Engineering Drawing and Computer Graphics
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Module - 02
Lecture – 13
Conic Sections – V

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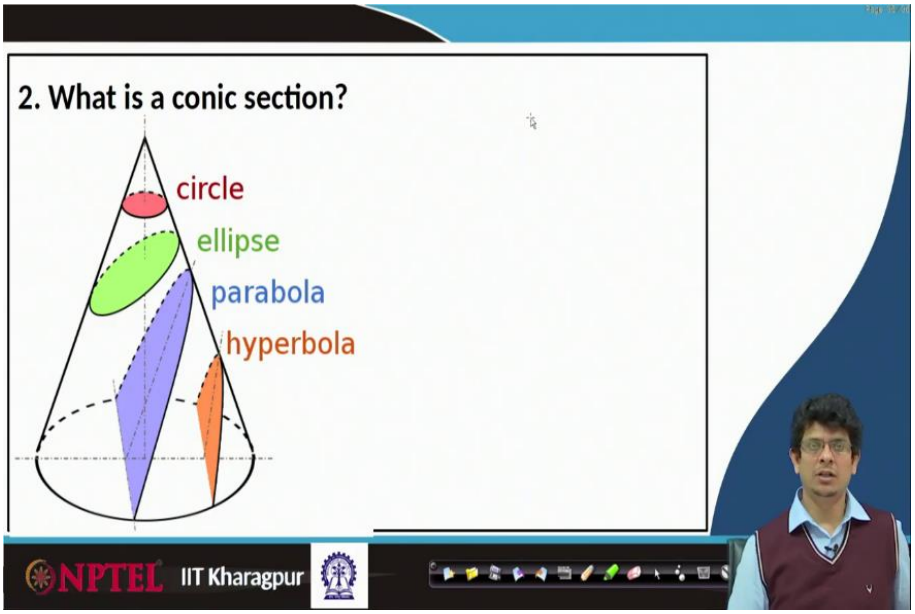

Conic sections, there we have learned many things like a horizontal slice to a right circular cone gives us circle, slant edges give us ellipse, further parabola, and hyperbola.

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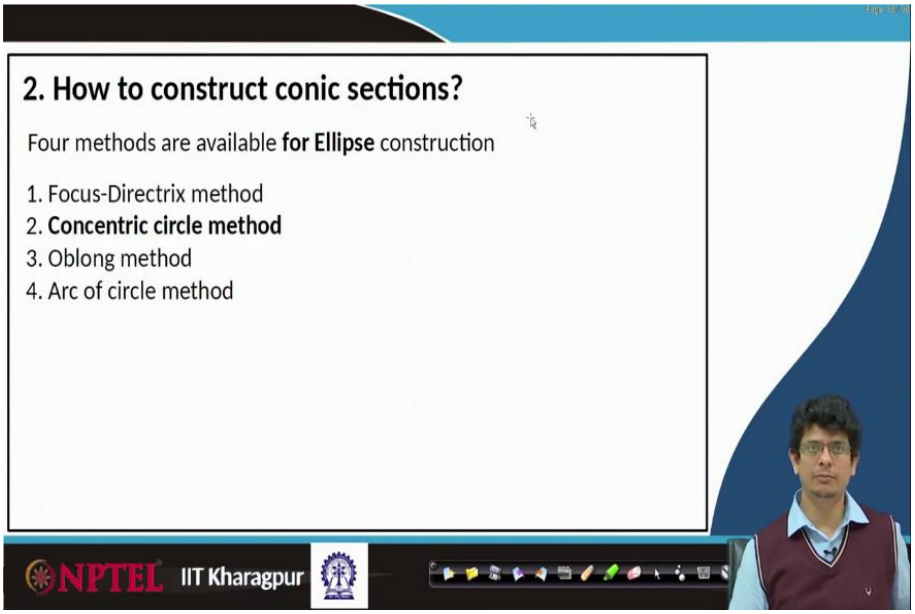

In today's class, we will learn two special methods to construct ellipse, one is the concentric circle method, and the other one is the oblong method.

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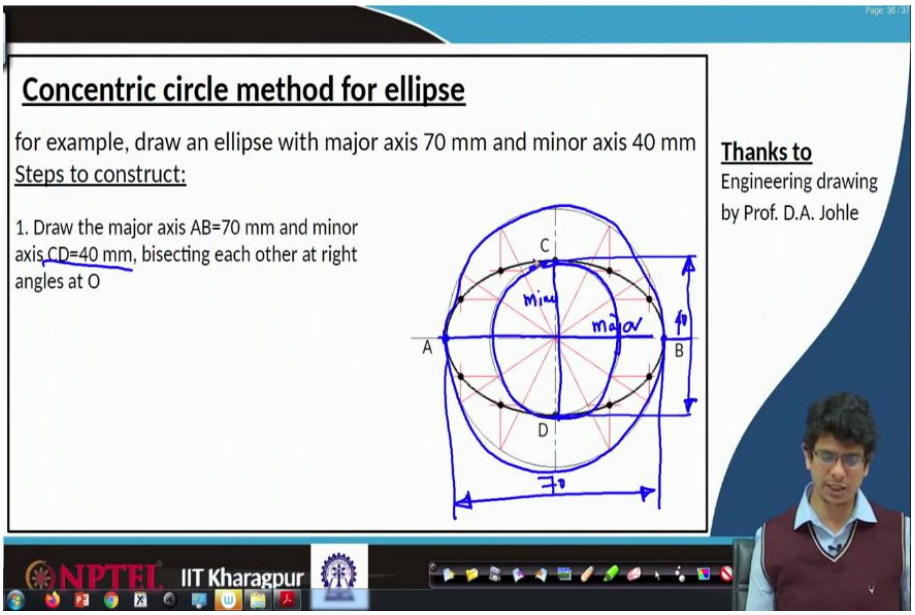

In the concentric circles method, two concentric circles are drawn from there how to construct an ellipse based on the major axis, minor axis given for an ellipse. We will draw two circles of two different radii concentrically, and then join the lines to construct this, an ellipse.

Let us look at that through an example. For example, draw an ellipse with a major axis 70 mm and a minor axis 40 mm. For that purpose, what we have to do is to draw a horizontal line, which

we call major axis, in this case, AB 70 mm and minor axis with 40 mm. Furthermore, these two bisect with each other at right angles at O.

So, let us look at this. So, AB points on a horizontal line; these are 70 mm apart. Furthermore, the minor axis for an ellipse supposed to be 40 mm, that means, if we are extending these lines, they should not be get intersected that is a way one has to draw, and this part supposed to be 40 mm.

Furthermore, if we see carefully, this is 70 mm major axis, so the diameter of this entire circle itself is 70 mm. The other minor axis is at 40 mm. By drawing one more circle, we will be in a position to construct an ellipse.

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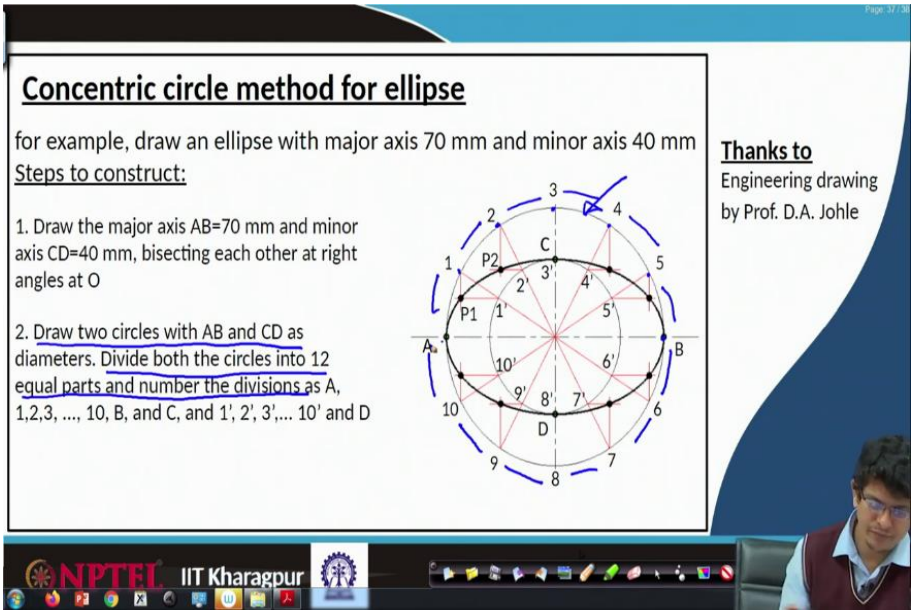

So, the first step, we have to draw two circles with AB and CD as diameters. After that, divide both the circles into 12 equal parts. So, let us pick the outer circle, this one. For this outer circle, the diameter is 70 mm; one has to divide into 12 equal parts. It can be 12, 24 equal number of parts one has to make it for both the major axis base circle and also minor axis base circle. Here we are going to make 12 parts. So, A begins with that 1, 2, 3, 4, 5; the sixth one is again B.

So, the first part, the second part, third part, fourth, fifth, sixth these are equal parts. On the bottom side also, so because of symmetry again 1, 2, 3, 4, 5, 6; in total, 12 parts we are going to construct.

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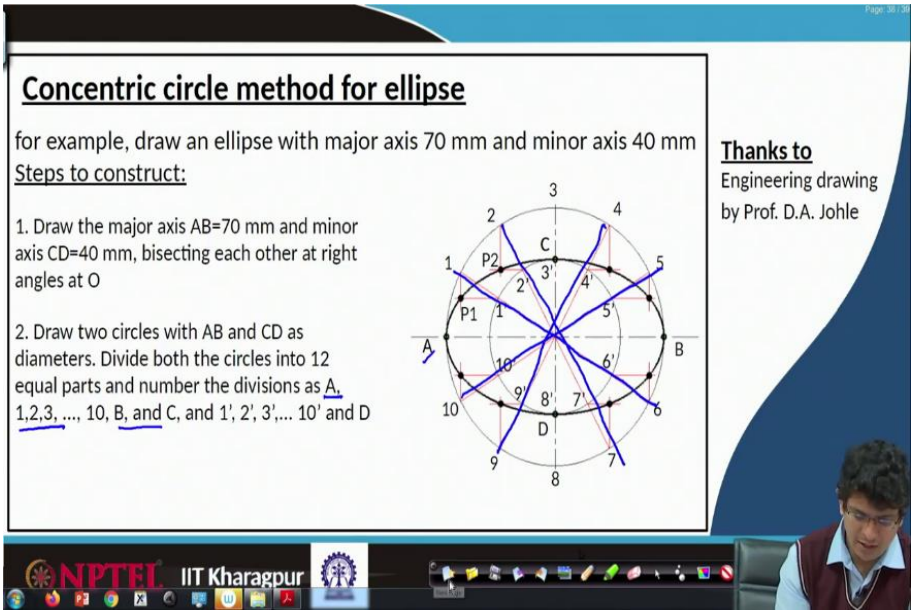

And the names what we are making is beginning with A all the way to 1, 2, 3, 4, 5, and again B starting with 6, 7, 8 and 9 and 10, and again it goes to A. Similarly, if we by making this equal division, that means, we will be in a position to really draw such kind of normals for this major axis circle.

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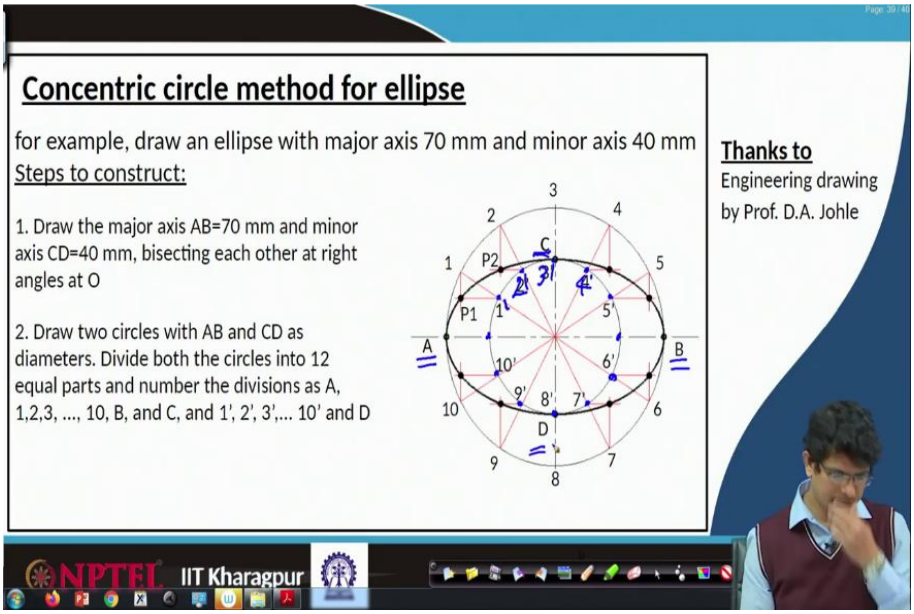

Once it is done, we will extend those lines, so that there will be minor axis base circle also divided into 12 equal parts. The outer ones we are going to name it as 1, 2, 3, 4, 5; inner ones we are

going to name it like 1', 2', 3', 4' and so on. This is the convention what we are going to use. On major axis, the letter is A and B; on minor axis, the letters are C and D.

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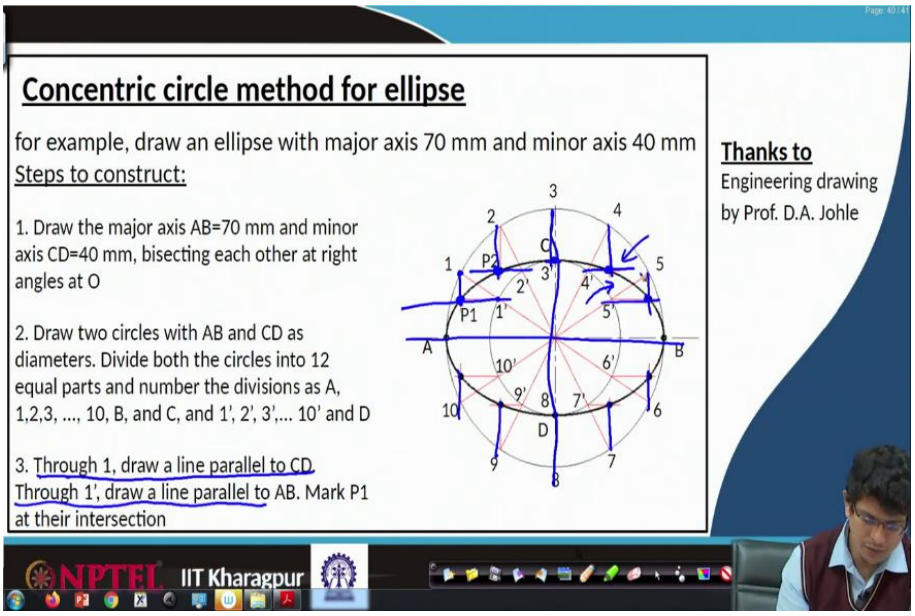

After the division of these 12 equal parts, we draw a line parallel to CD, through the first point. We have identified the first point is 1 parallel to CD; CD line is this one. Parallel to this CD line we are going to draw a line at 1. Similarly, we will draw at 2; 3 is already there. At 4 also we will draw, 5, 6, 7, 8, 9 and 10 points also we will draw.

Once that is done, through 1' draw a line parallel to AB. 1' is this point. AB line is this. Parallel to that, we will draw a line. Similarly a 2', 3' intersecting point, 4', 5' we will draw. Once we are doing after that, we have these intersection points which are away from the inner circle and into that outer circle.

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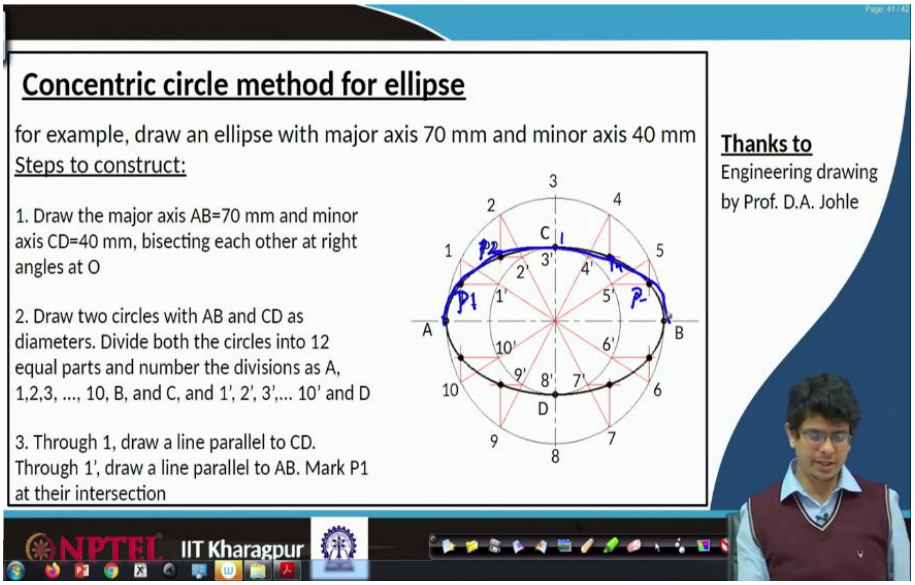

So, these points we will name it as P 1, P 2, P 3, this is P 3, which is already C, P 4, P 5, and B and so on. Once we have these points, we join them to get the top part of the ellipse.

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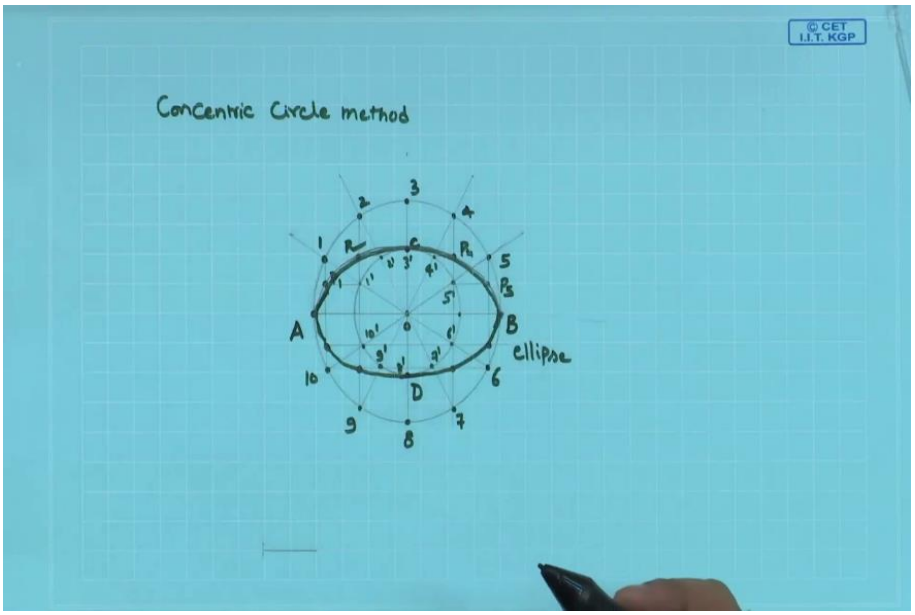

So, let us do that on the page. Ellipse with major axis 70 mm. So, let us draw 70 mm, 70 mm, the first point we are marking there, 70 mm we are marking, this is the one. And this is the major axis. So, by using bisector, we will be in a position to identify the center; otherwise, now it is 35 units. Once it is done, we will construct a circle which pass through both the points, let us name them: the first point is A, the second point is B, let us call this centre as O. We have to draw a perpendicular line.

So, if we have a drafter, it is relatively easy; otherwise, we use this set of scales and extend this is the line. So, the centre will be done; after that, we have to draw 40 axis diameter circle, that means, 20 millimetres radius we are going to pick; this is 20 mm. So, carefully pick measure 20 mm from here draw a circle. After that, we have to divide this one. So, let us name this point C and D.

Once it is done, we have to divide this into 12 equal parts. Let us count like the first part, second, third parts on this figure. So, the third part means let us use our protractor 30 degrees, again 60 degrees and 90 degrees. Let us join these lines. And similarly, join these points. Similarly, on this side also mark these points 60 degrees, and on this side 30 degrees. Let us join through this. So, we make 12 parts. Let us label them this point is 1, 2, 3, 4, 5, 6, this 7, 8, 9, 10 points. Similarly, inside points, 1', 2', 3' which is c', next one is 4', 5', and this is 6' B any point is there. So, let us call 6', 7', 8', 9, 10' done.

Now, what we have to do is, the second step let us look at that second step is through 1, draw a line parallel to CD; so through 1, draw a line parallel to CD. So, if we have a ruler scale, we could have drawn it in that way otherwise let us use our scale. We have this 90 degrees line, because they are bisecting. So, adjust the scale carefully and draw a parallel line. Similarly, a 2 draw a parallel line; 3 already there; at 4 also draw; 5 also we have to draw that line. So, let us do that it 5. So, vertical lines we have drawn.

Now, at 1' onwards, we have to draw horizontal. For 1 this is the horizontal line which is mapped with the grid. So, let us label this point as P 1. Similarly, at 2, we have to draw a horizontal line to intersect it is more or less at this point. 3, similarly at 4, also intersect this point. At 5, this is precisely on the grid map; so connect that. Once it is done, label them P 2, P 3 is already there, this is P 4, P 5 points.

Now, draw a freehand sketch which is passing through A P 2 C 3 P 4 P 5 and B. So, if we have French curves one can smoothly construct a nice line which is passing through that C P 4 P 5 and B. Similarly, one will be in a position to construct at bottom lines also. Let us construct those.

So, 1 and 10 points are on the same line which we have to extend. Similarly, at 2 and 9 points are on the same line, extend this 9 and 7 also in the horizontal plane. So, wherever it is intersecting locate those points, these lines are also extendable, and this is the other point. So, let us name this. Extend this 5 also this point. If we have more number of points, the curve looks nice and smooth.

So, let us join by freehand. This is the way one will be in a position to construct it. If we have 24 points or perhaps 48 points, we get a better picture. This is an ellipse. This is by concentric circle method. If we know the major axis and the minor axis, one will be in a position to construct this.

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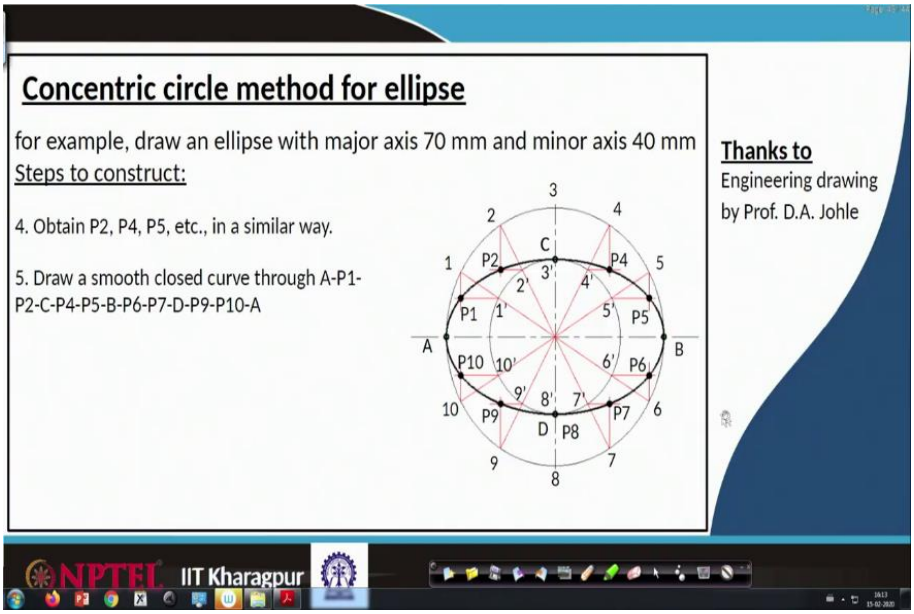

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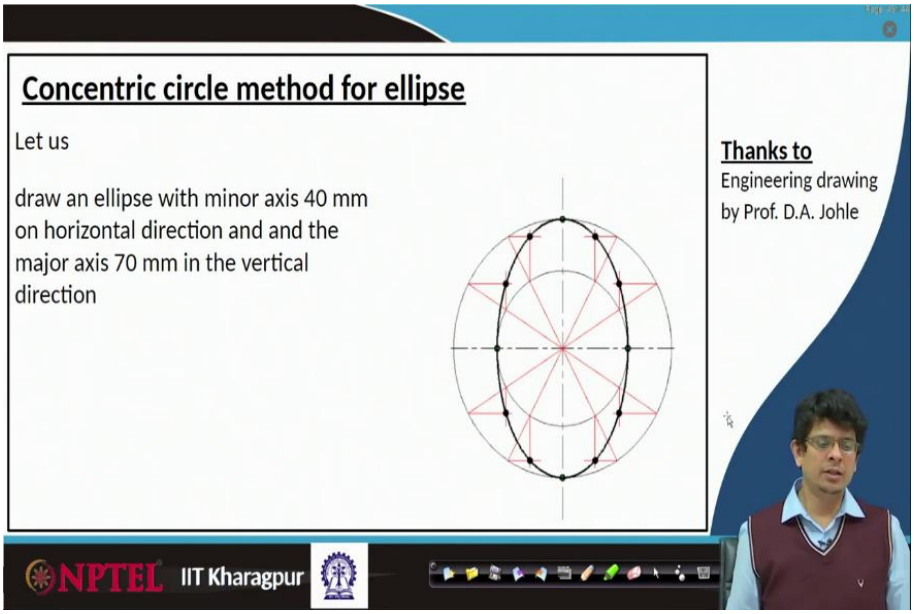

So, we are done with horizontal kind of ellipse. If we would like to construct vertical ellipse that means, the major axis is aligned with x-axis are now horizontal plane that if it is aligned with the vertical axis, the same procedure we have to do. Instead of drawing dropping this one line, all

the way down we are going to project this all the way this one line onto the horizontal axis, it is more like by symmetry. It turns out to be this kind of circle, please practice this example.

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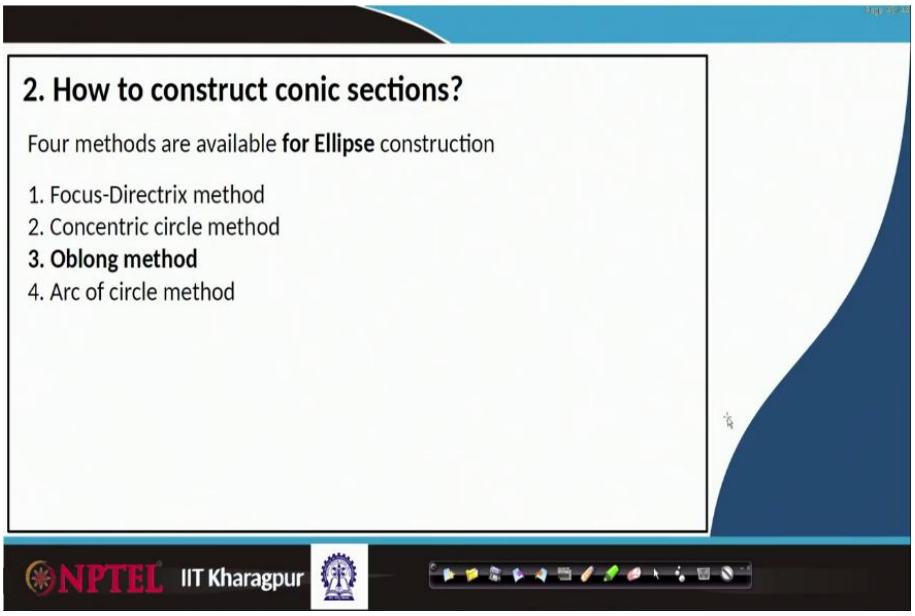

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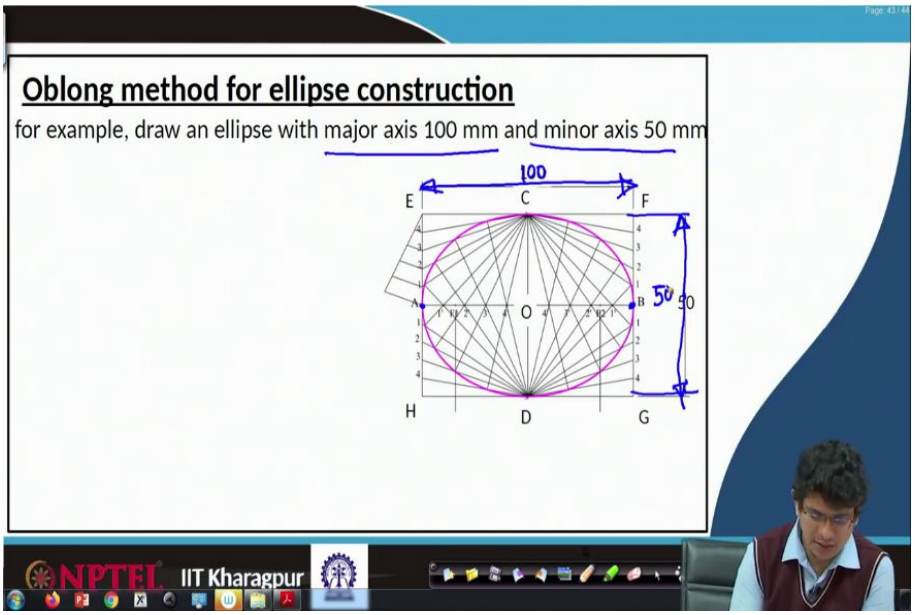

After doing this concentric circle method, we will go with the oblong method. In this oblong method, we construct a rectangle based on the major axis of 100 mm. Here, the minor axis for this ellipse is 50 mm.

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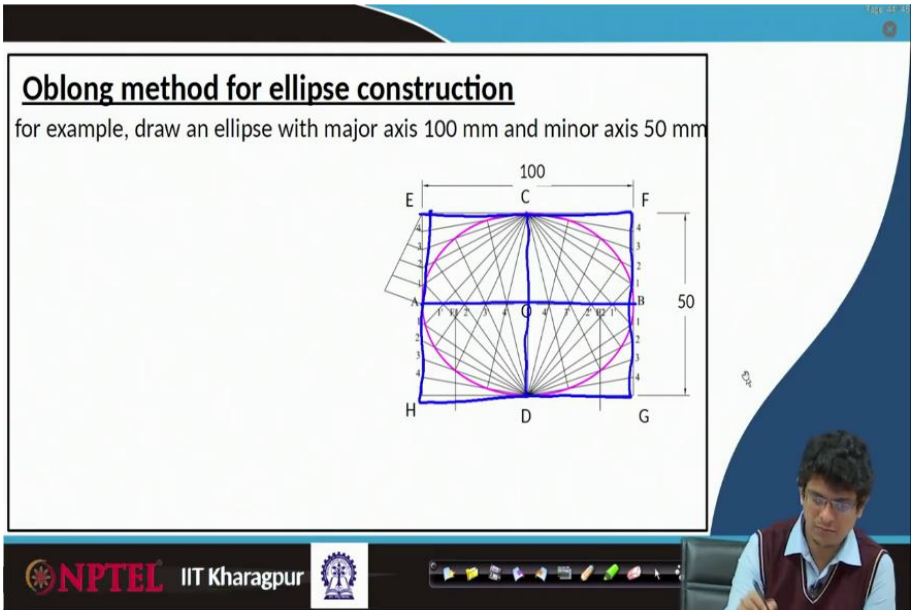

For that purpose, what we have to do is, first of all, draw AB line, draw CD line orthogonal to each other. Then construct a box a rectangular box where EF is equal to AB line.

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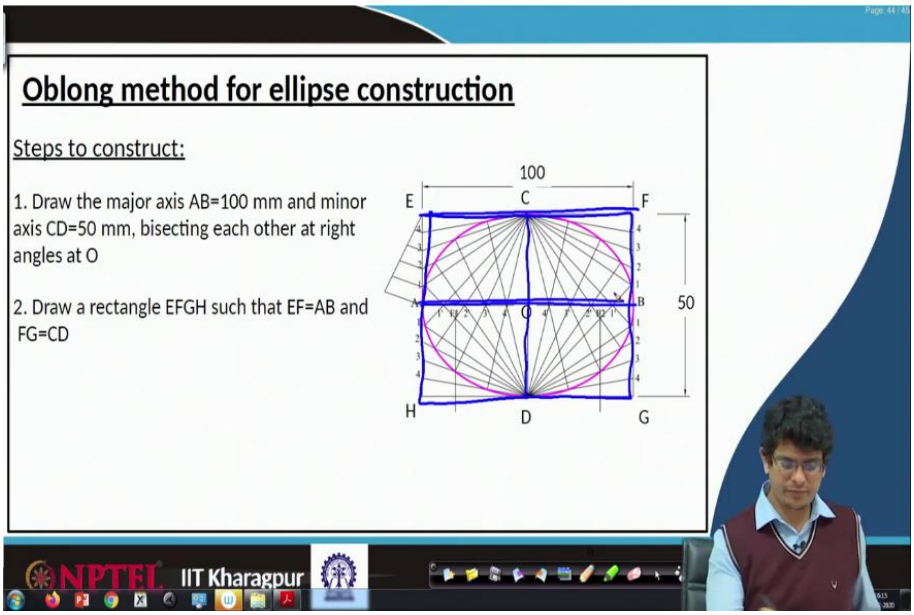

Then divide AO and AE into the same number of points

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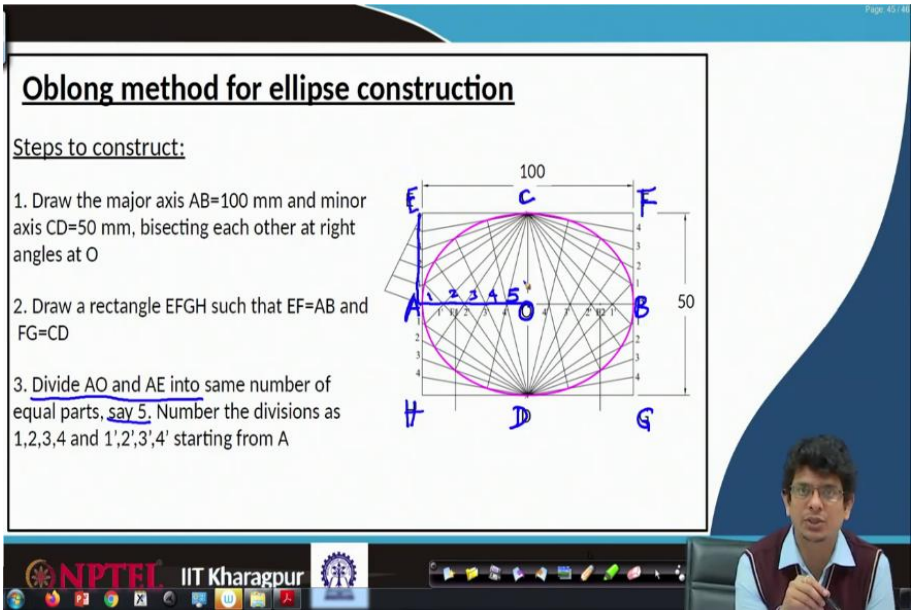

The intersecting point is O this point is A. BCD for the rectangle this is HG F and E. Now, divide AO and AE. AO is this one; AE is this one, this quadrant of that rectangle into the same number of equal parts let us say 5. If we have 50 points, then accuracy will be nice, and we will have a very smooth curve. If we have less number of points, it may not be a very smooth curve; that is the only difference.

So, what we are going to do is divide AO into an equal number of 5 parts.

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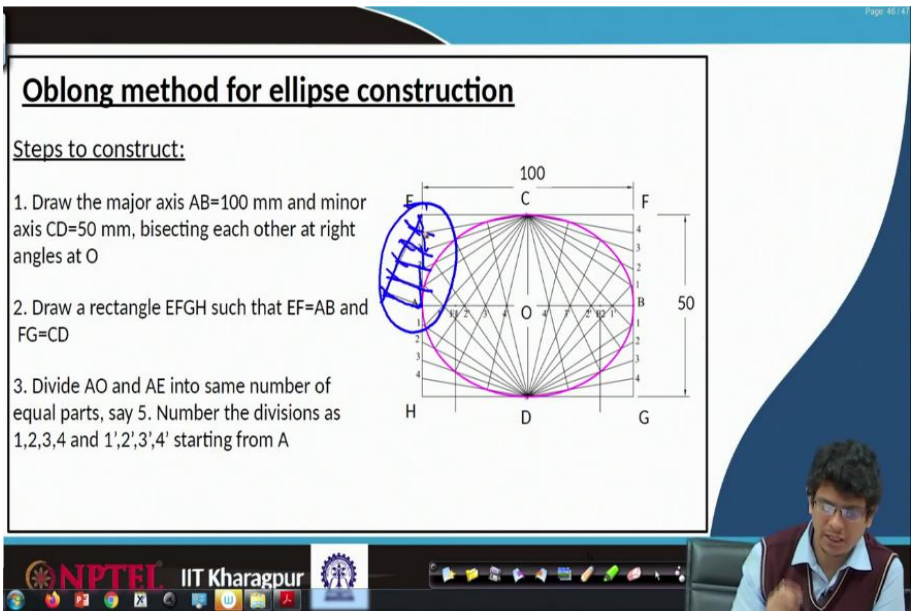

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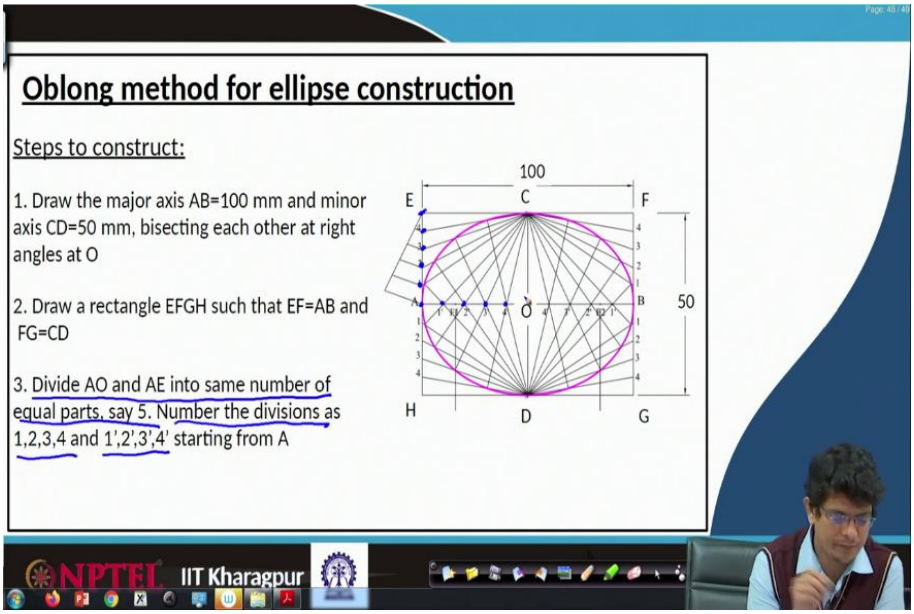

Then name after dividing that AO, AE into the same number of equal parts, let us say 5. Number the divisions as 1, 2, 3, 4. So, the division is this is A - first, second point, third point, fourth point, and eighth point. Similarly, 1', 2', 3' on the horizontal axis; 1', 2', 3', 4', and O.

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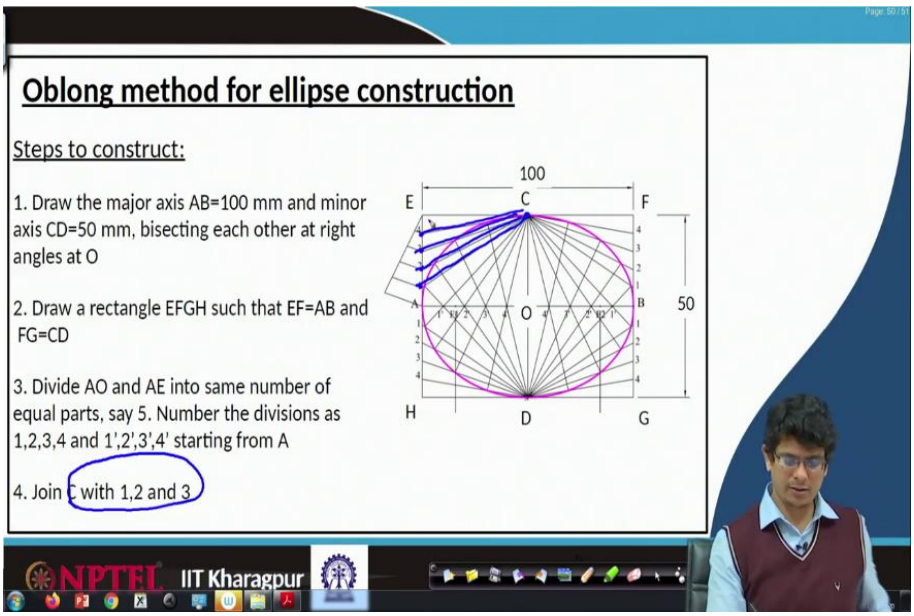

Once it is done, join C with 1, 2, 3 points. C is this; 1, 2, 3 on the side axis; 1, 2, 3, 4.

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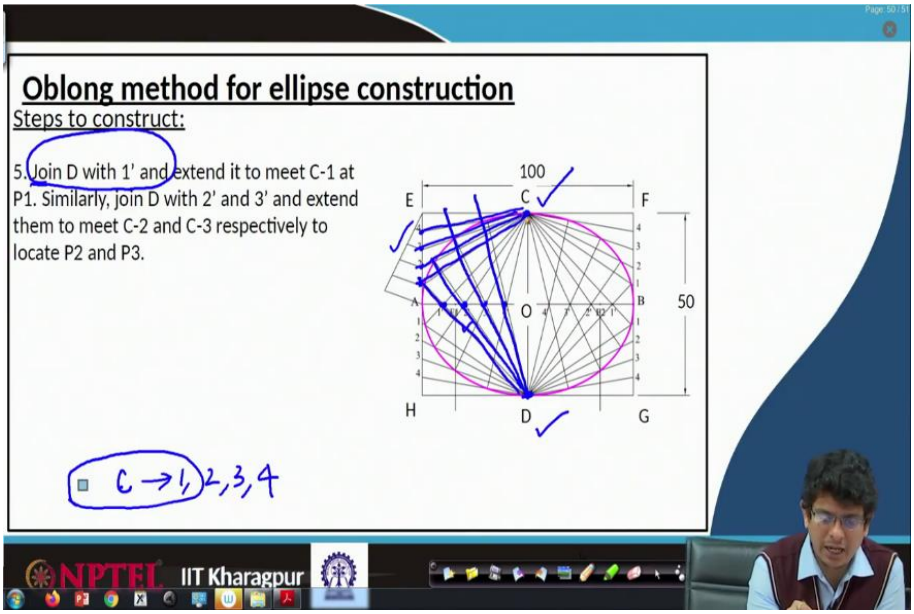

So, from there, draw lines, first one, the second one, the third one, the fourth one. From from C, we are going to connect 1, 2, 3, and 4 points. Once it is done, join D with 1' and so on. So, from D also we are going to join 1', 2'. So, C is on this side, D is on the other side. Join C onto this axis vertical axis join D with the horizontal axis.

So, 1', 2', 3', 4' will be in a position to get that. So, extend all these lines.

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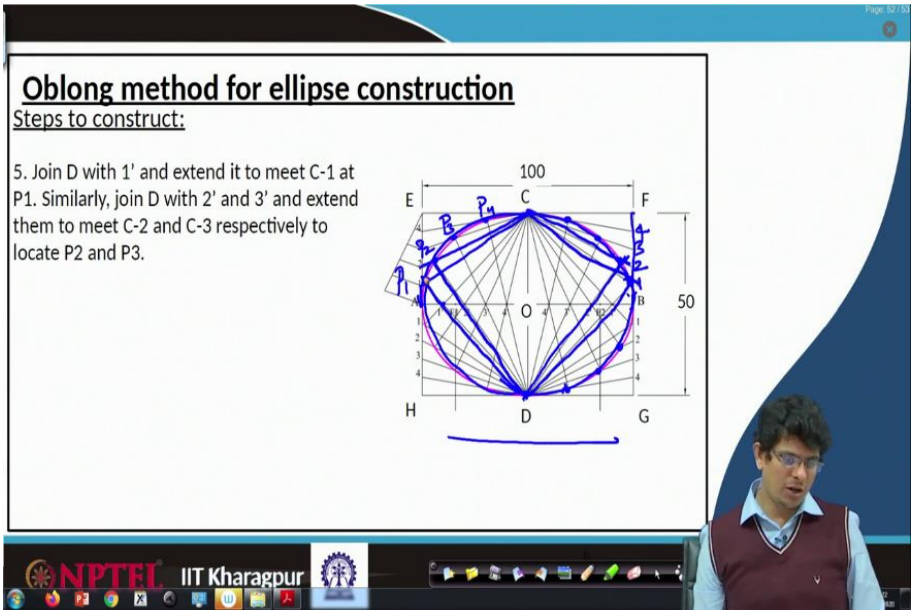

Let us pick first point C to 1; it goes all the way up to that point. When we are joining D to 1', this line goes all the way intersect at that point, then finally goes all the way. So, wherever it is

intersecting, let us stop it; let us call that point P 1. Similarly, from C to draw a line, all the way to the vertical axis.

Once it is done from D point, we have to go along that stop it where it is going to intersect 2. So, line by line, we identify, [nose] then indicate P 2, P 3, P 4, and the next point. So, once it is done from A, we will draw a smooth freehand curve. There is the way one quadrant of this ellipse can be constructed.

Once it is done, the same procedure we have to repeat it from C to B F line something like dividing into 1, 2, 3, 4 draw a line which goes C via 1. Similarly, from point D, all the way through 1', wherever it is intersecting, call that point; then from D go via 2', and similarly C via 2 wherever it is intersecting P 2. So, that identify these top portions also, one will be in a position to construct that. Same procedure one has to repeat it for this part also so that one will be in a position to identify these points, construct this curve.

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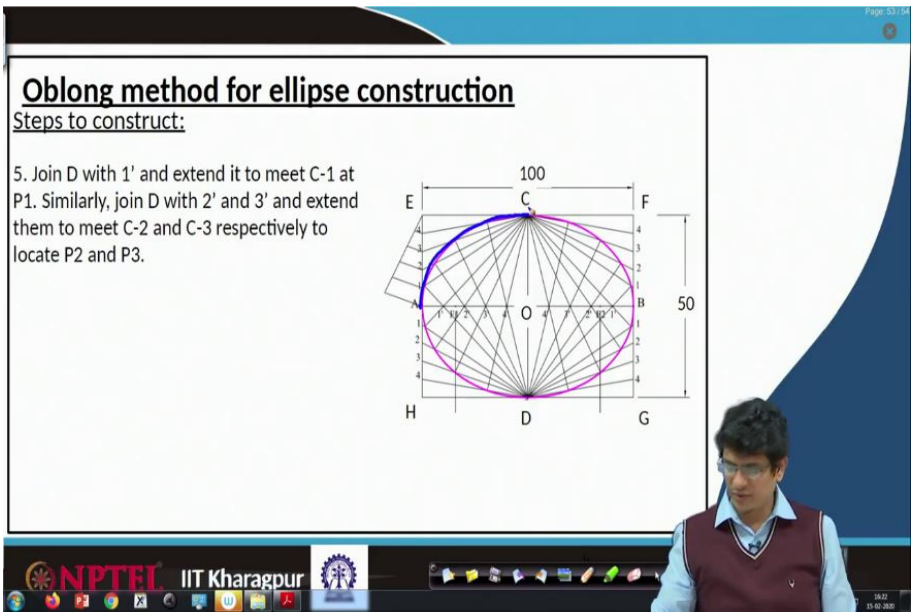

Let us briefly look at one quadrant of this, that means we will draw this rectangular box then construct this one-fourth quadrant of an ellipse. Let us do that. First of all, this is 100 mm by 50 mm; we have to construct it.

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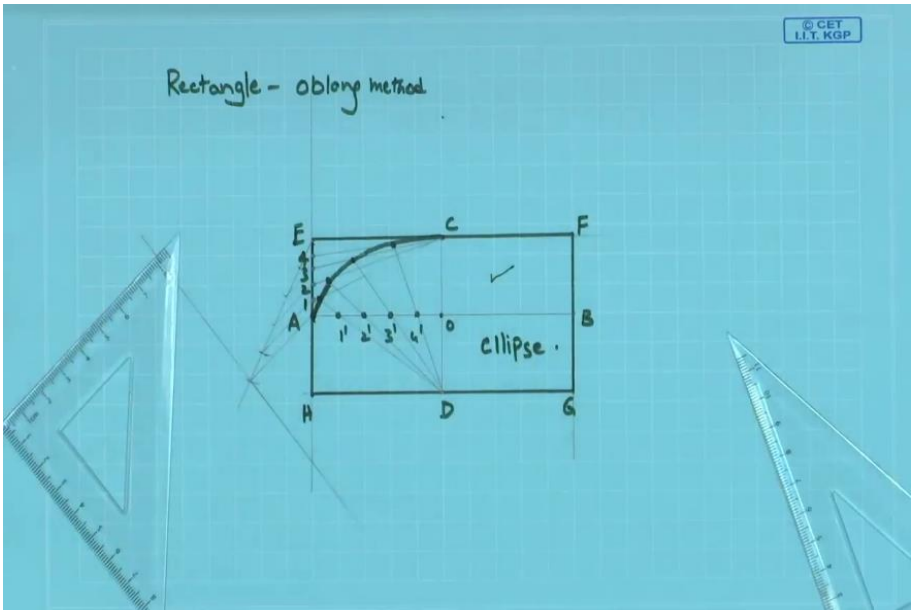

So, let us note 100 mm on the paper. These are the points. Then 50 mm, we have to locate it. Draw a perpendicular bisector. So, here because this is a 50 mm, so it is relatively easy to locate 25 mm on this graph sheet for us, 25 will be at the middle. Once we have that, we can construct a perpendicular line. So, once it is done, we will be in a position to construct this part. So, this is, on this graph sheet, so go ahead construct down. Similarly, construct on the graph sheet all the way down. This distance supposed to be same as, so from here, let us mark and join these lines. So, we have constructed a rectangle, let us name it. Once it is done, name A, B, E, F, C, O, D, H, G. Now, we have to divide into an equal number of divisions here, already we have a grid network. So, let us divide that into equal parts, perhaps 1, 2 3, 4. So, 1, 2, 3, 4, 5 equal parts are there, but now we cannot divide these equal parts 5 equal parts. So, for that purpose what we have to do is draw something like such kind of line. Use compass to locate 5 equal divisions, something like 1, from there 2, 3, 4, 5. Once it is done, join these divisions, one go parallel to that line. So, to go parallel to that line, let us draw a normal and so that we will have better support because we are not using any drafter here, so it is easy for us to go in this direction 2, 3, 4, 5. So, this is the way 1, 2, 3, 4, 5. Let us name it points 1, 2, 3, 4. Similarly, these points are 1', 2', 3', 4'. Now, what we have to do is from C to 4, C to 1, and so on. We have to connect. So, let us connect C point all the way to first point. So, C to 1, let us draw it 1, 2, 3, 4. Similarly, D onwards, we have to systematically connect it a line which is passing through 1' going to intersect there. D to 2'; 3', all the way to third line; from there, 4' to the fourth line. Now, mark the points, the first point this is the one, second, third, fourth, fifth, and this. So, our ellipse goes via these points; this is the way one has to construct. Furthermore, this part one has to construct by the division of an equal number of things. Similarly, this point has to be constructed by the

division of these things so that one will be in a position to complete the ellipse and this method what we call rectangle method or this oblong method.

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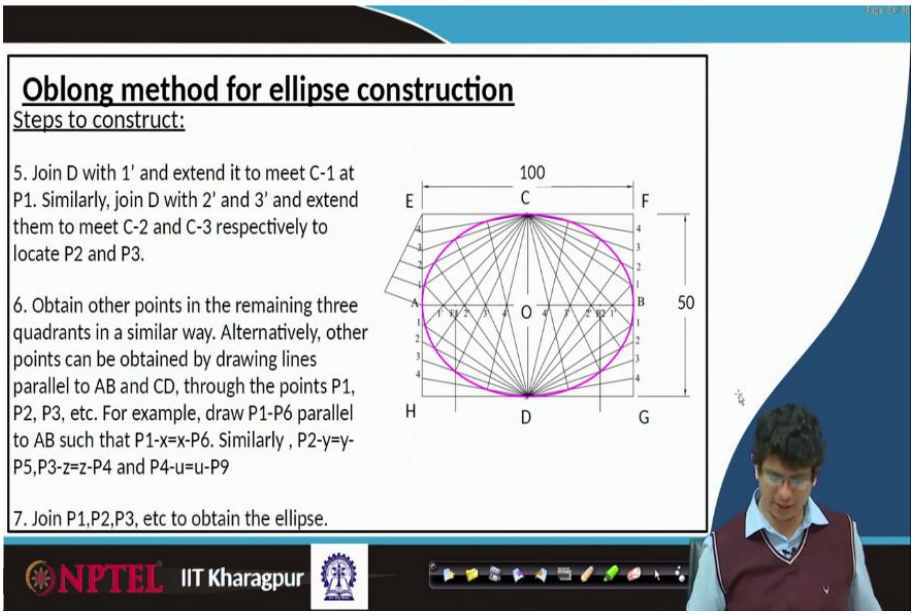

Once we join this P 1, P 2, P 3, and so on, these are the points P 1, P 2, P 3, and P 4 via C; we will get this ellipse.

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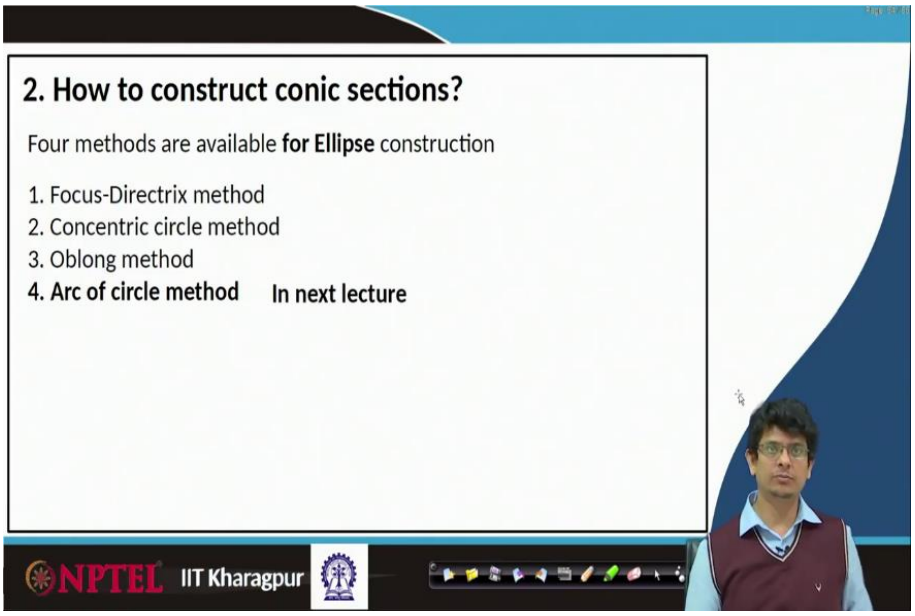

So, in this lecture, we have learned about the concentric circle method and oblong method. In the next lecture, we will learn about the arc of circles methods to construct an ellipse. Thank you very much.