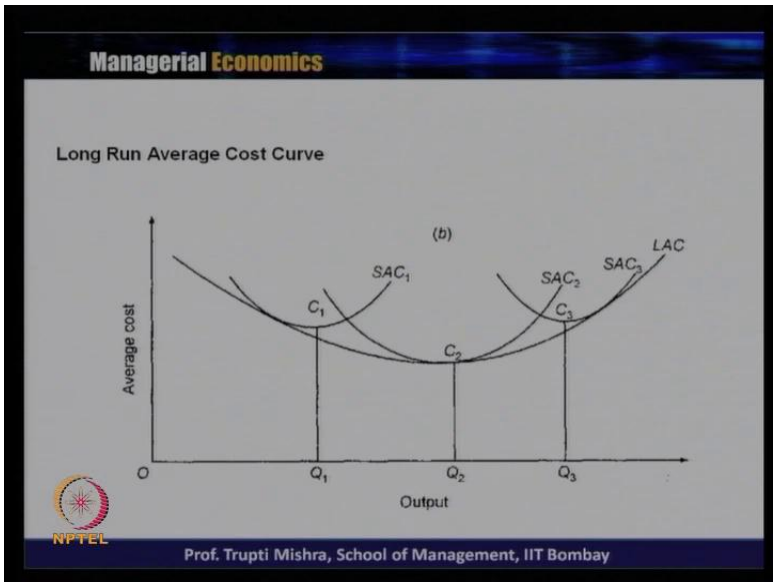

Similarly, we can also derive the short-run average cost curve. From the series of short-run average cost curve, we can try the long-run average cost curve; and long-run cost curve is nothing but the series of the short-run average cost curve at different level of output. Specifically in this case, if you look at its Q1, Q2, Q3 which keeps three different level of output.

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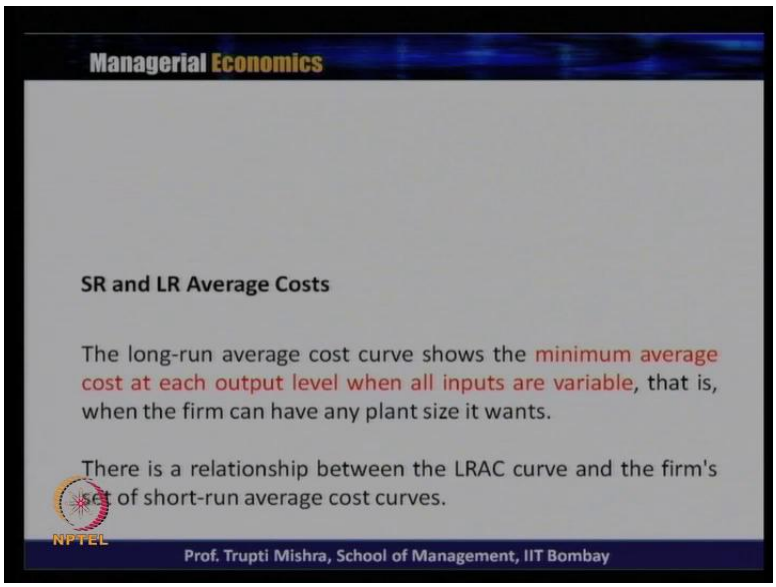

So now we will see, what is the relationship between the short-run and long-run average cost curve. So, long-run average cost curve shows the minimum average cost at each

level of outputs when inputs are variable, that is, when a firm can have any plant size it wants. So, there is a relationship between the long-run average cost curve and the firm state of short-run average cost curve. So, as we say that the long-run average cost curve is the minimum average cost at each output level when inputs are variable.

So whether if you look at the SAC1, SAC2, and SAC3, it gives three different level of variable cost and that is why this long-run average cost curve takes out the minimum of average cost at each short-run level of output, and it gives the minimum average cost curve of each output level when the variable in it is or some inputs are at least variable.

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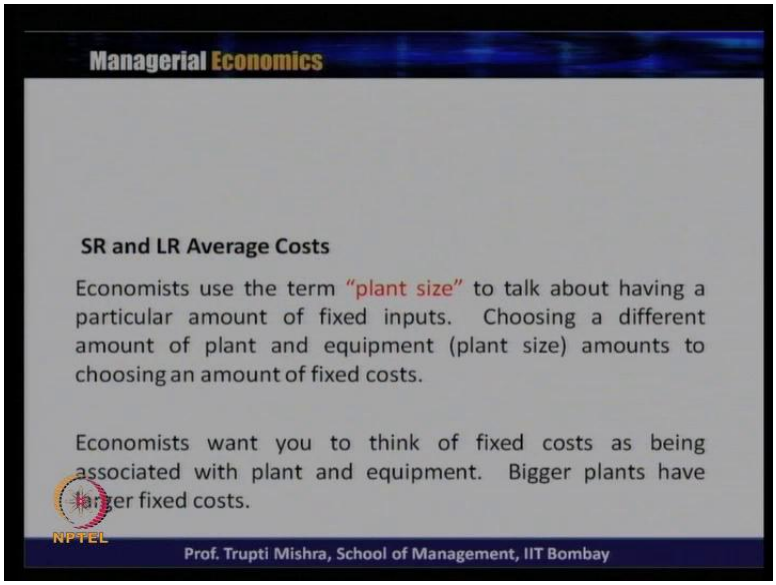

When it comes to the economies analysis of the short-run and long-run how they are related to each other. Economists specifically use the term "plant size" to talk about having a particular amount of fixed input. So, choosing a different amount of plant, equipment; that is plant size amount to choosing an amount of fixed cost. So, if the amount if you look at choosing a different amount of plant and equipment if it is a large plant, obviously large amount of fixed input is required.

If it is a small plant, then it is a small may be the less amounts of inputs is required and that correspondingly has some amount; in fact that correspondingly lead to the amount of the fixed cost. So if it is a large plant, there is large fixed cost. If it is a small plant, that is a small fixed cost and since they use the term plant size; so if the plant size is large, fixed

cost is more and it is in a different short-run cost curve. If the plant size is less, then it is a less fixed cost and the plant size is again different.

So, generally that is the reason the plant size has a reference point for the short-run average cost curve with regards to the fixed input and with regards to the fixed cost. So, economists want you to think of fixed cost as being associated with the plant and equipment. Bigger plant has large fixed cost and vice versa, smaller plant has the less fixed cost. So it always the, may be when you are in thinking about the cost of production; the fixed cost and the variable cost of production, always the plant size is in the back of the mind that, what is the plant size because that is the direct impact on the fixed cost of the production at least the initial stages of production.

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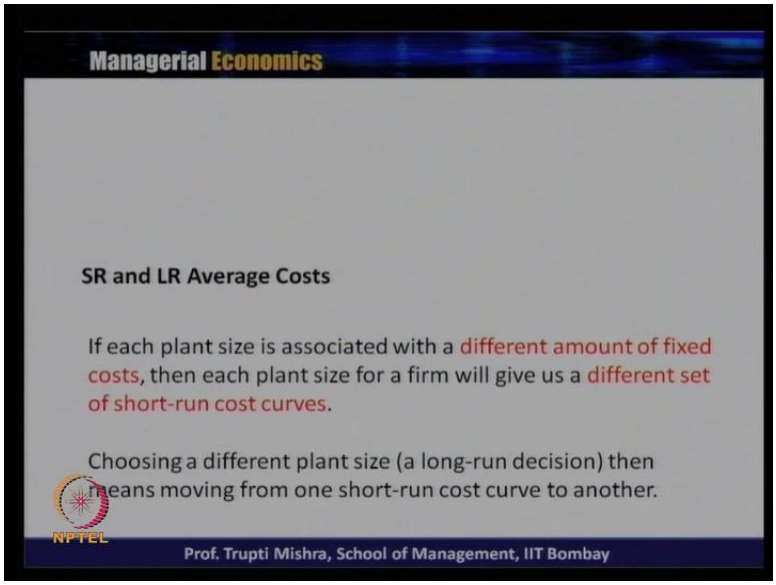

So, each plant is associated with a different amount of fixed cost. If it is a large plant, large fixed cost. If it is a small plant, they say there is less fixed cost. So each plant size is associated with a different amount of fixed cost, then each plant size for a firm will give a different short-run cost curve.

So, if you look at in the previous graph also we are explaining the short-run total cost curve one, two, three, how they differ from each other. They differ from one; they differ from each other on the basis of output. And second, they differ from each other on the basis of the cost. So obviously if the output level is higher, then the fixed unit is higher and also the variable input is higher; and if it is a small then the fixed and variable cost

will also differ. So, in this case STC1, STC2, STC3, they show three different level of output and also different level of cost.

So, each plant size is associated with a different amount of fixed cost and each plant size of a firm will give us a different state of short-run cost curve. Choosing a different plant size that is a long-run decision then means moving from one short-run cost curve to another or to simplify this, when you are moving the output level or when you are trying to increase the output level from one level to another level. Basically it is a transition from one short-run cost curve which is at the lower level of output to another short-run cost curve which is a higher level of output.

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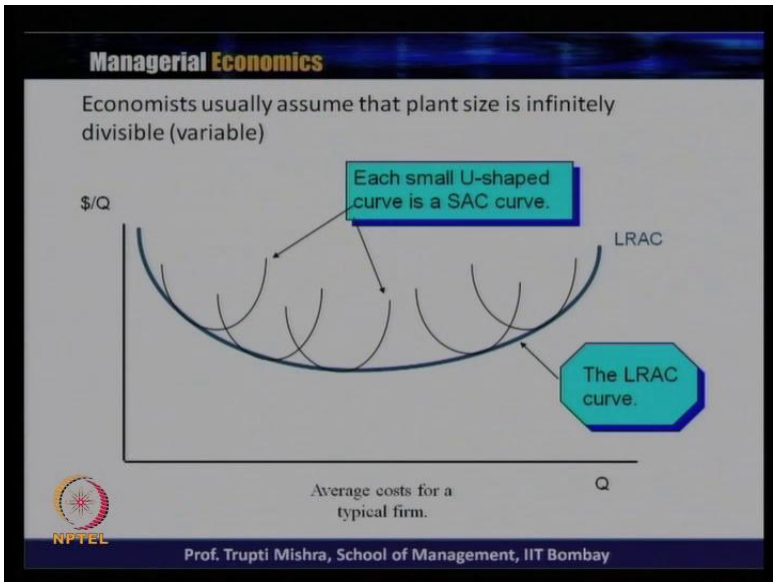

So, this is the typical example of the long-run average cost curve and economist usually assume that the plants are size is infinitely divisible, that is variable and each small U-shaped curve is the short-run average cost curve and this is the long-run average cost curve. In the x-axis we are taking the average cost for a firm; where x-axis we are taking the average cost of the firm and the y axis we are taking the level of output.

So, long-run average cost curve is the summation of each small U-shaped short-run average cost curve which is different from each other in two aspect; in term of variable and in term of the different output and in term of the cost associated with that level of output.

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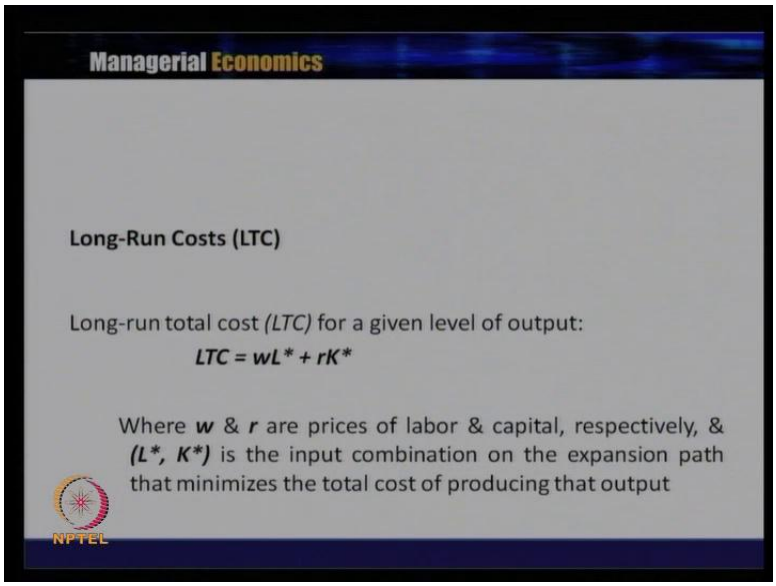

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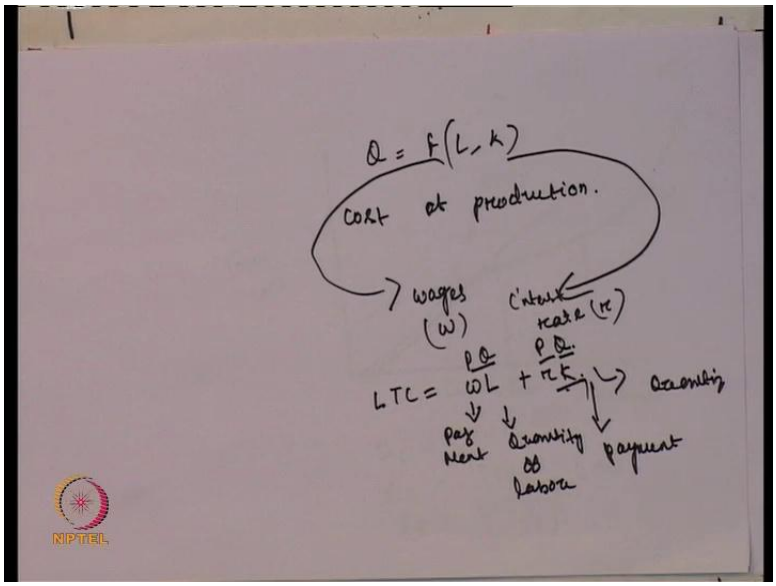

Then when it comes to formulizing the long-runs total cost curve, till the time we are assuming that the long-run total cost curve or the cost curve altogether is Q is a function of labor and capital. When it comes to cost of production, what is the expense the firm they are incurring when they are producing a product. So, the major expenses come from the input to produce the product that is labor and capital. So, labor is the payment whatever we make to use labor as the input of production that is wages and k whatever the payment we are spending on k that is comes as the interest rate.

So, if you take w as the wages, r is the interest rate, then long-run total cost is wL plus rk; w is the payment for using labor, L is the quantity of labor input, r is the payment for using capital, k is the quantity of capital input. So, w is the payment for labor, L is the quantity of labor. So this is price, this is quantity. Again this is price, this is quantity. So, this is the quantity of labor input, this is price of labor input and long-run total cost is equal to whatever the payment or whatever the cost of expenses what the firm is incurring on the two different level of output.

So, long-run total cost curve is wL plus rk, where w and r are as the price of labor and capital respectively, and L and k is the input combination the expansion path that minimize the total cost of producing output. Why we take the input combination on expansion path. Because that give us the optimal production with a minimum cost of production and that is the reason we take the input combination the expansion path because that gives us the optimal output keeping the cost constant in the background.

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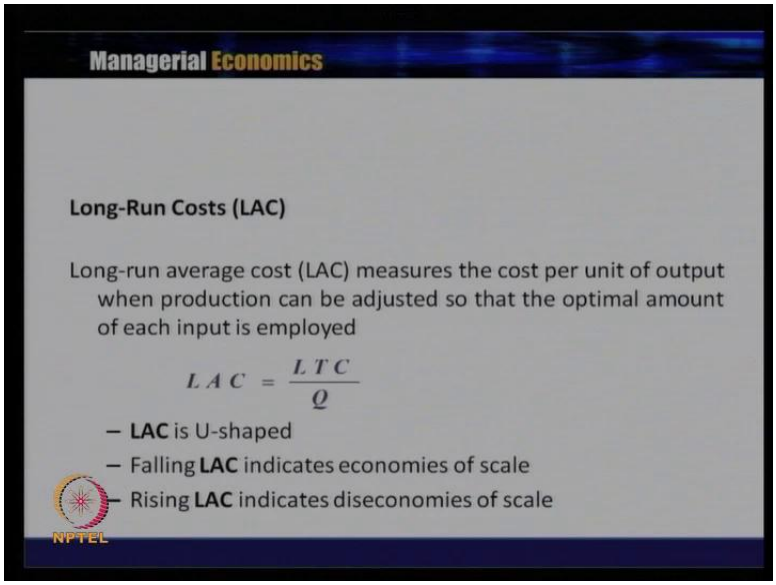

Then how to measure the long-run average cost curve or algebraically how we can find out the long-run average cost curve. It measures the cost per unit of output when production can be adjusted so that optimal output of each input is employed. So, long-run average cost curve measure the cost per unit of output when production can be adjusted so that optimal amount of each input is employed. So, long-run average cost curve is long-run total cost curve divided by the Q. So, Q is the unit of output.

Long-run average cost curve is U-shaped. Decrease in long-run average cost curve indicates economies of scale and increasing long-run average cost curve indicates the diseconomies of scale. We will discuss more on the economies of scale and diseconomies of scale at a later point of time specifically what are the economies of scale, different type of economies of scale, and what are the different type of diseconomies of scale, how economies of scale leads to decrease in the cost of production, and how diseconomies of scale leads to increase in the cost of production.

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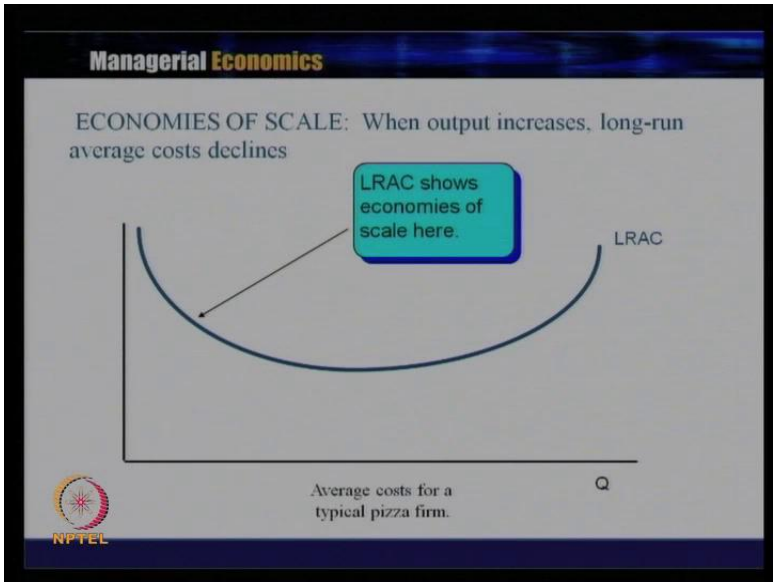

So, economies of scale basically what is the meaning of economies of scale. When output increases, long-run average cost curve decreases and that is the reason the long-run average cost curve is decreasing at the initial stage and that is because of economies of scale.

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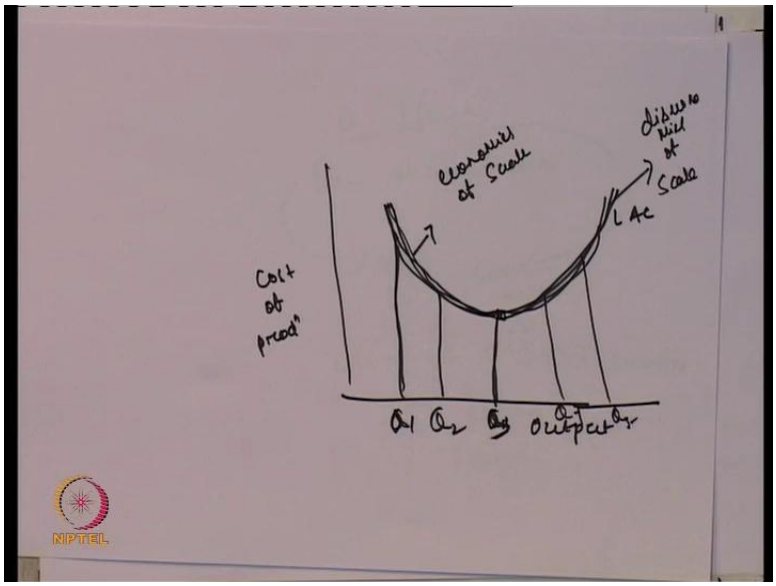

So, if it is a case of U-shaped long-run average cost curve, then at the initial stages when it is decreasing; if you take output here, cost of production here, then generally the long-run average cost curve is follow a U-shaped, where this because of economies of scale the decreasing part is economies of scale and the increasing part is diseconomies of scale. So, what are economies of scale? As you mention that when the output increases, so output is suppose Q1, output is Q2, output is Q3.

So Q1, Q2, Q3 at the different level of output, the cost of production decreases and when it is the minimum point; this is the minimum point. This can be called as the optimal output because this is the level of output. Beyond which if you are increasing the level of output, the cost of production increases; so up to this. This is the evidence of economies of scale and beyond this if still the output is increasing, the average cost per unit is increasing and that is the reason this is the evidence of the diseconomies of scale.

So, the decreasing part of long-run average cost curve is because of economies of scale; that is reduced cost of production, reduce average cost of production or may the per unit cost of production and when it is increasing, that is in term of increase in the cost of production or per unit cost of production beyond a certain level of output. The minimum point at the long-run average cost curve is generally known as the point of optimal output; that is the minimum cost that can be by incurring that, that is the maximum level of output what the firm can produce.

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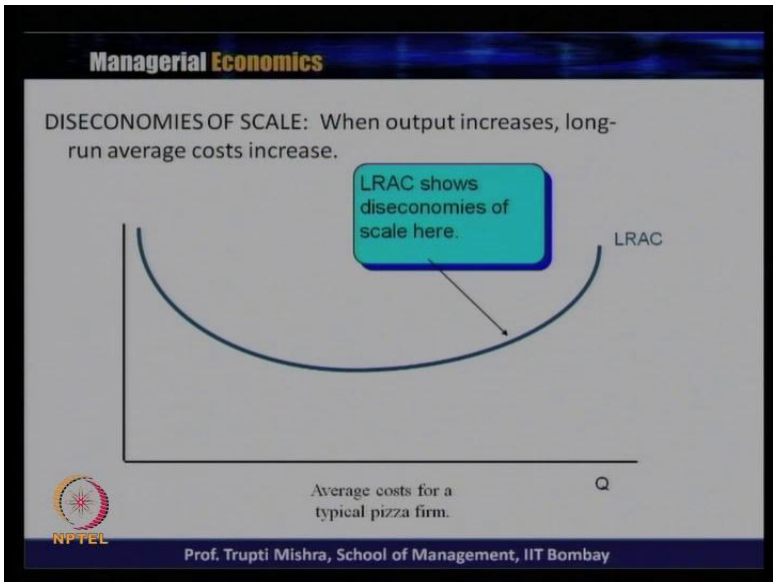

So, again this is the graphical example of diseconomies of scale and the meaning of diseconomies of scale is when output increases, long-run average cost increases and that is in the increasing phase of the long-run average cost curve.

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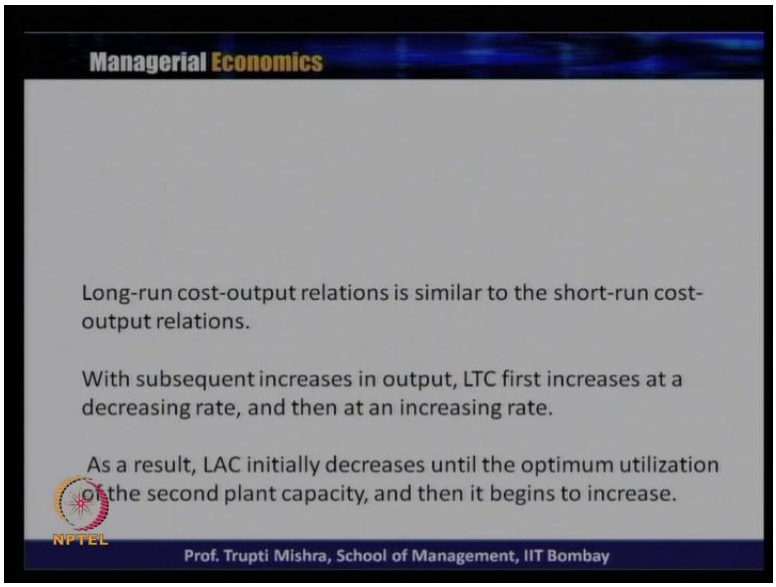

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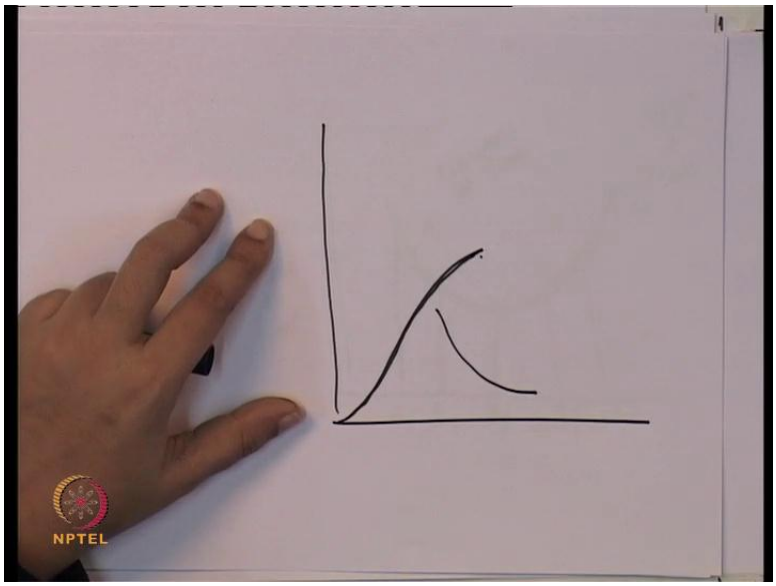

So, if you look at whether it is a short-run cost-output relation or in the long-run cost-output relation, the long-run cost-output is similar to the short-run cost-output relation. With subsequent increase in output, the long-run average total cost curve initially first increases if you look at it first increases and then it decreasing rate, and then at the increasing rate and as a result if you look at if it is the long-run average cost takes this shape that is the reason initially the average total cost or as long-run average cost curve is decreasing. So, with the subsequent increase in the output, long-runs total cost curve is first increases at the decreasing rate.

Then at increasing at the increasing rate and since long-run total cost curve is increasing at the decreasing rate initially, the long-run average cost curve also initially decreases and when long-run total cost curve is increasing at the increasing rate, then generally the long-run average cost curve also increases. Because average cost is nothing but derived directly from the total cost dividing by the number of unit of output. So, as a result when long-runs total cost curve is increasing at a decreasing rate, long-run average cost curve initially decreases until the optimum utilization of the second plant capacity and then it begins to decrease.

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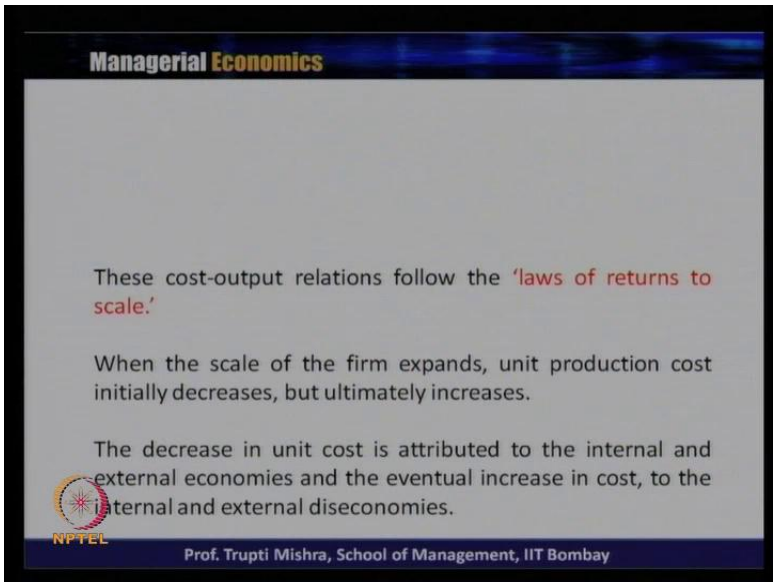

So, this cost-output relationship whether it is a specifically in case of a long-run, it follows a law of return to scale. So, you remember your return to scale that when input increases in a fixed proportion; if the output increases more than that, this is the case of increasing return to scale. If the output increases less than that this is the case of a decreasing return to scale. And if the output is increasing in the same proportion as the input increases, then this is the case of a constant return to scale. So, the cost-output relation in case of long-run it follows the 'law of return to scale'. When the scale of firm expands, the unit production cost initially decreases, but ultimately it increases.

So initially when the scale of output increases when the level of output increases, then the unit production cost is initially decreases but ultimately beyond a level beyond the minimum cost of production after that generally, the unit production cost is increasing. So, the decrease in the unit cost that is the average cost is attributed to the internal and external economies of scale. As we discussed just before couple of minutes, because economies of scale is the reduced the cost of production and so the decrease in the unit cost is attributed due to the economies of scale which is of two types; one is internal economies and another is the external economies and eventually when there is a increase in the cost that is because of the diseconomies; and diseconomies is again two types. That is internal and external diseconomies.

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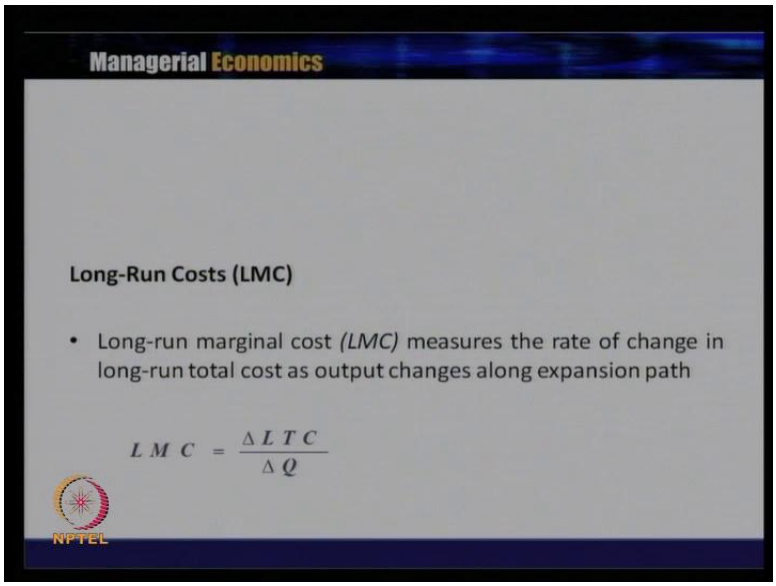

Then we will come to the long-run marginal cost and as you know marginal cost is nothing but the addition to the total cost when there is a production of one more unit of output. So, long-run marginal cost curve measures the rate of change in the long-run total cost as output changes along the expansion path. So, it is the rate of change in the long-run total cost as output changes along the expansion path. So, long-run marginal cost curve is the change in the long-run total cost curve; that is delta LTC divided by change in the quantity that is delta Q. So, LMC is the change in the LTC with respect to change in the Q or we can say this is the first order derivative of the total cost with respect to the Q.

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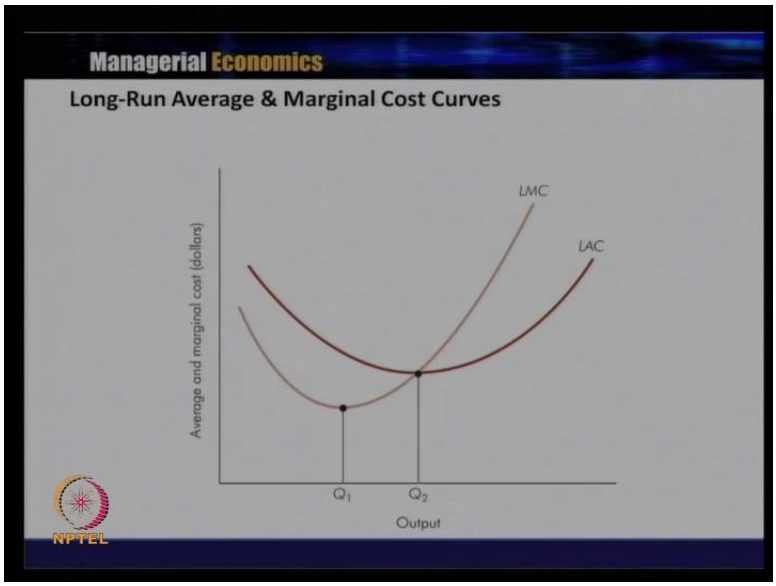

When you graph the long marginal cost curve and long-run average cost curve, both the costs are U-shaped. Initially it decreases with the increase in the output, but it increases when there is an increase in the output is more than that. The long-run marginal cost curve will always intersect long-run average cost curve at the minimum point. So at the minimum point of average cost curve, the long-run marginal cost is equal to the long-run average cost curve.

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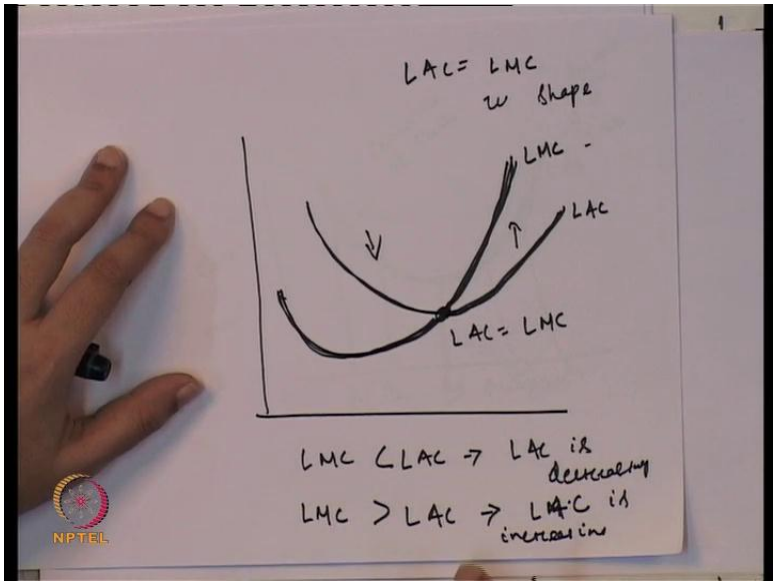

So, if you look at the relationship between the long-run marginal cost curve and long-run average cost curve, the first evidence comes here is that when long-run average cost curve is minimum at this point, the long-run average cost curve is equal to the long-run marginal cost curve. So, long marginal cost curve is U-shaped. The long-run marginal cost curve is below the average cost curve. LMC is less than LAC, when LAC is decreasing and long-run marginal cost curve is greater than long-run average cost curve, when long-run average cost curve is increasing; that is in this segment and corresponding to this, the long-run average cost curve is equal to the long-run marginal cost curve.

So, long-run marginal cost curve is below long-run average cost curve when it is decreasing and long-run marginal cost curve is above long-run average cost curve when it is increasing. At this point the long-run average cost curve is equal to the long-run marginal cost. Apart from this two more facts that both the curve that is LMC and LAC both of the both the curves they are U-shaped and always the LMC intersect LAC at the minimum point of the long-run average cost curve.

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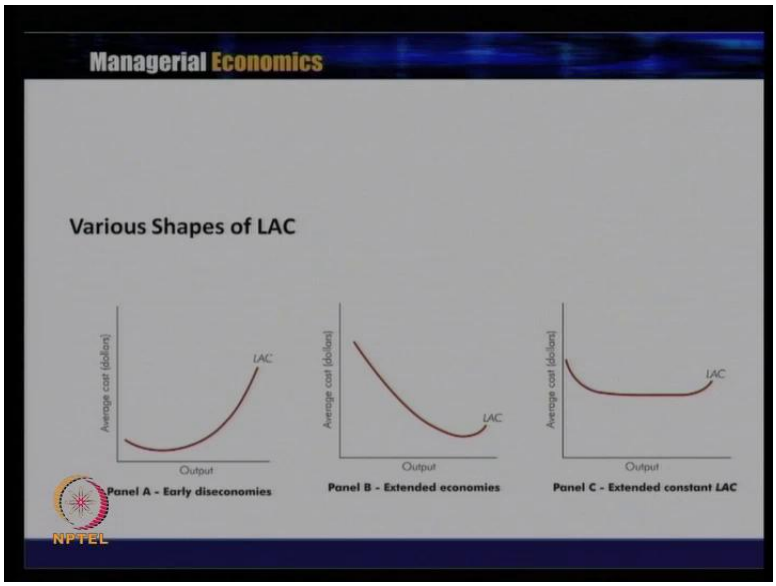

Then we will discuss about may be few more types of long-run average cost curve, which generally not follow a regular shape of the long-run average cost curve; that is U-shape and then we will find out what is the reason behind not following a specific shape or regular shape of the long-run average cost curve. So, if you look at the graph, initially in the first graph you are taking the average cost in the left axis and output in the right

axis; that is x-axis and if you look at, it is a case of early diseconomies because the long-run average cost curve is increasing much before reaching the minimum cost or much before reaching the midpoint of the curve.

So, this is the evidence of early diseconomies and what is the implication of early diseconomies. The input increases at the higher cost of production or when the firm expanding its production; when the firm is increasing the scale of production. Generally the input or generally the cost of production is increasing. So if it is the case of the general trend, then in this case generally it initially decreases but first decreases. But in case of early diseconomies what it has happened; that the cost of production has reduced much before the optimal point or much before the minimum point

Then if you look at the second graph that is extended economies; in this case, the minimum point or the decreasing portion is the decreasing portion of cost of production is more than the normal level or the regular level, and this is the evidence of the extended economy. The extended economies means, the reduce cost of production is enjoyed to a larger extend by the firm. So, economies of scale are reduced cost of production when the scale of output increases. But in this case of specifically in the case of the second graph the economies of scale has been enjoyed by the firm to a larger extend and that is the reason this is the case of the extended economies of scale.

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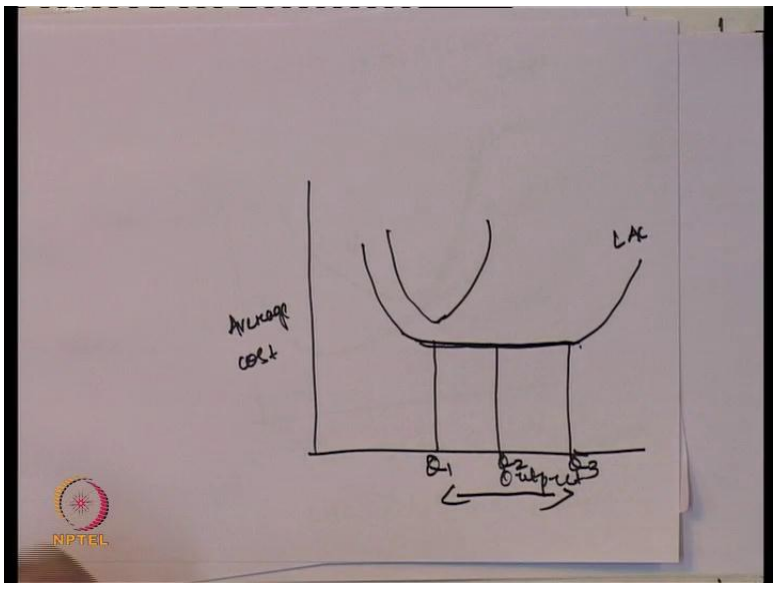

If you look at the third graph, it is the case of the extended constant LAC and what is this extended constant LAC. This is interesting to look that the minimum cost of is not a point rather it is in a segment. So, this output level, this output level, this output level. Suppose this is Q1, this is Q2, this is Q3. This is long-run average cost curve and if you look at the economies of scale has been achieved from this point, because the cost of production is decreasing. But this should be the minimum point and ideally after this point again, it should follow an increasing trend if it is a case of the long-run average cost curve of the normal shape of the long-run average cost curve. But if you look at the minimum point is extended over a range of production, which implies that at the minimum cost at the same level of cost the firm has moved from Q1 unit of output and Q3 unit of output.

Generally when you look for the evidence of this type of average cost in the real world maybe it is difficult to find. But it is possibility that sometime if it is a batch production and the same level of cost of production is used for a specific batch of production. So, initially when the cost of production is decrease or the cost of production is incur for a specific level of output; generally at the same level of output in case of batch of production, the possibility is there that you get a constant long-run average cost curve. Otherwise finding evidence for this type of constant output relationship is difficult when you take this example to the real world scenario.

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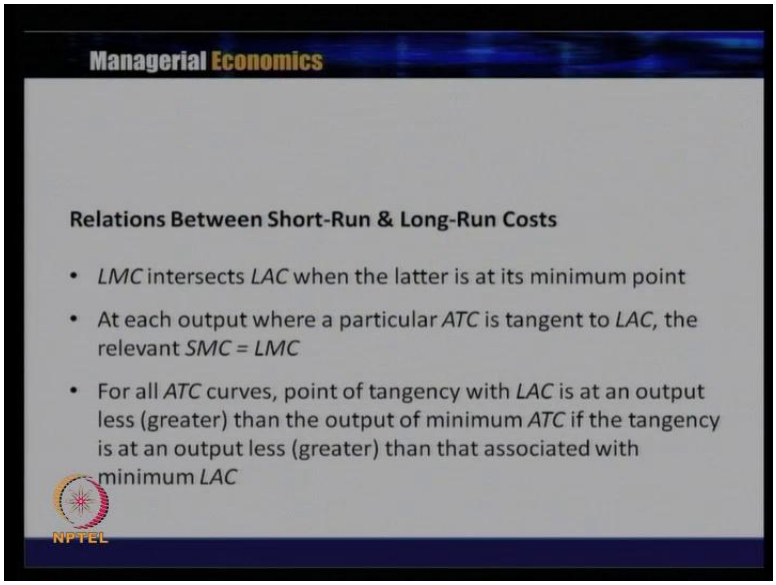

So, when it comes to the relationship between the short-run and long-run cost curve again, the long-run marginal cost curve intersect LAC when latter is at the minimum point. At each output where particular to ATC is tangent to LAC the relevant SMC is equal to LMC, and we will examine this relationship again with the help of the long-run average cost curve; how it becomes a series of long-run average cost curve and then how they both of them they are related to each other.

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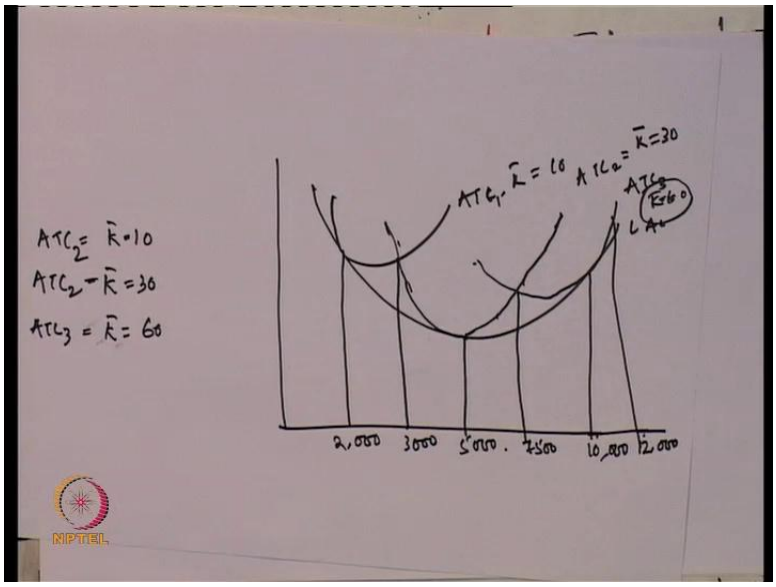

This is a ATC 2 where k is equal to capital is fixed at 3, because this is a case of short-run and this is average total cost curve 3, where k is equal to 60. So, if you look at what is the difference between ATC 1, ATC 2 and ATC 3. It is three different short-run cost curves. In case of average total cost this is short-run. Capital is fixed at 10 in case of average total cost curve in case of 2; that is capital is fixed at 30 and in case of average total cost curve 3, the capital is fixed at 60.

So, this is 2000. Suppose this is 2000 then this is 5000, may be this can be called as the optimal level of output. This is 3000, this is 7500, this is 10000, and this is 12000. So, if you look at if it is the output level 2000, there is no much choice left for the firm to; only they have to operate at the short-run cost curve by capital as 10. When the output level is 3000, either it can be produced through average total cost curve 2 by using capital as 30 or through average total cost curve 1 that is using capital at 10.

But if the firm is still interested to expand for them, it is always better to operate at the decreasing portion of the cost curve and that is the reason that when 3000 unit of level of output is produced, it is desirable for the firm to operate at a higher capital input mix because with that the firm can still expand up to the point 7500. But if it is a case of means the firm is no more interested to expand the output, for them it is always preferable to operate at the short-run cost curve ATC 1 where k star is equal to 10 because the capital requirement is less.

Similarly if you look at the output level 5000, this is the optimal level of output because this is produced with the minimum cost of production. Similarly if we look at the output level 7500, this can be produced either by using short-run cost curve 3; that is ATC 3 or maybe the short-run cost curve 2; that is ATC 2. If it is produced with the help of ATC 2, it is lying at the increasing cost portion of the average total cost curve and if it is produced through ATC 3, then it can be produced through the decreasing portion of the short-run cost curve.

So if the firm still interested to expand, they can always pick up the short-run cost curve 3. But if they want to just stop here, they are no more interested to invest more in this capital and they will choose a combination that is average total cost curve 2. So it is always the individual firm decision that, whether for that level of output whether they will take a short-run cost curve where the capital requirement is more, or they will take a short-run cost curve where capital requirement is less. If this is the point beyond which they are not going to expand the output, they will always prefer a short-run cost curve where the capital combination is or the capital input combination is less.

But if there is still scope to increase the output or still they prefer to increase the scale of production, they will always pick up a short-run cost curve which is at a higher capital requirement or higher capital input requirement because that still did the scope. When they further increase the scale of production where or whether they further increase the output; because with the same level of capital, just changing the variable cost, still they can increase the output level.

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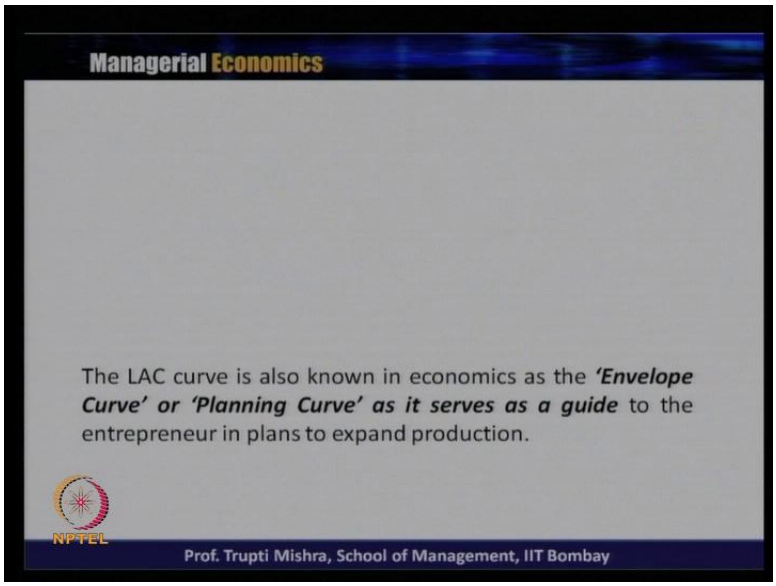

So, this is how the short-run and long-run average cost curve they are related. But this long-run average cost curve is also known as the 'planning curve' or the 'envelope curve' because it serve as a guide to the entrepreneur in plan to expand the production, and this is called as the envelope curve because in the long-run average cost curve is basically envelopes the different short-run cost curve.

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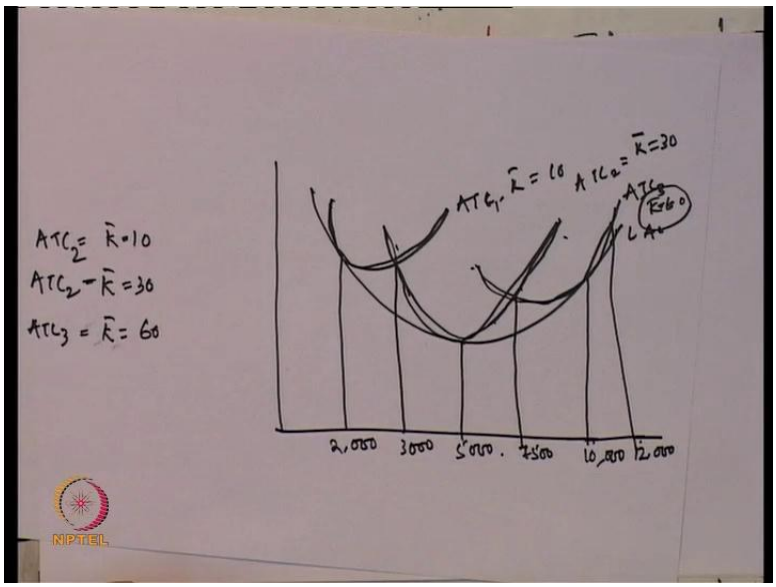

Like if you look at the graph also, this long-run average cost curve generally it envelopes the short-run average cost curve 1, short-run average cost curve 2 or short-run average

cost curve 3. So in this case it generally known as an envelope curve, because it takes the different scenario of short-run cost curve and put them as a longer planning horizon. So if this is the capital, this is the input, this should be the level of output or up to this level of output, this short-run cost curve is can be used or in reference case, we can say this is the capital input combination can be used to produce this level of output.

And this is known as the planning curve because since it gives a scenario of different capital input combination, this is different short-run cost curves and that helps the entrepreneur; that helps the firm to identify the capital input combination at the different level of output on what is the cost associated with that, or may be sometimes it helps in the planning the efficient cost analysis when at the different level of the output, and that is the reason it is known as the envelope curve and it is also known as the planning curve; this long-run average cost curve.

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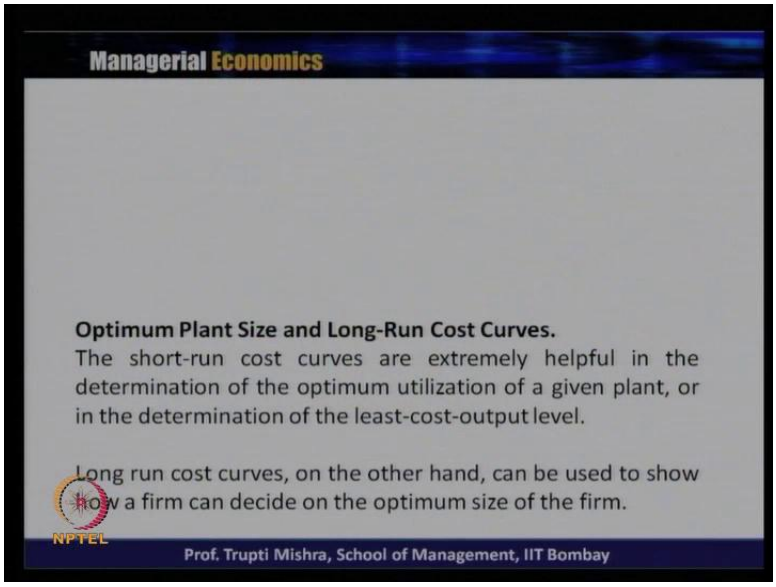

Then we will come to the discussion of optimum plant size, how it can be achieved in case of case of a long-run cost curve. The short-run cost curves are helpful in the determination of optimum utilization of a given plant. The given plants size is 500 units. The short-run cost curve will help you in identifying what is the optimum utilization of a given plant, what is the right input makes when there is a fixed input and the output can be changed only by the variable input. Generally the short-run is helpful in the determination of the optimum utilization.

If it is a case of a given plant or in the other hand we can say that they helps the firm, they helps the business for determining the least-cost-output level; means what is the optimal output which can be produced with the lowest cost of production. However when it comes to long-run cost analysis, long-run cost curve on the other hand can be used to show how a firm can decide on the optimum size of the firm. So, in the first case we talk about the optimum utilization of the given plant. But in case of long-run, we generally use this long-run cost curve to decide what is the optimum plant size; means how best it can be achieved with the same level of the plant size or what should be the optimum capacity used on the basis of the input requirement, on the basis of the output level.

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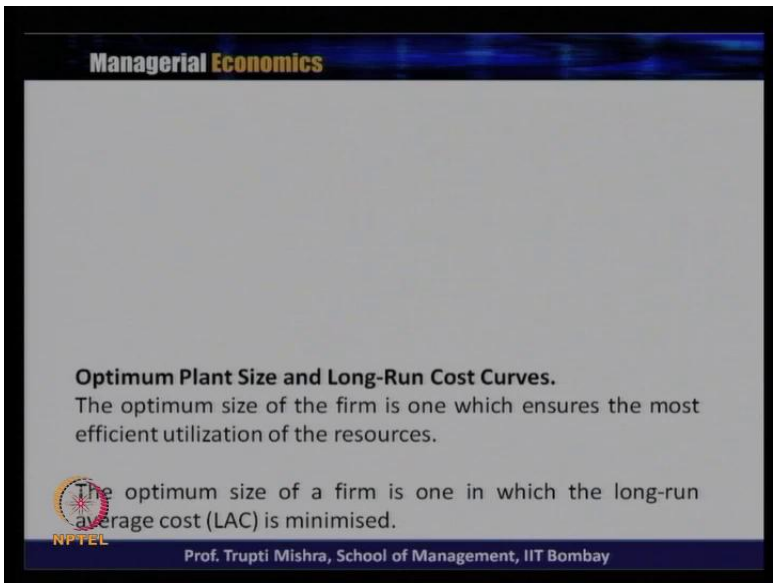

So, which one is the optimum size of the firm or how to decide the optimum size of the firm. The optimum size of the firm is one which ensures the most efficient utilization of the resources. So, the optimum size of the firm is one in which long-run average cost curve is minimal. So, how to define an optimum size of a firm? The optimum size of the firm is one which ensures the most efficient utilization of the resources and the optimum size of the firm is also one in term of the long-run average cost curve, when the long-run average cost curve is minimized.

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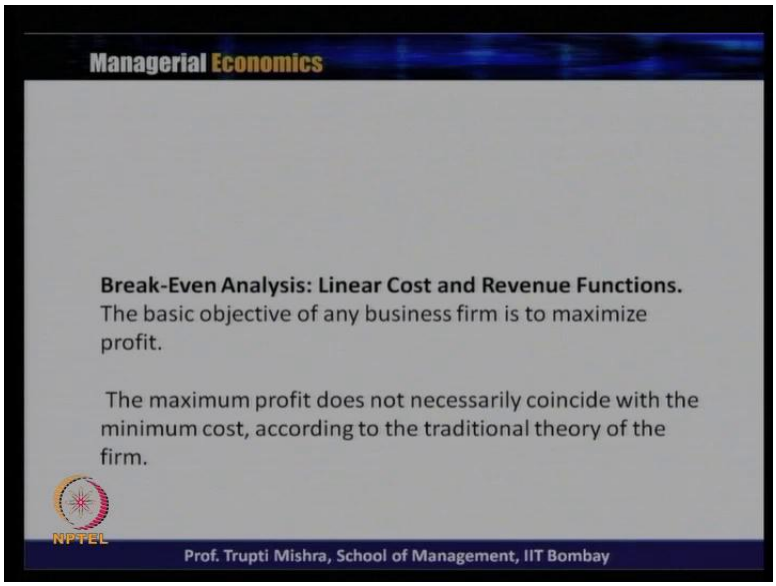

So, that will analyze this optimum plant size with the help of the break-even analysis maybe that is through revenue analysis; that is through profit analysis; that is through cost analysis. But in general when it comes to the optimum output, the optimum size of a firm in the long-run; this is always the point at which the long-run average cost curve is minimized. So then we will introduce the break-even analysis, specifically in case of linear cost and revenue function and then we will analyze in case of non-linear cost and revenue function.

So, the basic objective of any business firm is to maximize the profit. So if you look at any economic agent, if their optimization problem it is related to either for the maximization of profit or for minimization of cost. So, the basic objective of any business firm is to maximize the profit, but it is not that the maximum profit always coincides with the minimum cost. If it is maximum profit coincide with the minimum cost that is the optimal level of output or that is the optimum operational level for the firm.

So even if the optimization problem is to maximize the profit, it is not that always the maximum profit coincides with the minimum amount of the cost and if you look at go back to any traditional theory of firm in economic analysis, they say that maximum profit can be achieved with a minimum cost. But when you take this example to a real world scenario, it is not that every time the maximum profit coincide with the minimum cost

and that is the difference; points over here is that maximum profit can be achieved also not at the minimum point of the cost of the production.

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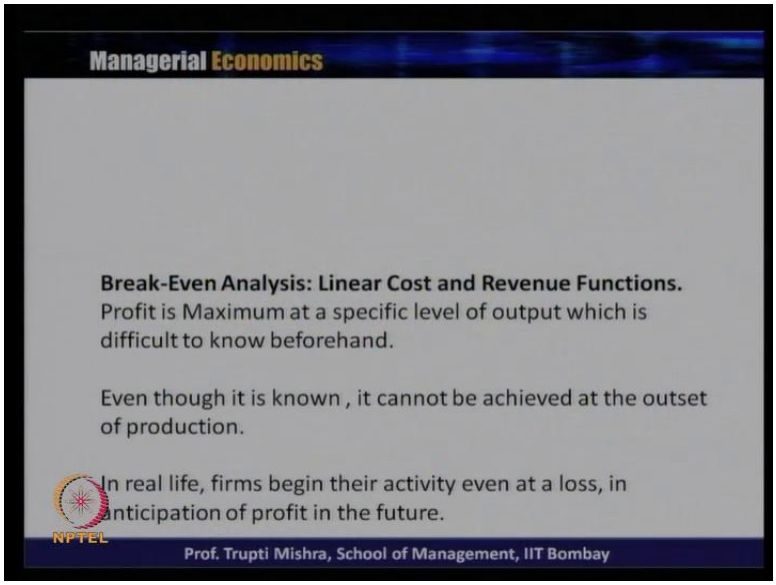

Profit is Maximum at a specific level of output which is difficult to know beforehand. So, which level of output where profit is maximum it is difficult to know at least in the beforehand; because it is not that before production start or before production level, it is easy to know at which level of output profit is maximum and in case if it is known, it cannot be achieved when the production operation is on. So first difficulty comes here is, it is difficult to know which one is the specific level of output where profit is maximum. Second, the second difficulty comes even though you know at which level the output is leads to maximum amount of profit it cannot be achieved at the outset of the production.

So in real life, firms begin their activity even at loss, in the anticipation of profit in the future. So when someone starts business, it is not that at the day one they get the profit. So initially there is a threshold time, where the firm begins the activity. They continue the activity even if it is a loss, and why they continue the activity even if they are incurring a loss; because there is a anticipation that they will get profit in the future. So, the production level is not known generally. If it is known also, it is difficult to achieve the production level where profit is maximum and there is one more dynamics here also in the firms behavior is that, the business activities continues even if there is loss because there is a anticipation of profit.

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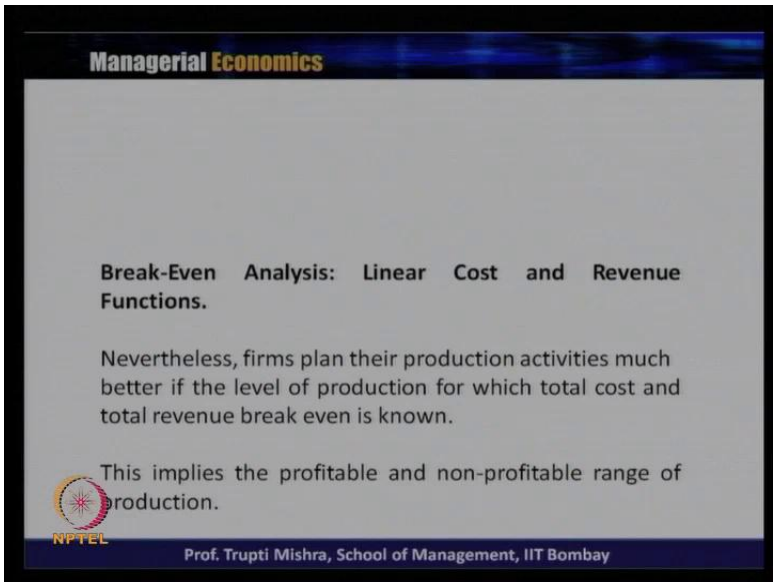

Nevertheless, the firm plan their production activity is much better way if the level of production for which total cost and total revenue break even is known. So, even if all these uncertainties are there, still firm plan their production activity much better if the level of production for which total cost and total revenue break even is known. This implies if the firm knows the profitable and non-profitable range of production. So, the relationship between the total cost and total revenue at different stages of output that gives us, which one is the profitable level of profit range to operate for the firm, and which one is the non-profitable range to operate for the firm.

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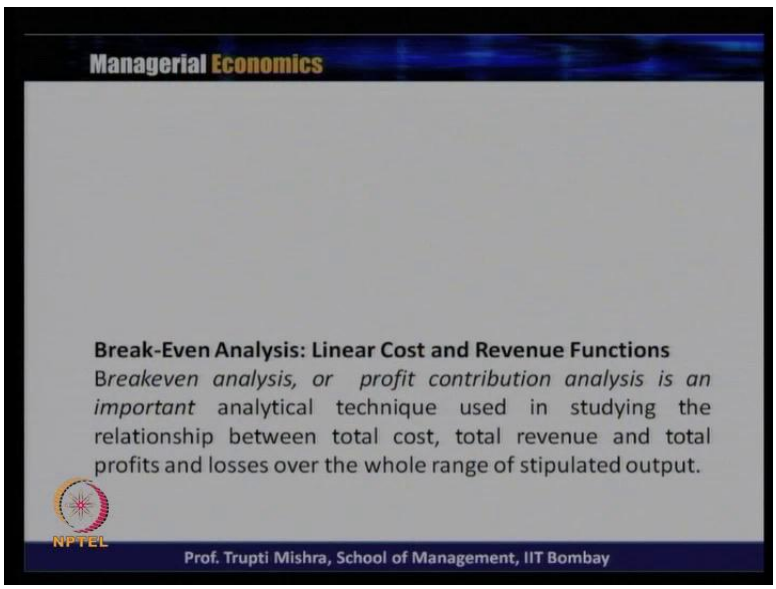

So, that we will see through the breakeven analysis or it is also called as the profit contribution analysis. This is an important analytical used in studying the relationship between the total cost, total revenue and total profit or losses over the whole range of stipulated output. So, break even analysis or else known as the profit contribution analysis is a technique through which we study the relationship between the total revenue, total cost, profit and loss over a stipulated level of output, because there is a certain level of output and with a certain level of output, we can study the relationship between revenue, cost, profit and the loss, and the technique through which we study the relationship between all these four variables that is generally known as the breakeven analysis or profit contribution analysis

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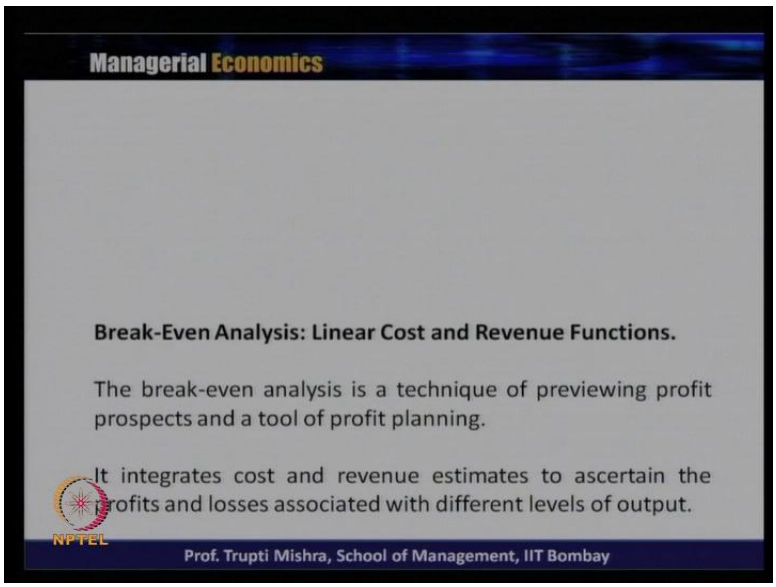

So the breakeven analysis, it is a technique of previewing the profit prospect and the tool for profit planning. It integrates the cost and revenue estimate to ascertain the profit and loss associated with the different level of output. So, it is a technique that previews the profit prospect and tool of profit planning. Because when you know the relationship between profit total revenue, cost, loss over a period of time that helps the producer to plan for the profit planning for at what level they have to operate, and it generally integrates the cost and revenue function in order to study the profit and loss.

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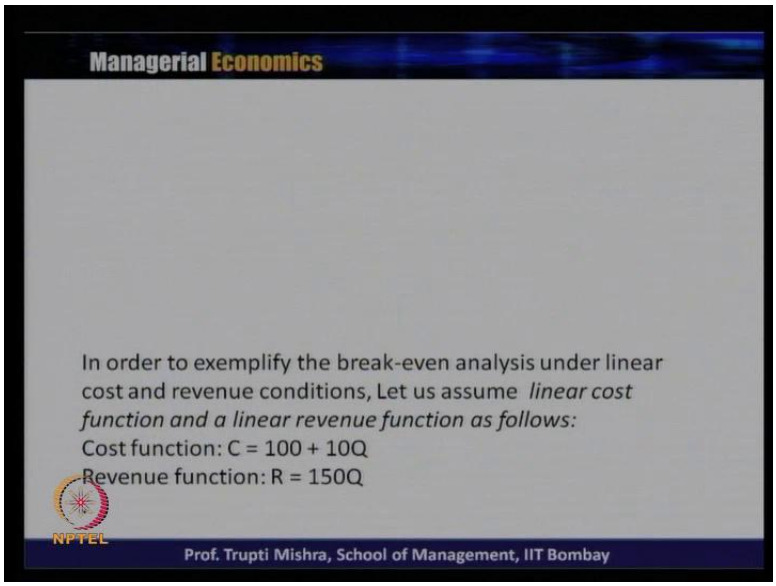

So to understand this breakeven analysis more, we will just take an example of a numerical function to understand how this cost and profit they are related.

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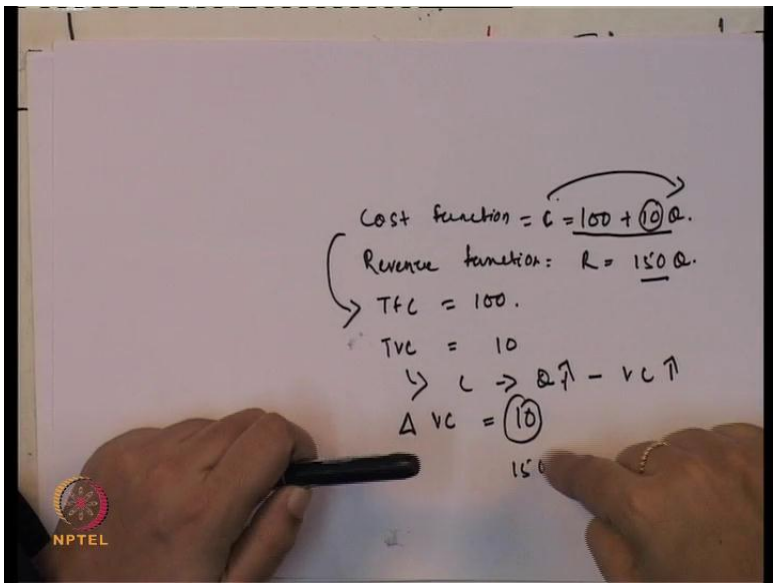

We will take a linear cost and linear revenue, and let us assume that the cost function is c which is equal to 100 plus 10Q, and revenue function is R which is equal to 150Q. Now if you look at what is the typically in the case of total fixed cost. Here this is the total cost function 100 plus 10 Q. What is the fixed factor over here in case of the cost function? The fixed cost is equal to 100 and what is the total variable cost. The variable

cost varies at a constant of 10 because the c will change with the respect to Q. This happens in case of variable cost because fixed cost in constant at 100.

Whenever there is a change in the output that will lead to change in the variable cost and the variable cost will change by which change at ten times, because this is the rate at which the variable cost is changing. So, the total fixed cost is 100. Variable cost is increasing at a constant rate of 10 per unit in response to increase in the output, and the revenue function implies that the market price for product is 150 and when it comes to the per unit sale. This is equivalent to this is equivalent to 150Q. So, this implies that the market price for firm product is 150 per unit of sale.

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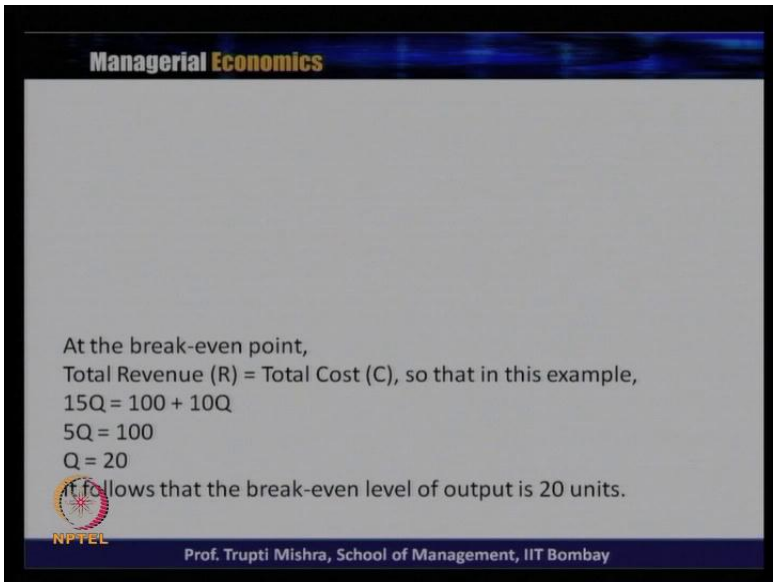

So, when you identify the break even points. So looking at this, how we should identify the breakeven point.

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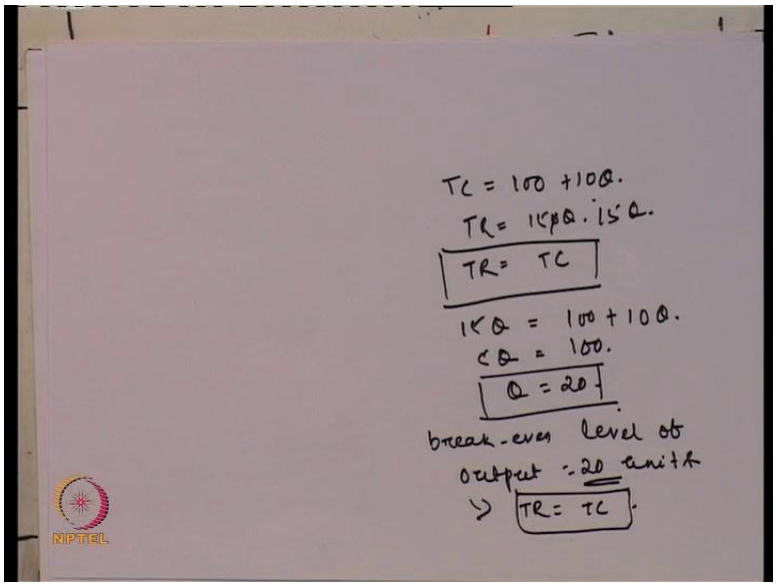

We have known as the total cost that is 100 plus 10Q and we know the total revenue that is 150Q. So, total revenue should be equal to total cost. So, this is actually 15; this is if you take this as 15 Q, then at the breakeven level total revenue has to be equal to the total cost. So, in this example if we look at this total revenue is 15Q, which is equal to 100 plus 10Q and if you simplify this that this is 5Q is equal to 100; Q is equal to 20.

So this Q is equal to 20, what is the implication for this? It follows that the breakeven analysis or the breakeven level of output is equal to 20 units. So, these 20 units is what; 20 units can be achieved at total revenue is equal to total cost. So, breakeven achieved at a point when total revenue is equal to total cost and break even output level is 20 units, because this is achieved through the equalization of the breakeven condition; that is total revenue is equal to total cost

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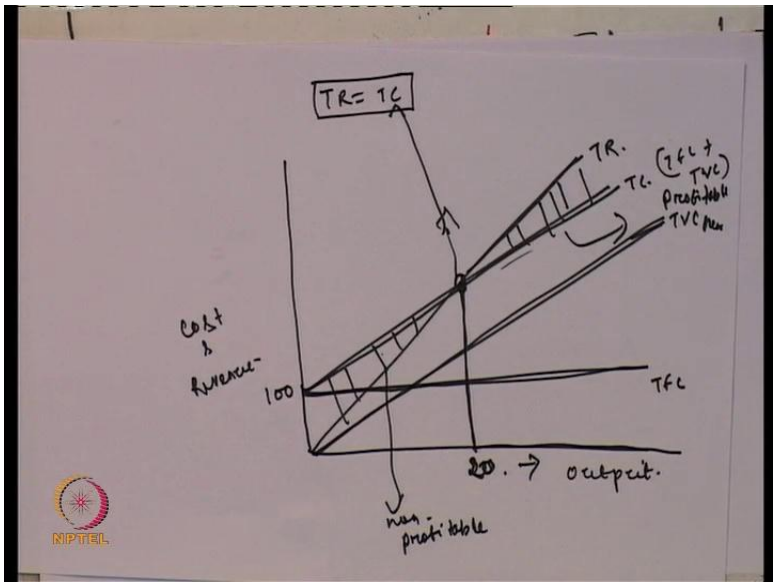

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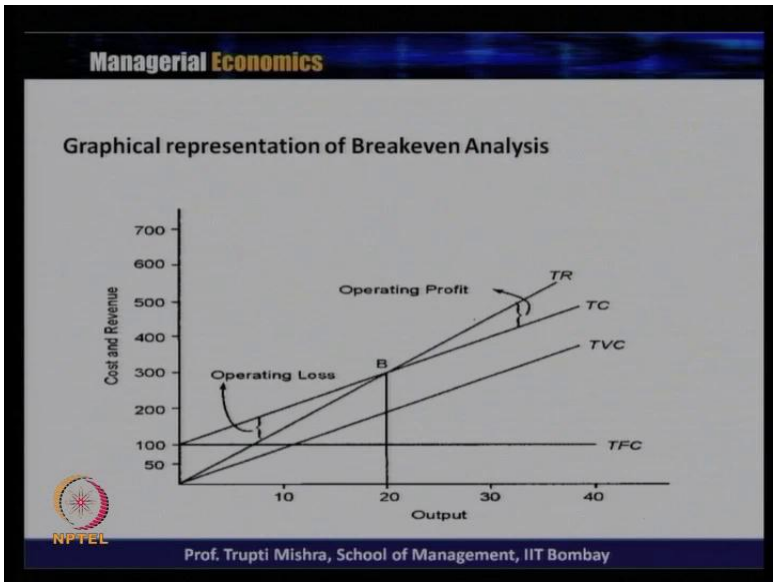

Now when you look at the graphical analysis of this, look at the total revenue, total cost, total variable cost, total fixed cost. So output is in the x-axis, cost and revenue are in the y-axis. So this is the total revenue, this is the total fixed cost, this is the total cost, and this is the total variable cost. This is 100 and this is 20. Now to understand this relationship or the breakeven analysis with the help of the graphical representation what is the breakeven condition? The breakeven condition is total revenue is equal to total cost.

So this is the total revenue which starts from origin because any level beyond 0 level of output, the firm is incurring the total revenue. Total fixed cost is fixed at 100. Total variable cost starts from origin, whenever there is a Q, their corresponding variable cost is there. Total cost is summation of total fixed cost plus total variable cost. That is the reason it starts from 100. Because up to this, it is the total fixed cost plus the total variable cost. Now what is the breakeven point? Breakeven point corresponding to this is the total revenue is equal to the total cost.

So corresponding to this, we get the level of output as 20. Now assuming 100 as the fixed cost, the output will be 20. Breakeven output level will be 20, because at this point the total revenue is equal to the total cost. So, breakeven analysis generally tells us the relationship between the total revenue and total cost. Now what happens if it is the output level is below 20 or output level is more than 20. If it is below 20, the cost is more than the revenue; it is not profitable for the firm.

If it is the produce beyond 20, then the total revenue is greater than total cost. So, this is the profitable level of output. The firm is going to get profit if it is a higher level of output and that is the reason if you look at, this is known as the profitable range of output and this is known as the non-profit range of output. Because if the firm is operating at output beyond 20, the total revenue is more than total cost and if the firm is operating before 20, the total cost is more than total revenue. So, this is known as the non-profitable range of output and this is known as the profitable range of output.

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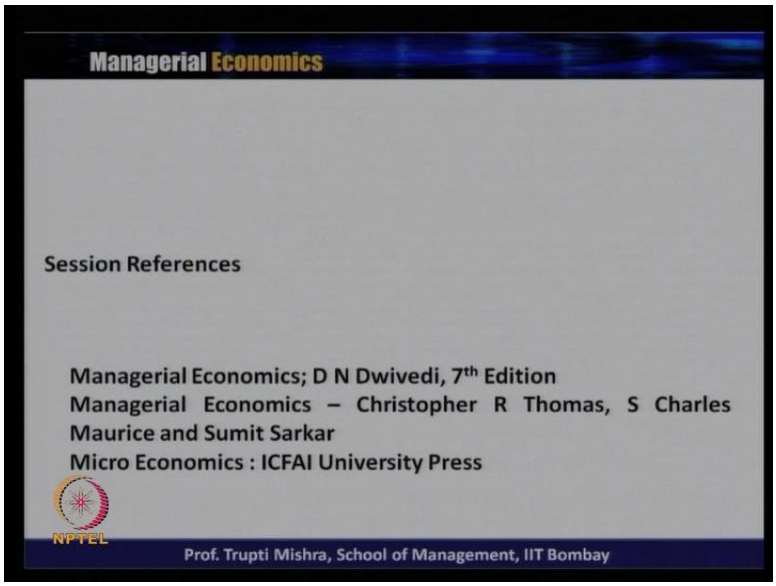

So, we will talk about the algebra behind this breakeven analysis, and how the breakeven analysis works before in case of non-linear cost function in the next session. So, these are the session references that is being followed exclusively for preparing this session.