Introduction to Market Structures
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Module 4: Monopoly
Lecture 15
Price Discrimination II

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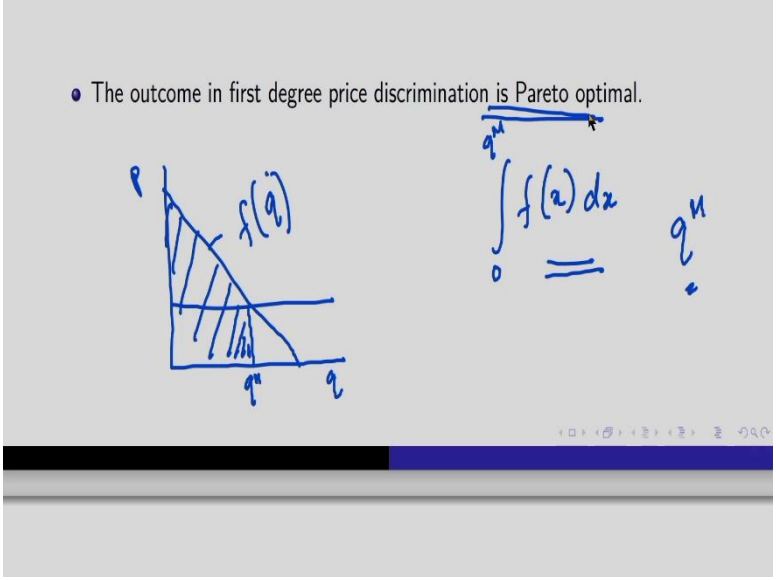

Hello, welcome to my course, Introduction to Market Structures. So, we were doing first degree price discrimination in a monopoly and we have seen that suppose here is the price, here is the quantity, and this is the demand curve. Suppose there are individuals are similar in terms of the demand curve, so the aggregate market demand curve is this and suppose the marginal cost is this, it is CRS then the monopoly is going to sell this much amount to each consumer and the price each consumer has to pay is this, right? this whole.

So, if this is the demand curve which is given, in this way then the price is from 0 to q m whole area under the demand curve. So, this is the amount- $\int_0^{q^M} f(x)dx$, they have to pay and each consumer will get this amount-q^M. And if there are "n" individuals so it will be "n" into this, okay? Now we will show that this is actually a pareto optimal situation, why?

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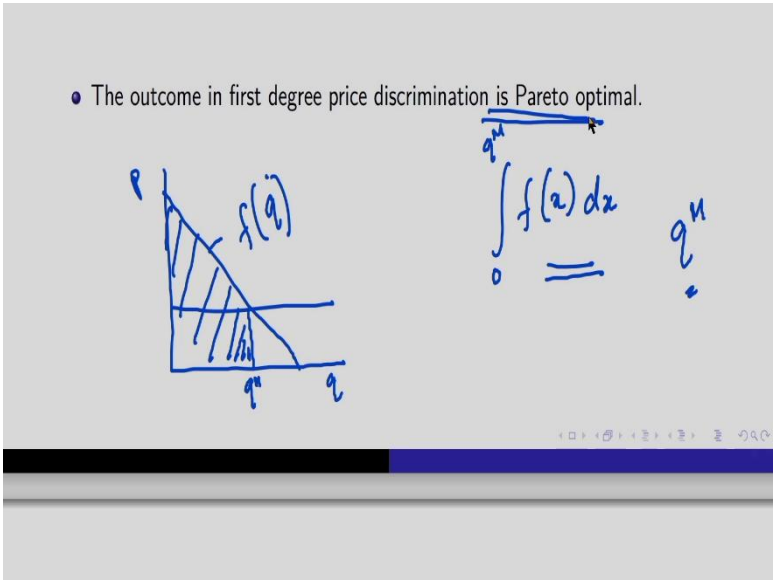

Say, take the case of a competitive outcome, in competitive market we know that, price is equal to marginal cost. So, the output produced is such that you have price is equal to marginal cost. So, suppose the demand curve is this and the marginal cost is this, then competitive outcome would be this, this much quantity because at this quantity price is equal to marginal cost. Although in a competitive market we have seen that we generally do not take CRS because the output is indeterminate in that.

But suppose it is a monopoly market and suppose the government regulates the price and they said that price should be equal to marginal cost so it is like this- P=MC. So, the output is this and at the same time this condition is also being satisfied. So, here, this is the output, monopolist is producing but now suppose the monopolist is not under any regulation and it can discriminate the price so it will charge the whole area under the demand curve as the price and the price is going to be 0 to q M, this- $\int_0^{q^M} f(x)dx$, right?

So, here it means if you look at this marginal, this is the marginal cost so this area under the marginal cost, so this green region, this is the total variable cost, fixed cost does not matter whatever be the level of the output so that is it. So, total surplus in this economy, in this market is this orange area.

And this whole surplus is now is going to the monopolist when they can do the first-degree price discrimination, okay. But the output produced is the competitive output so we know if we are here, if the output is this, then if we produce output more than this here, then we are making a net loss of this amount.

If we are producing less than the this amount here, then we are forgoing this much grey amount of surplus that is why it is not pareto optimal, we can produce a little bit more and we can generate this much surplus and if we are producing more than this, then actually we are making a loss of this pink amount, right?

So, that is why this output where price is equal to marginal cost is the pareto optimal thing, that output. And here we are not talking about the distribution of the surplus, in the competitive market this whole surplus would be going to the consumer but in a first-degree price discrimination this will be going to the monopolist so here monopolist is getting all the surplus, but if we want to make anyone better off here then what we will have to do, we have to give some surplus from the monopolist to the consumer so if we want to make the consumer better off then we have to hurt the monopolist.

So, that is why this situation where all the surplus is accruing to the monopolist is a pareto optimal situation because if we want to move from that to any situation where we want to make anyone better off, we will have to hurt someone else. So, if we want to make any consumer better off, we have to hurt the monopolist and if we want to make the monopolist better off, then we do not have any other option, okay. So, in this sense, this is a first-degree price discrimination is a pareto optimal situation.

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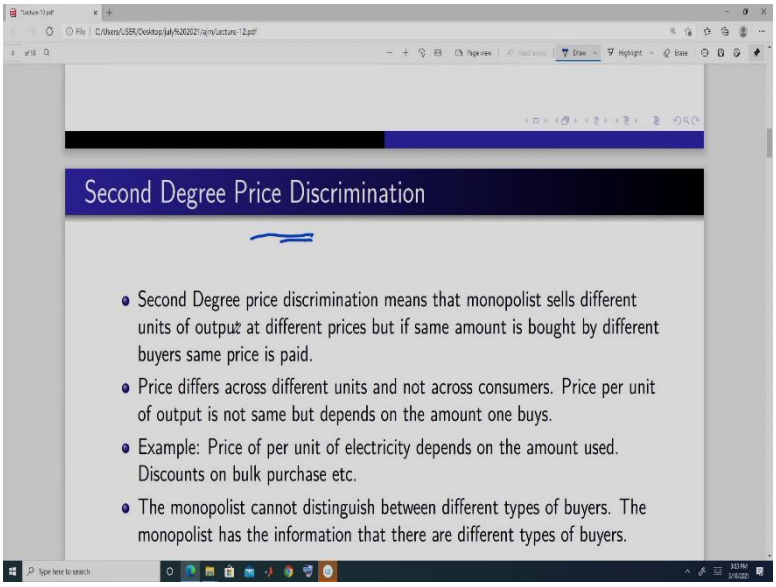

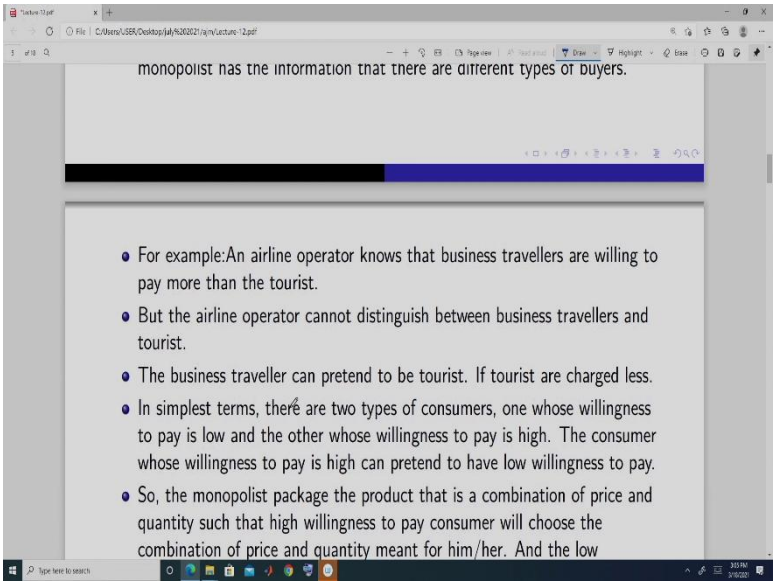

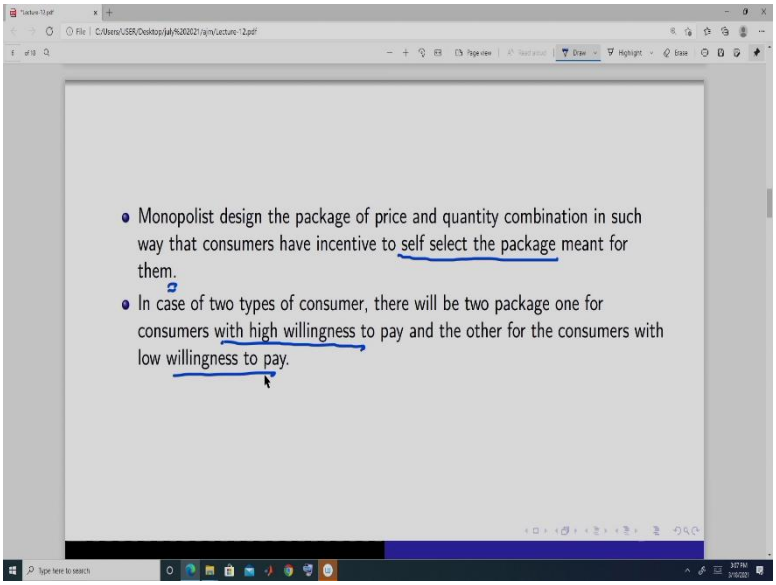

Next, we move to something called second degree price discrimination, in the first-degree price discrimination what we have seen is that the monopolist can distinguish between the consumers and also, they know the monopolist knows that who is whose consumer is of what type and so the monopolist is going to able to extract all the surplus from the consumers and it is very difficult to implement so it requires us a lot of information.

Now, in a second-degree price discrimination what we assume that the monopolist sells different units of output at different prices but if the same output is bought by different buyers' same price is paid.

So, it means the monopolist cannot distinguish between the consumers, it knows that there are different types of consumers or there are different varieties of consumers and when we

say different types of consumers or different varieties of consumers it means that the demand curve of these consumers are different.

It means that their willingness to pay is different from each unit of output and so we get different demand curve, so we have different types of consumers and monopolist knows that there are these two types or three types or four types of consumers but if a consumer comes to buy a product it cannot say or it cannot distinguish, what is the types of this a. So, what the monopolist is going to do?

The monopolist is going to package these goods or you can say bundle so it will give a combination of price and output in such a way that, it is for, this bundle is for this type, another bundle is for another type and each type is going to select their respective bundle which is designed by the monopolist. So, it is something like this, that airline provider, it knows that it has two types of travelers, one is the business travelers and another is the tourist.

Business travelers are willing to, they have more or they have high willingness to pay why because it is binding on them, for this business things, they have to make this travel and the tourist, they are not, their willingness to pay is not that high because they can wait if the price is very high, they may postpone their travel or they may reschedule their whole schedule.

So, in that sense the willingness to pay is different for the business travelers and for the tourist traveler but the airline operator or the person who is selling the ticket he or she cannot distinguish between a business traveler and a tourist traveler, so but they know that there are these two types of travelers.

So, they will package these tickets in such a way that the business travelers are going to choose the package which is meant for them and the tourist travelers are going to choose that package which is meant for them. So, this criteria is called self-selection method, okay. So, monopolies design the package of price and quantity combination in such a way that consumers have incentive to select the package meant for them.

So, in case there are only two types of consumers then one is, has a high willingness to pay and other consumer has a low willingness to pay then there will be possibility of having two package and one is meant for this high willingness to pay and another one is for this low willingness to pay.

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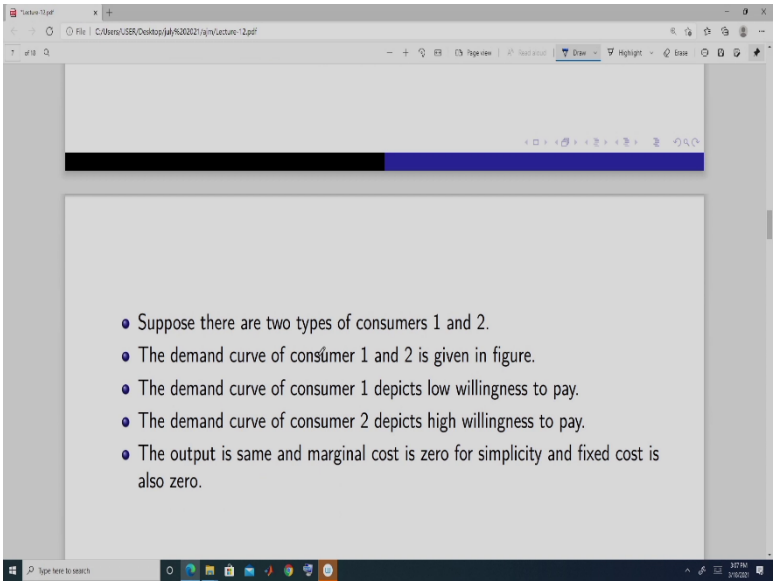

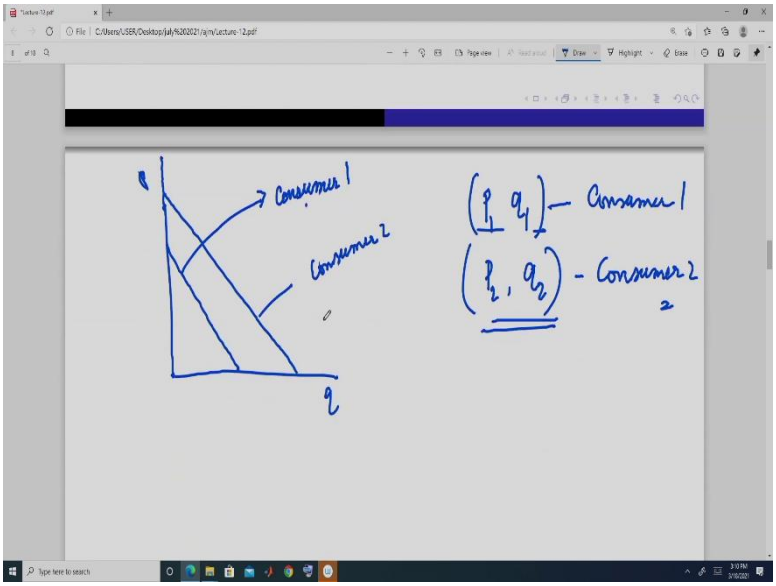

So, now we do a model on this. Suppose there are two types of consumers, consumer one and consumer two. Consumer one and two's demand curve is given here, okay. Consumer one has this, okay? This is for consumer 1 and this is suppose consumer 2, so this is the quantity and this is the price so the consumer 1 has low willingness to pay for each quantity and consumer 2 has high willingness to pay or at each price consumer 2 demands a higher quantity than consumer 1, okay.

So, monopolists know that there are two types of consumers and their demand curve is of this nature, okay? Monopolist know this demand. But monopolists further, if it wants to discriminate price perfectly, it has to know which consumer is of which type but monopolist does not have that information okay.

So, what monopolist can do, it can design one price bundle that is p1 and q1, another price bundle p2 and q2. And this (p_1, q_1) is for consumer 1 and this is (p_2, q_2) for consumer 2, okay. And when the consumers are buying, the consumer 1 will always buy this bundle and consumer 2 is always going to buy this bundle. So, this means that the bundles are designed in such a way that the consumer 1 is always going to buy the bundle meant for him or her and the consumer 2 is going to buy that bundle which is meant for him or her, okay.

Now, how to do this? Here we make a further assumption that the marginal cost is zero and the fixed cost is zero. And, So, the cost is completely zero so that is simplifying assumption because it will give us an easier way to analyze this simple case.

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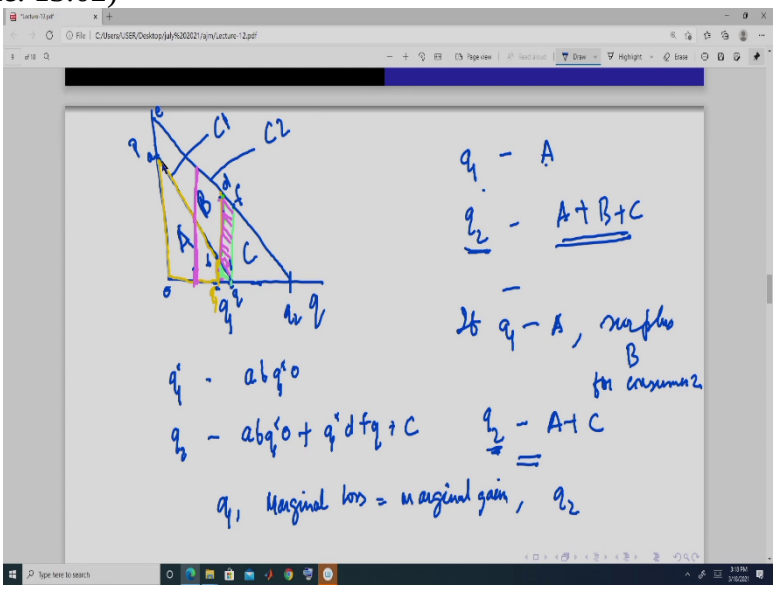

So, suppose price here and this is for consumer 1 and this is for, so this is for C1 and this is for C2, price. So, monopolists can sell this q1 unit to consumer 1 and q2 unit to consumer 2. Now suppose this whole triangle is this A, okay and this region is suppose B and this triangle is suppose C.

Now, if consumer, if the monopolist, sells this at price A, this whole area of this A, okay. And sells quantity 2 at a price A plus B plus C then this bundle which is meant for consumer type 2, they are not going to buy this bundle, they are going to buy this bundle because if they buy this bundle, they are going to get this much and they are willing to pay this whole area and they are actually paying this so they get a surplus of amount B, if they buy q1 which is sold at A then the surplus is B for consumer 2.

So, monopolist should not set this bundle instead monopolist can set q should those who are willing to buy bundle 2, this much amount they should pay A plus C. So, if the consumer is charged this amount for this bundle and the same A amount for bundle A, then those who are buying this bundle which is will be bought by consumer 2, they are going to get a surplus of amount B and they are also going to get a surplus of amount B if they buy this bundle A so they are indifferent. So, once they are indifferent, then we assume to break that indifference that consumer 2 buys this bundle okay.

So, this is one way of bundling. Now the question is, whether that is a profit maximizing bundle or not? Okay. So, here you can see that now suppose instead of this, if I make bundle for consumer 1 this is suppose q1 then what is happening? Consumer 1 is going to pay this much amount, this much amount, so what I am losing?

I am losing this small triangle, I am losing this amount, okay and what I can charge consumer of type 2, now I can charge them this additional amount, this whole amount to consumer B so suppose now I make this amount suppose this is O so then, and this point is suppose small a, o, this is q1, q1 star, and this is not O, this is suppose small b, okay this amount is suppose small c, this is d, this is b, this is q and this is suppose e, okay**,** e I have already given, this is suppose f so then for q1 which is this yellow, which is now q1 star.

Then the amount they have paid is given by the region a, b, q1 star and o, this region, okay. And q2 which is same, this amount, now the monopolist can charge this a, same amount this a, b, q1 star o, this whole region plus q1 star, d, d, f, q plus c. So, this pink area is the net gain if the monopolist follows this strategy rather than following this strategy and so the profit is higher here by this amount so the monopolist will go on.

So, like this it will go on as long as this at the margin, if it increases from here to here, this much is the loss and the gain is this much, right? At the margin. So, till at that point where marginal loss is equal is marginal gain. So, the bundle this q1 will be determined in such a way that marginal loss is equal to marginal gain, okay. And q2 is going to remain same and this whole region is going to be charged to for the second consumer and the consumer 1 will be charged only this amount, okay? So, this is second degree price discrimination, okay.

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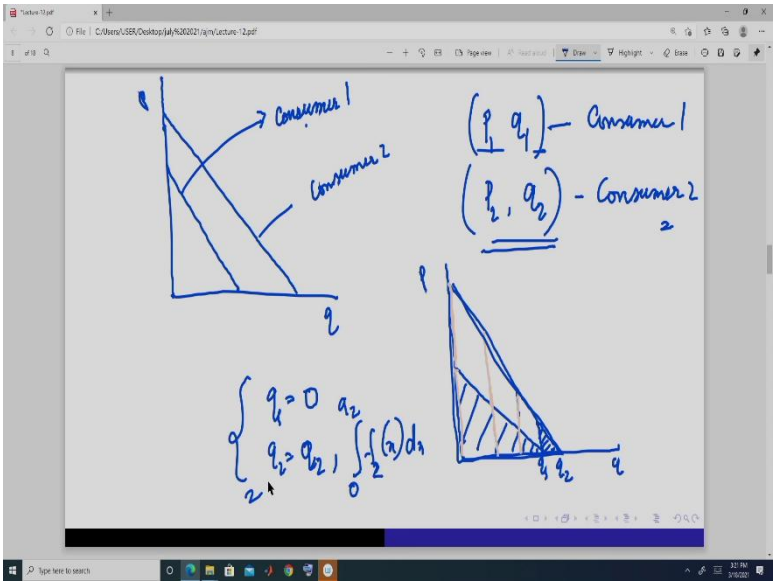

But here we may have a problem, the problem is that now think of a situation like this, let me use this portion a little bit. Suppose the demand curve is like this and demand curve is like this, okay? this is q1, this is q2, okay. q1 it can charge this amount and q2 it can charge this amount but if we use that marginal principle what is happening, if we do here like instead of this, if we shift this q1 here so this much is the loss and this much is the net additional unit, so we are going to reduce this.

If you do this, here this is the, at the margin this is the loss and this is the gain, right? So, we are gaining more so we will go on doing like this and then here you will see the gain is more than this, it is possible to do. So, in this case, what will happen or in this case, what we will get that q1 is always equal to 0 and it will have a package of this and it will charge this whole triangle.

So, q2 is A, q for the consumer 2 it is going to be this q2 and the price is going to be this whole, this is the demand curve of consumer 2, this whole amount. So, here consumers which are of type 1 they are not going to buy any bundle. So, this can be the optimal bundle in this situation, okay.

So, this is one case where the consumers the monopolist is only selling the product to those consumers whose willingness to buy is very high and it is not selling the product to those consumers whose willingness to pay is low, okay. So, this is, this can be an outcome when the monopolist cannot distinguish between the types of consumers and it wants to discriminate the consumers because then it can earn more profit. So, then in that case it is only going to sell to the consumers who are willing to pay more, okay.

Next type of market price discrimination is third degree price discrimination. So, what we have done? In first degree we know that the monopolies can distinguish between the type of consumers and it can charge each quantity at a different price, okay. So, a same consumer if it is buying different quantities it will be charged different prices or if the consumers nature are different then for the same quantity, they may be charged different amount, okay? Because their willingness to pay is different.

But that is possible and what we have done? If the consumers are of same nature suppose they are similar, we have assumed that and then we have devised a strategy where a fixed bundle is fixed amount of quantity is sold in the market and that is where price is equal to marginal cost, okay in the first-degree price discrimination.

In the second degree we have assumed that the monopolist cannot distinguish between the type of consumers and monopolist will package the goods into a combination of price and quantity in such a way that it will be meant for a specific type of consumer. So, for consumer type 1, it will have a price and quantity and for consumer type 2 it will have a different price and quantity, okay.

And it will be such that the profit is maximum, and when the profit is maximum for some specific type of demand curve, we see that when there is the marginal loss, if you charge slightly less to the low paying, low willingness to pay consumer and the marginal gain, that you get by charging a little bit higher to the high willingness to pay consumers, if they are equal then you are at an optimal point, okay.

Now, this condition can also lead to an outcome were depending on the nature of the demand curve where the monopolist is not selling any quantity to the low, to the consumers whose willingness to pay is low and it is only selling to the consumers whose willingness to pay is higher amount or who is willing to pay higher amount, okay. And we have given one example, diagrammatic example.

Next is the third degree, in the third degree what it assumes that the consumer knows that there are two types of market and these two types of market is because of there are two types of consumers but for each it charges same price per unit of quantity for whatever amount you are willing to buy.

So, it is something like this, that if you go to a movie hall you will get some student discount, if you go to suppose some, if you use some services, some public utilities or services, you get senior citizenship discounts so those are. You know that this is a market for the senior citizen and there are another type of consumer who are not senior citizen so you can charge different prices to them, so you can distinguish these two types of a.

Or say for example the students who has I card and if you only show the I card you get the discount so you can distinguish between the consumers and you know their demand curves are different, okay. So, depending on this type of consumers you charge the same price for whatever amount they want to buy.

So, here you are not discriminating in terms of quantity, you are discriminating only in terms of types of consumer, in second degree price discrimination you cannot distinguish between the consumers so you bundle or you package the goods in a combination of price and quantity in such a way that you charge different prices for different quantities but here you charge same prices but you charge same prices that price may differ according to the type of consumers because you can distinguish between them so that is why this is different from the first degree because in first degree you do the both.

So, if a consumer is, you can charge according to, you can charge different prices to different consumers and also you can charge different prices for each or different quantities to each consumer. But here you charge same prices for any amount, the same price per unit for any amount they are buying but you can charge, you can differentiate in terms of the types of consumers, okay so that is.

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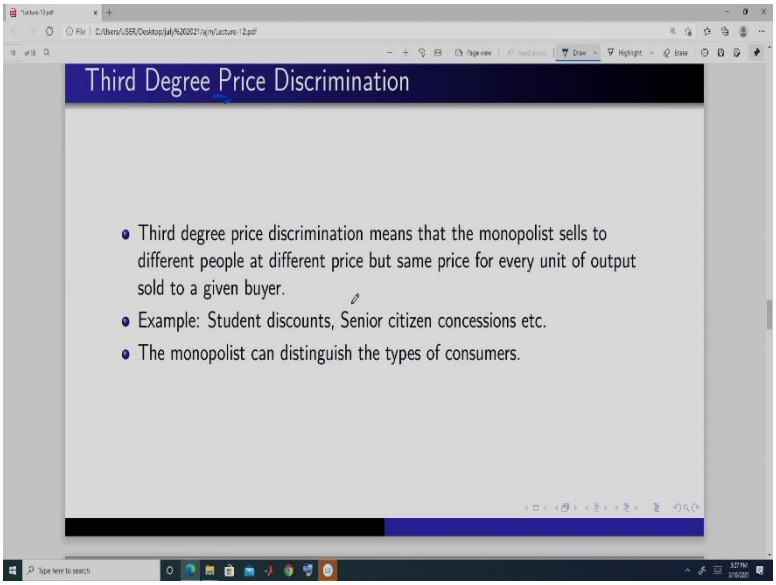

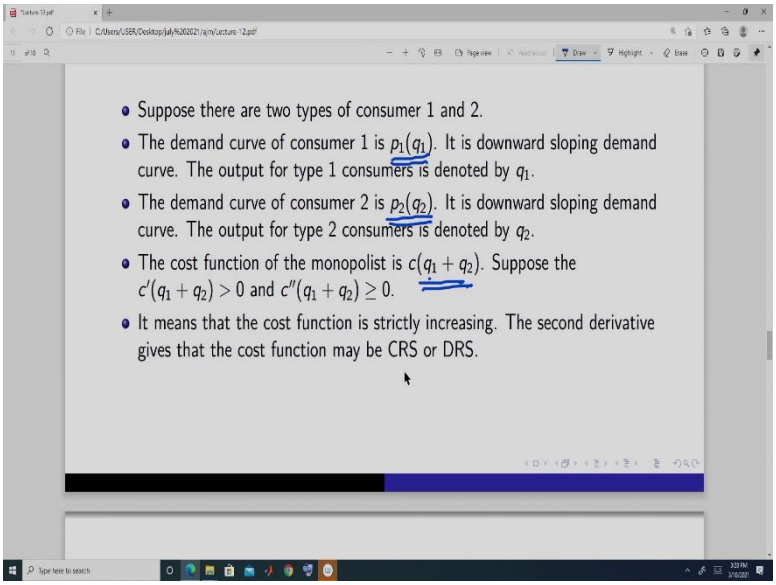

So, the informational requirement is much less compared to the first-degree price discrimination, okay. So, here we will again, suppose there are two types of consumers, consumer 1 and consumer 2. Consumer 1's demand curve is this- $p_1(q_1)$ and consumer 2's demand curve is this-$p_2(q_2)$. And the quantity you are selling to consumer 1, so you take a monopoly it is given by q1 and consumer quantity you are selling to consumer 2, is given by q2, okay.

So, these demand curves are downward sloping and they are not same, they are different , okay and you have to assume that the cost function is for this nature-$c(q_1 + q_2)$, we have assumed a general cost function so this is strictly increasing because marginal cost is always positive and marginal cost can either be constant or it can be increasing so the possibility of

CRS or constant returns to scale or DRS that is decreasing returns to scale, we consider only these two situations.

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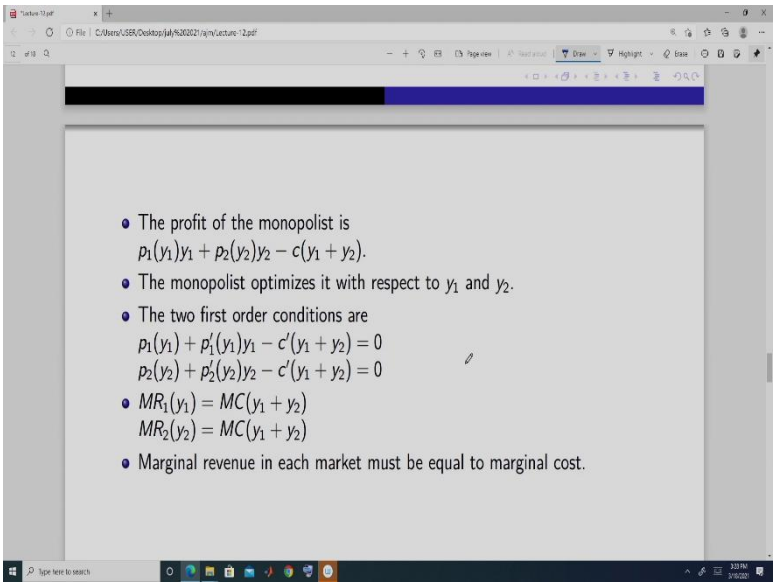

So, aggregate profit of the monopolist is given by this amount- $p_1(y_1)y_1 + p_2(y_2)y_2 - c(y_1 + y_2)$ because, this amount- $p_1(y_1)y_1$ is the revenue from type 1 consumers or market 1, that is you are selling y1 unit of output, okay I have messed up here.

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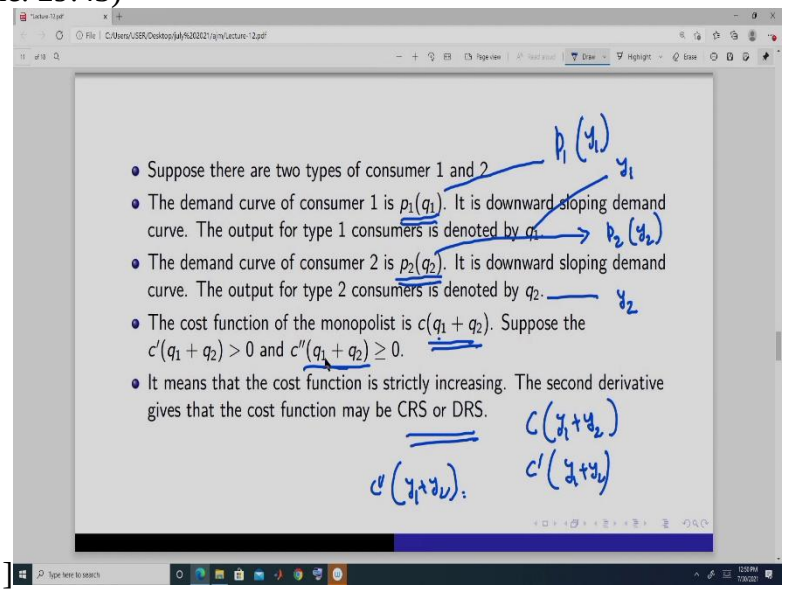

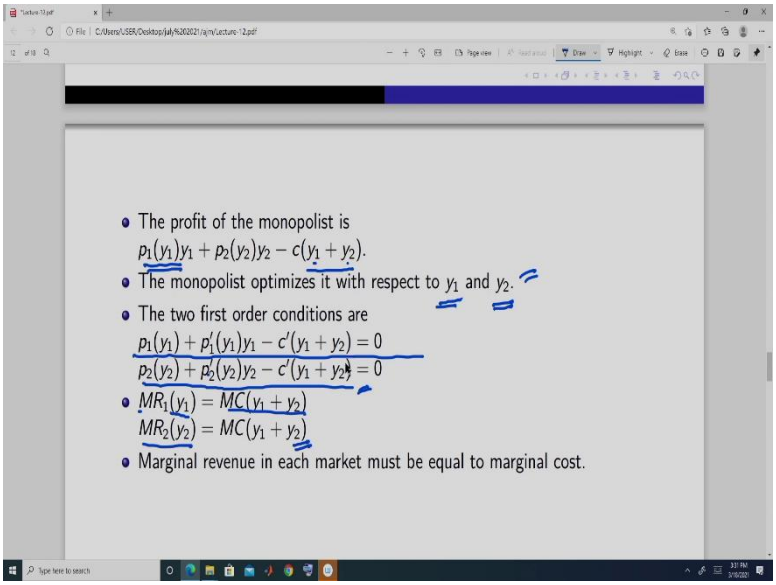

So, let us take this thing this to be instead of q1 let us take y1, instead of q2, let us take y2, okay? Output here is not q1, it is y1, output is y2, okay. And this here cost function is c y1 plus y2, i.e $c(y_1 + y_2)$ and marginal cost is this- $c'(y_1 + y_2)$ and the derivative of the marginal cost is this- $c''(y_1 + y_2)$, okay. I just messed up the symbols.

So, CRS or DRS will give satisfy this- $c''(y_1 + y_2) \geq 0$, but this condition is also satisfied when one of the factor is fixed and the other is variable and the law of diminishing marginal product is operating. In that case we will get this, that is the marginal cost is upward sloping and so we will get the second derivative of cost function to be a positive number.

So, you take this-$p_1(y_1)y_1 + p_2(y_2)y_2 - c(y_1 + y_2)$, so this portion-$p_1(y_1)y_1$ is the revenue from selling to type 1 consumers, this is the revenue from selling to the type 2 consumers-$p_2(y_2)y_2$and this is the total cost of producing y1 and y2- $c(y_1 + y_2)$, this is the total output it is producing and it is selling the goods are identical in nature so the cost is same, okay.

Now monopolist is going to maximize this profit with respect to y1 and with respect to y2 because these two are for two types of market, for consumer type 1 and for consumer type 2. And so, since all of these are differentiable so we take the derivative and the first order condition when we optimize with respect to y1 is this- $p_1(y_1) + p_1'(y_1)y_1 - c'(y_1 + y_2)$=0.

So, this is marginal revenue- $p_1(y_1) + p_1'(y_1)y_1$ and this is the marginal cost-$c'(y_1 + y_2)$. And this- $p_2(y_2) + p_2'(y_2)y_2 - c'(y_1 + y_2)$=0 is the first order condition from when we optimize with respect to y2 and since the demand curve is downward sloping and, it is not convex, strictly convex and this is always positive or this is second derivative is positive one,

equal to 0 so we will always have an optimal point which maximize x with respect to y1 and y2,okay.

So, this first order condition is marginal revenue from consumer or type or market 1 should be equal to marginal cost and marginal revenue in type 2 market should always equal to marginal cost, so from this first order condition, okay. So, that means marginal revenue should always be equal in this both the market.

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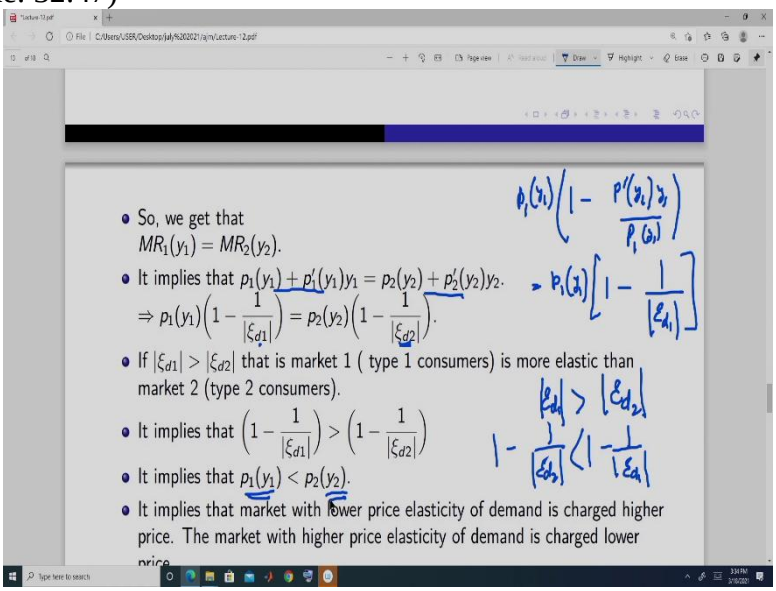

So, from there we get this marginal revenue- $\mathrm{MR}_1(\mathrm{y}_1) - \mathrm{MR}(\mathrm{y}_2)$, these two should always be equal, if that is the case then it implies that this portion which is marginal revenue in market 1 should be equal to marginal revenue in market 2, i.e $\mathrm{p}_1(\mathrm{y}_1) + \mathrm{p}_1'(\mathrm{y}_1)\mathrm{y}_1 = \mathrm{p}_2(\mathrm{y}_2) + \mathrm{p}_2'(\mathrm{y}_2)\mathrm{y}_2$. So, we get this, this should be equal to this.

Now here we know, if we take this common, we can write it this- $\mathrm{p}_1(\mathrm{y}_1)(1 - \frac{\mathrm{p}_1'(\mathrm{y}_1)\mathrm{y}_1}{\mathrm{p}_1(\mathrm{y}_1)}$ and this we have shown, can be written as elasticity of the demand curve of market 1- $\mathrm{p}_1(\mathrm{y}_1)[1 - 1/|\xi_{d_1}|$] and this is also same, is the elasticity or price elasticity of the market 2- $\mathrm{p}_2(\mathrm{y}_2)[1 - 1/|\xi_{d_2}|$] and this is from market 1. Now these two things should be equal and suppose the elasticity in market 1 is more than elasticity into market 2, then what do we get?

We get that, if we get this- $|\xi_{d_1}|$, we can show that this why? Because this is the case if we take the negative then here, okay, this is the demand price elasticity in market 1 and price elasticity in market 2. Price elasticity of market 1 is more than price elasticity of market 2, i.e

$|\xi_{d_1}| > |\xi_{d_2}|$, and from there we know that one this, then if we take the negative sign this, will be, we can write this so we get here.

So, this means, since they are equal so price in market one should be less than price in market two- $p_1(y_1) = p_2(y_2)$. So, this means what? That if price elasticity of demand is less then you charge a higher price and if the price elasticity is high, price elasticity of demand is high you charge a lower price.

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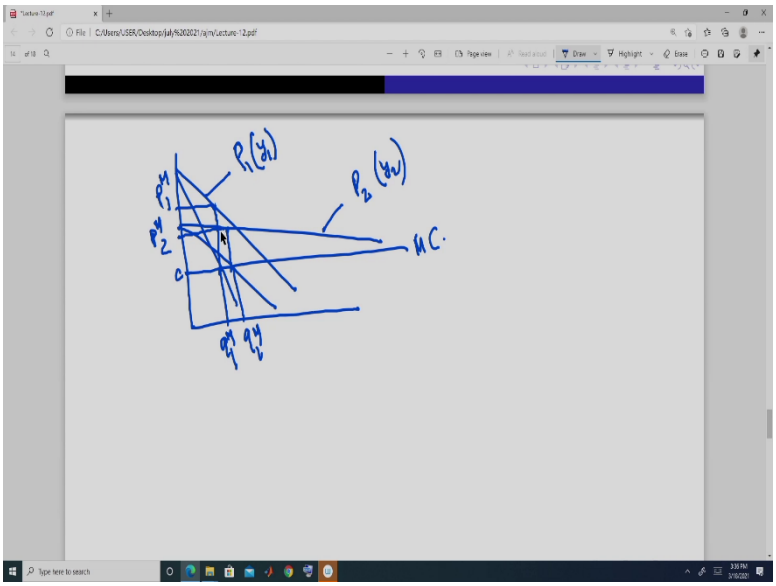

So, diagrammatically what we are doing is suppose this is, okay, so this is the marginal revenue, this is suppose p2 and it is, this is the marginal revenue, okay? And suppose this is the marginal cost, say, okay? so for market one this is the, and for market two this is the revenue so price here is this, price here is this, this is the monopoly price in market 2, this is the monopoly in market 1. So, this is the price, this demand curve you know, is more flat so it is more elastic. This demand curve is more steeper so it is less in elastic.

So, you are charging or the monopolist is charging a higher price in inelastic demand curve and it is charging a lower price in elastic demand curve, okay, this is happening. So, this is mainly the third-degree price discrimination, okay.

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$P_1(y_1) = P_1 = 100 - y_1$

$P_2(y_2) = P_2 = 50 - y_2$

$C(y_1+y_2) = c(y_1+y_2), \quad c>0, \quad c<50$

$\pi = (100-y_1)y_1 + (50-y_2)y_2 - c(y_1+y_2) - F$

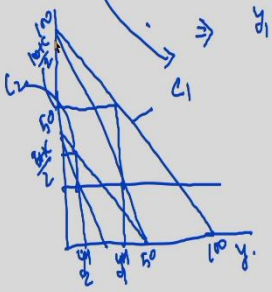
$\frac{\partial \pi}{\partial y_1} = 100 - 2y_1 - c = 0$

$\frac{\partial \pi}{\partial y_2} = 50 - 2y_2 - c = 0 \Rightarrow y_2 = \frac{50-c}{2}$

$\Rightarrow y_1 = \frac{100-c}{2}$

$\Rightarrow P_1 = 100 - \left(\frac{100-c}{2}\right) = \frac{100+c}{2}$

$\Rightarrow P_2 = 50 - \left(\frac{50-c}{2}\right) = \frac{50+c}{2}$



Now, we will solve one problem or one example. Suppose demand curve which is this or you can say price inverse demand curve is this, let us take some examples, this- $P_1(y_1) = P_1 = 100 - y_1$ okay, this is type 2- $P_2(y_2) = P_2 = 50 - y_2$ and this is type 1. Just the opposite of what we have done earlier, okay.

And the marginal cost is equal to suppose, C, sorry not marginal, variable cost is this- $C(y_1 + y_2) = c(y_1 + y_2)$ where C takes a positive number and C is less than suppose 50, okay. So, the profit of the monopolist is from market one that is type one consumers, total revenue.

Total revenue from type 2 consumers, here the willingness to pay for the type 2 is less than the willingness to pay of type 1, okay. So, this is a constant and suppose some fixed cost, okay? So, here the monopolist is going to do what? Y1, so this is first order condition, it should be equal to 0, i.e $\frac{d\pi}{dy_1} = 100 - 2y_1 - c = 0$

Second, this first order condition, the second first order condition-$\frac{d\pi}{dy_2} = 50 - 2y_2 - c = 0$, from this we will get that y1 is equal to 100 minus C divided by 2- $y_1 = \frac{100-c}{2}$, and this will give y2 is equal to 50 minus C divided by 2- $y_2 = \frac{50-c}{2}$, then what we are going to do, so monopolist price is, so it is going to be equal to 100 plus C- $P_1 = 100 - \frac{100-c}{2} = \frac{100+c}{2}$

And this in the market 2 and it is going to be this- $P_2 = 50 - \frac{50-c}{2} = 50 + c$. So, here, if you try to do it diagrammatically so this is the output so this is suppose 100 and this is 100, this is 50, this is 50. And So, these are the two-demand curves, this is for consumer type 1, this is for consumer type 2.

Marginal cost is something like this, marginal revenue here, marginal revenue here, so this is the monopoly price in, which is 50 plus C divided by and this is in market 2, this is in market 1 and the price is this much, okay. And this price is 100 plus C divided by 2, okay. So, this is the third-degree price discrimination, okay.

So, this is actually the end of this module, module 4 where we have done the monopoly thing and in the monopoly first we have, what we have done? We have defined the monopoly market and then we have derived the optimal output and the monopoly price. then we have looked at monopoly behavior that is since there is only one firm in the monopolies and all the

buyers have to buy from that firm only, so it can vary according to different types of buyers and also the amount of information it has.

So, it can involve in or engaged in price discrimination so we have done three types of price discrimination. First degree price discrimination, where the monopolies can charge different prices for different units of output and it charges also it can vary the price according to the types of consumers.

In second degree price discrimination, what we have seen is that the monopolist cannot distinguish between the consumers, so if a consumer, so it can only bundle the price and quantity combination in such or it packages the price and quantity in such a way that it is specific to its type of consumers, for consumer type 1 it will have a specific bundle of good and price or specific combination of price and quantity.

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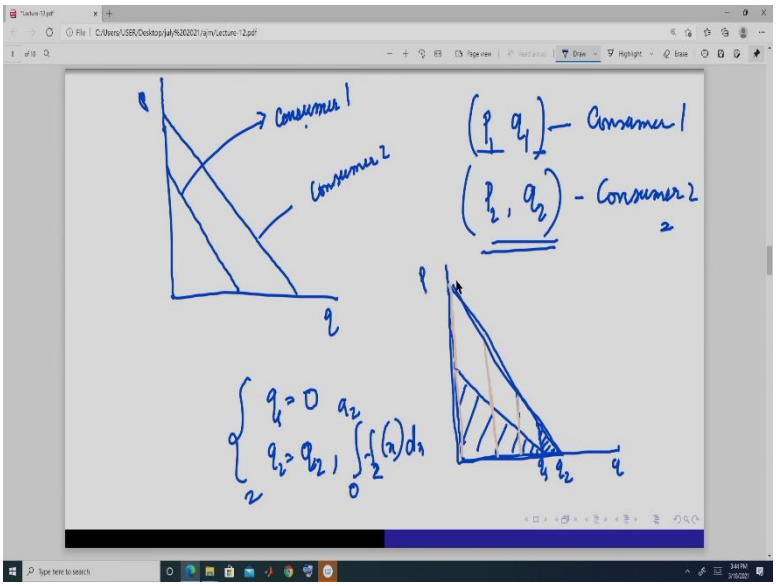

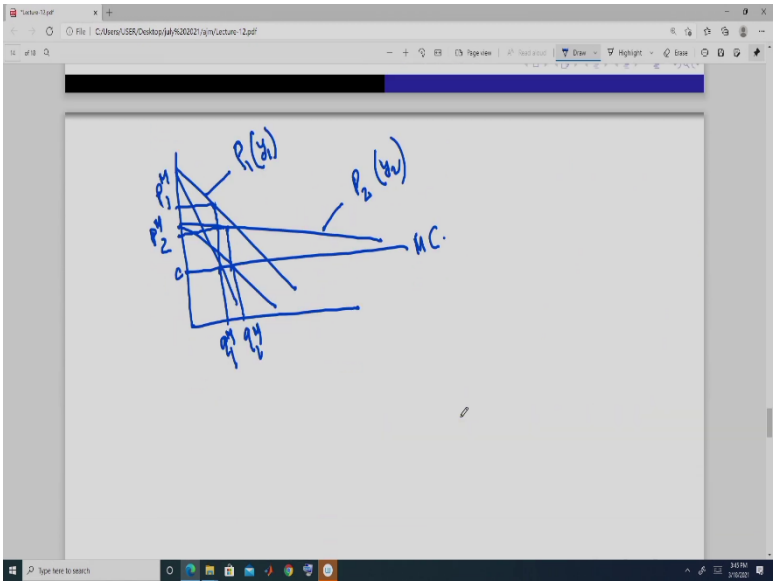

For consumer type 2, it will have a specific combination of price and quantity, and if the demand curves are of certain type as we have seen in this situation then it may happen in second degree price discrimination the monopolist is not selling any output to the consumer whose willingness to pay is low, for this consumer whose demand curve is this. It is only selling to the that consumer whose willingness to pay, willingness to pay is high.

And then we have done the third-degree price discrimination and in the third-degree price discrimination it is assumed that the monopolist same price for whatever amount you are going to buy so that is per unit price remains same but it only distinguishes in nature among the types of consumers or among the types of market, okay.

So, we have seen that a market whose price elasticity of demand is high in that market the less price will be charged and if the price elasticity of demand is low then a higher price will be charged, okay. So, this is what we have completed, covered in monopoly and the next topic that we are going to do is the game theory.

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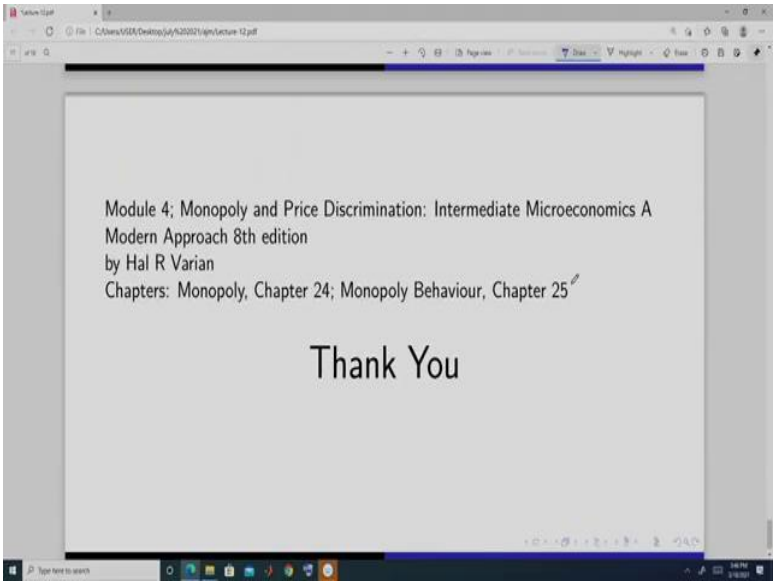

So, for this portion what you can do is you can read from this chapter 24 and chapter 25 of this book, Intermediate Microeconomics – A modern Approach 8th edition by Hal Varian. So, these two chapters, this is the monopoly and the price discrimination is from this chapter and the monopoly is from this chapter, okay. Thank you.