Introduction to Market Structures
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Module 12: Entry Deterrence, Bundling and Tying
Lecture 41
Dixit is Model of Entry Deterrence

Okay, Hello everyone! Welcome to my course, Introduction to Market Structures.

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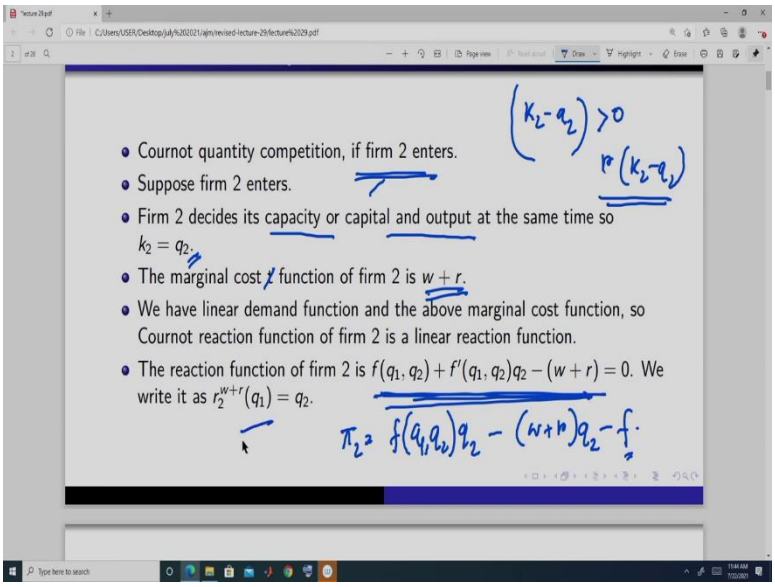

So, we were doing entry deterrence model and specifically we were doing the Dixit model. So, in the last class we have derived a reaction function of firm 1 and the reaction function of firm 2 given that firm 2 enters. Now, firm 1 here is the incumbent firm. So, it can invest in its capacity which is same as capital and firm 2 is an entrant firm and it enters if it is profitable for that firm to enter. If its profit is 0 if it enters, then that firm does not enter, okay.

So, today we are going to solve this problem and we are going to solve this assuming a general downward sloping demand curve, okay. Suppose we assumed at the firm 2 suppose enters, okay. So firm 2 enters, okay. So, when it enters we know there is Cournot competition, okay. So, based on that we will get that there are Cournot reaction functions, but the reaction function of firm 1 is going to be slightly different than the usual Cournot reaction function that we have done a while doing the Cournot oligopoly or Cournot duopoly but for firm 2, it is going to be same as the Cournot reaction, okay.

Now further firm 2 decides its capacity and capital at the same time, okay. So, it is this, so it means that when it is deciding his output at the same time it is deciding the amount of capacity

it wants to have. So, it will never going to have capacity more than its output. So, if it is more so, if suppose capacity is this-$k_2 - q_2$ and it produces some amount this and this amount is suppose positive, then the cost on this excess capacity is this much-$r(k_2 - q_2)$.

So, it is not going getting any return on this excess capacity. So, that is why it is not optimal strategy for firm 2 to have a capacity higher than its output. So, that is why k2 is always going to be equal to q2 that is output of firm2. And marginal cost, function of firm 2 is this- w+r because it decides its capacity and the labor at the same time.

So, and since suppose we assume that the demand curve is linear, then we get the reaction function of firm 2 in this form-$f(q_1, q_2) + f'(q_1, q_2)q_2 - (w + r) = 0$. Why do we get this? Because we take the profit function of firm 2 can be written in this form this is suppose the demand curve or demand function output of firm 2, so this is the total revenue, this is the total cost for on production and the cost for entry is this. So this is the profit- $\pi_2 = f(q_1, q_2)q_2 - (w + r)q_2 - f$ and if we take the derivative with respect to q2 we get this reaction function, okay and we denote it in this way which is a function of q1, output of firm 1, okay.

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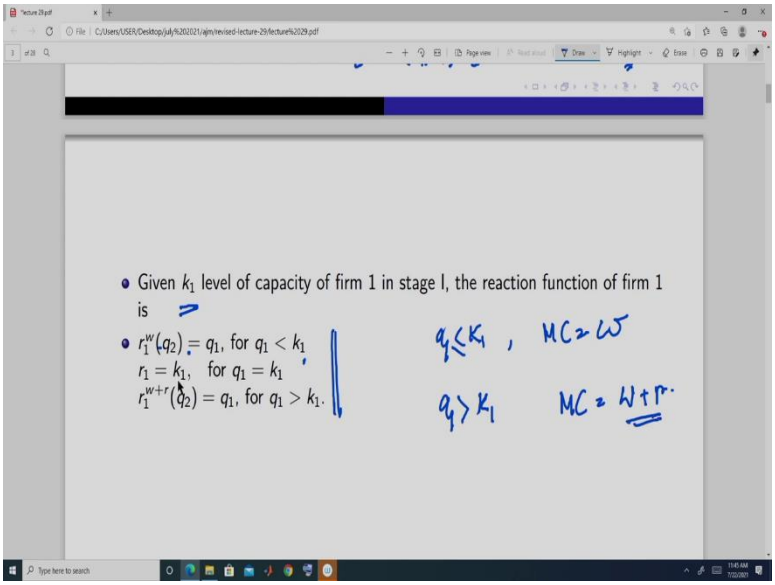

And reaction function of firm 1 suppose there is a k1 capacity which is an arbitrary number, okay in stage 1. Then the reaction function of firm 1 in stage 2 it is given like this, this is the case- $r_1^w(q_2) = q_1$ when q1 is less than k1. So, when the it is producing less than its capacity, then it requires marginal cost is only this. So, when q1 is less than this less than equal to this, marginal cost is only w. And when q1 is greater than this k_1, then the marginal cost is it is this-

w+r, because it has to now expand its capacity. So, that is why from there we get this and we have done it in detail in the last class, okay.

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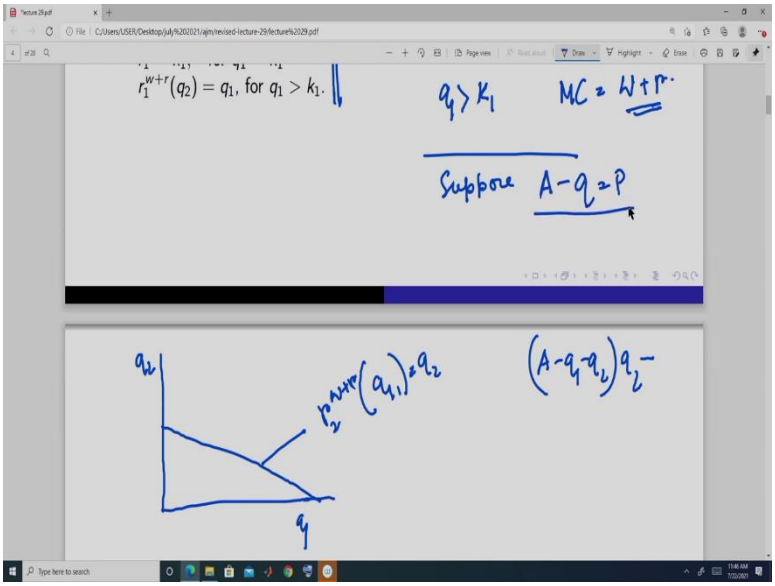

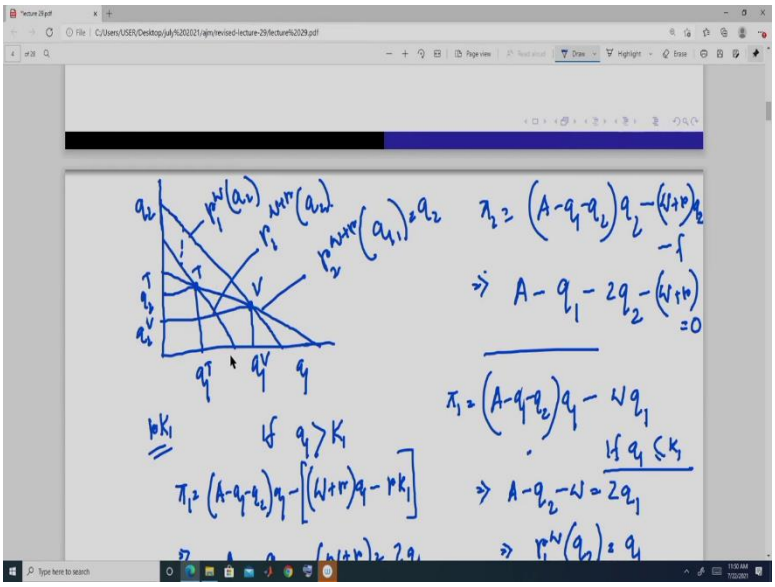

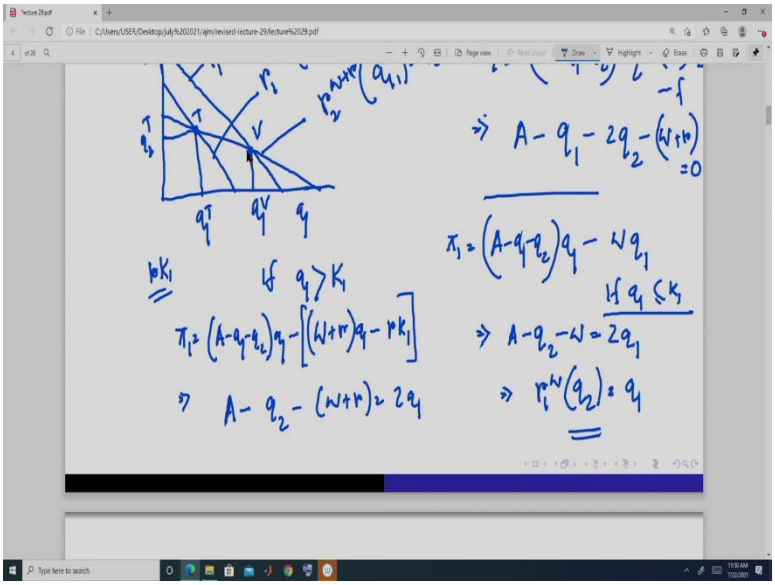

Now, we will denote some specific outputs and our analysis will be based on those outputs suppose this is the output of firm 1 output of firm 2 and this is the reaction function of firm 2, okay this is, now here you can look at suppose the demand curve is this. Demand curve, so let us write here, suppose demand curve is this-A-q=P, okay then we get this, this is the profit function- $\pi_2 = (A - q_1 - q_2)q_2 - (w + r)q_2 - f$ and reaction function of firm 2 it is this- $A - q_1 - q_2 - (w + r) = 0$. So, it is this thing and the reaction function of firm 1 is like this-$\pi_1 = (A - q_1 - q_2)q_1 - wq_1$.

So, this is what, this it is this, this is reaction function- $r_1^w(q_2) = q_1$ if it is this suppose some k, k is big enough. So, we get this and the reaction function if output is greater than is this, then so it will be because it will be producing till it is k1, based on this capacity it will be this, in the A additional amount will be based on the, **so**, the marginal cost is this, not the total cost.

So, total cost for A because it has already incurred this much cost this in stage 1, right. So, it will be this one and so, the reaction function of firm 1 is… So, it is something that was this and this reaction function is this of firm 1. Now, this is the symmetric output, because this is the reaction function and this is the reaction function. So, we take this point to be the point T and this is this asymmetric thing, this point is V and this is V.

This is the Cournot outcome when we have reaction function is this, this-$A - q_2 - w = 2q_1$ and if from here, now, if we can have k here and the reaction function of firm 1 is this. If k is here then the reaction function is like this, okay we have done that.

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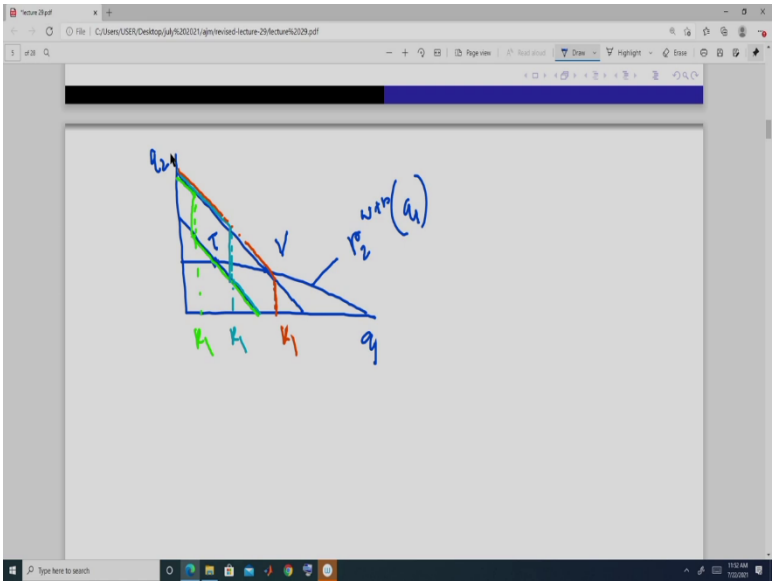

Now, what do we can see here this is the point T this is point V. So, we can have the reaction function of firm 1, if this is k1 then the reaction function is this green line we may have a situation like this if suppose this is k1, then this light blue line is the reaction function of firm 1 and if this is k1, then the red line is the reaction function of firm 1 and we will do the…

So, the reaction functions are of this nature and we will now see that what is the outcome in stage 2. Why we are looking at stage 2? Because it is a two stage game and in a two stage game we look at subgame perfect Nash equilibrium and in subgame perfect Nash equilibrium we solved it using backward induction.

So, we will first solve the stage 2 assuming that suppose firm 2 enters, because moment firm 2 enters there is Cournot competition and we now we have defined the reaction functions of firm 1 and firm 2 here. Now first in the stage 2 we may have a situation where firm 1 needs to expand its capacity. When do we see that?

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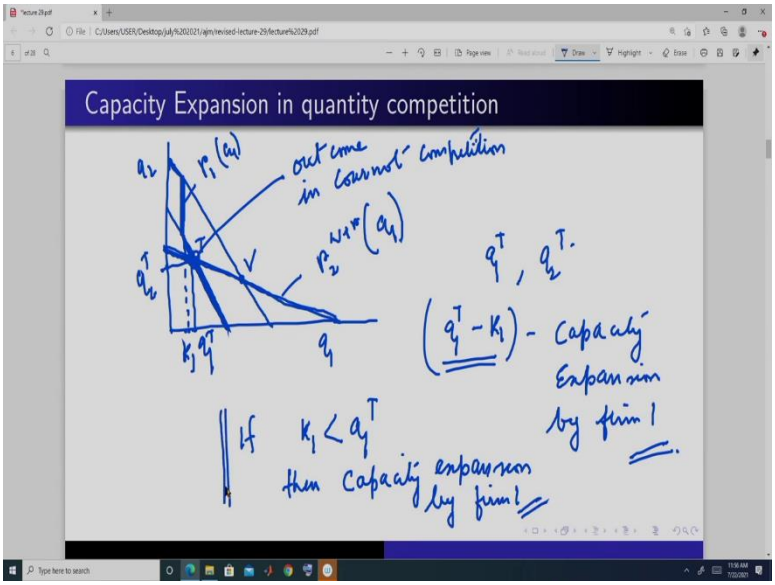

Suppose this is the outcome, this is q1, q2, this is the reaction function of firm 2, okay. This point is V this point is T and suppose K is here. So, the reaction function of firm 1 is this thick blue line, okay. Now, if this is the reaction function of firm 1 and the reaction function of firm 2 is this, then they intersect at this point. So, the outcome in stage 2 is this point, so this is the outcome in Cournot competition, right?

So, if this is the outcome in Cournot competition because this is the reaction function of firm 1, okay this line, this kink line. So, they intersect here, so, what is the output of firm 1? Output of firm 1 is this, output of firm 2 is this capacity of firm 1 is k1. So, this much amount-$q_1^T - K_1$ it has to expand. So, this much is amount of capacity expansion by firm 1, okay in this situation. Because this is the reaction function of firm 1 and this is the reaction function of firm 2 they intersect here.

So, this point is the Cournot outcome, Cournot quantity competition outcome. So, the output of firm 1 is this, output of firm 2 is this and here this much, this is greater than the capacity of firm 1. So, this so, it will lead to an capacity expansion by firm 1, okay. So, in this what happens if k1 is less than this output q1 T, then we see that there is capacity expansion by firm 1, this is the outcome in this kind of scenario when the capacity of firm 1 is not sufficient.

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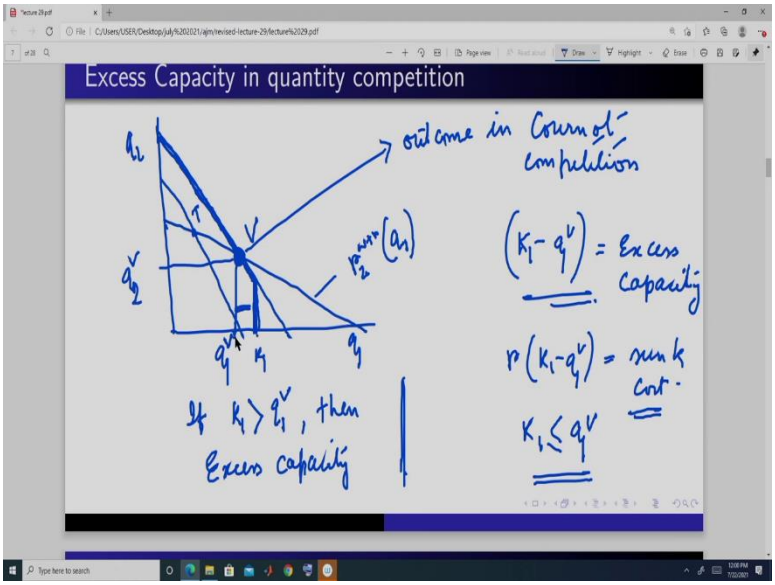

Now let us when we have excess capacity, firm 1 may have a situation where it has excess capacity. So, this is suppose the reaction function of firm 2. So, this point is p and this point is v we know these points, okay. Now suppose the capacity of firm 1 is here k1. What is the reaction function of firm 1? Reaction function of firm 1 is this thick blue line, kink at this point and reaction function of firm 2 is this, this point is the outcome in Cournot competition.

Now, if this is the outcome in Cournot competition, what is the output? This is the output of firm 2, this is the output of firm 1; okay capacity is this much, so this much sis the excess capacity k1, this should be small k, okay q1 V. So, this is the amount- $K_1 - q_1^v$ on excess capacity. Now, what is the cost in this?

This is you can say, this is equal to sunk cost, because firm 1 is not going to get any return on this. So, firm 1 will never want to have this unnecessary cost because it is not getting any return to this. So, that is why here we get that the k1 should always be less than equal to q1 V, this is the outcome- $K_1 \leq q_1^v$. And here this is the excess capacity and when do we get excess capacity? When k1 is greater than q1 V.

So, if k1 is greater than this output of, this much level of output of firm 1, then there is excess capacity, right? we get this. Now, when this is one outcome and firm 1 we will never want to have excess capacity here because if it has then it is a sunk cost for it, this much amount of cost is it is not getting any return on it, it is unnecessary. Because if it has this then also the outcome is this, okay if capacity is here is equal to this outcome is same. So, this must cost is unnecessary.

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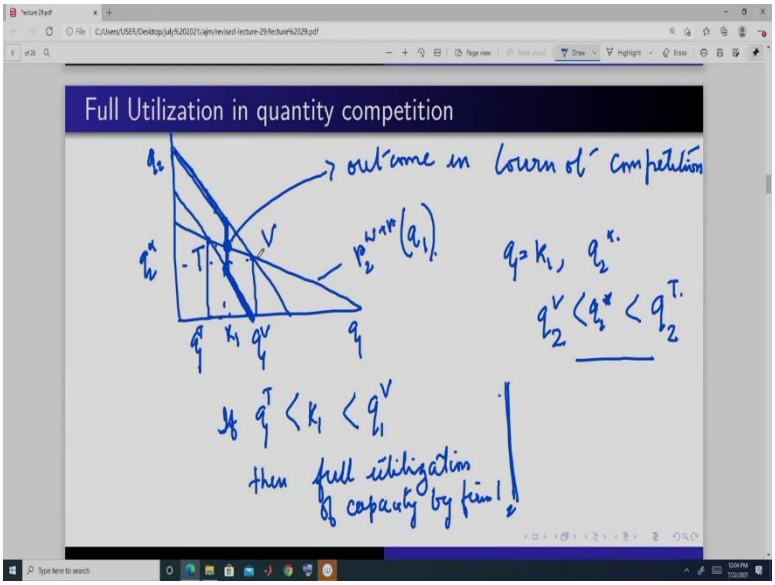

Next, let us look at when there is full utilization of capacity. Suppose this is the reaction function of firm 2, This is T and this is V, okay as we have already defined, okay. Now suppose capacity is here, so the reaction function of firm 2 1 is going to be this blue line this and where do they intersect, they intersect at this point. So, this is the outcome in Cournot competition.

If this is the outcome, then what is the output of firm 2? Firm 2 produces this much and firm 1 produces this k1. So, kl is equal to this-q1 and this is q star, where, q star is greater than this much amount, q1 V, sorry, and it is less than this in this situation- $q_2^v < q_2^* < q_2^T$, okay and output of this. So, when, so here you can take any if you look at this any point here, K here, it will be like this only, here it will be like this. So, if k lies within this range then full utilization of capacity by firm 1, okay.

So, we have seen that in stage 2 suppose firm 2 enters, then what are the possible outcomes depending on the capacity of firm 1? So, if capacity is very low like this, then the firm 1 needs to expand this capacity and the outcome is at this point T point, if capacity is too much, then the outcome is at when firm 2 enters is at V and the firm 1 has some excess capacity.

If the capacity of firm 2 lies within this range, then the outcome is at this point which lies between in between T and V and there is full utilization of capacity, okay. So, these are the three possible outcomes when firm 2 enters in stage 2, okay.

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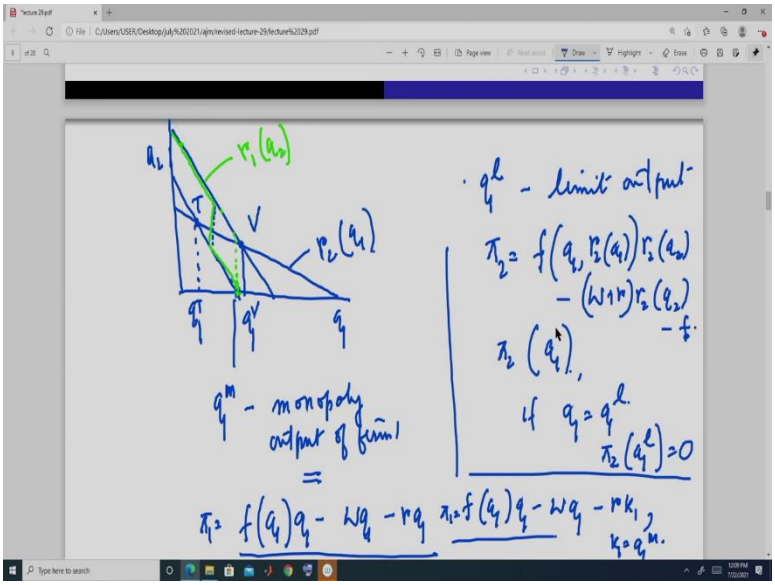

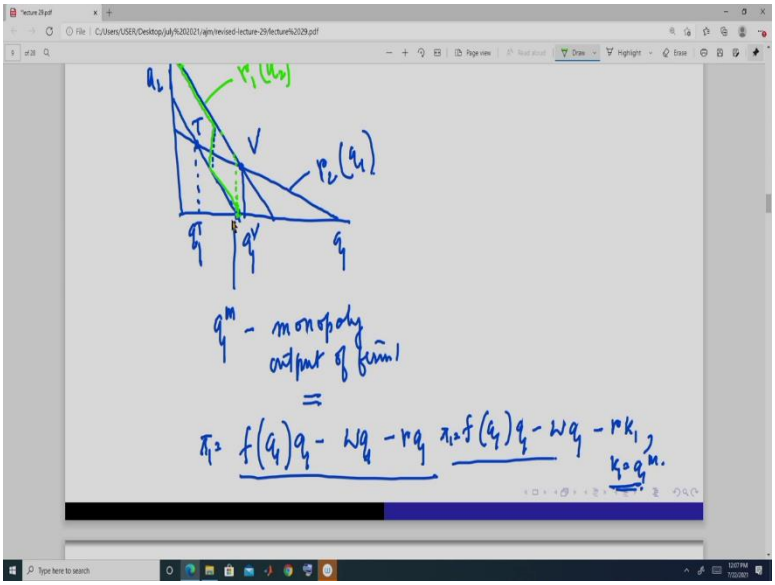

Now we will move to stage 1, but before moving stage 1 what we will do? We will define certain outputs of firm 1, because based on those outputs we are going to decide the optimal amount of capacity chosen by firm 1. So, let us look at this; this is the reaction function of firm 2, this is the point T and this is the point V, okay.

Now, this is the output of firm 2 which is q1 T, this is q1 V. Suppose capacity is somewhere here and we get a, suppose let us draw the reaction function by this green line, this is the green is the reaction function of firm 2 and this is reaction function of firm 1, okay. Now here this output is q1 m, this is the monopoly output of firm 1, okay. And in this monopoly outcome what do we have? The profit of firm 1 you can write this, here this much is going to be the output so, we will require this q1, this much amount of capacity also.

So, we can write it in this way and this is the monopoly profit-$\pi_1 = f(q_1)q_1 - wq_1 - rq_1$, okay. Now here this thing given or instead of this we can write it in such a way that to keep this same, where k1 is equal to this-$K_1 = q_1^m$, okay. This will also give me this point, okay because then the reaction function is going to be this point, this point okay and so this is going to be the monopoly outcome.

Now, we are going to also have another that is output that is this q1 l and this is the limit output, we have already defined what do we mean by limit output. Because we can write this profit of firm 2 can be written as a function of because we can write this… so, this function-$\pi_2 = f\big(q_1, r_2(q_1)\big)r_2(q_2) - (w + r)r_2(q_2)$ this is actually a function of q1 we can write it if we plug in the reaction function we get this.

Now, if this q1 is equal to output which is q1 l the limit output then it is this-$\pi_2\left(q_1^l\right) = 0$. So, that is why this is called the limit output of firm 1. If firm 1 produces this output, profit of firm 2 is going to be 0 we have to incorporate the entry cost also and the entry cost is F here, okay.

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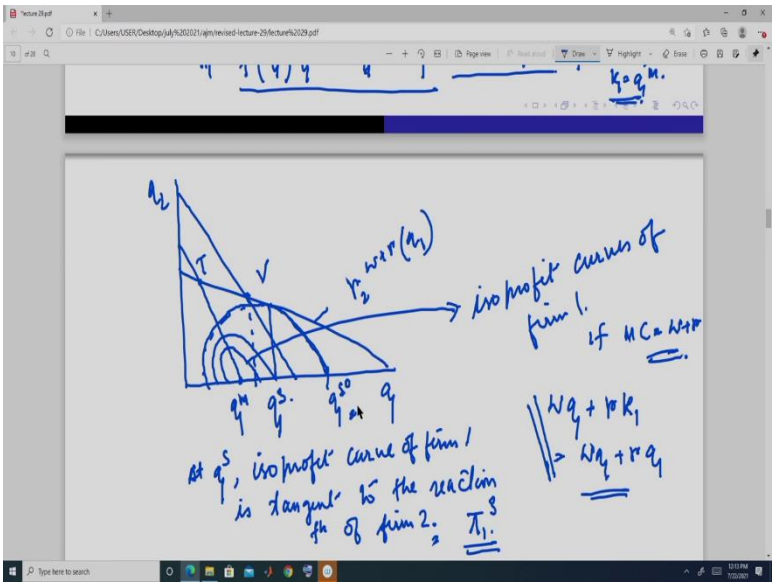

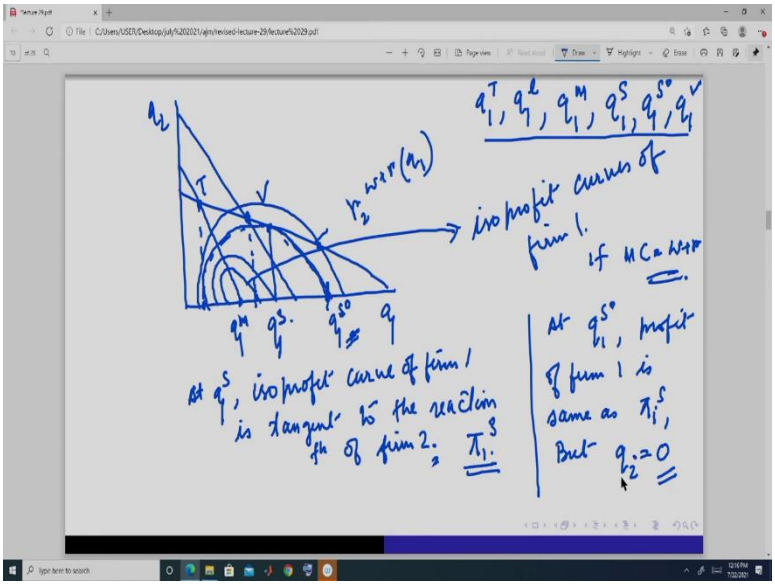

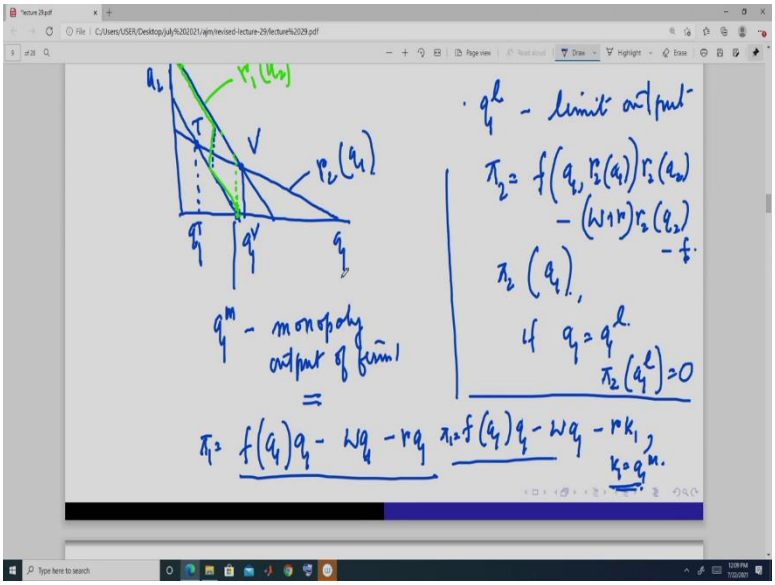

Next we define another output and that is the Stackelberg output of firm 1. Now, these outputs q1 m, q1 l, q1 T, q1 V all these can be of different values and we can rank them also and depending on their ranking we will get the outcome in stage 1, okay. So, this is output of firm 1, output a firm 2 this is the reaction function of firm 2.

Let us draw it like this, this is point T, this is point V, this is q1 m and we know these are the isoprofit function, oh sorry. Here when we are drawing it, it is isoprofit curves of firm 1 if its reaction function, if its marginal cost is, if MC is equal to w plus r, right? and you will see it is in fact MC because otherwise the there is no point in having excess capacity we have seen that in capacity greater than this output, this output, right?

So, we may have a situation oh sorry, it is not we may have; we will have a situation where, so it will, the capacity will be such that it is going to produce that much amount, it will never have

excess capacity, okay. So, if it does not have excess capacity, then it means, then this portion, this at the optimal point this is equal to this-$wq_1 + rk_1 = wq_1 + rq_1$, if we are always going to have full utilization, okay and we will see that we will always have full utilization, okay. So, that is why we are taking this as the isoprofit curves rather than taking from here.

Now, again we will have this and we may have Stackelberg outcome like this. This is the Stackelberg outcome of firm 1 because at q1 s isoprofit curve of firm 1 is tangent to the reaction function of firm 2, we have this. So, we will get some profit and suppose this profit of firm is this Stackelberg represented in this way. Then each point in this isoprofit curve will give me this because isoprofit curves means all the combination of output of firm 1 and output of firm 2, so that the profit, level of profit is fixed.

So, we will have output here also. So, at q1 s naught, profit of firm 1 is same as the Stackelberg output, but q2 is equal to 0, okay this. We will also require this output because see this profit at this point is same as profit at this point. Now, here you can see that if we take isoprofit curve like this and suppose we look at this point, then this point lies above this isoprofit curve.

So, the profit here is going to be less than this profit, okay if that is the case, then we would prefer this Stackelberg rather than this, right and here we will use this to in certain situation to determine whether when what kind of optimal capacity the firm 1 should have, okay that is why we required this output and this Stackelberg thing, okay. So, I hope it is clear so, we have defined these outputs q1 T, q1 l, q1 m, q1 s, q1 s naught and q1 V okay and all our analysis, further analysis will be based on these outputs, okay. So, I am, I hope it is now clear the definition of these outputs of firm 1 okay.

So, this point is giving me q1 T, this point is giving me q1 V, this point is giving me q1 l m, q1 s is given by this point where isoprofit curve firm 1 is tangent to the reaction function of firm 2 and q1 s naught is given by this point where the output of firm 2 is 0, where the profit of firm 1 is same as the Stackelberg output or where these two, this profit level on this k, it can, it could have been this point also not but we have taken this, because this is also a point where profit is same as this level, but the output of firm 2 is 0 but we have taken the higher one; this one. So, remember this, okay out of these two profit, these two outputs we have taken this and not this, okay.

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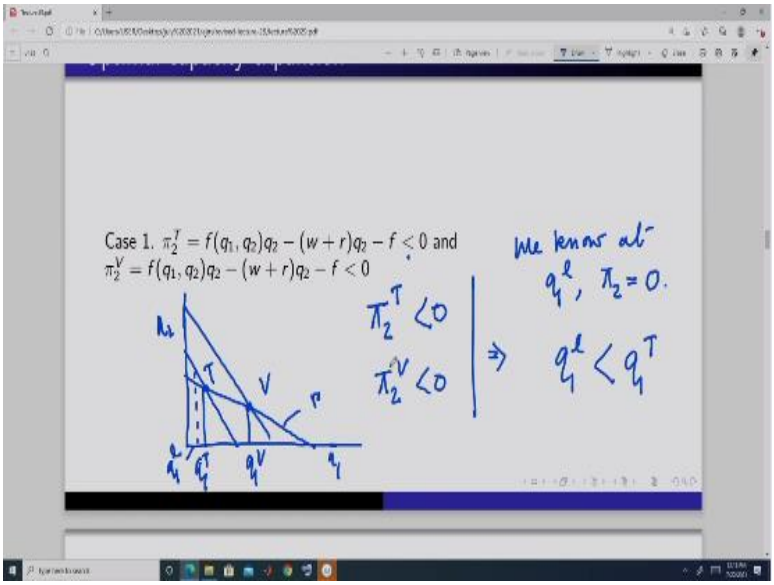

Now, let us look at stage 1. So in stage 1, let us look at this situation where profit of firm 2 in at point T is 0 is less-$\pi_2^T = f(q_1, q_2)q_2 - (w + r)q_2 - f < 0$, is negative and a profit of firm 2 at point V is also negative. So, if this is the reaction function of firm 2 and this is point V and this is point T, then profit of firm 2 at T is negative, profit of firm 2 at V is negative. And we know at q1 l profit of firm 2 is equal to 0, so this implies, q1, this is what q1 T this is q1 V.

So, q1 T is implies that q1 l is actually less than q1 T, so q1 l is somewhere here, then only the profit at this is going to be negative of firm 2. So, we will see what is the best thing to do here.

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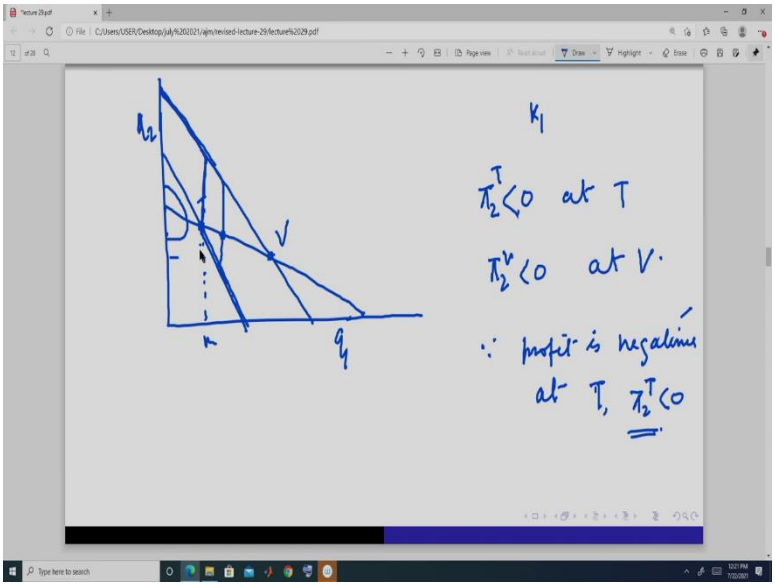

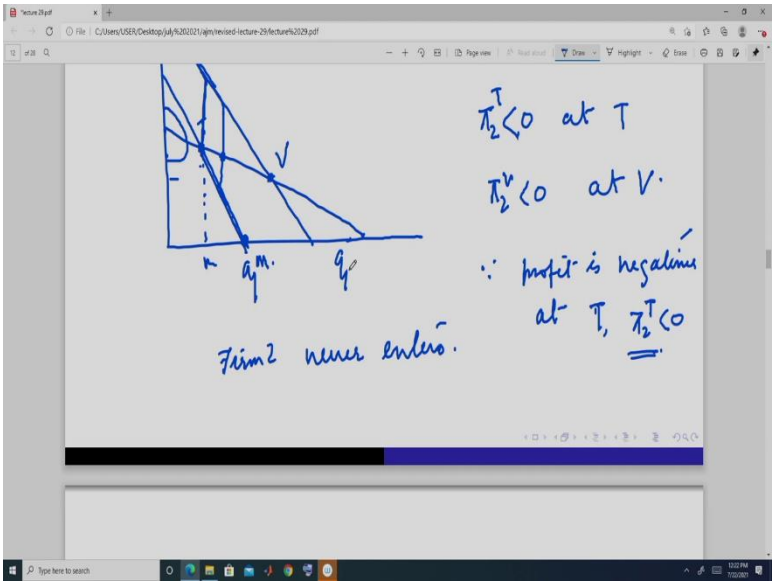

So, in this case, when case 1 we have got, okay this is suppose the reaction function have firm 2. So, firm 2 firm 1 while doing this calculation in stage 1, while deciding k1, it will see that profit of firm 2 here is 0 at T, again this is also 0 at V, right? So, now suppose the capacity is here, so the reaction function is this and if firm 2 enters, the outcome is this, right? if firm 2 enters but here profit is negative.

So, firm 2 will not enter, so since profit is negative at T, that is this, So, firm 2 never enters here, whatever, because if the capacity is here, then reaction outcome should be this, but since profit is negative here, it will be negative here also, it will be negative and since it is negative here also, okay. So, what do we get in this situation?

We, because see, if we look at this reaction function of firm 2, isoprofit curves are somewhere here So, this is the monopoly, right? so profits are decreasing like this. If it is negative here, then it will be negative here also, right? So, that is why it is even if capacity is here reaction function is this firm 2 to enters output is this in stage 2 it will earn negative profit, so it is better not to enter and earn 0.

So, here in this situation, output the firm 1 is going to be this one, this monopoly output because firm 2, never enters, so firm 1 will not be threatened by the entry of firm 1, so because even if it gives a signal that I am going to enter, it is not going to threaten firm 1 because firm 1 knows that firm 2 is not going to enter.

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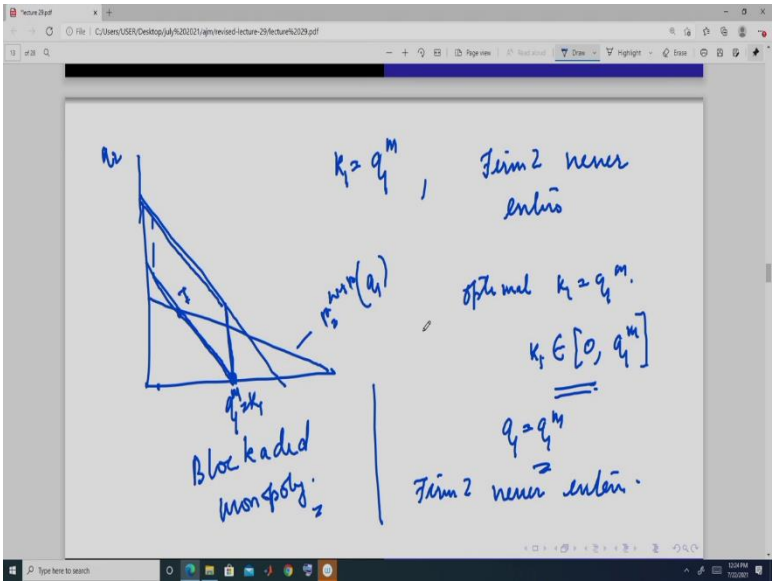

So, in this situation we get a thing that k1 is always going to be of this much amount-$K_1 = q_1^M$, monopoly amount and firm 2 never enters. So in, if this is the reaction function of firm two, is going to it will and this is going to be the outcome, okay. So, optimal k1 is this or even if it is anything, it will never go into, because if suppose the k is this, the reaction function is this, so this point is T, so it is profit is 0 negative. So, it is not profitable to enter.

So, you can write k1 can lie between 0 and this $[0, q_1^M]$ and the outcome is this-q_1^M and firm 2 never enters and so, this case is called something called blockaded monopoly. Firm 1 produces monopoly output and still firm 2 does not enter. So, it gets the monopoly profit, why? Because the entry cost is you can think in such that if it enters firm 2 earns a negative profit, okay. So, that is the reason.

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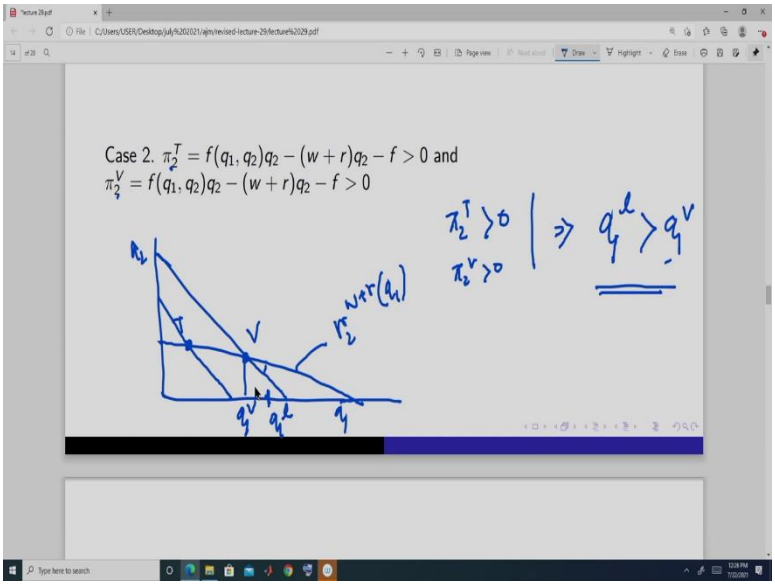

Next look at the case when firm 2 is profit at point T is positive and also at point V it is positive. So, it is this is output of firm 2, so this is, this curve is the reaction function of… so this point is T and this point is V. So, here also profit of positive at this point, positive at this point. So, this means, so this implies that q1 l is greater than this output. So, q1 l is somewhere here. So, if this is the thing, then what should the firm 1 do in stage 1?

Because while in stage 1, firm 1 while deciding k1 it will do this calculation, it will see. So, it will know that in this point also firm 1 is, firm 2 is making quality profit in these two, so it is making positive profit, okay. Because the q1 l is somewhere here, limit output is greater than q1 l and we know that if suppose the capacity is here, so, we will do that thing.

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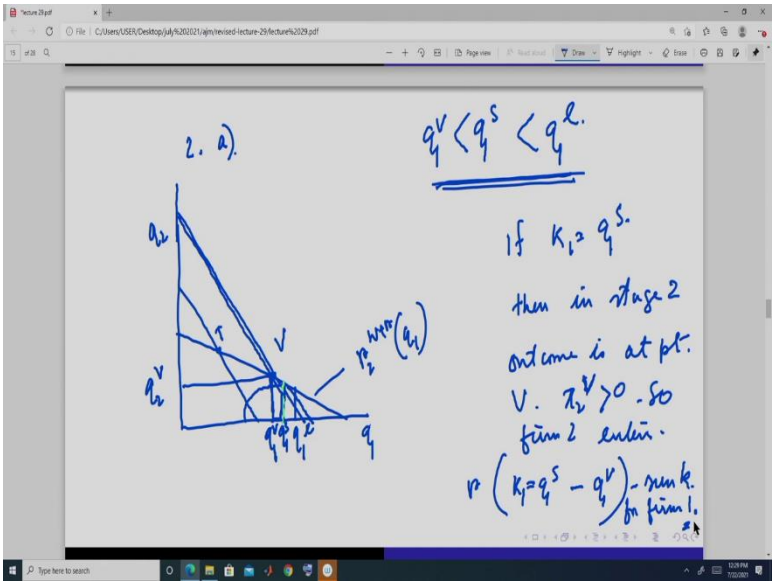

So, we will have to situations now. 2a; suppose the case is this q1 S is greater than q1 V, have this q1 q2, okay we have this and suppose this is q1 l, this is q1 V and suppose this is q1 S. So, it is somewhere here, this is the Stackelberg thing, okay we have this. Now, if k1 is equal to q1 S, so capacity is this. So, let us this green line gives me the capacity, then what is going to be the reaction function of firm 1?

It is going to be this and this. So, if this, then in stage 2 because it knows the outcome is this, profit is, stage 2 outcome is at point V and profit of firm 2 at V is positive. So, firm 2 enters and the output of firm 1 is q1 V, output of firm 2 is q2 V. Now, this much it is going to get as a sunk cost. So, if this is the situation, then what is the… So, this here minus is the sunk cost for firm 1.

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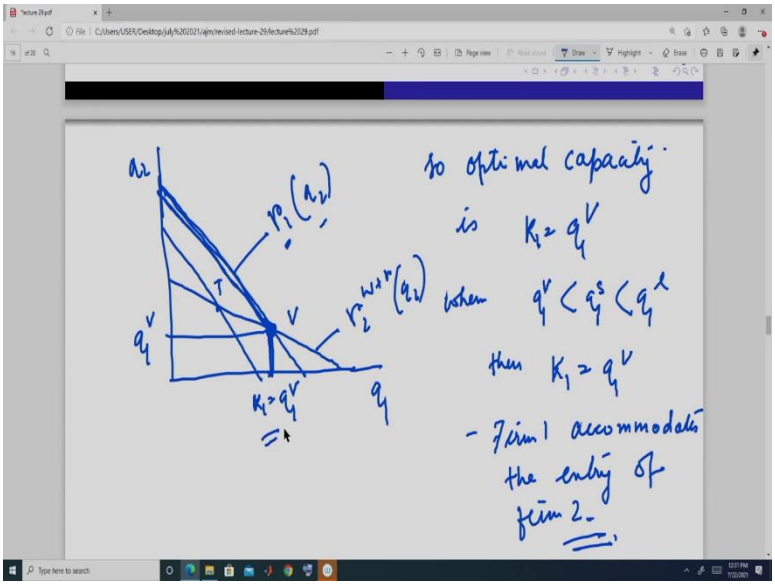

So, here optimal capacity is, so optimal capacity is this-$K_1 = q_1^v$. So, when k1 is this and firm 1 accommodates the entry of firm 2 and the outcome that we get is… And this is the outcome, okay so in this case, firm 1 accommodates the entry.

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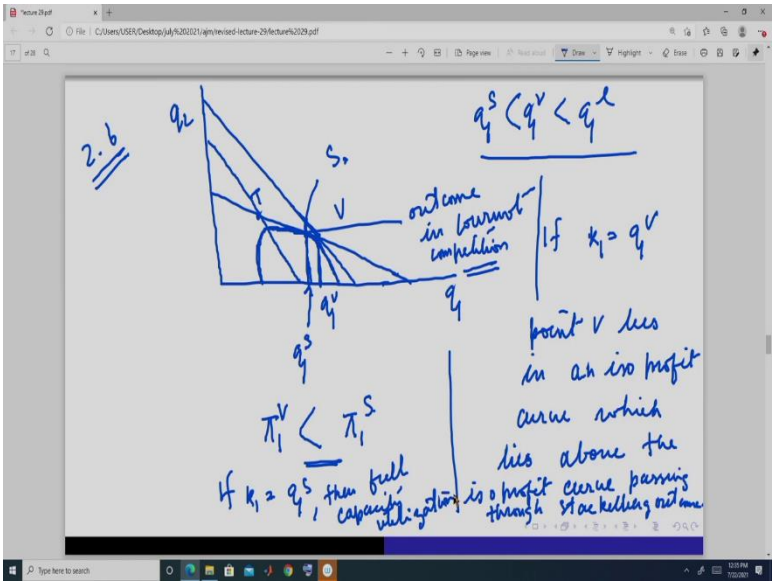

Now, let us look at this. Situation is this is always going to be the case-$q_1^s < q_1^v < q_1^l$ and this case is going to be that. This is q1 S, now here if k1 is equal to q1 V following from the previous case, so this is 2b, okay. Then if this is, so this is the outcome, right? we get here and since this is the Stackelberg output, so, that it is somewhere isoprofit is tangent here. So, this point, point V lies in a, in an isoprofit curve which lies above the isoprofit curve passing through Stackelberg outcome.

This point in this, so, profit of firm 1 V is less than profit of firm 1 at this point, suppose this is S. So, if now because of this, if k1 is equal to q1 S this capacity is this. So, outcome is here this is the outcome in Cournot competition, full capacity utilization, now this is the third case, if this then full capacity utilization. So, profit will be at a higher rate this if k1 is this.

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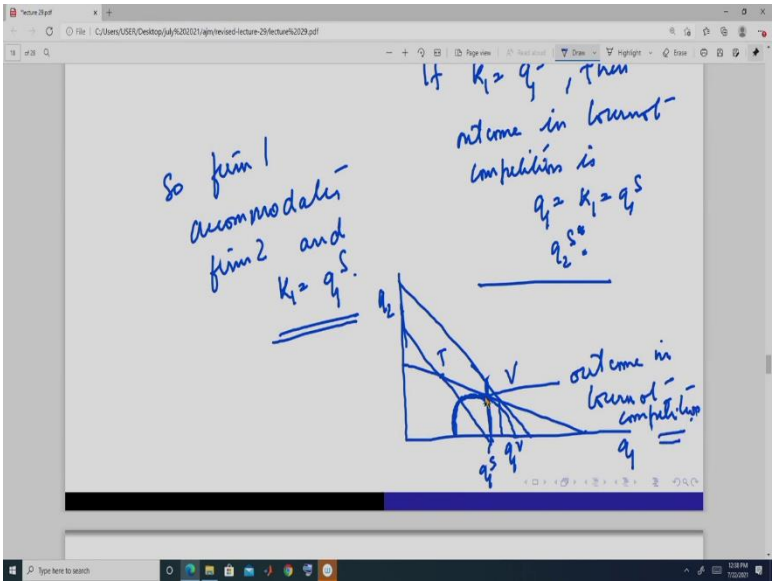

So, if k1 is equal to this then the outcome in Cournot competition is q1 is equal to k1 which is equal to q1 S and q2 is this Stackelberg output, this q1 star. So, here profit will be higher than this point. So, but if it produces less, if its capacity is less here, so the reaction function will be this. So, again it will be at an isoprofit which is higher than this because it is at this point it is not tangent.

So, that is why it is optimal for, so, firm 1 again accommodates firm 2 and k1 is equal to the Stackelberg output this-$K_1 = q_1^s$ and the outcome that we get is something like this, okay. So, the reaction function is going to be this, so they intercept, this is the outcome in Cournot competition, okay. So, in case 2, we see the firm 2, firm 1 always accommodates, it cannot deter the entry of firm 2.

In case 1 what we have seen that the firm 2 never enters blockaded monopoly, in case 2 when the profit at this point and this point both are positive, that is profit at T and profit at V are positive, that means the limit output is more than q1 V that means which is greater than q1 V then we have firm 1 always accommodates the entry of firm 2.

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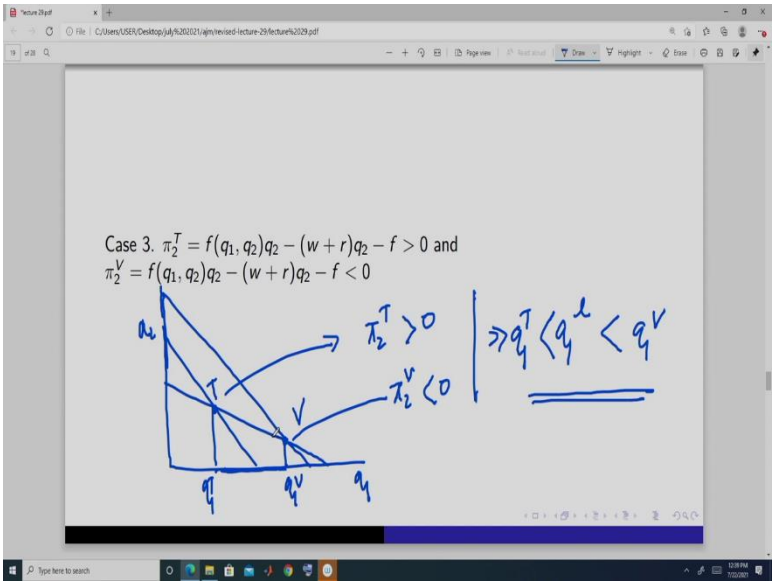

Now let us look at case 3. In case 3, we have a situation when we get this outcome that suppose this is the reaction function of firm 2, this is point T, this is point V, okay. Now profit here of firm 2, this is positive, profit here of firm 2 it is negative. So, this implies that q1 l is less than q1 V this and it is greater than q1 T. So, q1 l limit output lies in this range, okay. Now what are the possible outcome in this situation? So, let us look at the first output.

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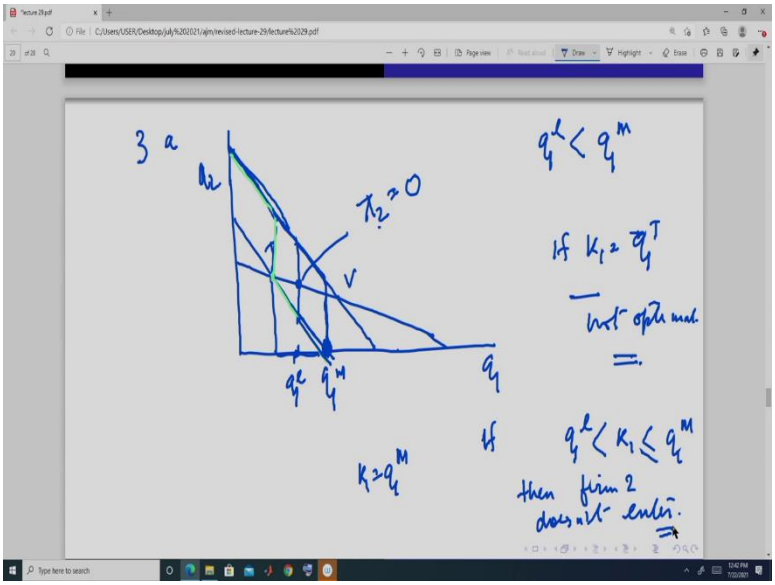

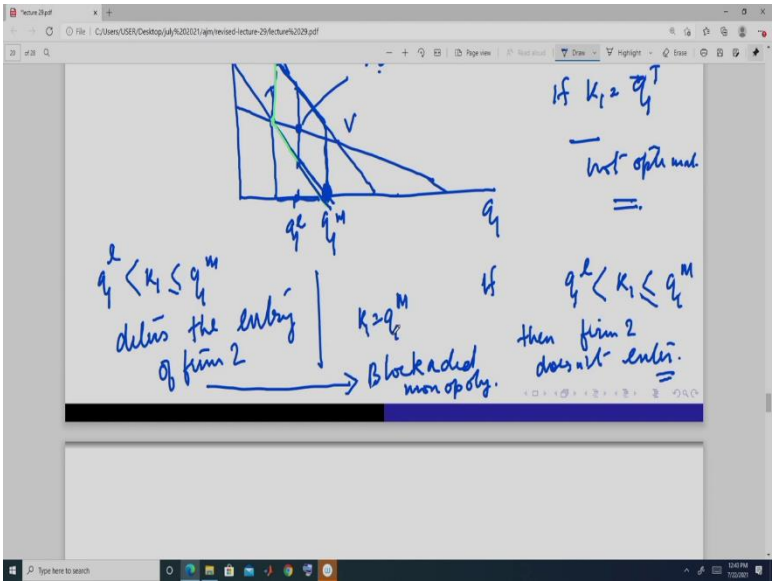

This is supposed 3a; here if this is less than monopoly output of firm 1, q1 q2, okay. This is point T, this is point V and this is q1 m. Now here q1 l lies here, somewhere here, suppose it is at this point, okay. So, here this is suppose q1 l, this point is. Now, if here K1 is equal to suppose T is this, so then the reaction function is something like this, given by this green line is going to be like this and at this point a so it will, it means firm 2 will enter. Because at this profit is positive for firm 2. So, this is so this- $K_1 = q_1^T$ is not optimal and does not deter.

But, here if q1 k1 is this, is suppose this much outcome, if firm 2 enters then outcome will be this firm 1's output is this. So, here profit of firm 2 is equal to 0 at this here. So, then this is will deter the entry of firm 2, firm 2 will not enter because it is earning 0 profit. So, the actual outcome is of firm 1 is going to be this.

So, in this situation and if it produces k1 is suppose is equal to and this much reaction function will be this, actually the output is this because if capacity is more than this, if capacity is more than this, then firm 1 monopoly output, then it will always, then firm 2 does not enter. If it does not enter, then what is going to happen? It means firm 1 has deterred the entry.

So, k1 lying in any point here in this range is, k1 lying in this range it deters the entry of firm 2 and this is also a situation of something like blockaded monopoly because firm 1 has producing what? Firm 1 is producing monopoly output and but still it is blocking the entry it is deterring the entry of firm 2, right?

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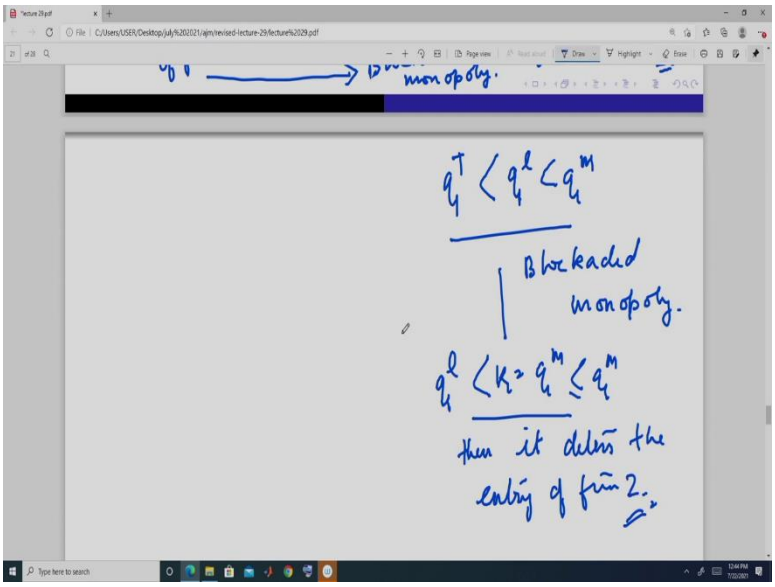

So, whenever, whenever this limit output is less than this- $q_1^l < q_1^m$ and this is greater than this- $q_1^T < q_1^l < q_1^m$, then we have blockaded, again we have blockaded monopoly and k1 is equal to q1 M or it is anywhere here k1 m less than equal to q1. If this is the situation, then it deters the entry of firm 1, sorry deters the entry of firm 2, okay. I hope this is clear.

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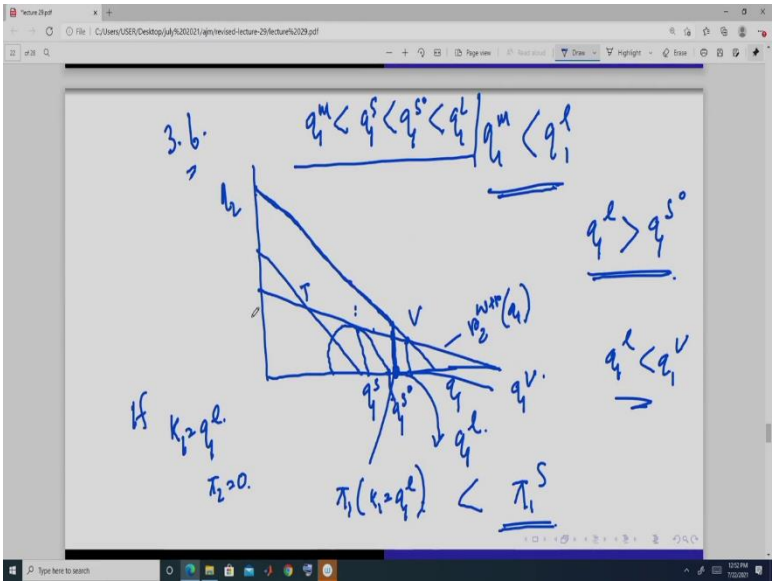

Next, let us do another situation. This is suppose case 3. So, in case 3b; we will… this is the reaction function of firm 2 and this is point T and this is point V and this is q1 S. So, here q1 l is greater than q1 m because we have already taken when it is less in the previous case and this is q1 S, okay naught this point. And q1 l is suppose greater than q1 S naught, okay. So, it is this point is q1 l.

So, this in case b what we have taken this is greater than q1 S greater than q1 S naught and this is greater than q1 l, okay this is-$q_1^m < q_1^s < q_1^{s^o} < q_1^l$. Now here if suppose it blocks the entry. How it can block? Let us do one, let us draw these curves slightly like this, so that this point is V, okay. So, this is q1 l. In earlier one q, so q1 l is less than q1 V this has to be satisfied this point is q1 V. So, here if this is the situation then what do we get?

It can block because this is A. So, if k1 is equal to q1 l, then it is going to do what? We will get this reaction function and then profit of firm 2 is 0. So, outcome is, this is the reaction function of firm 1, right. So, firm 1, firm 2 does not enters, firm 2 does not enter and reaction function is this, so outcome is this.

So, this is the profit point of firm 1, this we need produces k1 is equal to k1 this. But suppose and this is the profit, if output of firm 2 is 0 and firm 1 is getting the Stackelberg profit, then the profit is here this is the monopoly profit. So, it is closer. So, this profit is less than the profit of Stackelberg.

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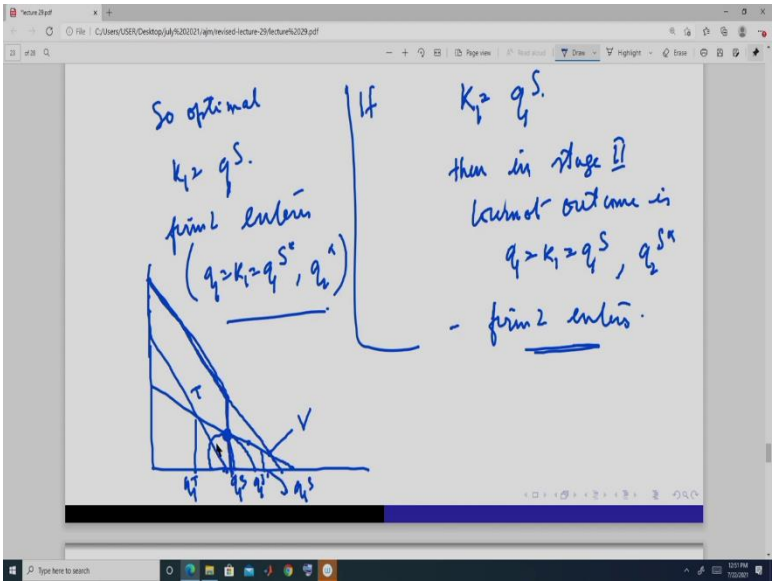

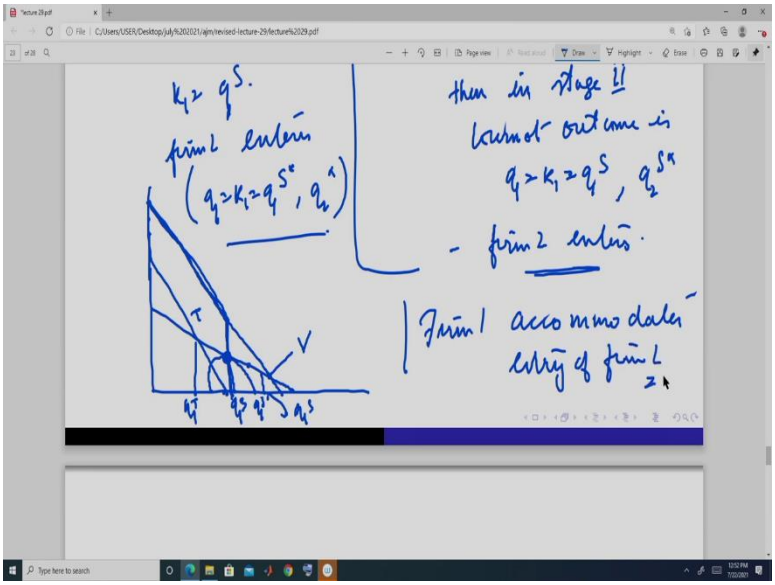

So, in this case if k1 is equal to output of this, this Stackelberg thing then in stage 2 Cournot outcome is q1 is equal to k1 is equal to this and q2 is this, this because firm 2 is going to, if this is the case firm 2 is going to earn a positive profit because q1 l is this, this point is q1 limit output of firm 1. So, firm 2 is enter.

So, in this case, firm 2 enters, but if firm 2 enters, it gets more profit then by deterring the entry of firm 1, firm 2. By deterring the entry of firm 2, it gets less profits, then by allowing the firm 2 to enter and having capacity this much. So in this case, so, the optimal k1 is this, this- q_1^s and firm 2 enters and the outcome, Cournot outcome is k1 is equal to this- $q_1 = K_1 = q_1^s$ and the profit this much-$(q_1 = K_1 = q_1^s, q_2^*)$.

And you can see and the reaction function of firm 1 is going to be this much, this one and this is going to be the outcome, okay. So, in case 3b; we see that firm 1 accommodates the entry of firm 2. So, here firm 1 accommodates entry of firm 2, okay.

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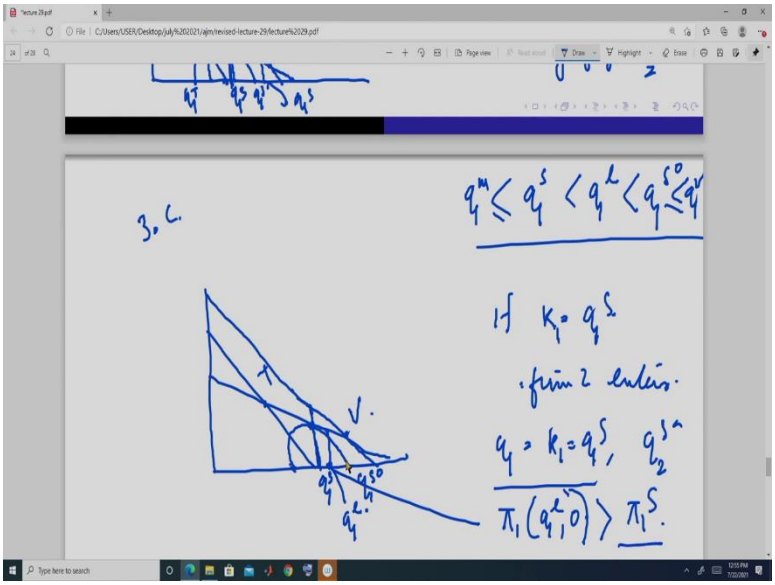

Next we will look at this 3c; when we get a situation like this, then this is we do not know. So, suppose this is the outcome, this is q1 S, this is q1 S dot and the limit output is somewhere in between okay and this is suppose V, okay. Now here if k1 is equal to q1 S, okay limit output is here, right? then what is going to happen?

Its profit is this and here limit output is this much so, in this A reaction function limit output is at this point, so it is here Stackelberg. So, firm 2 this is going to be the A, so firm 2 enters and if firm 2 enters what is going to be an outcome? It is going to be k1 is we have seen this and this is output a firm 1 and q2 is this Stackelberg, profit is here. So, at this point and this point, since they are in the same isoprofit, so the profit is same.

But if you compare this limit output and this you will see this is greater than this. So, if firm 2 suppose produces 0 output and firm 1 produces this. So, this the profit it gets is more than the Stackelberg thing. So, at this point this profit of firm 1 when it produces this and output of firm 2 is 0, this is greater than the Stackelberg, so we get it from, why it is greater?

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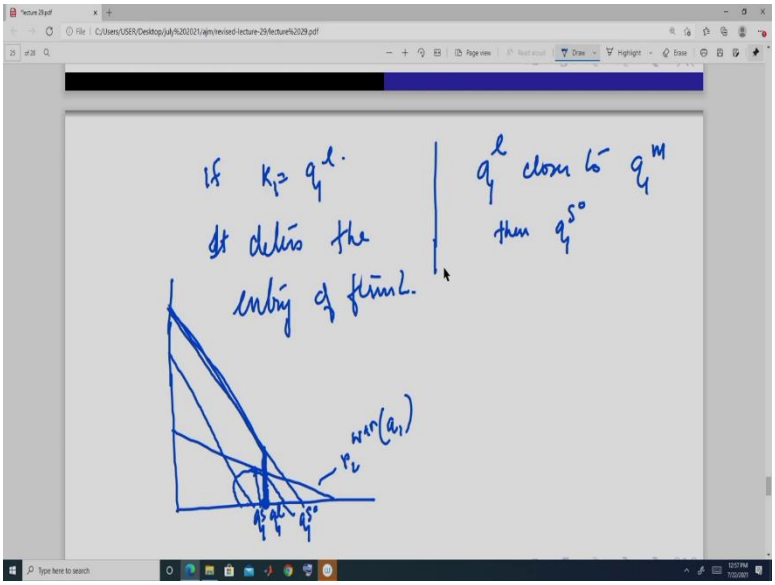

Because q1 l this is closer to q1 m then q1 S naught, so this is closer to q1 m and this is here q1 S naught and q1 A is this. So, in this situation, in this situation if k1 is equal to q1 l, then it deters the entry of firm 2 and the output is, in this situation we will get the reaction function suppose this is of firm 2, here this is this, and the this thick line is going to be reaction function and it is going to produce here.

Not here, it is going to produce here, outcome is going to be here in this A. Because k1 is this and this is since it is left of this A. So, profit here is higher than the Stackelberg profit this point, so it deters the entry of firm 2.

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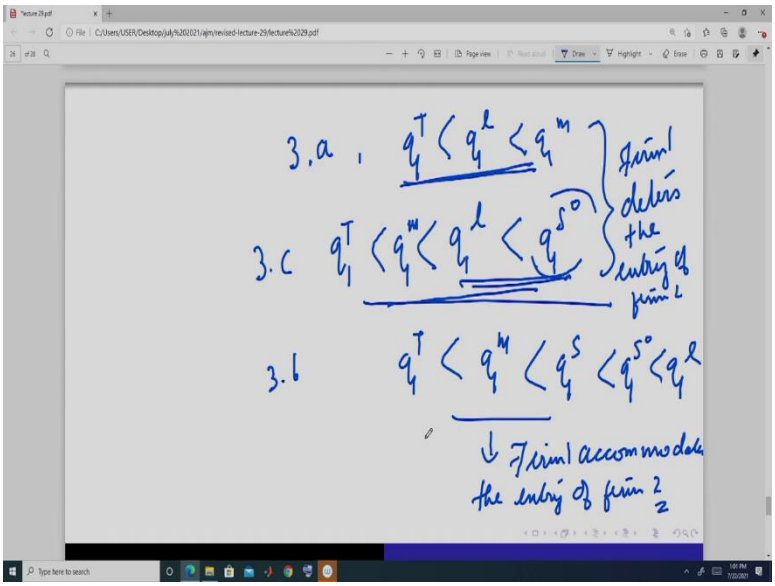

So, what do we get we get that firm 1 can deter the entry of firm 2 in this situation, when in case 3a where q1 l is less than q1 m and in case 3c when q1 l is less than q1 S naught and this is… so, this is the important thing. And in case 3b when we have in this it deters, firm 1 deters the entry of firm 2, here firm 1 accommodates the entry of firm 2, okay.

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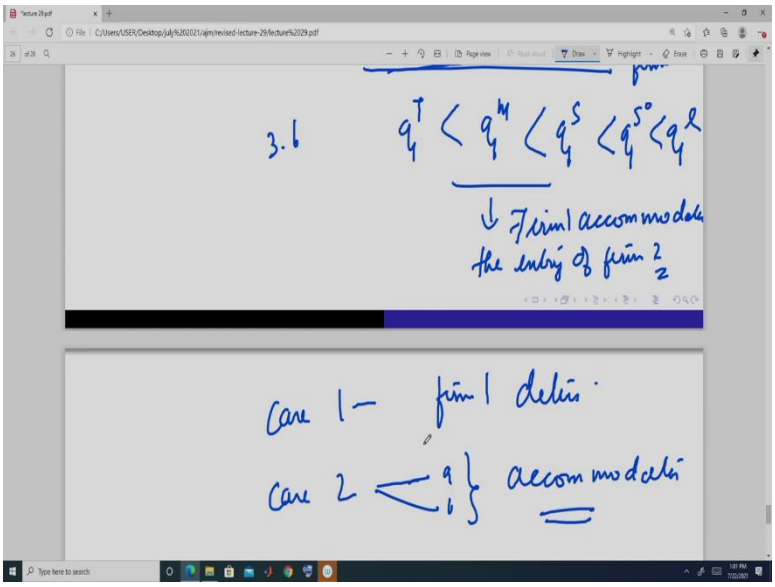

And we have seen in case 1, firm 1 deters and in case 2 in all the cases we have seen, we a and b; it accommodates. So, these are the subgame perfect Nash equilibrium. In case 1, firm 1 deters is it is a blockaded monopoly, in case 2 it always accommodates because profit of firm 2 is positive both at point V and point T. In case 3, we get mixed outcome in case 3a where we have this situation firm 1 deters, in case 3c when we have this, that is limit output is less than this outcome, this output of firm 1, then firm 1 deters

But if limit output is greater than this, then firm 1 accommodates the entry of firm 2 and there is this Stackelberg outcome in Cournot competition, okay. So these are the outcomes that we get in this Dixit's entry deterrence model. So we see that firm 1 will not always deter the entry of firm 2, it sometimes it will accommodate. But in certain cases we see that it will deter the entry. So, it is not a uniform thing to say that firm 1 will always want to deter the entry of firm 2, okay.

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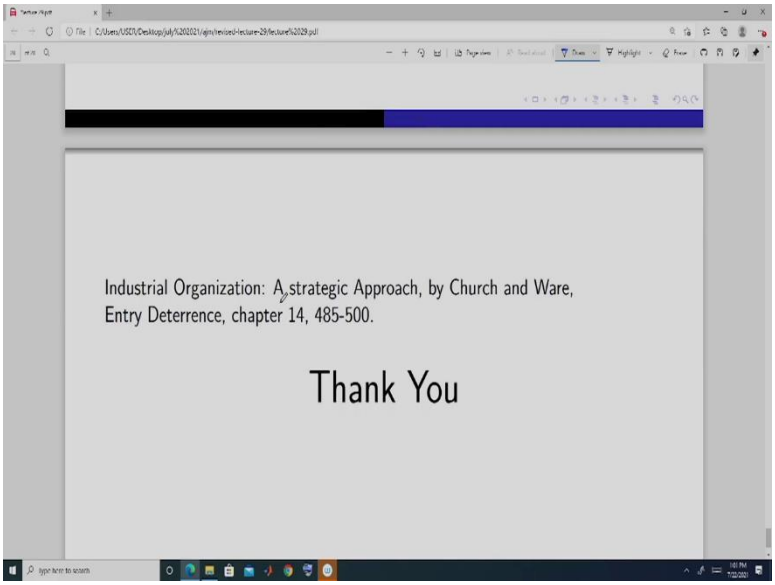

So you can read this portion from chapter 14 of this book, Industrial Organization: A Strategic Approach by Church and Ware. So these are the specific page numbers. Thank you.