Introduction to Market Structures
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Module 11: Product Differentiation and Entry Deterrence
Lecture 39
Dixit's Model of Entry Deterrence

Hello. Welcome to my course Introduction to Market Structures.

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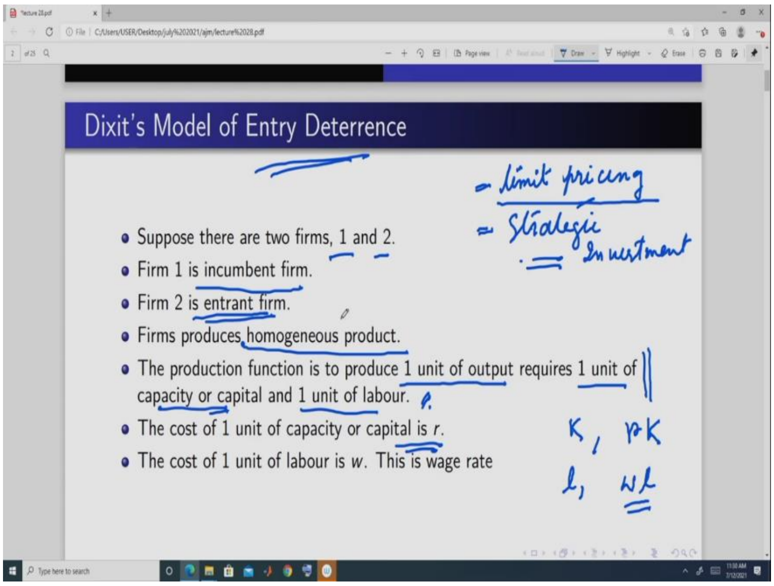

So, today we are going to start a new topic and that is Dixit's Model of Entry Deterrence. Entry deterrence means that suppose there already exist a firm in the market, and now one new firm may want to enter that market. Then this firm, which is already existing in the market, it may act in such a way that its action that gives a signal and that signal actually deter the entry of firm 2 or the firm which wants to enter this market. So, this is the entry deterrence.

And now the firms may follow many strategies to deter the entry. And if it is successful in deterring the entry of firms, then that firm which is already there, it can get the monopoly profit or it will be the sole producer in the market, so it will over time, it may earn lot of profit. So, this the strategies or the policies so that a firm deter the entry, this is important to study. Why?

Because it mean, because the firm, those can be considered as part of the monopoly practices. Because you deter the entry of new entrant or new firm so you get a monopoly rent out of it. And we have seen that if a firm is monopoly then it is not social welfare maximizing or it is not Pareto optimal also, right? So, because of this reason the regulatory bodies, they always keep and watch that whether the firms are deterring the entry of the new firms or not, right? So, that is why we study this.

Now, in the entry deterrence this can be done broadly in two ways. By setting the price very low, so that is called the limit pricing. Or you have so much capacity that you can produce a huge amount of output, and suppose you incur some economies of scale because of that so your average cost is low. So, you get some your cost of production is low, so you can sell at lower price or you can sell more so the other firms may not enter.

So, mainly these two are the strategies that the firm follows. And we are not going to do limit pricing, because if we do the, because the limit pricing models, it requires asymmetric information also and we have not done asymmetric information. So, that is why we are not going to do this. But we are going to do strategic investment. And that is this model. And this model was first proposed by Avinash Dixit, so that is why it is Dixit's Model of Entry Deterrence, okay. So, now let us move to the model.

So, suppose, there are 2 firms, firm 1 and firm 2. Firm 1 is an incumbent firm. Incumbent firm means that firm 1 is already existing in the market, okay. And firm 2 is an entrant firm, it is going to enter, okay. And for simplicity, we are assuming that both the firms produces homogeneous product. So, we know what is the meaning of homogeneous product. It means that the output produced by firm 1 and firm 2 are perfectly substitutable. So, whether you buy from firm 1 or from firm 2, it does not matter.

And for simplicity further we assumed a very specific form of production function and it is, production function is, to produce 1 unit of output requires 1 unit of capacity or we call it capital and 1 unit of labor, so you will require both capital and labor and 1 unit of capital and 1 unit of labor is going to give you 1 unit of output.

So, this is to keep all the calculation simple, we assume this thing and this assumption is actually straight from the Dixit’s Model and in the Dixit Model also this assumption was made, okay. Now, we have to specify the cost of these inputs. So, the cost of capital or capacity is r per unit. So, if you are employing suppose k units of capital then your cost is on capital is r into k. And the cost of 1 unit of labor is w, so it is the wage rate. So, if you are employing l amount of labor, so there wage cost is this, w into l, okay.

Now, here capacity or you can think this capacity as the machine and that is creating a kind of capacity in the production. So, it is, you can think of same as a, it is same as capital, okay. That we have been assuming till now in this course, okay. So, here capacity and capital is same thing in this model, okay.

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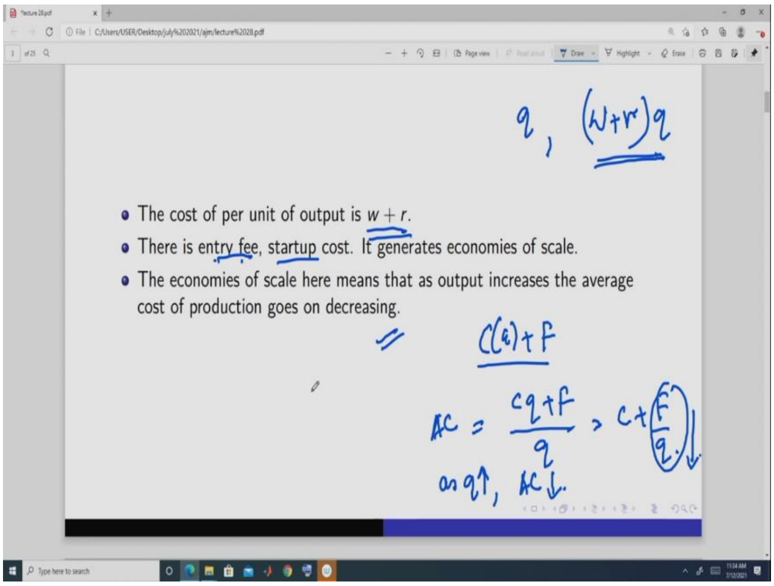

Now, so because of these two costs, so cost per unit of output is this- w+r. So, if you want to produce q units of output then your cost is, because you will require q units of labor and q units of capital and the price of capital is r and the price of labor is w, so this is the- (w+r)q, okay. Now, here we introduce one more cost and that is the startup cost or entry fee. Now, how do you motivate this cost? Entry fee or startup cost is something like this. Suppose a firm wants to enter this market.

Now, first it will have to know the demand in that market. Now, it will not know that demand automatically, it will have to spend some time. It will and that and it will have to go through the market, through, do some survey and then find out survey of the existing market and survey by doing some kind of market research like how much, what is the possibility of demand of this good in this market?

So, those will cost some amount and those are fixed. Like if you know that the demand in this market is this much. Suppose hundred units is that the maximum a firm can sell. Then it means that the amount of expenditure you have incurred to know that information that is gone, you will not and it is fixed. If you produce, if you vary your output that cost is not going to change that you have already incurred. So, that is why it is a fixed cost, you can say. And it is we call it an entry cost, because you do a little bit of market research.

And also, you want to study the technology that is available, what kind of labors you require, what kind of machines you require. So, for those kind of things you will spend some time and you will use some resources, to know, to get those information. So, that is going to generate some cost. And that is actually constitutes this entry fee or you can say startup cost, okay.

And see, this startup cost is a fixed cost. Now, fixed cost, it will generate economies of scale. Now, what do we mean by economies of scale? Economies of scale here, it means suppose, your cost function is of this nature- c(e) +f, right. Now, this is suppose very specific this- cq+F. If you take this, this is what AC, Average Cost-$\frac{cq+F}{q}$. Now, this you can write this as-$c+\frac{F}{q}$. Now, what is happening? As output increases, your AC is going down. Because this portion $\frac{F}{q}$ is going down, as q increases.

So, this is what economies of scale means in this context that as the output increases, average cost goes on decreasing, okay. So, if you incur some this entry cost or startup cost, you will always try to produce as much output as possible, because then it will reduce your cost per unit of output, okay. So, this is the specification that we have, specification of the Dixit's Model.

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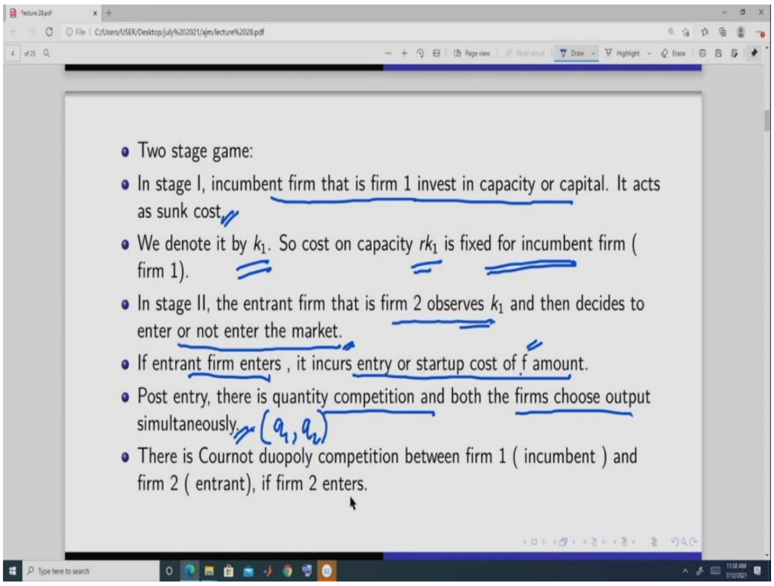

Now, let us specify the game. So, it is a two-stage game. In stage 1 incumbent firm that is firm 1 invest in capacity or capital, okay. So, it will fix, buy some machine or it will buy some fix set up some capacity in that firm. And that expenditure incurred on buying those capital or setting up those capacity that is a sunk cost.

So, that is sunk cost means, you will not here, sunk cost in this in the sense, it means, definitely since it is a capacity if you want to resell it, you will get some money for it. So, in that sense it is not sunk. But it is sunk in the sense that if you are suppose, your capacity is to produce 100 units and you are producing only 50 units, so this 50 which is lying idle, you are incurring some cost on that. So, in that sense, it is sunk. So, you have a capacity to produce 100 units and you are producing only 50 units. So, for 50 units you are getting some amount of revenue, because you are selling, producing 50 units and you are selling 50 units.

But since your capacity is to produce 100, so this 50 which is, which, that amount of machines that you are not using or the capacity that you are not using, which is lying idle, that is that, but you have already incurred the cost, while setting up that much capacity or while buying that much amount of machine, so that is not giving you that much amount of capacity or machines are not giving you any return, so in that sense it is a sunk cost. And we denote the capacity or capital of a firm by k1, okay. So, cost on capacity is, if it decides to have a capacity of k1 is rk1 and it is fixed for incumbent firm. So, if you have decided k1 units of capacity then r into k1 is cost, you have incurred, okay.

Now, in stage 2, the entrant firm that is firm 2, observes k1. So, firm 2, which is deciding to enter, it knows, what is the capacity of firm 1, okay. And that is this. And then decides to enter or not enter the market. So, it takes the decision to enter or not into the market after observing the capacity of firm 1 or the observing the capacity of the incumbent firm.

If the entrant firm enters, that is, if firm 2 enters it, incurs entry cost or startup cost of f amount, okay. So, it will be the amount is some f. The post entry, once the firm 2 enters, firm 1 already exists, there is quantity competition and both the firms choose output simultaneously. So, we have actually, we have separated these decisions that is firm 1 now make a decision whether to, make a decision on the amount of capacity in stage 1.

Firm 2 observes this capacity in stage 2 and decides whether to enter or not. Suppose it wants to enter. As it enters then there is firm 1 and firm 2 simultaneously decides the output of each of their output, q1 and q2. Their output, here q1 of firm 1 and q2 of firm 2. So, you can say that the game is something like this. In stage 1 capacity that is k1 is decided, in stage 2, firm 2, after observing k1, decides whether to enter or not. And then there is Cournot quantity competition between firm 1 and firm 2. Now, this Cournot competition, you can also think as a part of stage 2, okay.

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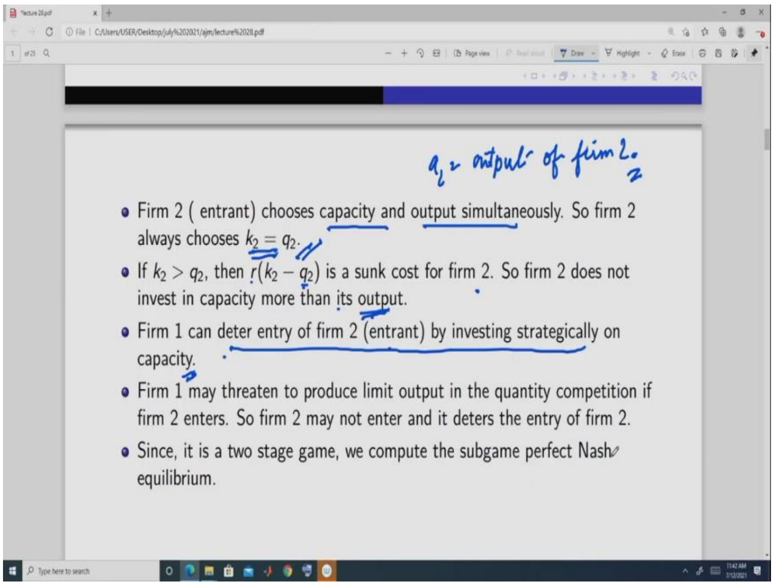

Now, here firm 2, it is deciding its capacity and output simultaneously. It is not like firm 1 deciding its output in stage 2 after the firm 2 has entered or not, after the decision of the firm 2 to enter or not to enter. But its decision on the capacity is done in stage 1. But for firm 2 these two decisions that is how much amount of capacity to have, or how much amount of machines to have, and the output it is going to produce that is taken simultaneously. So, firm 2 always chooses k2 is equal to q2. Where q2 is the output of firm 2, okay.

Now, this is always going to be true. k2 is equal to q2. Why? Because if k2 is greater than q2 then r, this much amount of capital or capacity, i.e. $r(k_2 - q_2)$ is sunk for firm 2. So, it is not getting any return, so firm 2 does not invest in capacity more than is invest, more than is output. If it have more capacity or more machine then the output it needs to produce, then that amount, which is incurred in setting up that capacity or the cost that it incurs, is going to be a sunk cost and it will not generate any income. So, that is why it is, firm 2 will always choose k2 is equal to q2.

Now, firm 1 in stage 1, can deter entry of firm 2, by investing strategically on capacity. So, it is something like this. So, firm 1 may threaten that I have a huge amount of capacity, if you enter, I will produce something called limit output. And so firm 1 says that if you produce, if you enter, then I will produce limit output. And if firm 1 produces limit output then firm 2 will not enter. And so that is why it is it deters the entry.

So, based on this capacity that capacity itself is going to give you, give firm 2, a kind of a signal that whether firm 1 is actually going to produce limit output or not. Now, since this is, see, this is something like this. So, firm 1 decides the capacity. Now, if it have a sufficiently big amount of capacity, then what, firm 2 may know that may think it. It like this, if I enter firm 1 is going to produce this much amount of output till its capacity, okay.

So, then what is going to happen? So, that is why firm 2 is not going to enter. The moment firm 2 does not enter then firm 1, what it can do? It can produce the monopoly output. So, it will not actually produce the limit output. But because it has a capacity, a huge amount of capacity that may deter the entry. Because firm 2 may think that if I enter, firm 2 will firm 1 is going to produce still its capacity and that is going to be my limit output.

Now, what is limit output? We will discuss later. But limit output, think it is something that deters the entry of firm 2. Now, since it is a 2 stage game, so we are going to find the, compute the subgame perfect Nash equilibrium. And how do we do? We use backward induction to do.

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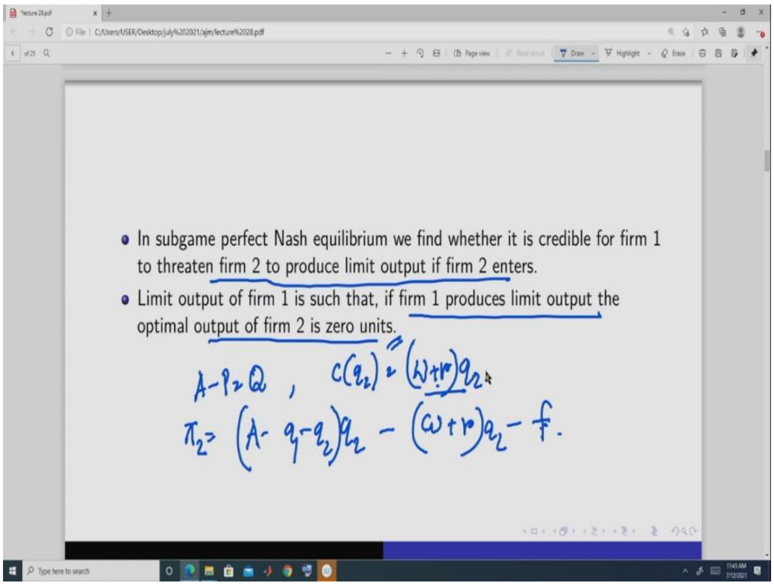

Now, again here in this subgame perfect Nash equilibrium, we find whether it is credible for firm 1 to threaten firm 2 to produce limit output, if firm 2 enters. Now, see, if we have seen in Cournot outcome that if generally the Cournot, in Cournot outcome, if firm produces the Cournot outputs that is profit maximizing, right?

But if it wants to produce more than the Cournot output, then it is going to give it. That firm less k. So, there is a possibility that, that if I threaten the firm 2, that if you enter I will produce till my capacity and since I have a huge capacity, so you will not be able to, you will make a loss. But then it may happen that itself may be creating a loss for me, so that is why, that may not be, that threat may not be credible enough. So, that is why I may not threaten it. So, in subgame, we will have to find whether this threat is actually credible or not, okay.

Now, we will define, what is limit output. Limit output of firm 1 that is the incumbent firm is such that if firm 1 produces limit output the optimal output of firm 2 is 0 units. So, if firm 1 produces limit output firm 2 does not produce. Now, here, how do we get it? Suppose we will do it.

I will show it using 1 example. Suppose the market demand is this. So, the profit of firm 2 and suppose the firm 2's cost function is, c or let us take in this case only, so that it will be very specific. Because to produce 1 unit of output, it requires 1 unit of labor and 1 unit of capital. If it were produces q2 units of output so its cost is w plus r into q2. This-$c(q_2) = (w + r)q_2$.

So, the profit of firm 2, if q1 is the output of firm 1. So, this is going to be the market price, this is going to be the total revenue-$\pi_2 = (A - q_1 - q_2)q_2 - (w + r)q_2 - f$, this the sunk cost f. So, cost function is this, to produce the output q units. Its cost is this. This it has already incurred. So, we have put an additional thing. It is not part of the total cost function, okay.

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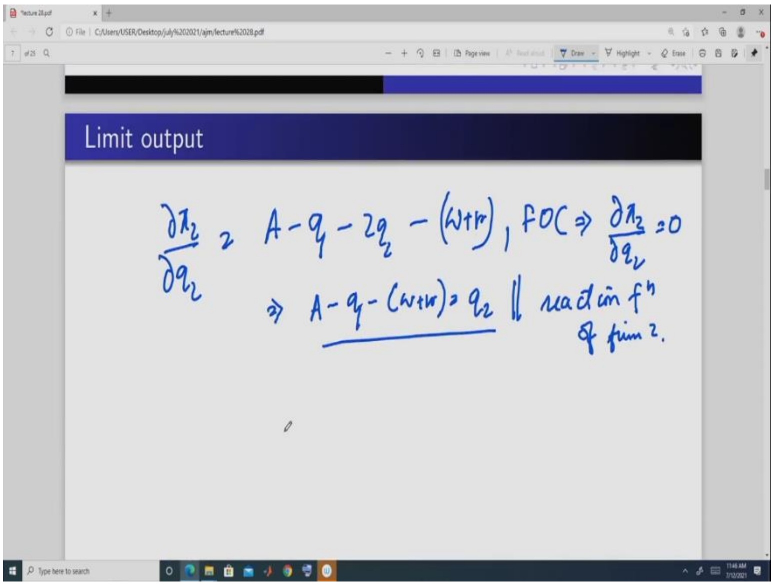

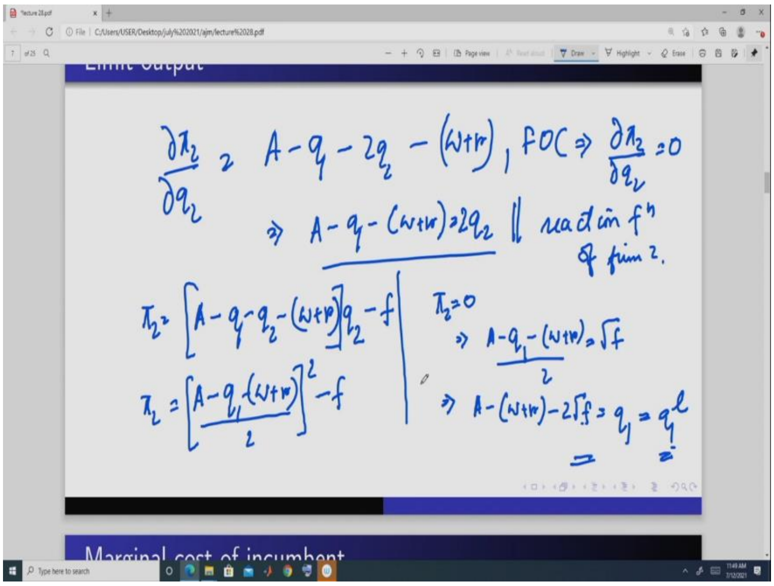

So, if we, how to find the limit output? If we optimize this, with respect to q2, what do we get? And then first order condition gives me equal to 0-$A - q_1 - 2q_2 - (w + r) = 0$. So, then this implies what? This implies. So, this is the reaction function of firm 2-$A - q_1 - (w + r) = q_2$. So, plug in the output of firm 1, we get the output of firm 2. Now, here if we plug in that output of firm 1 then the optimal output is 0. That is what the limit output is.

Now, you will see, how to derive the limit output of this. Now, this profit function of firm 2, you can write it in this form-$\pi_2 = [A - q_1 - q_2 - (w + r)]q_2 - f$. This form. Here taking q2 common, oh sorry, this. Now, we know q2 can be written as a function of q1 from the reaction function. So, this becomes and you plug in that here, so it will be square, this-$\pi_2 = \left[\frac{A - q_1 - (w+r)}{2}\right]^2 - f$. Now, equate this equal to 0.

So, what do we get? We get, this implies this. So, from here, we get and we denote this as limit output of firm 1-$A - (w + r) - 2\sqrt{f} = q_1 = q_1^l$. If firm 1 produces this much amount of output, see, if firm 1 produces. Here it will be 2. So, firm 2 is not going to produce anything because its a is going to be 0. Because plug in this here, you will get that this cancels out, what is left is this. And square of that you will get f. So, profit is 0. So, firm 2 does not produce, does not want to enter at this here. So, this is the limit output. So, we will use this concept in this model, okay.

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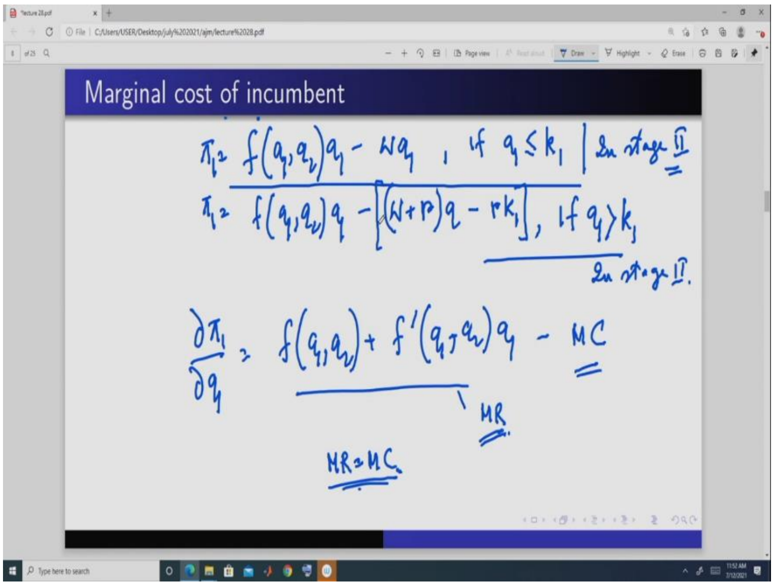

Next, we define the marginal cost of the incumbent. Because suppose, we require the marginal cost. Why? Because the profit function of firm 1, you can say if we take a general demand function like this, so output of firm 1 is q1 output of firm 2 is q2. So, this is the price into this, it is this, is the profit of firm 1-$\pi_1 = f(q_1, q_2)q_1 - wq_1$. If q1 is less than k1, less than equal to, and the profit of firm 1 is going to be what? This is going to be cost in stage 2, right.

Now, here this now this plus r this. So, this is the output, minus this is going to be the cost. If q1 is greater than, output is greater than its capacity or its capital, this in stage 2, so this cost portion is changing according to the output and given capacity in stage 2. So, this is the general demand.

So, now we know, when we take this, what do we get? We get, see, this is not a continuous thing, equal to, you can say marginal cost. Because this here. So, this portion, you can think as, something as, marginal revenue, okay. And this is marginal cost. So, the reaction function of the Cournot reaction function is such that marginal revenue is actually equal to marginal cost, okay. And we have done this while looking at the iso-profit curves of the firms, while doing Stackelberg, right? So, now, let us get this marginal cost first. Define the marginal cost based on this cost function.

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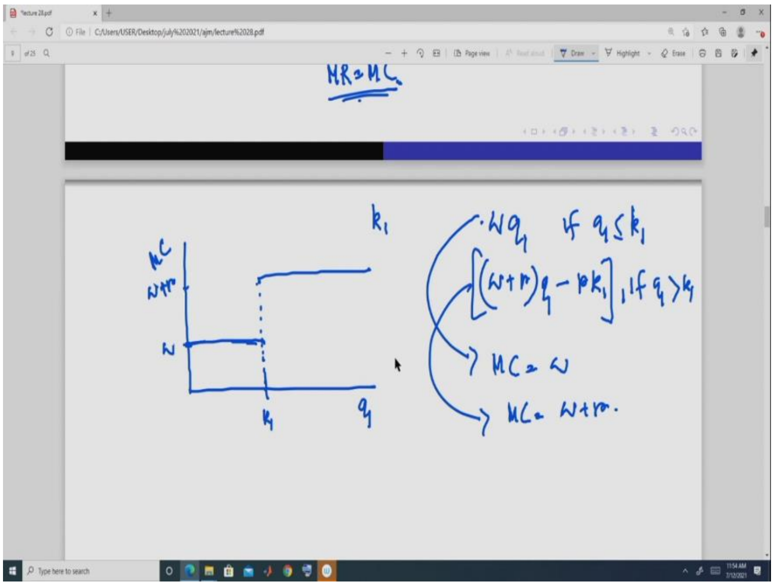

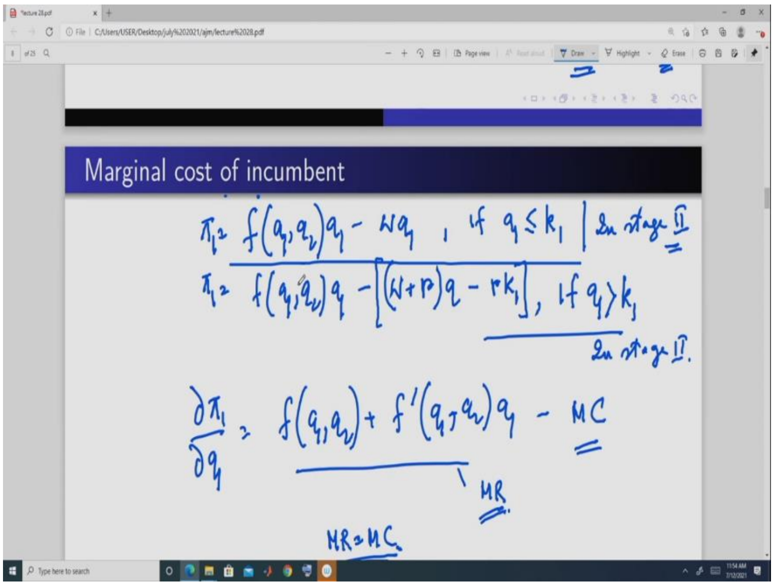

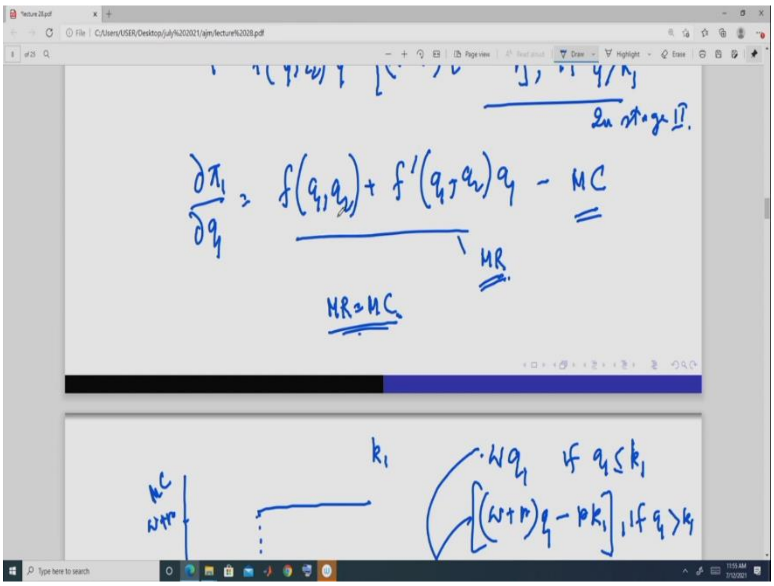

So, suppose k1 is the capacity and k1 is this. In this axis we take the output of firm 1, in this axis marginal cost. So, till capacity its cost is this. So, suppose this is w, so till this much, its cost is this. Now, if q1 is less than equal to, small k1, but it is this-$[(w + r)q_1 - rk_1]$. If q1 is greater than k1. Or the here, in this, these are the total cost so M C is w. There M C is w plus r.

So, suppose this is w plus r. So, from here, so the marginal cost is a horizontal curve, but it is stepwise. So, it is this much, still this much output. And from here it is this, okay. This is the marginal cost. Now, what is the objective of firm 1? Firm 1, while choosing its output, because we are going to find the subgame perfectness equilibrium, now to find the subgame perfect Nash equilibrium, we use backward induction. So, that is, we first take the last stage.

So, here in this game, the last stage is which game? Last stage is the Cournot competition, provided firm 2 has entered, right. Here, so in Cournot competition, firm 1 will try to maximize this profit, which is given by this here, either it will maximize this or it will maximize this, depending on its capacity k1.

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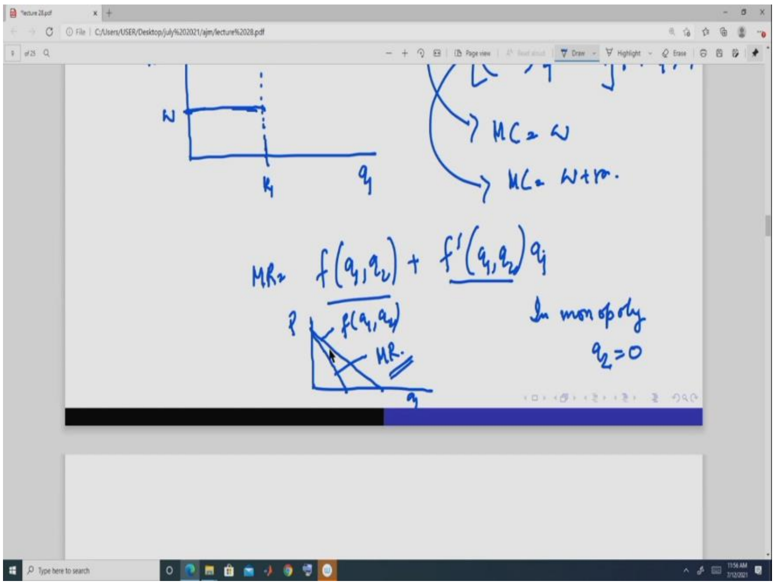

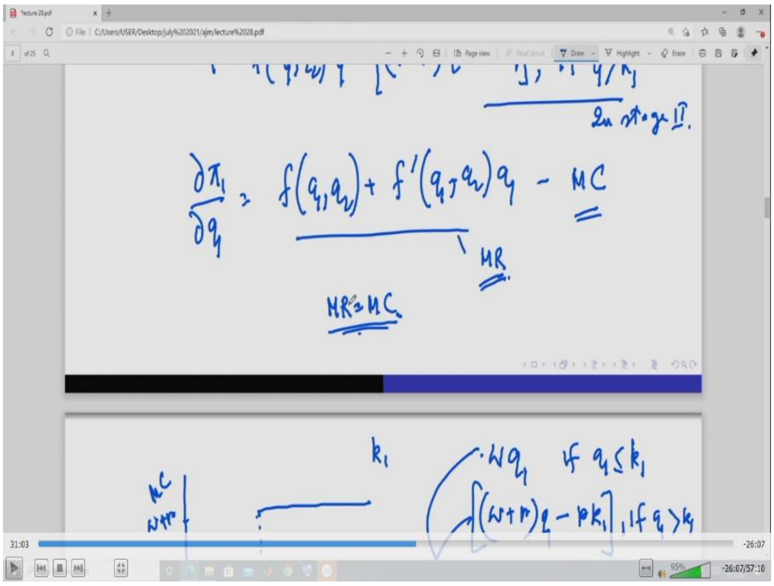

So, these marginal revenue curves, these, these marginal revenue, see, they are, we know marginal revenue curve is this, for a general demand function, downward sloping demand function. This as-$f(q_1, q_2) + f'(q_1, q_2)q_1$, is a downward sloping, right? if we take the output here and if we take this, it is downward slope.

Since if we take the price here, this is the demand function, this portion is going to be the negative into a, so into the output, so it will be somewhere here, this is the marginal revenue. We have done this while doing the monopoly thing. But in monopoly, what we have done? We have taken this is equal to 0. But here, here it will take some positive amount. Now, see if the q2 takes a higher value, this is going to be.

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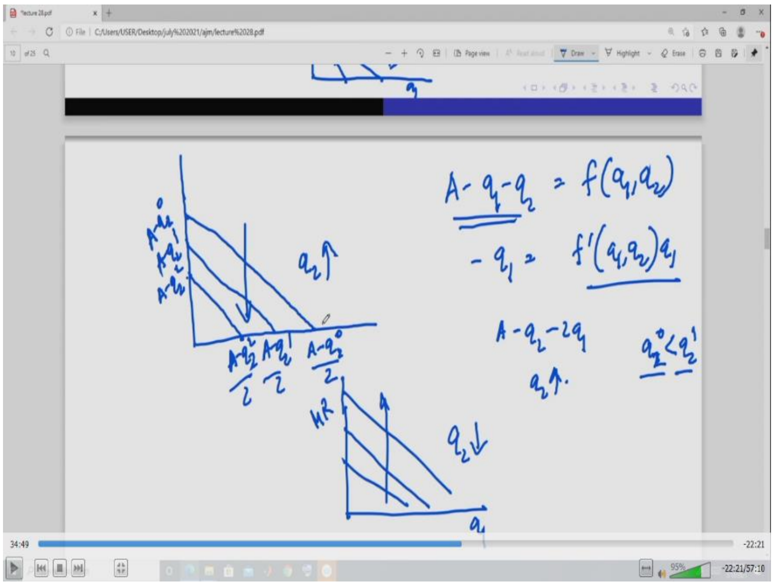

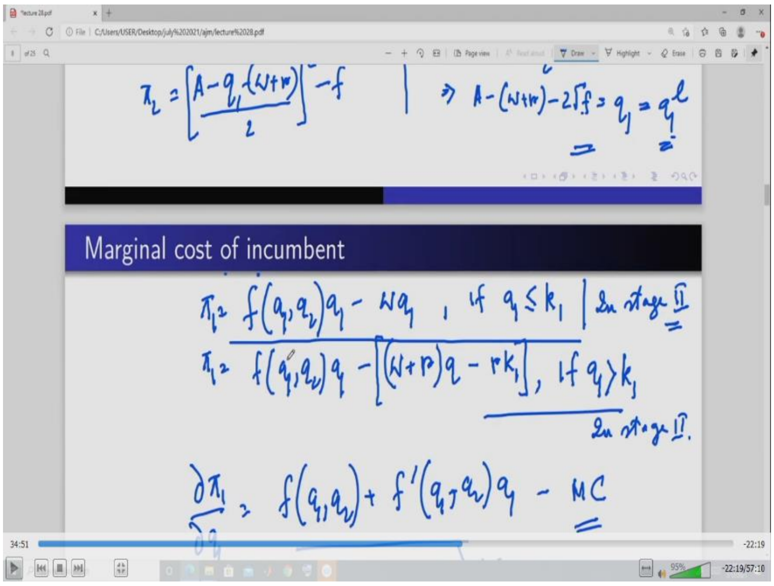

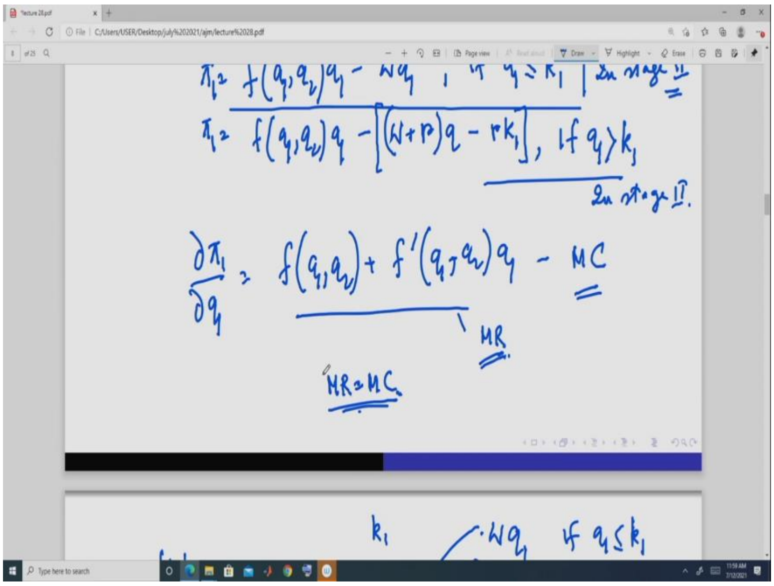

Let us take an example. And it will be clear. So, this is the f. This is the inverse demand function you can think-$A - q_1 - q_2$. And if we take the derivative of this with respect to q1, it is minus 1 and into this, so it is this. Now, if you look at this, this curve, now fix one q2 and this point is going to be this and this is going to be, it is this.

Now, if you increase the q2 suppose q2 is increased, then what will happen? This is going to go down, suppose instead of bar fix q2 at q not, then this is suppose q2 1 this is q2 1, and q21 is greater than q not 2. So, we will get like this. Suppose take this. This is q2 2 and this is suppose a q2 2. So, as q2 increases, we move in this direction and we go this way, when q2 falls. This is marginal revenue, right?

And from this a and also from profit maximization, what we have done in Cournot? We know at the optimal output there this marginal revenue should be equal to marginal cost. Because the given output of firm 2, the reaction function, output of firm 1 is given by the reaction function of firm 1, okay.

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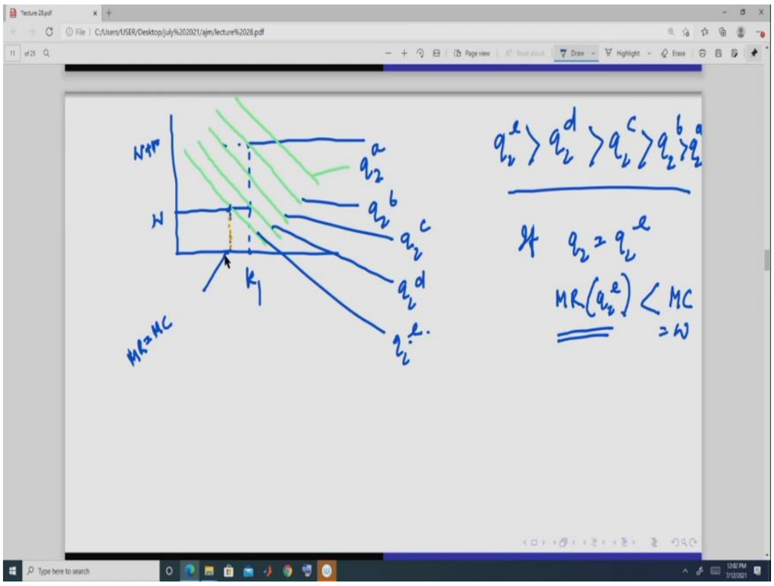

So, it is going to be something like this. Now, suppose this is one marginal revenue. It is like this. This is for suppose q2 is a, this is suppose q2 b, this is suppose q2 c, this is suppose q2 d, and this is suppose q2 e. Now, from here, if we look at this marginal revenue curves, we get that q2 e should be greater than q2 d, c, b, a, right? We get this ranking of the output of firm 2- $q_2^e > q_2^d > q_2^c > q_2^b > q_2^a$.

Now, here what is happening? At this point, what is happening? At this output, M R which is given here, is equal to M C, which is this. Capacity is this. But if I produce this much in this, so what do we get? We get that if the output of firm 2 is this, then we should, my output is given by this. Because marginal revenue equal to here. Because here, if I look at my capacity here, okay what is happening? Marginal revenue is this much. Marginal cost is this.

So, at this capacity, if q2 is q2 e, marginal revenue this, this is less than marginal cost and what is the marginal cost here? w. So, definitely it is less than w plus r. So, in this situation what is going to? Optimal output is this. From that a Cournot thing. So, the reaction function is going to be, it is going to produce less than its capacity.

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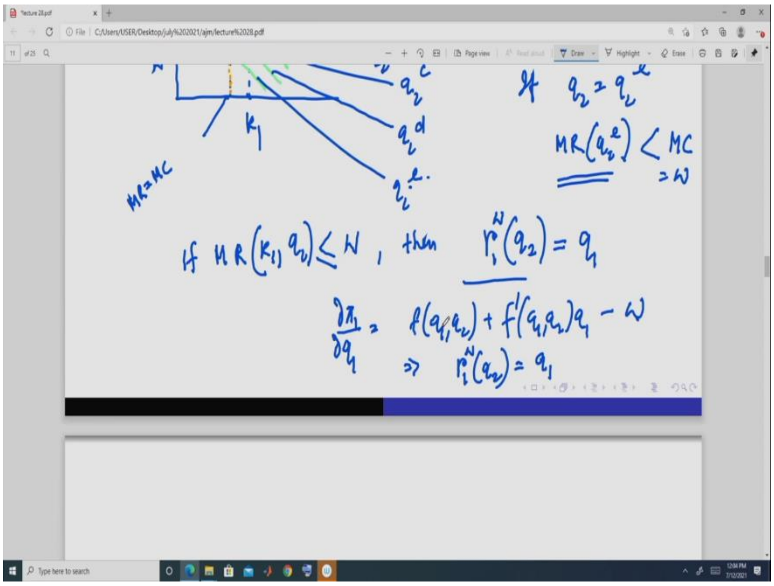

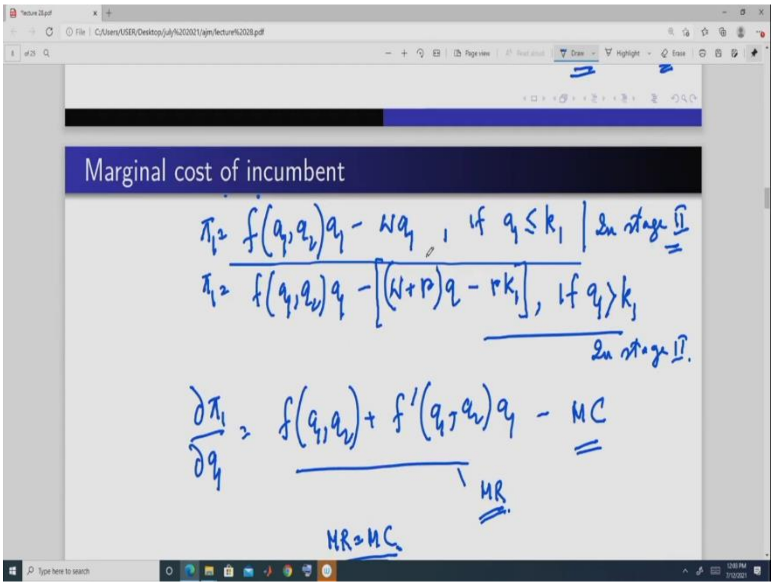

So, that is why, what do we get? So, we write the reaction function in this form. So, if marginal revenue at this, suppose, firm 1 is producing its capacity, and firm 2 is producing some amount, some amount it can be of any of this point, if this is less than w, less than equal to w, then reaction function of firm 1 given some a, is going to be, what? It will going to be based on only w.

So, it is going to be, from here and we get this. If it this, we get this. Why? Because, if we take the derivative with respect of the first equation, then it is, we will do a specific example, so that will be more clearer to you. It is going to be this only-$f(q_1, q_2) + f'(q_1, q_2)q_1 - w$. Till this much, if the q2 is this and suppose, firm 1 produces this, then here, marginal revenue is equal to 1, right?

So, this is going to be the optimal Cournot thing. Marginal revenue is equal to marginal cost, right? So, it is going to be given by this. And so this reaction function is, since the marginal cost is this, we write it in this form. We denote it w only, is equal to this-$p_1^w(q_2) = q_1$, okay. Now, suppose, q2 is here, here take this. In this what is happening?

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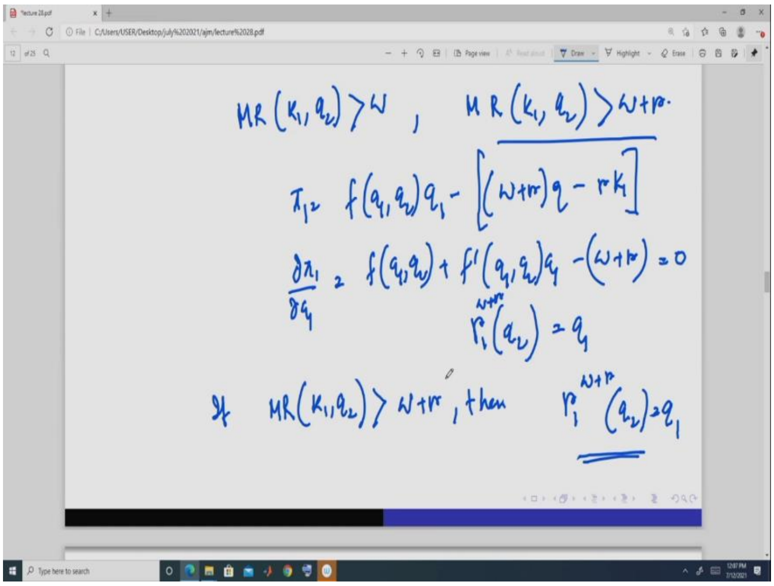

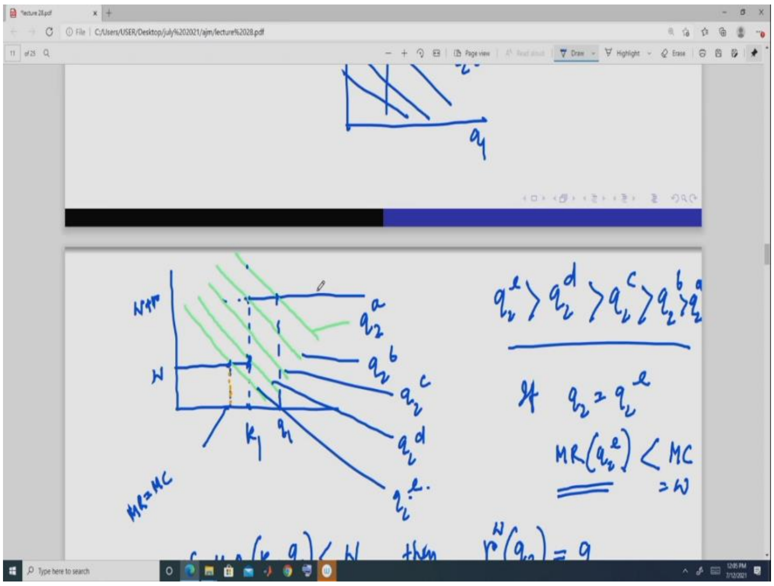

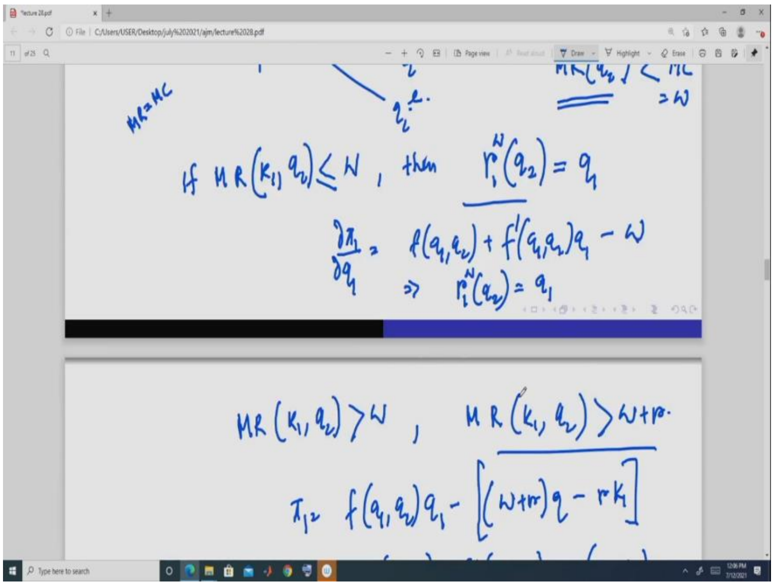

Marginal revenue is greater than w. It is greater than w and it is greater than w plus also. Further, is greater than. So, since it is greater, marginal revenue is greater and marginal cost is here, so it is better to produce some more output, so that you get more additional revenue is more than the additional cost. So, you will produce up to this much amount of output, right?

So, here your cost function is your profit function in this Cournot is going to be this- $f(q_1, q_2)q_1 - [(w + r)q - rk_1]$. This so, your reaction function. So, this portion remains same as this. But here it is this, w plus r and it should be equal to 0. So, this reaction function, we denote as w plus r is equal to. So, if this is the case then if marginal revenue is greater than, here also, this, it should be always greater than actually, greater than-$MR(k_1, q_2) > w + r$. Then w plus r then the reaction function is this-$r_1^{w+r}(q_2) = q_1$.

Now, if it is here, from this point to this point, anything, marginal revenues, here marginal cost is same as marginal revenue, here marginal revenue is more, but if it produces more, so it will, marginal cost here, but marginal revenue here, so it will not produce. Here if it produces, marginal revenue will be here, marginal cost is going to be here. So, it will not produce.

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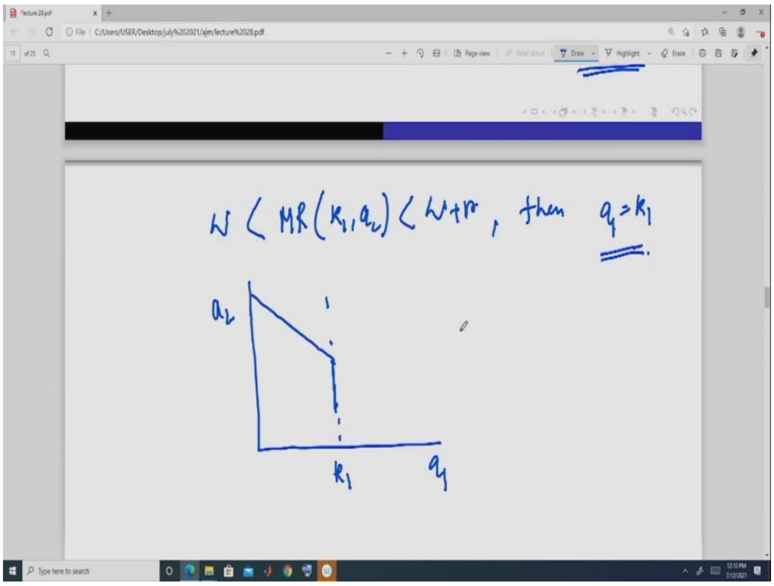

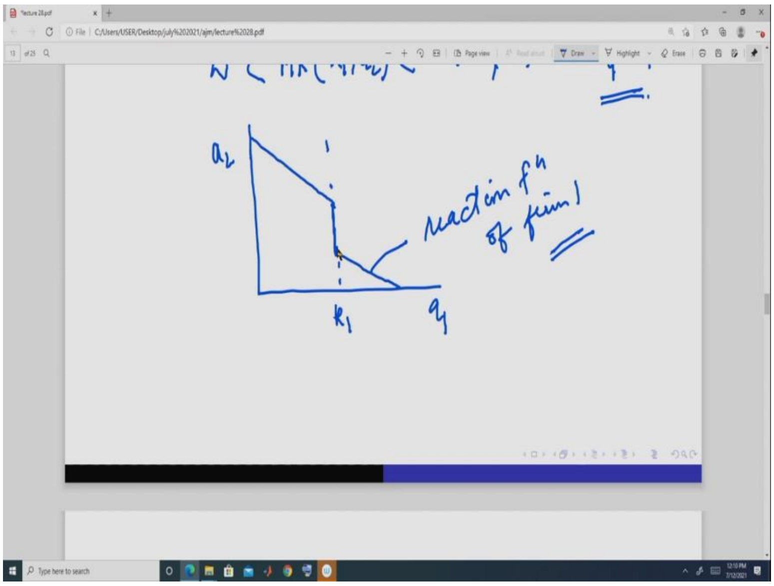

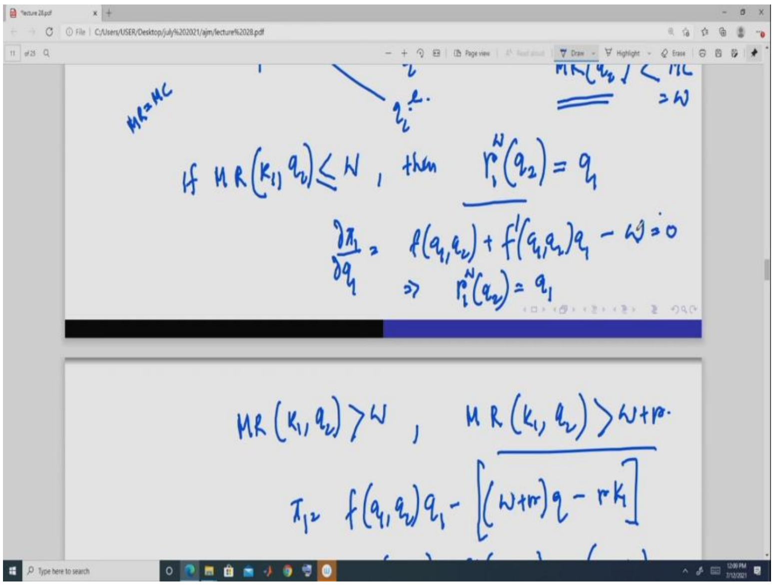

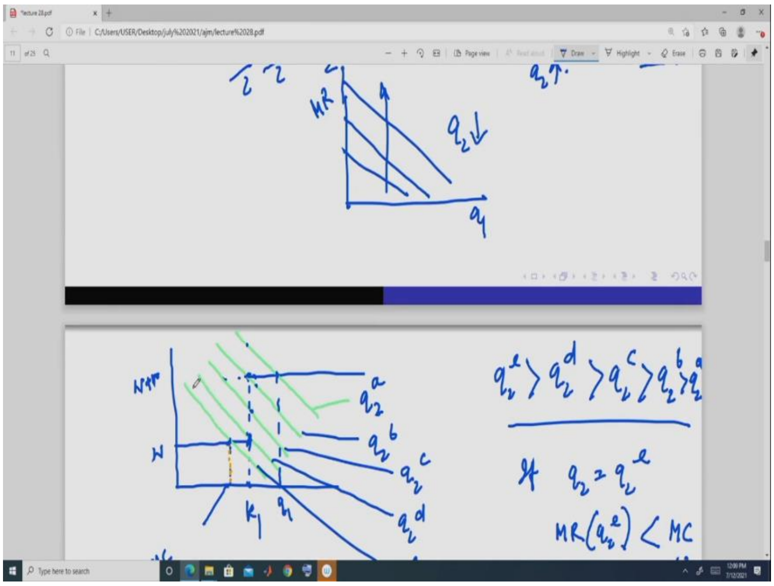

So, in this range, if the output is such, output of firm two is such that the marginal revenues are of this nature, that is, if the marginal revenue of, if it lies between this and this-$w < MR(k_1, q_2) < w + r$, then it will produce same, up to its capacity. I got this. Then this means what? So, this means, see, we can now draw the reaction function of firm 1. This is output of firm 1, this is output. Suppose capacity is this, k1.

Now, from here, what do we have got? This is the reaction function, when this and when the marginal revenue is this, when this is the marginal revenue, when the output of firm 2 is very high. So, that means, when output is here. So, if it is here, then in this case, so marginal reaction function is given by this a-$p_1^w(q_2) = q_1$. And this reaction function so it is given by this, equal to 0. So, it is suppose something like this.

Now, at from this, this region, this region, so some intermediate amount of q2. So, here it will be producing only q1. So, for some this, it will be some amount like this. Then again if it was like this, for these curves, or when the marginal revenues are like this, so here it is increasing, right. So, output of firm 2 is less and less. So, it will be here. Here in this position. So, then reaction function is given by this region, this portion. So, it will be like this. So, this is going to be the reaction function of firm 1, okay. So, it is going to be kink at the capacity. This so, let us do 1 example and it will be clear to you.

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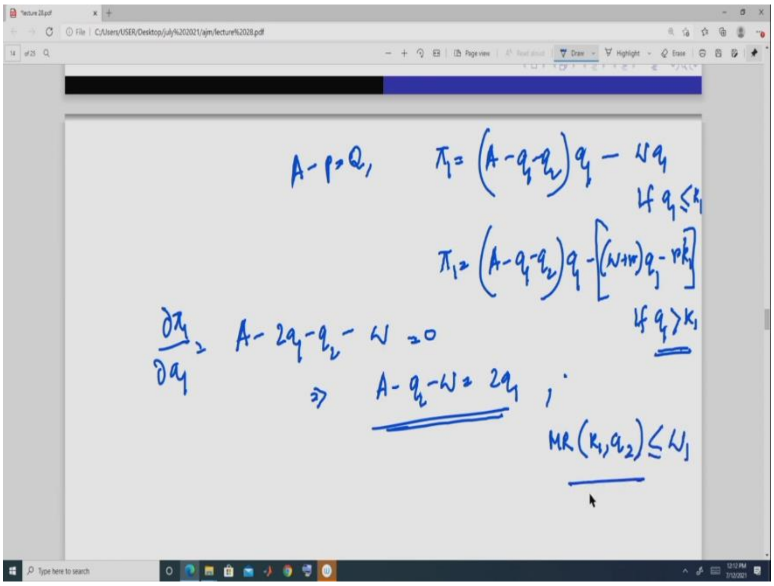

Suppose the market demand function is A p is equal to q- A-p=Q. So, the profit function of firm 1 is-$\pi_1 = (A - q_1 - q_2)q_1 - wq_1$. If this is less than equal to k1 and it is going to be this, okay-$\pi_1 = (A - q_1 - q_2)q_1 - [(w + r)q_1 - rk_1]$. Now, here if we take the derivative of this, it is this-$A - 2q_1 - q_2 - w = 0$. So, this is the reaction function-$A - q_2 - w = 2q_1$. So, this is the reaction function, when. Again.

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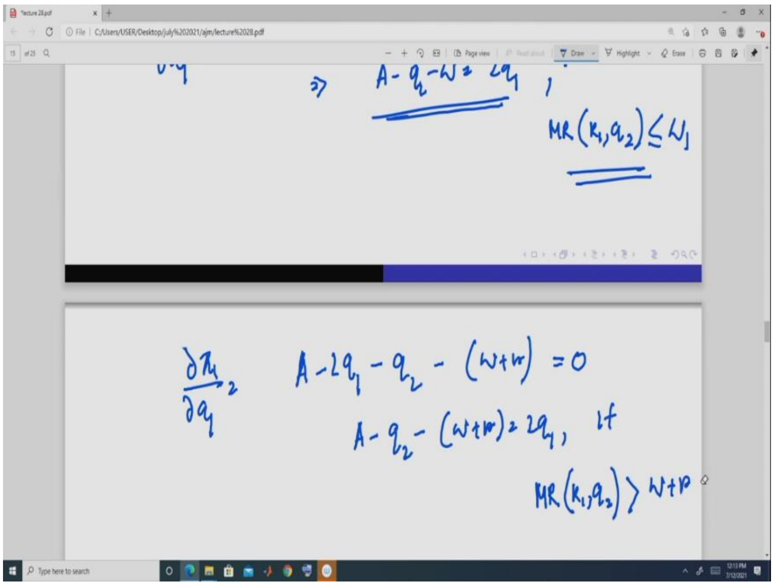

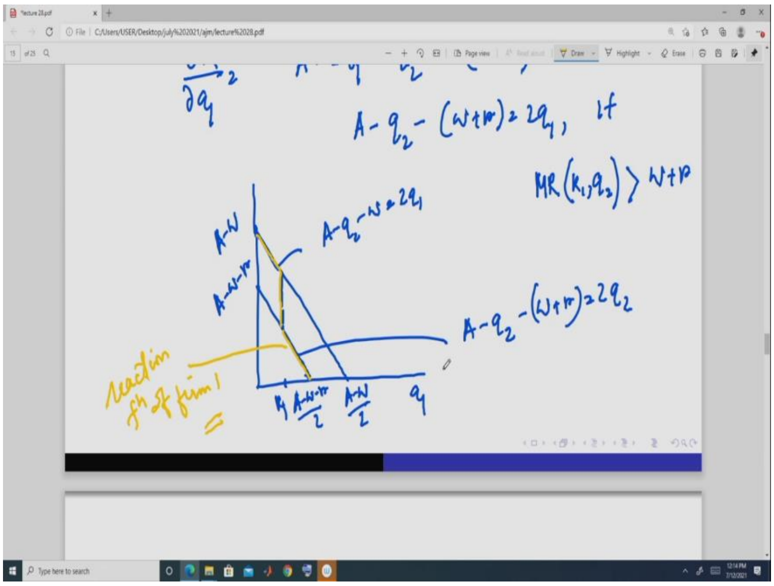

So, this is equal to 0, is reaction function, if it is w plus r-A $- q_2 - (w + r) = 2q_1$. So, but, if we try to plot these two-reaction function, it is going to be this. It is this. Now, this function is this one, so this is and this is. Suppose k is here, so reaction function of it is going to be this, this, this. So, this is the reaction function of firm 1, this yellow line. So, it is kink like this, if k is this.

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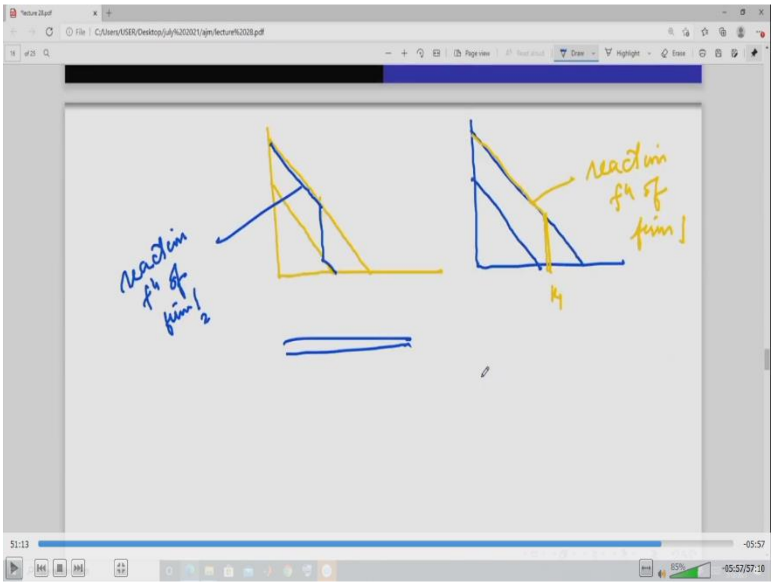

Now, if k is here, then the reaction function is going to be like this, this blue line. Now, we may have a situation like this. This is k1. Reaction function is this. This is the reaction function of firm 1. Here this blue line is the reaction function of firm 1. So, we have understood the reaction function of firm 1. It is going to be of this nature, right? We have solved 1 example also.

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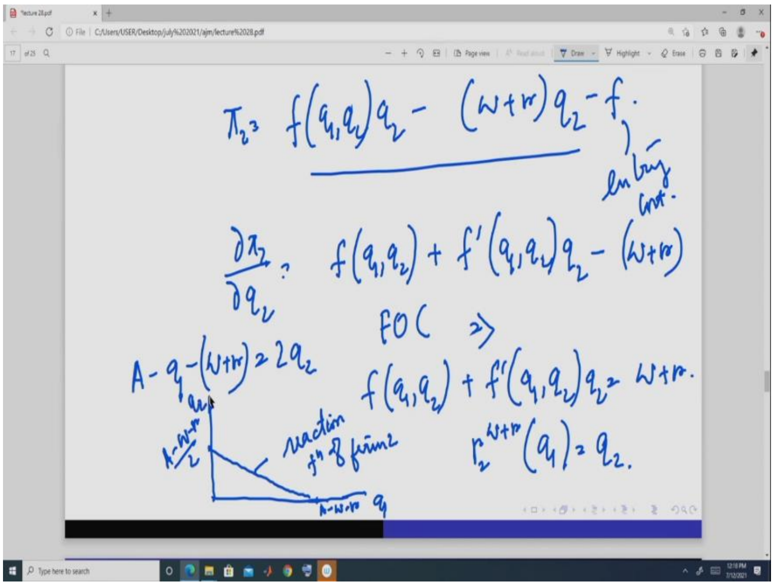

Now, what is going to be the reaction function of firm 2? Firm 2, its reaction function, if we take the general demand function, profit function is this, f-$\pi_2 = f(q_1, q_2)q_2 - (w + r)q_2 - f$. This is the entry cost. So, it is going to be-$f(q_1, q_2) + f'(q_1, q_2)q_2 - (w + r)$. So, first order condition implies what? This, so, we will get the reaction function. Reaction function of firm 2 is always going to be this-$f(q_1, q_2) + f'(q_1, q_2)q_2 = (w + r)$.

And if we plug in here, then it will be going to be-$A - q_1 - (w + r) = 2q_2$. So, two q2. So, it is, this is going to be a minus by 2, and this is suppose, so this is the reaction function of firm 2. In this axis we have taken q1, in this axis we have taken q2, like this we will get. So, we know the reaction functions of firm 1 and reaction functions of firm 2, okay.

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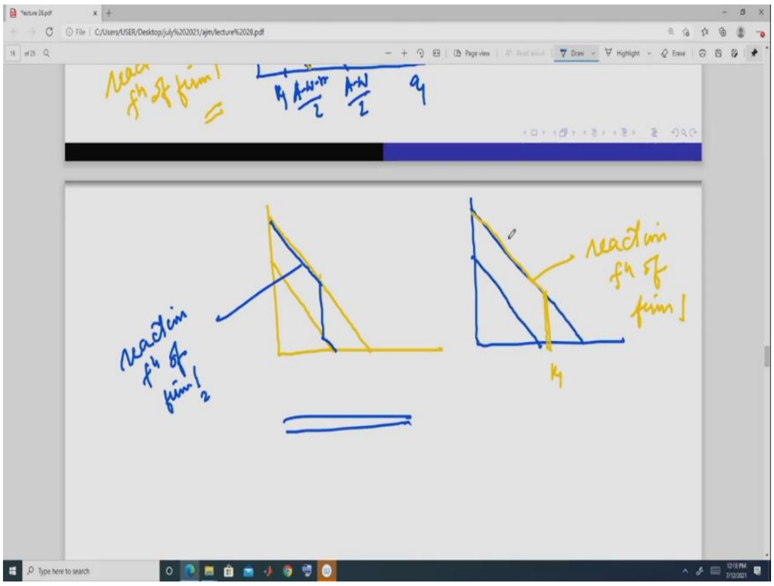
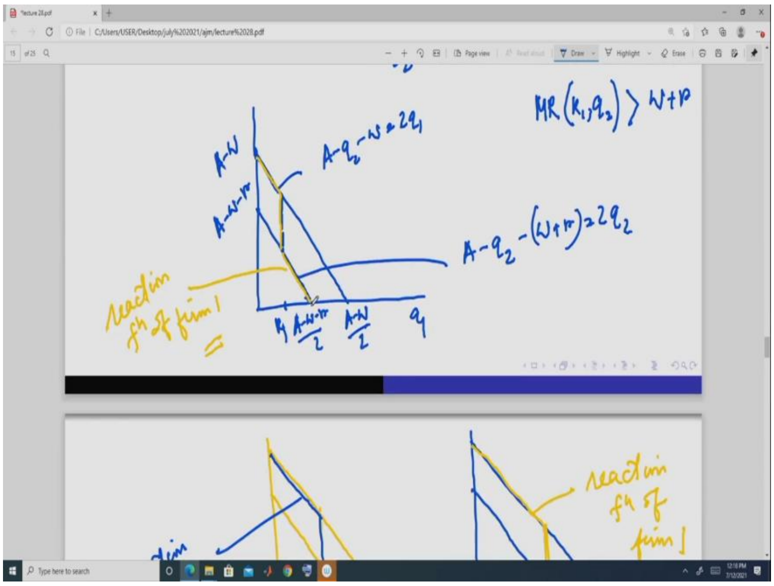
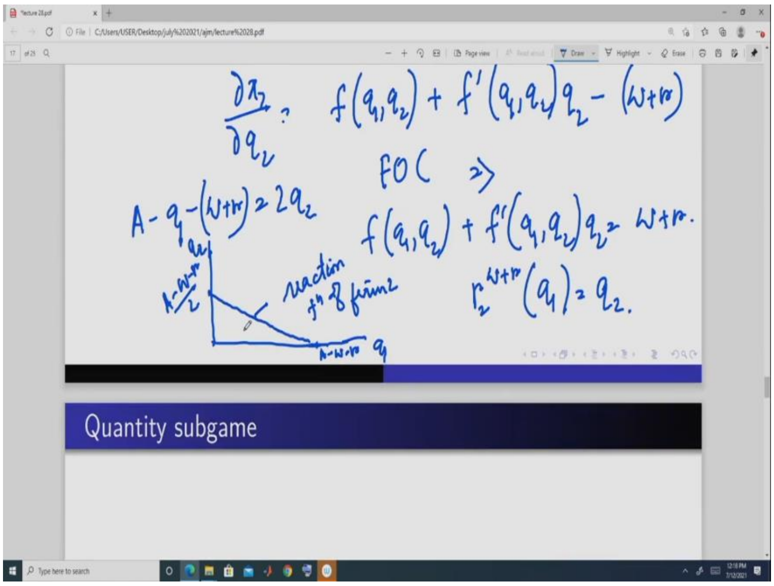

reaction fn of firm 1
reaction fn of firm 2
reaction fn of firm 1


MR(k1,q2) > w+r
A-q2-w=2q1
A-q2-(w+r)=2q2
reaction fn of firm 1
A-w
A-w-r
q1


∂π2/∂q2 = f(q1,q2) + f'(q1,q2)q2 - (w+r)
FOC ⇒
A-q1-(w+r) = 2q2
f(q1,q2) + f'(q1,q2)q2 = w+r.
reaction fn of firm2
r2^{w+r}(q1) = q2.
q1
Quantity subgame

So, firm 1's reaction function is kinked. It can be of this nature, it can be of this nature or it can be of this nature, right. And firm 1’s reaction function is this.

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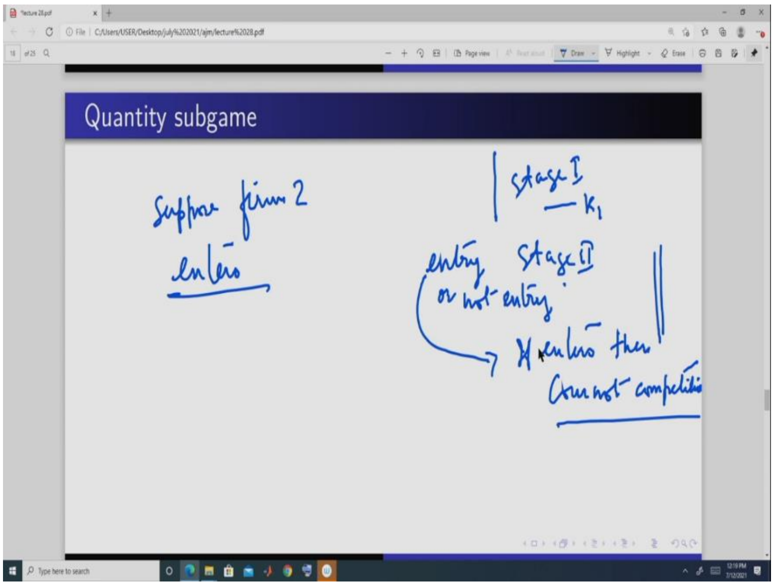

Now, we try to solve this game. So, this game, it is like this. In stage 1, this is decided, small k1. In stage 2, entry or not entry. If enters, then Cournot competition, right? So, this is the a. So, we suppose, firm 2 enters. So, in this stage, this is going to be the last stage, quantity competition, that is the Cournot competition. So, we will do that first, okay. And then we will move backwards.

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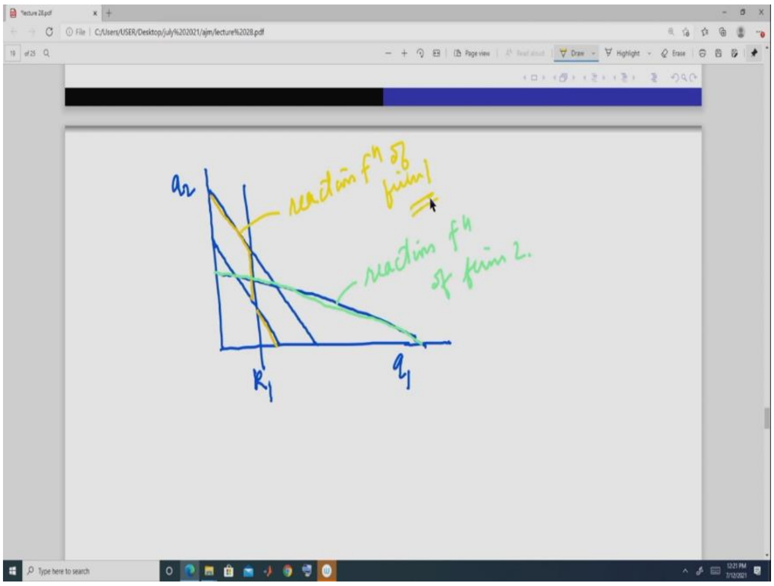

So, one possibility can be of this nature. Suppose this is q1 and this is q2, and this is suppose k1, okay. And this is the reaction function of. So, this yellow line is the reaction function of firm 1, okay. And this green line is the reaction function of firm 2. Firm 1 given capacity k. We get this, because the capacity is this.

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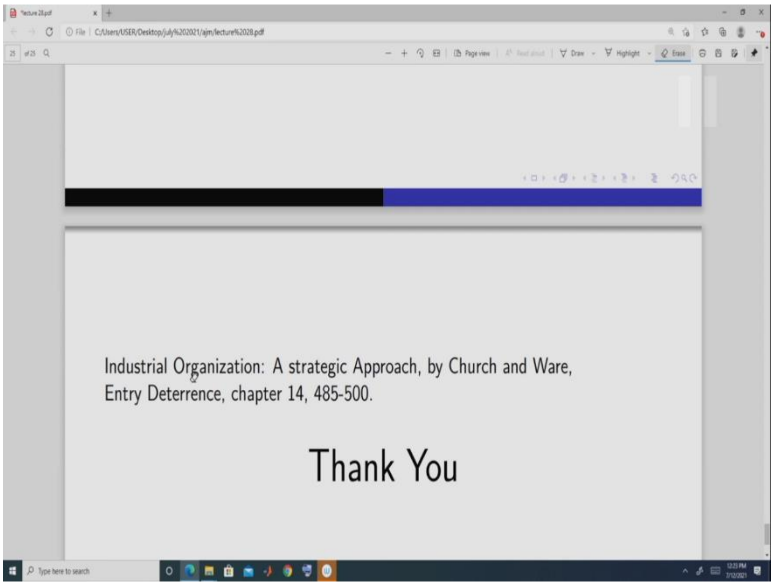

You can read this portion from this chapter 14 of this book by Industrial Organization: A Strategic Approach, by Church and Ware, Entry Deterrence. This chapter is entry deterrence and these are the specific page numbers. So, thank you now. So, we will continue this in the next class.