Conduction and Radiation

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Module No. # 01
Lecture No. # 20
View Factor

So, in today's class we will solve a few problems, which exploit the view factor algebra. And the extent possible we will try to obtain all the view factors in a n surface enclosure system by using view factor algebra itself. Towards the end of the class may be we will work out one problem in which we have to use the double integral. It is not actually double integral but, double integral over a i a j to in order that you are able to appreciate, how we can use this fundamental formula to derive view factors.

So, in yesterday's class we looked at the triangular enclosure problem that is general triangle with a not equal to b not equal to c. The line segments are given as a b c. This duct is infinitely deep in the direction perpendicular to the plain of the board. May be this point I did not emphasize in the previous class, so lot of people had doubt whether, it is having a finite depth in the direction perpendicular to the plain of the board.

So, it is implicit that we are looking at a two dimensional geometry. So, we are not worried about the depth direction is much longer compared to compared to the other dimensions it is for you to assume unit depth.

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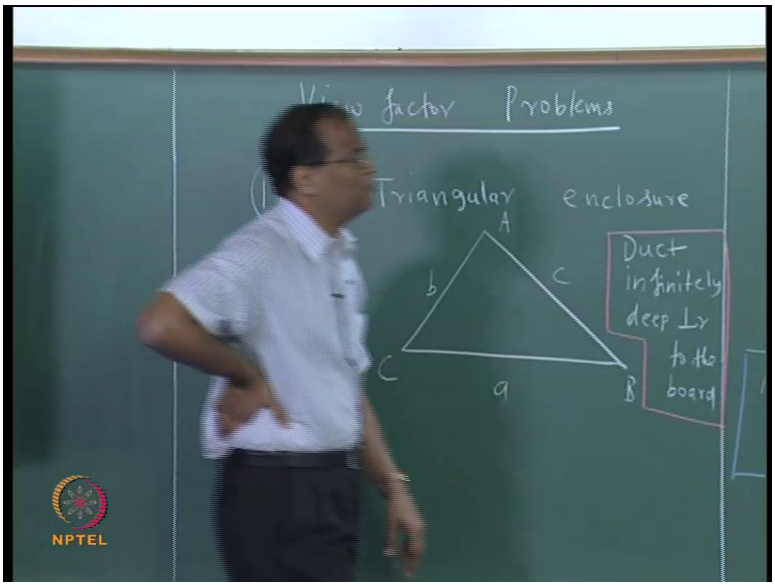

Therefore, the area of this surface, we can say it as b into 1. So, that is why I put it as b meter square per meter depth. That is a way you people will say, surface area of a pipe is also set the so, many meter square per meter length of the pipe. So, that way it is consistent.

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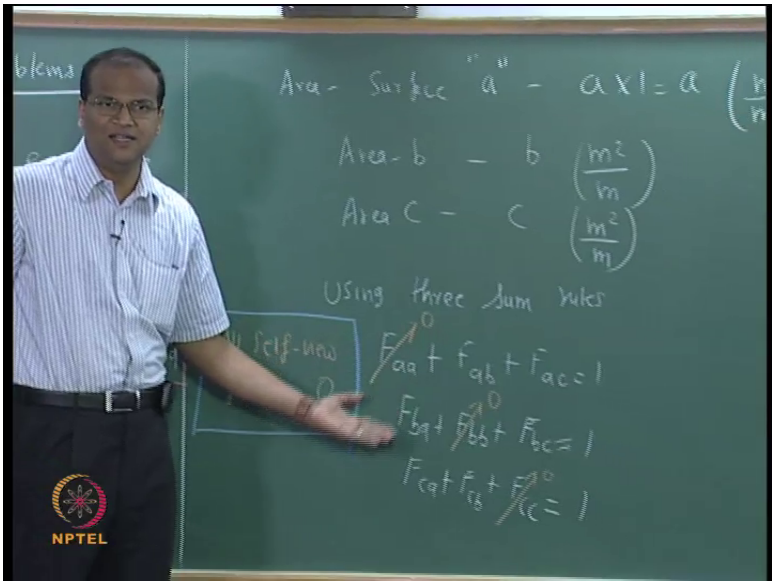

Now, I start solving this problem by first writing the three summation or sum rules.

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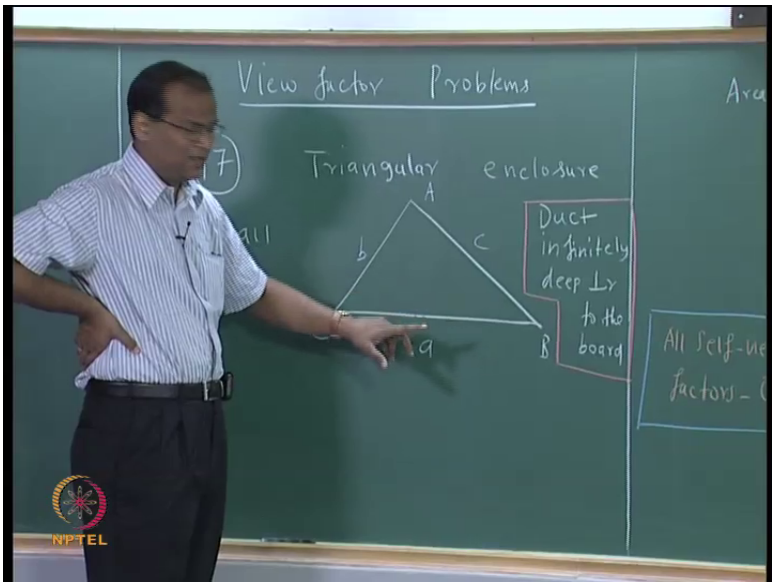

I apply the sum rule for the surface a f of a to a plus, plus f f of a to b plus f of a to c equal to 1 it is a plain surface therefore, f a a equal to 0.

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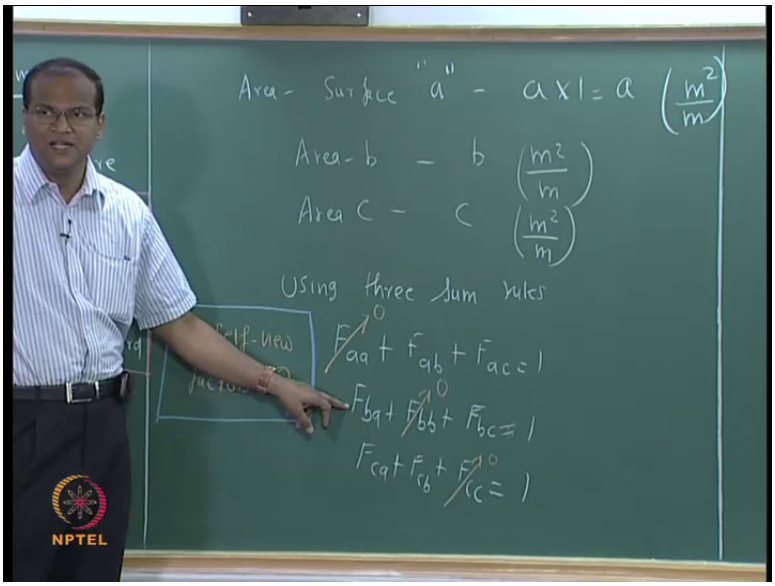

By the he same token I can write down the summation rules for surface b. As well as for surface 3 so totally.

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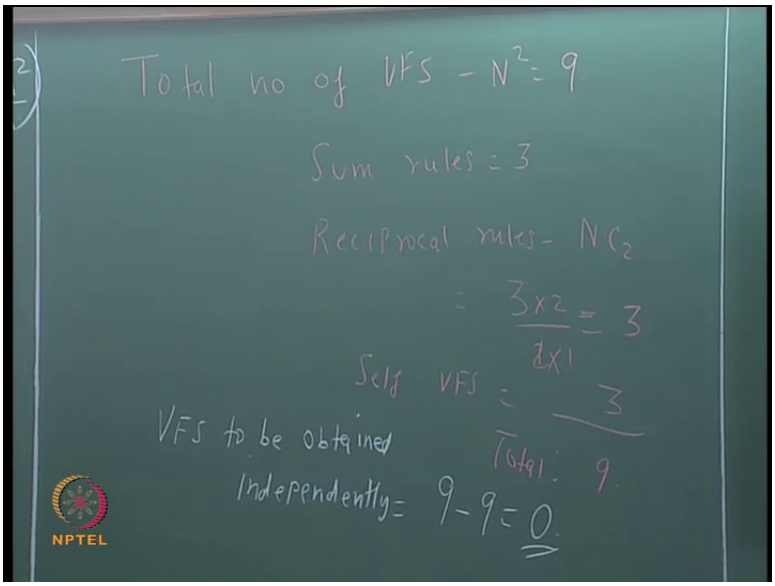

We call this as 1 2 3.

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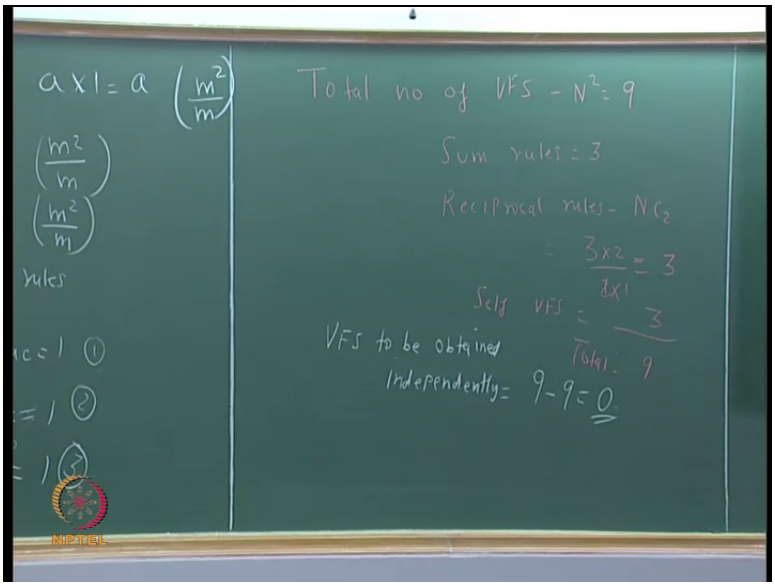

In fact you can start with this as a preamble to the problem, we can start of the problem by saying how many total number of, how many view factors are there in total, how many sum rules, how many view factor relations are available for you to exploit. So, that n square minus minus minus minus finally, we arrived at a number 0.

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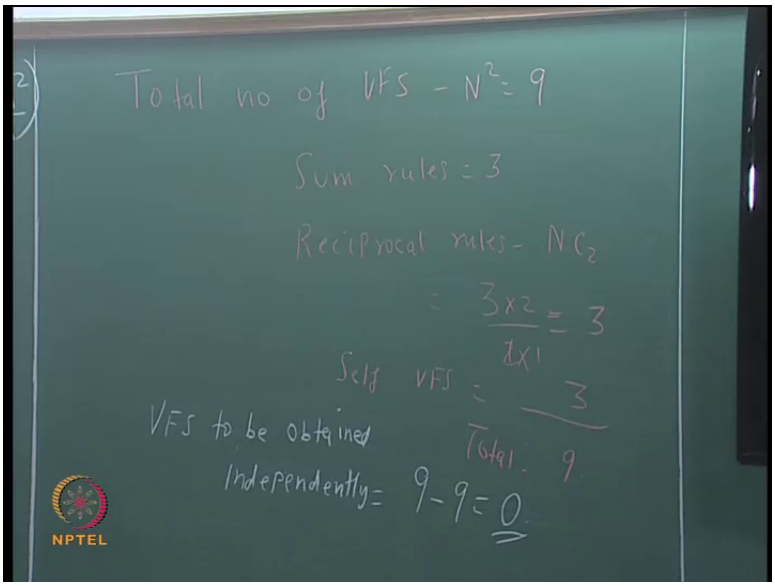

Therefore integration formula is not required then once you are convinced then you know that somehow, we have to algebraically manipulate all the view factor relations to get the view factors.

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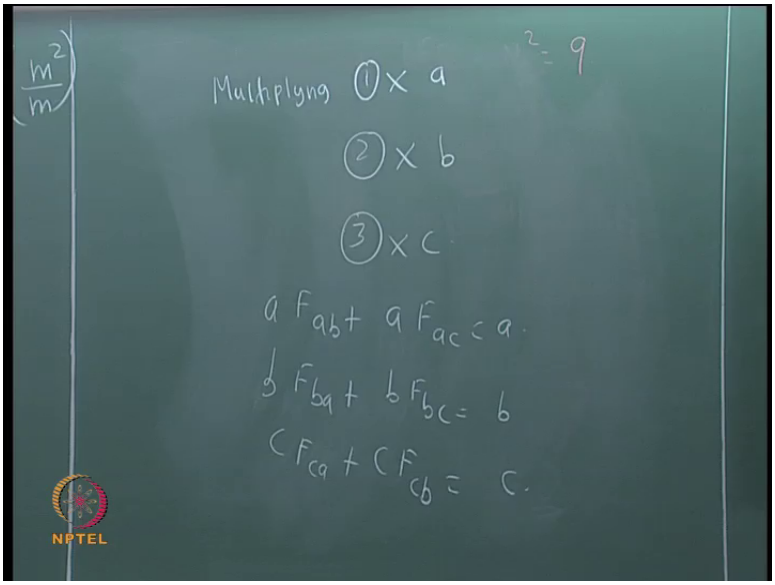

Now, I will erase this, I keep this. So, ok which other fellow will go b f p c. Whatever is indicated in red color is the same. And we are subtracting 1 red from the other red that also subtracting 1 blue from the other blue. So, what remains in equation 7 is So, this nothing but…

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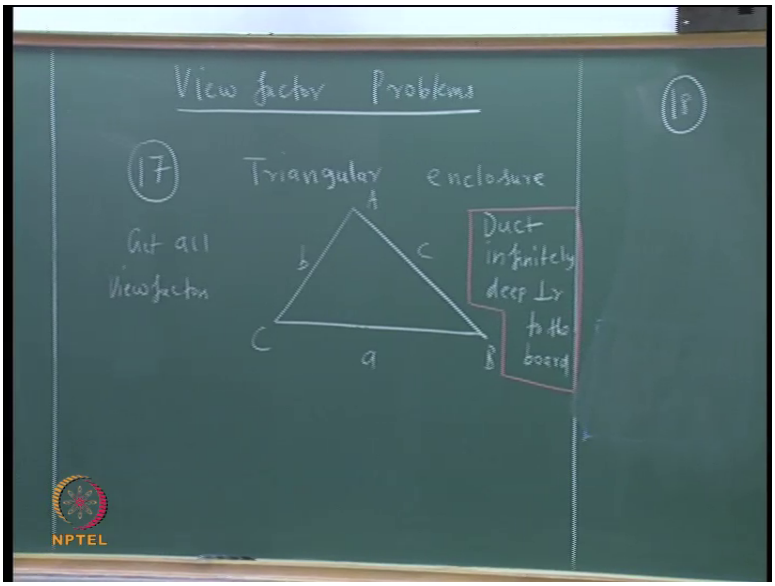

So, this is 1 and this is 2. So, there is a vacuum it is radiating and all I am interested in getting f 1 2 so, in order to make it general. So, that you are able to follow what I am saying let us say this is l this is also l I will call this as a wedge. This is a wedge in English we keep saying no do not drive a wedge between the two people.

So, this is a typical wedge now, the included angle is alpha problem 18 get f 1 2the question clear it follows from problem 17. So, if you want back side there is no activity. Please, remember we are using enclosure theory therefore, what is a first step in technology put a dotted line and close this fellow and make him a triangular enclosure.

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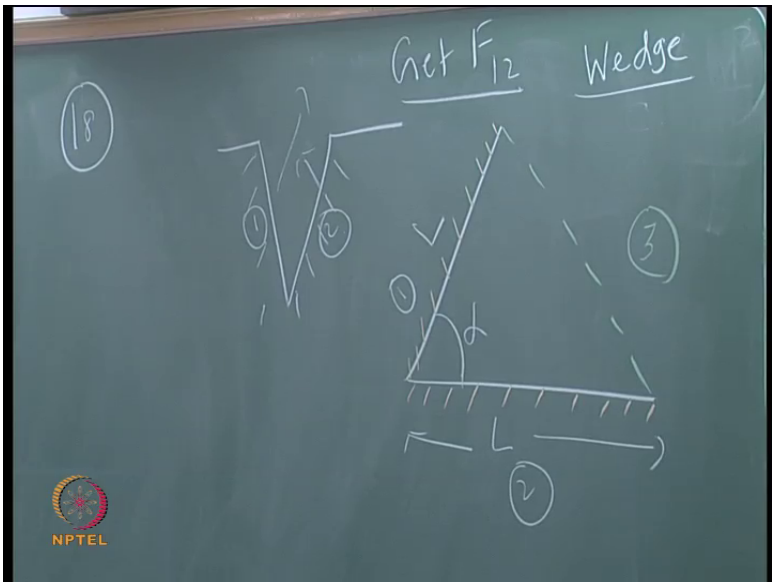

Let us use a green color chalk, we can make him 3, if we want not required. So, Vikram got it what is it 1 minus, 1 minus, 1 minus sin alpha by 2 how many of you got it. What happen got it finish doing, you know why do not you do it you came late complete that come see, what happened you are able to see from there.

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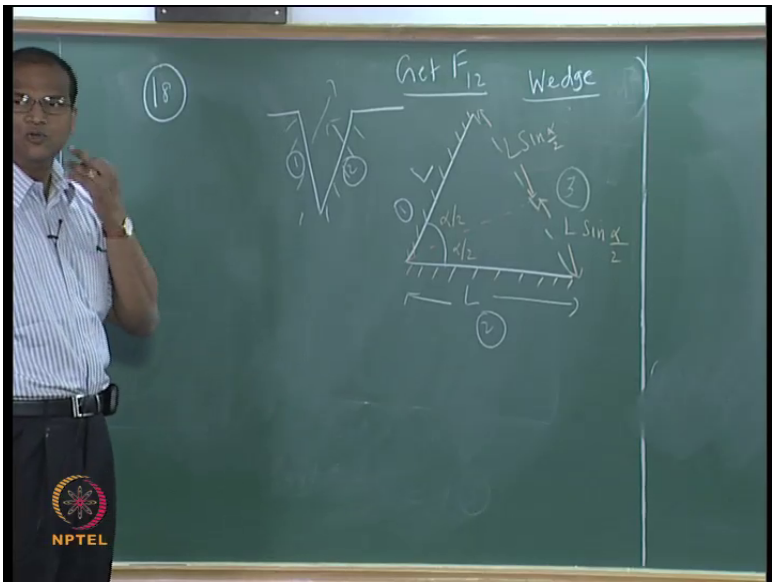

So, I will put a dotted line here, what is this fellow this is alpha by 2 what is sin alpha by 2, sin of alpha by 2 is this by hypotenuse. Therefore, this will be l sin alpha by 2, which one this one, what about this fellow also. So, the length of the side 3 is 2 l sin alpha by 2.

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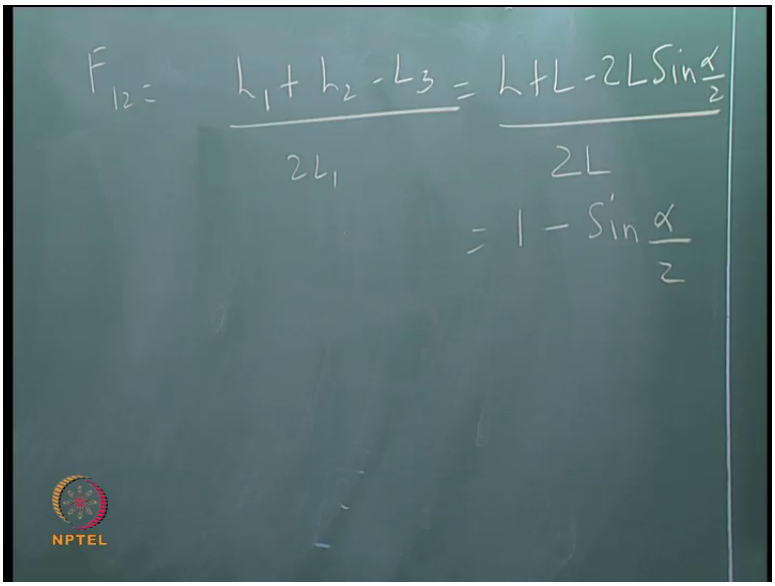

F 1 2 I am saying length of first surface as l.

ways of optimizing one, see your optimization heat transfer does not always mean that you want to maximize the heat transfer, like sometimes you also want to minimize the pumping power or you want to have a trade off.

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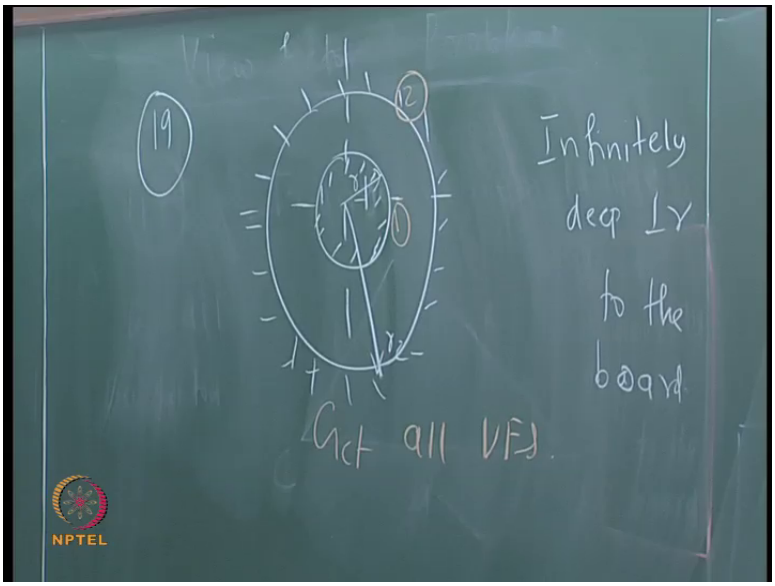

So, we will stop it at that stage. Now, do not worry about the radiation activity on the outside of surface two. Do not worry about the radiation activity on the inside of surface one. problem 19, was the cylindrical duct get all view factors. very good get all viewers, how

many view factors are there? No no no no (( )). We have matrix What do you want to do I want to put it as a b c d man

Student: (( ))

Length is also d is the length as well as the (( )) it qualifies the surface.

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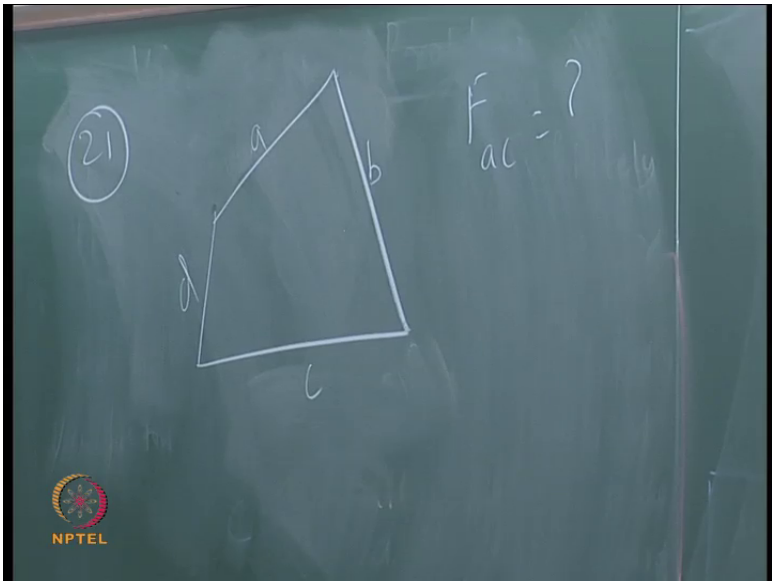

Everybody is through with this what is f a c? what about f a d come on, not so easy (( )) how many independent view factors are to be determined.

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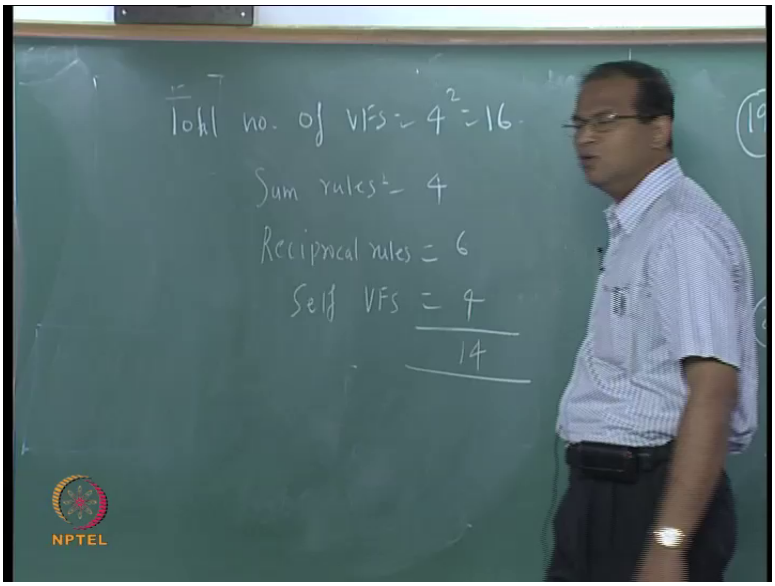

Viewers total some rules, reciprocal rules n c 2 4 into 3 by 2 6 self view factor so, total is 4 plus 6 plus 4 14. So, number of view factors to be independently determined two.

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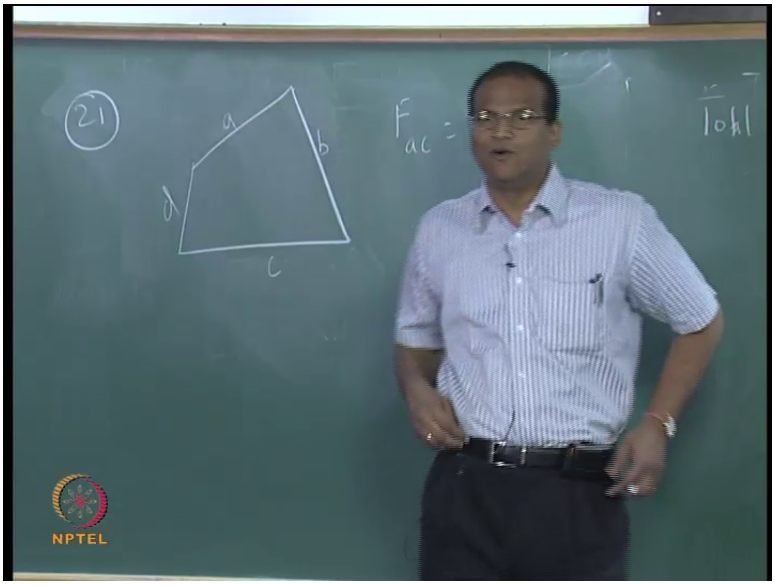

But, what are these two if f a to c and f b to d. If you get f a to c that same formula can be used. So, now you have to crack, if you want to crack this problem, then you have to get this you have to somehow get the f a to c.

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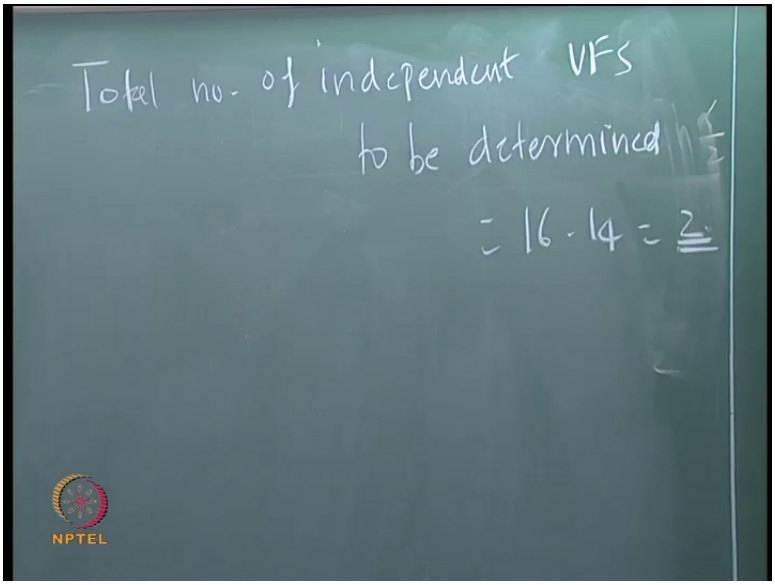

Now, very good to in order to make it in 2 triangles what should you do first.

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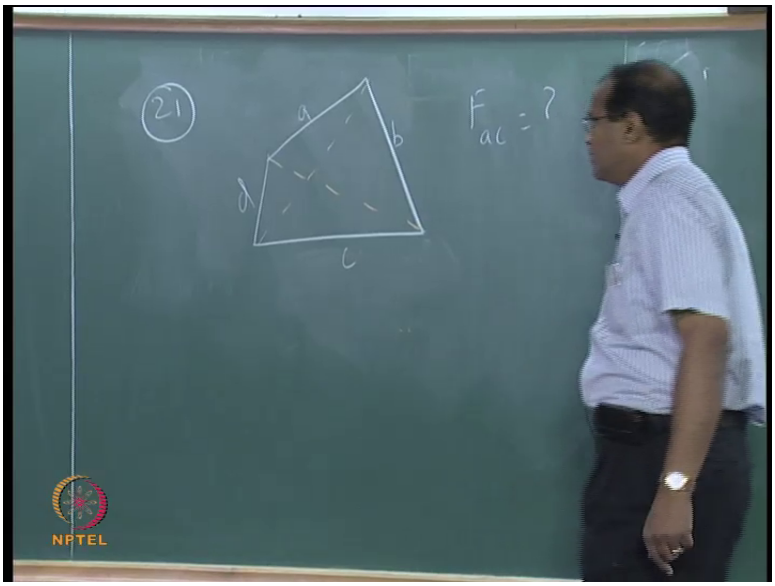

Draw the diagonals, draw the diagonals very good just draw the two diagonals, which triangle you want to take like this, ok. Yeah now, how do you proceed? Yeah please, tell me can you (( )) you want to label the diagonals you want to do that is it required. think, got it 1 minus triangular enclosure with trapezoidal duct and diagonal duct. I am looking at the list of problems I have to solve today. (( )) That you know you already studied somewhere you derive, you have to derive it.

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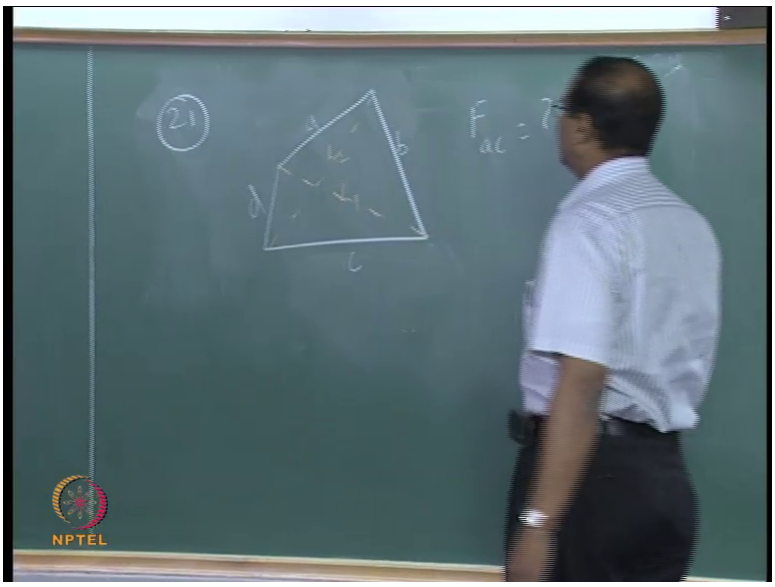

Next now, I think it is better to you want to name the diagonals l 1 l 2 I think we should have placed the vertices, as we should have name them as you know or that does not matter (( )) l 1 l 2 (( )) 1 is(( )) (( )) l 1 and l 2 (( )). Ok l 1 l 2 l 1 is enough.

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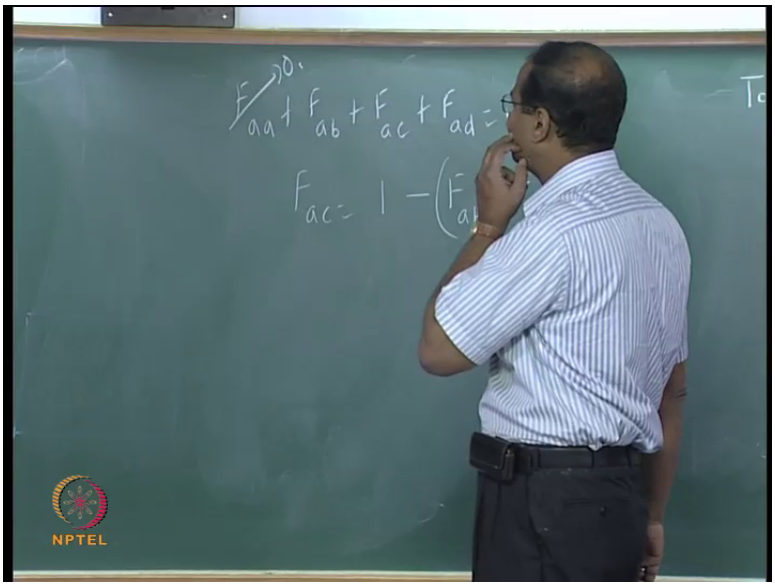

Now, tell me so f a c is 1 minus f this is correct f a a plus f c this is correct.

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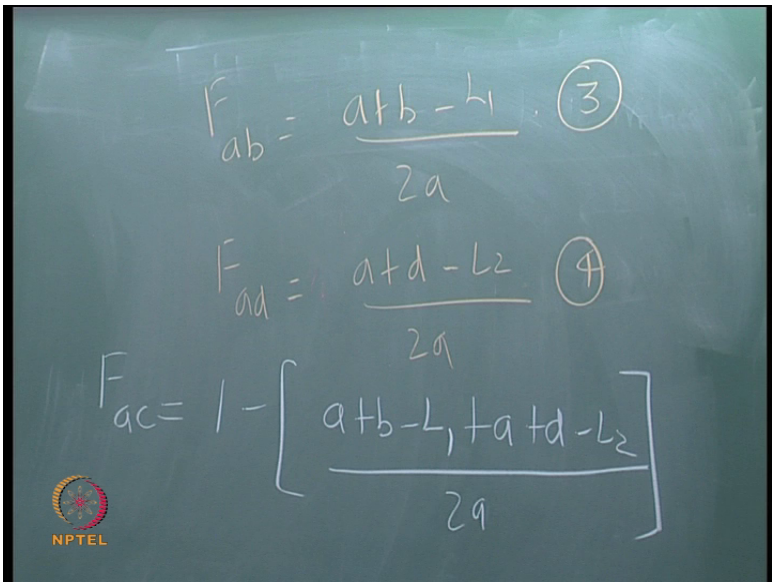

Now, f a b can be written as f a b is equal to a plus b minus l 1 by 2 a, f a d a plus d 2 a. Now, in substitute f a c equal to 1 minus changing the situation difficult situation by changing the enclosure itself.

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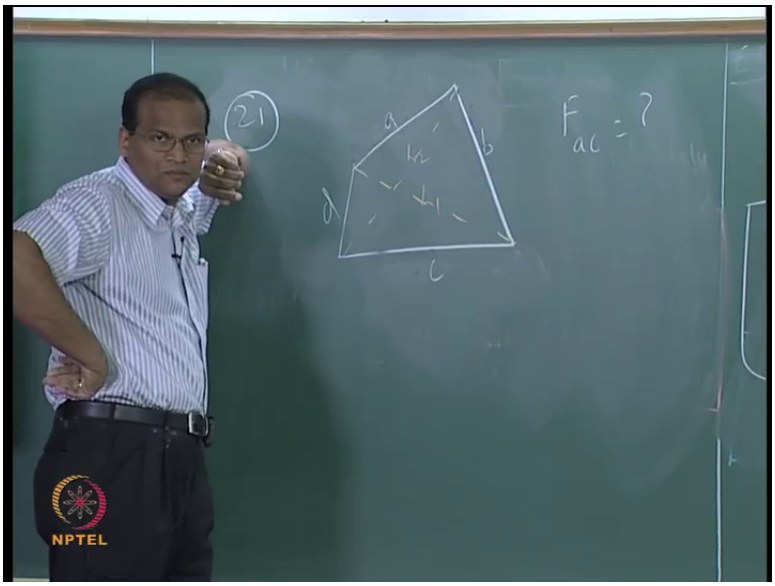

No, but, if you look at energy balance, what will the sum of f, f a to a plus a, a to b plus f a to b a to this must be 0. So, from here whatever is going to c and d must come through his imaginary l 1 I mean there is nothing wrong in that, that is the energy balance. He has valid point did you have understand are we doing something by putting this l 1 l 2. He is saying but, as far as I am concerned the energy which is falling on c and d has to come from this that is what I am saying. So, it is for me to assume that yeah tell. Now, let us twist it little more let us take a pentagonal duct. So, we did triangle then place we did quadrilateral.

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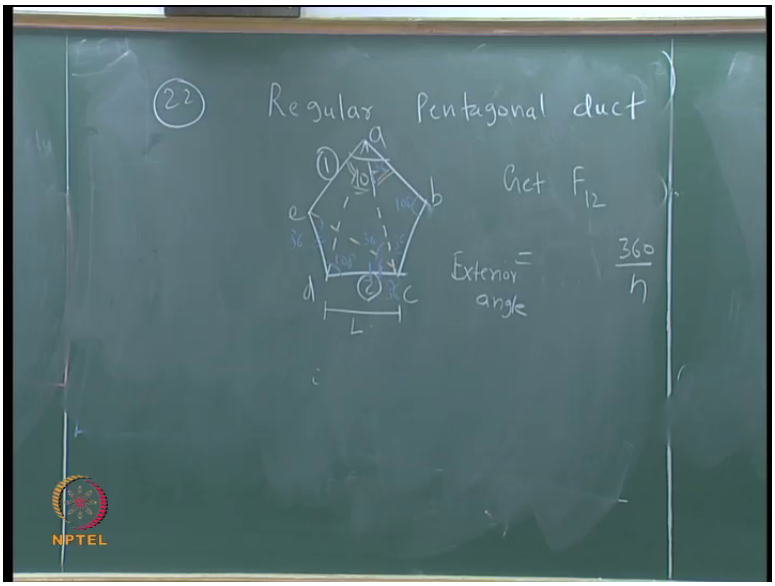

Now, problem number 22, so, problem number 22

a (( )) regular pentagonal duct, regular pentagonal duct all sides are equal. I can give Hexagonal duct though Decagonal duct and so on in the exam. Hexagonal duct is used you have hexagonal bolt and hexagonal duct can be used easy to make. So, what is f 1 to 2, what did I write here f 1 to 2 is f a c 2.

Now, you have to what I have to do here is basically you must remember your math, basically you must remember the included angle you must know, what is the included angle? (( )) Underneath because, this will be what is this So, what is called exterior angle? Exterior angle so the exterior angle for a pentagon is 360 by n is 5 72 1 not 8 is it or what is it (( )) is that correct exterior angle is 360 by n 72. Therefore, the interior angle is 108 each of this fellow is 108. Now, if I join this each of these angles is we do not know will it be 36. It will be equal (( )) it will be equal only it will be 36.

Now, this angle so, what is this 108, what is this it is isosceles triangle man. So, 36 this is 36, now, this is 108, this 36, this 36, if this is 36, this is 36, this is also 36, same story here. Ketan you are not happy that all were 36 but, unfortunately it is correct. Ok now, Vinay got it answer f 1 2 equal to (( )) (( )) Sin 54 minus half I do not know I have done I got 0.31 what is the answer (( )) right correct 0.309 is a right answer. Now, we will do it did you use this Hottel's crossed string yes correct. So, you have to use the Hottel's crossed string that is why I gave this problem after the Hottel's cross string.

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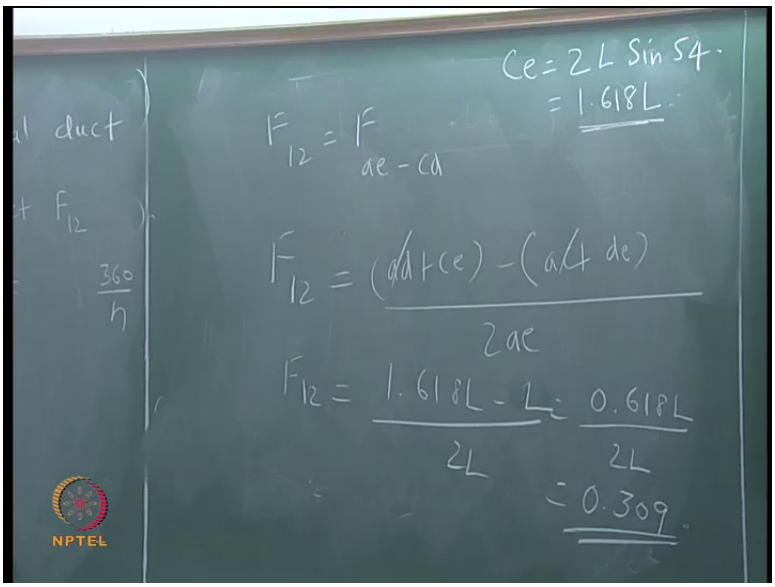

Now, we will have to f 1 2 is equal to, so what is f 1 2? How did you sort out this problem f 1 2 equal to how did you say f 1 2 plus, what did I write f 1 2 is equal to f why did I do this f a e to c d correct f a e to c d. Now, I am confusing my terminology does not matter now, f 1 2 f f 1 2 is equal to a d f 1 2 equal to a d plus c e minus a c plus very good by very good what did I do? a d and (( )) a d a c will get cancel. So, what is c e (( )) 2 a c (( )) 2 what is sin 54 1 point so d e is l.

Let us consider another situation. So, there is a circular duct there is a circular duct do not worry about the radiation activity inside it is r 1. Now, it is closed by another concentric cylinder but, unfortunately the other one is only half.

So, please get all view factors so, what is the first step close it very good close the bottom the dotted line and you will call him 3 if you want you can call that fellow 3, what is f 1 1? f 1 2. (( )) no no f 1 (( )) 0.5 f 1 3 0.5 (( )) Very good very good because the symmetry is there. So, f 1 1 f 1 2 equal to f 1 3 by symmetry, it is no special preference are you getting the point. Therefore suppose I make this fellow up to three-fourth and leave, then the (( )) ratio other things will come. Now, this fellow is not like this now what about f, what about f 3 3? (( )) f 3 3, f 3 3 equal to (( )).

Yeah what is f 2 2? Are you able to get the other things? So, f 1 1 is equal to 0, f 1 2 equal to 0.5 f 1 3 equal to 0.5 a 1 f 1 2 a 2 f 2 1. Therefore, f 2 1 equal to (( )) what is it r 1 by r 2, r 1 by r 2, f 2 1 is also the same as f 3 1 yes (( )) tell me correctly.

Let the r 1 (( )) no some half page is there know half will come sir half area and half the volume. Why half the volume for 1 it is full is not it 0.5, 0.5 into 2 by r 1 and the other 1 (( )), ok what is the final answer 1 by r 2r 1 by r 2 f 2 1 equal to f 3 1 equal to r 1 by r 2 is it correct. And then f 2 2 what I have done is suppose it is r 1 by r 2. It depends on I have given r 1 by r 2 equal to half (( )).

So, what are the other things required now, what is f 2 2? What about f 2 3? (( )) f 2 3 I think it is if it is struck or what obviously this problem can be solved is not it. It is simple problem why are you getting struck? So, we will stop here it is 9:50 so, we will work this problem in what tomorrow's class, tomorrow we will also do some integration I also give you a chart, what will what will be the view factor between 2 rectangles when you have got finite areas 2 d rectangles and all that.