Power Plant Engineering
Prof. Ravi Kumar
Department of Mechanical and Industrial Engineering
Indian Institute of Technology, Roorkee

Lecture - 40
Problem Solving – V

Hello, I welcome you all in this course on Power Plant Engineering. Today, we will do; we will solve certain problems in this section. The first problem is an input output curve of a 10 mega Watt station.

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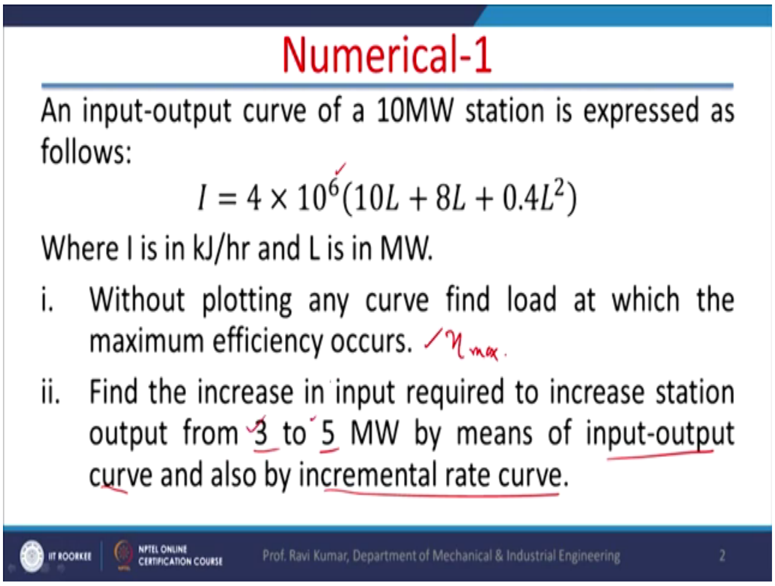

That is power station is expressed as follows, I is equal to 4 into 10 to the power 6. 10 L plus 8 L plus 0.4 L square this is load in mega Watts input in kilo Joules per hour without plotting any curve, find load at which the maximum efficiency occurs. So, first of all the efficiency maximum efficiency has to be found out.

Another is find the increase in input required to increase station output from 3 to 5 mega Watt by means of input output curve and also by incremental rate curve. So, by both the methods, we have to find the change in the input energy from 3 mega Watt to 5 mega Watt. So, you start with the maximum efficiency ok.

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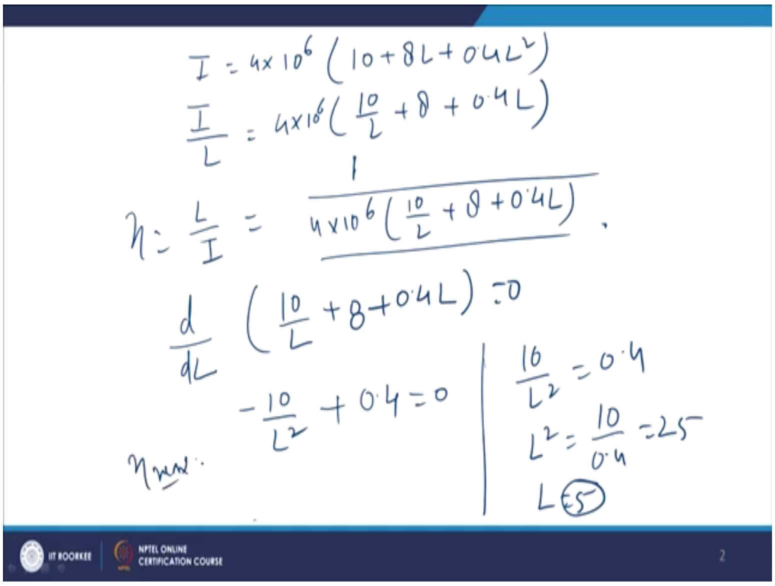

So, we have the equation, I is equal to 4 into 10 to power 6 10 plus 8 L plus 0.4 L square. Now, I will take I by L 4 into 10 to power 6 10 by L plus 8 plus 0.4 L. Now, efficiency is L by I so, reverse it right. So, it will become 1 by 4 into 10 to power 6 10 by L plus 8 plus 0.4 L. Now, efficiency is going to be the maximum when this is minimum right. So, let us differentiate it d by d L 10 by L plus plus 8 plus 0.4 L.

Now, when we are differentiating this equation, then this will become minus 10 L square this is a constant 8 is a constant it will be 0 plus 0.4 is equal to 0 or we can say 10 by L square is equal to 0.4 L square is equal to 10 by 0.4 is equal to 25 L is equal to 5. So, when L is equal to 5, the efficiency is maximum at this load the efficiency is maximum that is the first part of the numerical. Now, the another part is find the increase in input required to increase station output from 3 to 5.

Now, because now the station output is suppose giving 3 mega Watt. I want to increase the output to the 5 mega Watt. How much input has to be increased? So, that I get the 5 mega Watt output and there are two methods input output curve, where is first is input output curve, where there is a output and input curve and with the help of this curve you can find out how much input is required this is output and this is input right.

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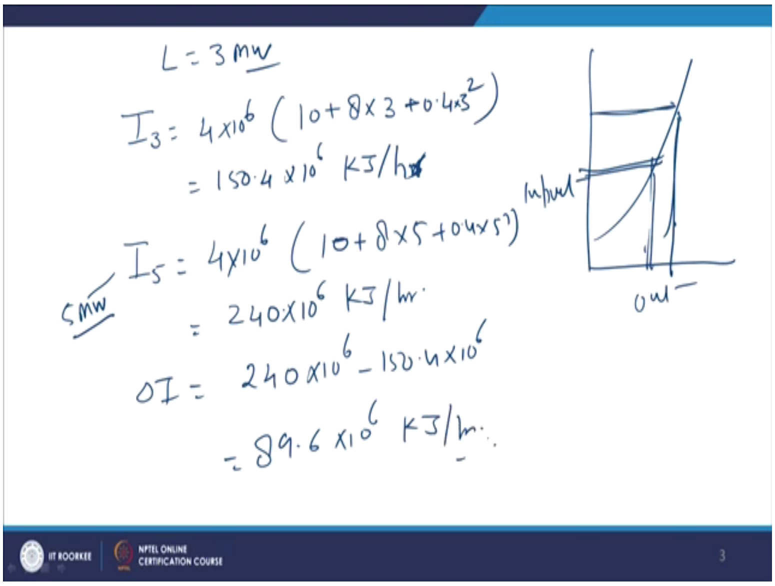

So, for the change in the output, you can find the change in the input, but I do not have any input output curve right and also by incremental rate of curve. So, for this purpose, we know that L is equal to 3 mega Watt. Now, we put L is equal to 3 mega Watt into the equation, we will put L is equal to 5 mega Watt in the equation and we will find the change in the input that is the only way. So, when L is equal to 3 mega Watt.

So, this is I 3 is going to be equal to 4 into 10 to power 6 10 plus 8 into 3 mega Watt plus 0.4 into 3 square. And this will be equal 150.4 into 10 to power 6 kilo Joules per hour because, I is expressed in kilo Joules per hours per hour. Now, I 5 when input for 5 mega Watt output it is 4 into 10 to power 6 10 plus 8 into 5 plus 4 into 5 square. Now, this gives I 5 as 240 into 10 to power 6 kilo Joules per hour right.

Now, we have inputs for both the cases, I mean for 3 mega Watt and this is for 5 mega Watt. Now, we can take the difference delta I is equal to 240 into 10 to power 6 minus 150.4 into 10 to power 6 and it comes around 89.6 into 10 to power 6 kilo Joules per hour ok.

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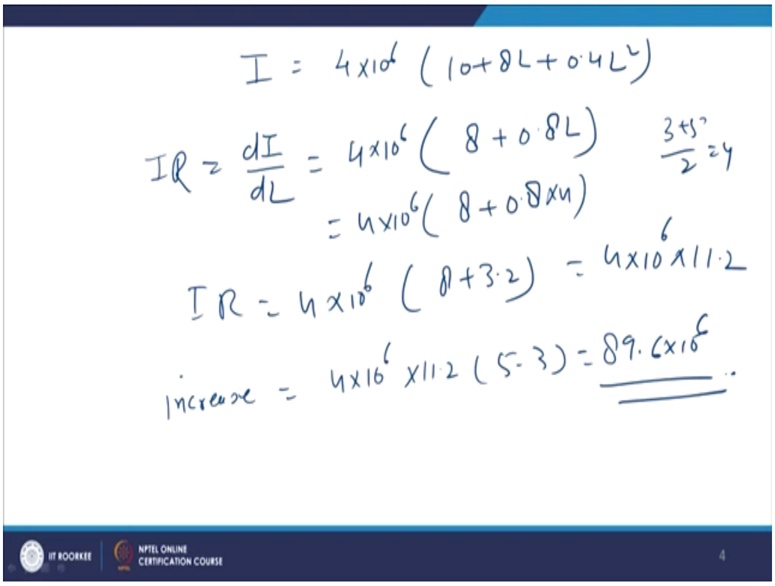

Now there is a incremental rate curve also, if we use incremental because I equation for I is given. It is 4 into 10 to power 6 10 plus 8 L plus 0.4 L square. Now, incremental rate IR is d I by d L. So, 4 into 10 to power 6 8 plus 0.8 L. Now, 8 point 0.8 L means 4 into 10 to power 6, 8 plus 0.8, we take the value of L as 3 plus 5 by 2 which is equal to 4 right. And in this case when L is equal to 4, the incremental rate is 4 into 10 to power 6 8 plus 3.2 is equal to 4 into 10 to power 6 into 11.2 and then increase is equal to 4 into 10 to power 6 into 11.25 minus 3 is equal to 89.6 into 10 to power 6. So, in the both the cases, we are getting the same increment in the input.

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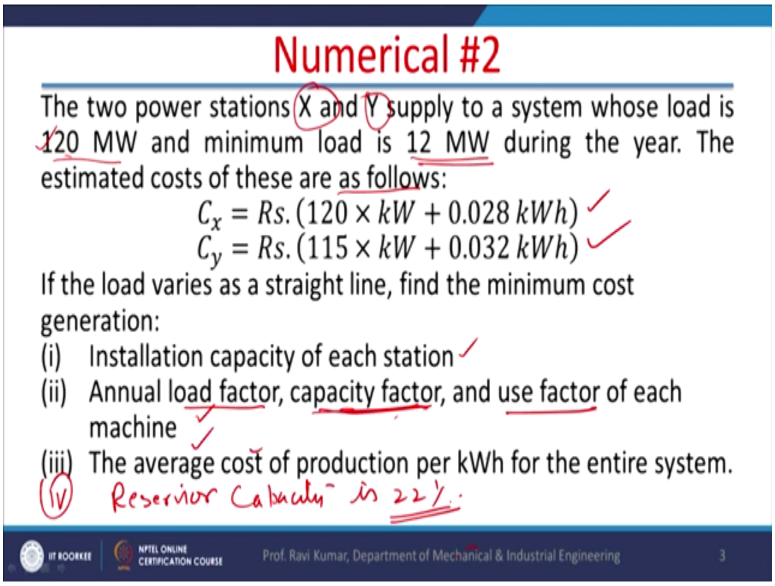

Now, numerical number 2, the numerical number 2 there are two power stations X and Y and supply to a system whose load is 120 mega Watt. So, the system load is 120 mega Watt and there are two systems X and Y. They are supplying; they are sharing the power of 120 mega Watt right and minimum load is 12 mega Watt 12 mega Watt is the minimum load during the year.

The estimated cost of these are as follows, C x is 120 into kilowatts plus 0.028 kilo Watt hours, C y is 115 into kilo Watt plus 0.032 kilo Watt hours. If the load varies as a straight line, find the minimum cost of generation.

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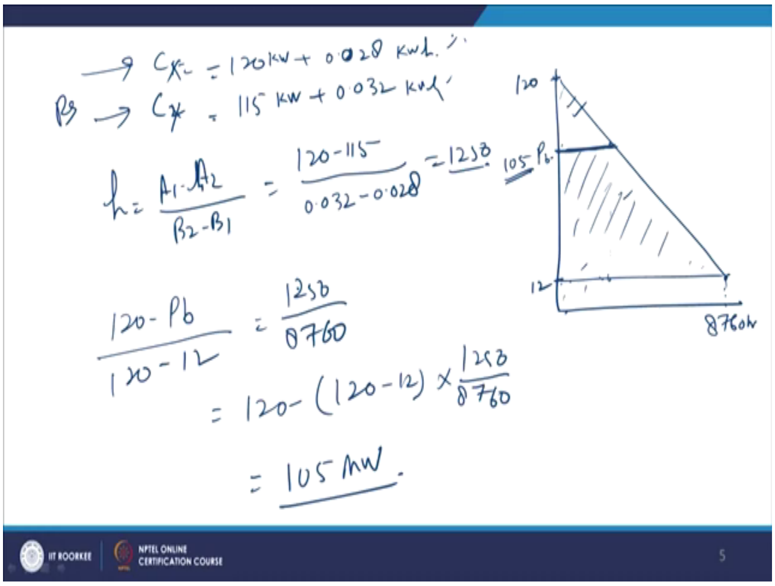

Load varies is straight line means, starting from here minimum load is 12 and maximum load is, minimum load is 12 maximum load is 120 mega Watt. So, this is 120 and this variation is straight, it is 8760 hours this is for the entire year right.

If the load varies as a straight line find the minimum cost of generation installation capacity of each station, annual load factor, capacity factor and use factor for each machine. The average cost of production per kilo Watt hour for the entire system. Now, we will start with C x is equal to 120 plus 0.028, C x is equal to 120 plus 0.028 this is kilo Watt and this is kilo Watt hours right. And C 2 C x this is C y C x. C y is 115 0.032, 115 0.032 right.

And this cost is in rupees both are in rupees as shown here. C x is in rupees and C y is in rupees. Now, we have to find the value of h. So, h is equal to A 1 minus A 2 divided by B 2 minus B 1. So, A 1 minus A 2 is 120 minus 115 divided by 0 032 0.028 and this is equal to

1250. So, for the duration of 1250 we will draw here, 1250 it will come somewhere here. For 1250 hours there is going to be peak load plant and one is going to be the base load plant.

So, which one out of these two will be the base load plant? This is going to be the base load plant this is going to be the peak load plant right. After identifying this, we have to find P base. Now, P base, so, 120 minus P base; 120 minus P base divided by 120 minus 12 this divided by this is equal to this divided by this right. So, it is equal to 1250 divided by 8760.

And if you manipulate this, you will find that it is equal to 120 minus 12 1250 by 8760 it is going to be a 105 mega Watt. So, 105 mega Watt is the cutoff line, it is the capacity of the base load plant and beyond that it is a peak load plant. Now installation capacity of another system peak load plant.

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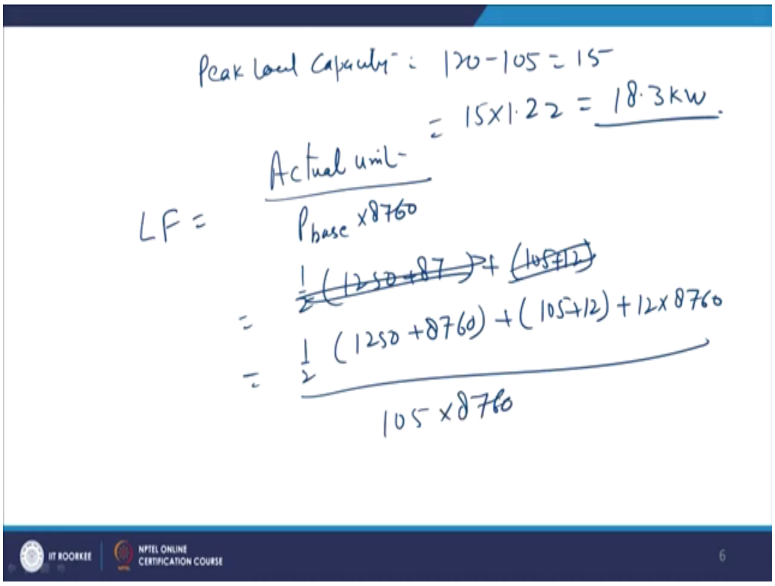

So, peak load capacity is it is 120 minus 105, it is 115 sorry 15 120 minus 105 is equal to 15 right. Now, here in this question if we assume that reservoir capacity is 22 percent, there is a reservoir which can have the capacity equivalent to 22 percent. In that case, the peak power is going to be 15 into 1.22 and it is going to be 18.3 kilo Watt.

Now, after that we have to find annual load factor, capacity factor and use factor. So, load factor is equal to actual unit generated divided by the maximum possible unit which can be generated or the capacity of the plant. So, actual unit is actual unit generated divided by the base plant capacity or power base into 8760 power base is 105.

So, 105 has to be multiplied by 8760 that is a energy which base plan can always generate throughout the year. So, it is coming as half 1250 plus 8760 plus 105 plus 12 sorry this is half 1250 plus 8760 plus 105 plus 12 plus 12 into 8760 divided by 105 into 8760 right.

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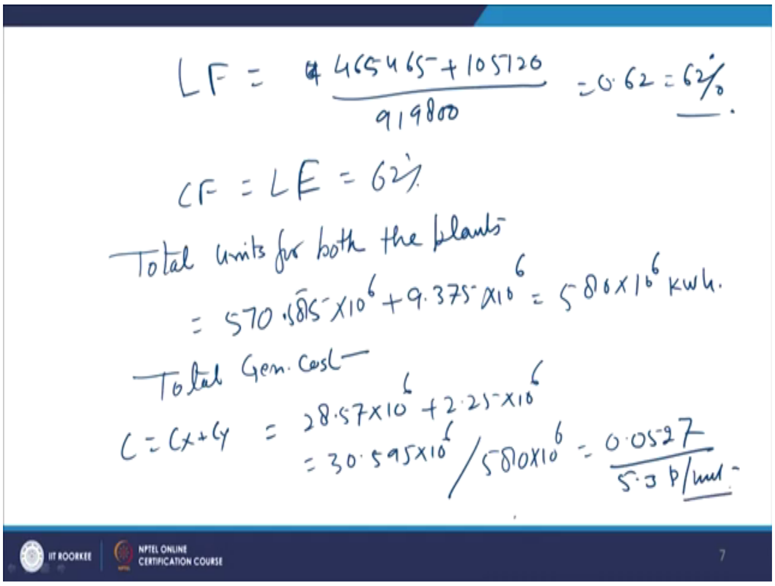

And this gives the load factor as 465465 plus 105120 919800 0.62 is equal to 62 percent. That is a load factor and there is a reserve capacity as I said it is 22 percent right.

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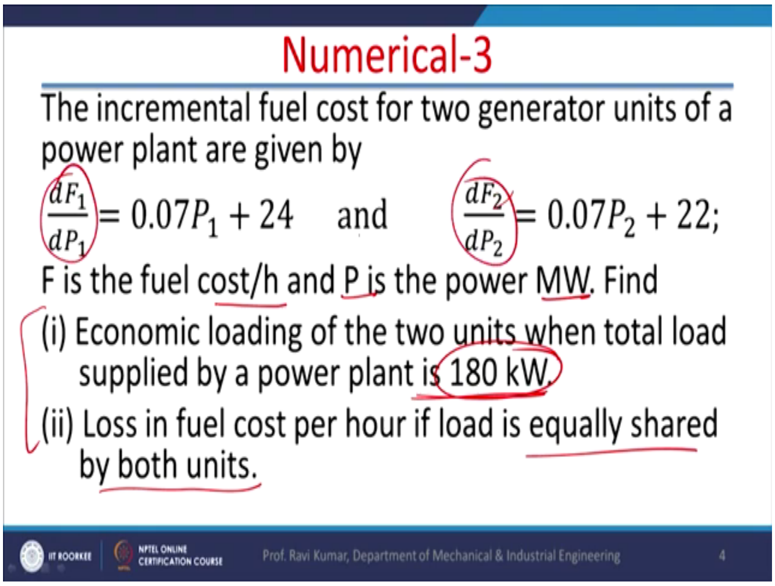

But there is though reserve capacity for base load plant. The reserve capacity is only for the peak load plant it is not for the base load plant. So, the capacity factor regarding the capacity factor, capacity factor is equal to load factor is equal to; load factor is equal to 62 percent for base load plant.

So, total unit for both the plants is equal to 570.8585 into 10 to power 6 plus 9.375 into 10 to power 6 is equal to 580 into 10 to power 6 kilo Watt hour. So, total generation cost C is equal to C x plus C y is equal to 28.57 into 10 to power 6 plus 2.25 into 10 to power 6 is equal to 30.595 into 10 to power 6 and it is it has to be divided by if you want to have the unit cost.

Then it has to be divided by 580 into 10 to power 6 and it will come around 0.0527 or 5.3 paisa per unit or per kilo Watt hour ok. So, this is we have calculated average cost of production per kilo Watt hour. Actually in this case, the area has to be calculated simply it is area calculation numerical. If you calculate this area, you will find that this is the energy produced by the any energy produced by the base load plant. So, take the entire area minus this area will give you the energy this energy.

And this is how you can calculate either you take area of this triangle or area of the bigger triangle minus this area this will give you the. So, you can have many combinations of finding out a solution of this problem, it will depend how you by which method you calculate the area ok. And the next numerical is about again on the economics of the power plants, the incremental fuel costs for two generator units of a power plants are given by d F 1 by d P 1.

This is incremental fuel cost, it is d F 1 by d P 1 is equal to 0.07 P 1 plus 25 and d F 2 by d P 2 is equal to 00.07 P 2 plus 22. F is the fuel cost and P is the power in mega Watt. Find economical loading for the two units, when total load supplied by the power plant is 1 eighty kilo Watt. Loss in fuel cost per hour if load is equally shared by both units. So, these two things have to be found out or have to be driven out of these data.

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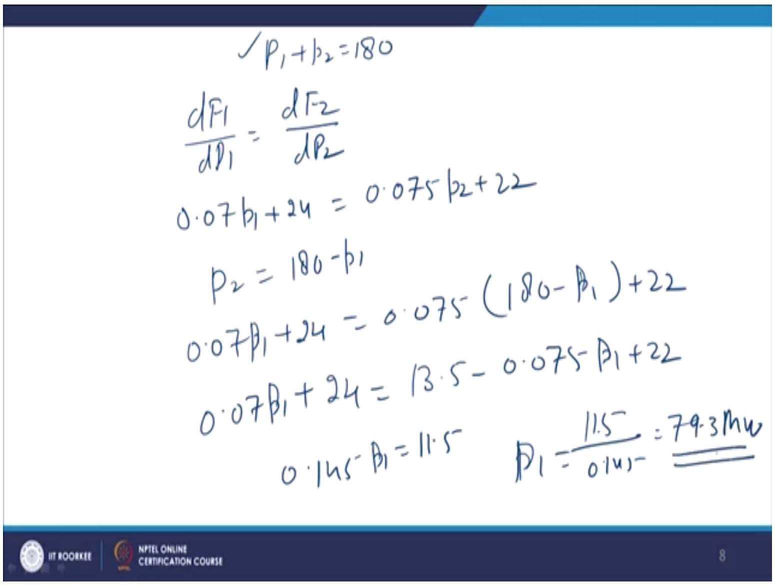

So, simply first of all next first of all take that P 1 plus P 2 is equal to 180it is given here 180 kilo Watt right. For economic loading for in a economic loading this has to be equal to this. So, d F 1 by d P 1 is equal to d F 2 by d P 2 for economic loading. Now, we are putting these values 0.07 P 1 plus 24 is equal to 0.075 P 2 plus 22. Now, from here we can always put from here P 2 is equal to 180 minus P 1. So, 0.07 P 1 plus 24 is equal to 0.075 180 minus P 1 plus 88 right.

Now, this gives 07 P 1 plus 24 is equal to 13.5 minus 0.075 P 1 plus 22 0.145P 1 is equal to 11.5 or P 1 is equal to or capital it is capital P. So, P 1 is equal to 115 divided by 0.145ah you know it is equal to 79.3 mega Watt.

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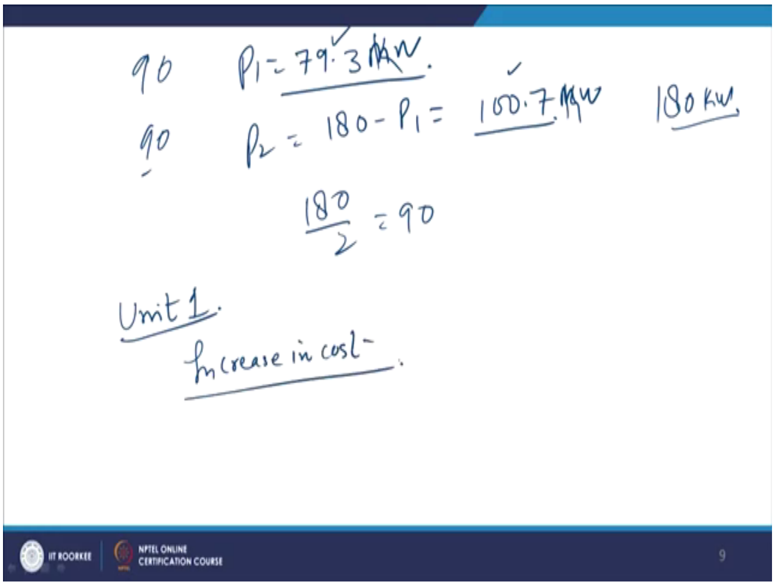

So, this is P 1. So, P 1 is 79.3 mega Watt right. Now, P 2 is equal to 180 minus P 1 is equal to 100.7 mega Watt. So, this is so, P 1 is 79.3 mega Watt sorry this is P 2. P 2 is 107 mega Watt total is 180 not it is mega Watt I think it is kilo Watt kilo Watt. So, it is this kilo Watt and this is this kilo Watt right. So, total is 100 kilo Watt 180 kilo Watt. Now is the author wants to know, if we divide this 90 we will make this 90 and we also make this 90.

Then, how it is going to affect the fuel cost? So, change in the fuel consumption. So, for this purpose suppose the load is equally shared, so, load is equally shared means 180 by 2 is equal to 90. So, unit 1, unit 1 increase in cost.

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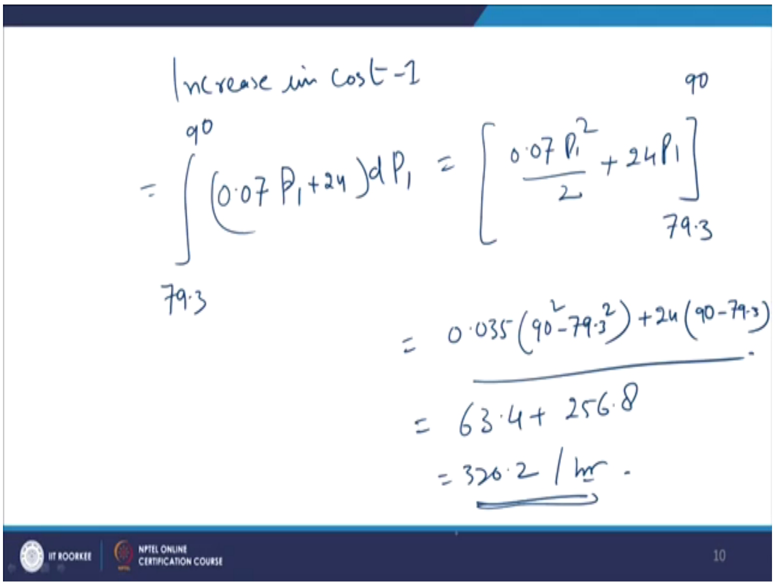

Now, increase in cost unit 1 is equal to 79.3 to 90 because, we have increased the fuel consumption is equal to 0.07 P 1 plus 24 d P 1. We have integrated it right. So, once we integrate because power is a output power is a output. So, once we integrate it, we get 0.07 P 1 square by 2 plus 24 P 1 79.3 to 90. And then it becomes 0.035 90 square minus 79.3 square plus 24 90 minus 79.3 ok.

And further simplifying this, we get 63.4 plus 2 56.8 is equal to 320.2 per hours. This is the fuel consumption per hour as increased yes.

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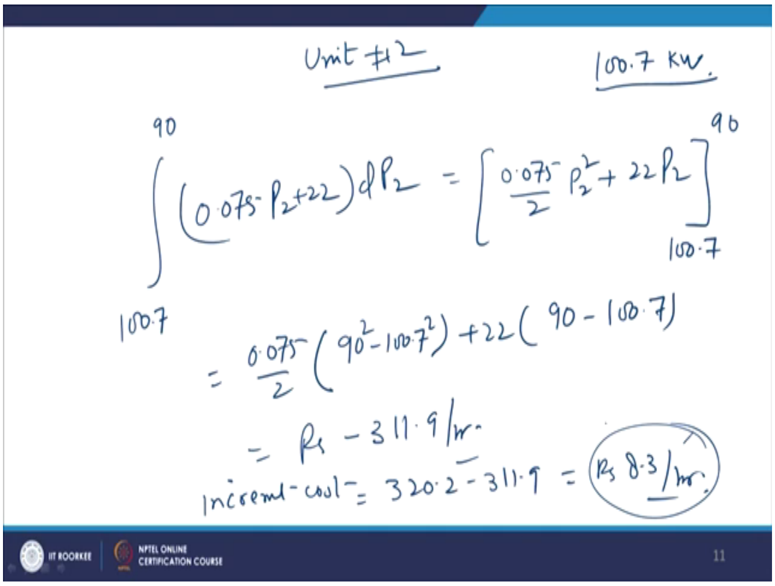

And the next is unit 2. Now, you got unit 2 is producing unit 2 is producing 107 unit 2 is producing 107 kilo Watt. Now, output of the unit 2 has to be reduced. So, we will start from 107 100.7 to 90 0.075 P 2 plus 22 d P 2 and that is equal to 0.075 by 2 P 2 square plus 22 P 2 100.7 to 90.

Then 0.075 by 2 90 square minus 100.7 square plus 22 90 minus 100.7 right. So, it is coming rupees minus 3119 per hour. And previously, it was coming 320.2 I think 320.2. This is positive that is negative and if you add these two you will find that net increment cost 320.2 minus 311.9 is equal to rupees 8.3 per hour. That is a net increment of cost for running system ok.

That is all was all for today and now we have complete all the lectures related with the course power plant engineering, I hope all of you must have enjoyed these lectures. Now, after that we will conduct the examination the schedule will come later on and I wish best of luck to all of you who are appearing the examination.

Thank you.