**Engineering Drawing and Computer Graphics**
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Module - 02
Lecture – 10
Conic Sections
Practice – II

Hello everyone. Welcome to our NPTEL Online Certification Courses on Engineering Drawing and Computer Graphics. We are covering module 2, lecture number 10 on Conic Sections and Geometric Constructions.

In today's class, we will practice a few problems: constructing tangents and normals to circles. In that, we will extensively use the method of bisectors to divide the arcs and lines.

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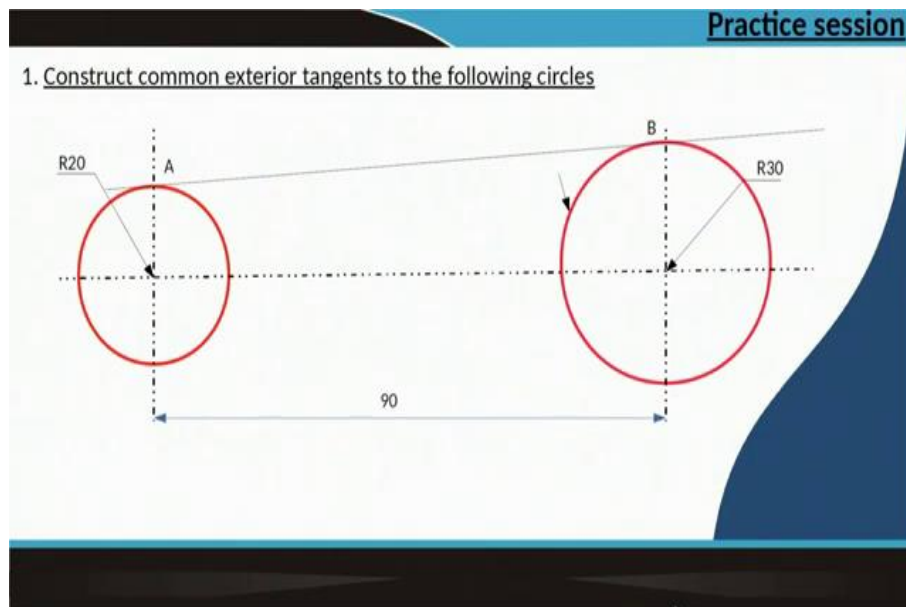
So, here a problem is posed there are two circles; circle A having a radius of 20 units, 20 mm, another circle of radius 30 units. By drawing conventions, if it is a circle, we have to write it in phi coordinates. The circle's diameter is 40 units, and the other diameter of the bigger circle is 60 units.

However, here just for simplification, we show it is having a radius of 20 units and 30 units. And, these two circles are separated by units of 90. This kind of problem we usually

go with engineering mechanics problems, where two pulleys assembled on shafts, rotating, and a belt drive has to pass through these pulleys, and that has to be constructed. Inspired by that kind of application, we are trying to construct a tangent passing over circle B and circle A.

So, let us construct this tangent passing through A and B.

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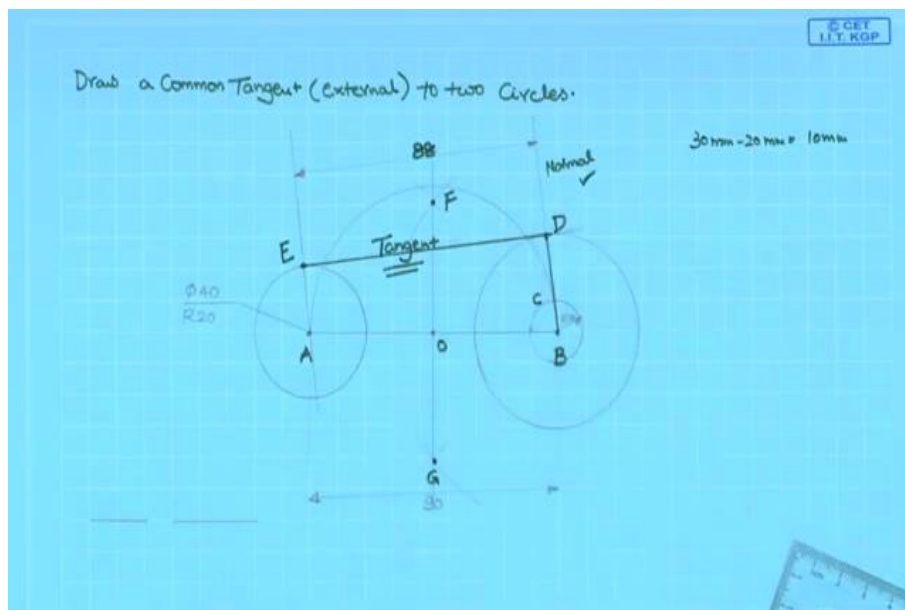
First of all, let us write our problem statement; it is an external tangent to two circles. The distance between these centres is 90 mm. So, let us first mark 90 mm.

So, we have constructed that one. Next, construct 20 units of the circle, 20 mm. Let us use the distance from first the point 20 units. So, a smaller circle from this end draws by 20 units, and the larger one of 30 units; let us name this the standard convention is representing phi 40 mm.

So, we are not writing any mm. Otherwise, it is a radius of 20 units. Let us call this point as A, name it as A, this circle. This one B. Once it is done, we will construct perpendicular bisectors to A and B circles; that means more than half of the distance we have to take mark the points as G and F. A construction line has to be constructed passing through G and F.

Let us call this intersecting point as O. Now; we want to construct a tangent from a larger circle, which pass through this other circle A. For that purpose, first of all, what we have to do is draw the difference in radius, that is 30 mm, minus 20 mm, which is 10 mm with that radius let us draw a circle from centre B.

So, 10 mm, let us mark it from here for the geometric construction draw a circle. The smaller one has a radius of 10 units. The standard convention is we show it outside the units, but just for clarity, I am representing this is R 10. Usually, we show it outside only to indicate this clarity; we are showing it here itself.

Now, draw another circle, semi-circle of radius OA or AB, diameter AB draw it. So, this larger circle will intersect the smaller one at this point, let us call that point as C. Now, join C and B all the way, which will touch this larger circle at point D.

So, in the earlier class, we have seen BD is the normal; if we are going to extend this line BD, that is normal to the circle. And what are we going to construct is: Parallel to this BD normal, if we can construct one more thing, it is again going to construct another normal to that smaller circle. So, let us do that. So, let us put the set square there and use our scale; one way is to use roller circle, roller scale based on that one can use, otherwise use your set square.

There first, you make it a parallel line to the smaller circle to construct a normal line. Now, the point where it is going to intersect the circle smaller one call it as E. Now, join point E and D. So, it is a tangent. So, it intersects only at one point on the circle. So, let us darken it. So, this is a tangent line.

Let us call this as tangent line, and this one normal. And, the other normal is for this circle, this one is another normal to that circle. This is the way we construct an external tangent to two circles passing through these points. Let us measure the distance between these 2 points is around 8.8 mm.

The original distance between these two circles is 90 mm; this is outside of the circle we show; this is horizontal line 90 mm. So, this is the way we construct tangent and normal to these two circles.
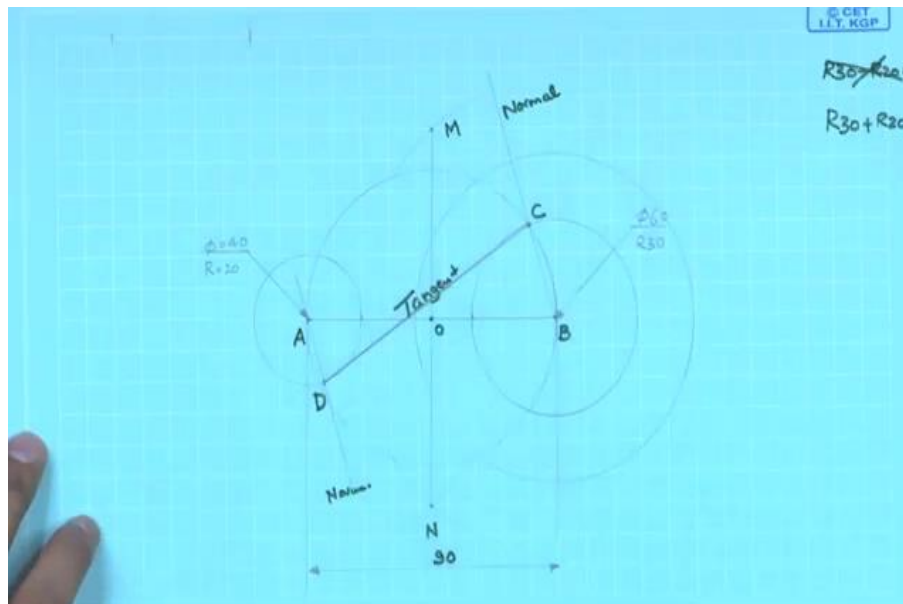
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2. Construct common interior tangents to the following circles
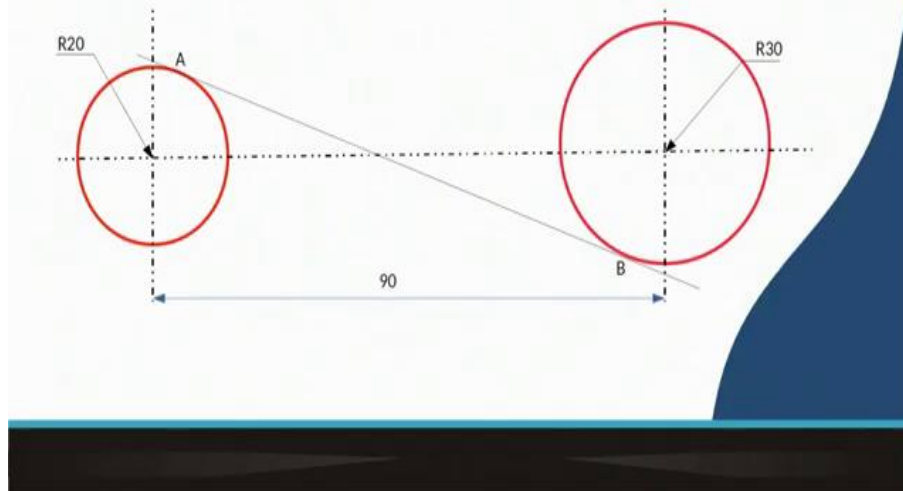
Now, let us look at the second question, how to construct a common interior tangent to that following circles?. So, what we have to do is repeat the same process, but on opposite sides.

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So, first, we have to draw two circles separated by 90 mm. We already have marked this 90 mm thing this one and this one point. Let us call point A and point B. First, we have to

construct a 20 mm circle, 20 mm radius, and 30 mm radius. So, 20 mm is here, and 30 mm is here.

First of all, we have to construct perpendicular bisector. Further, we have to take more than half of the distance, join them, name these points as M and N, and it is going to intersect at O.

Now, for external tangents, exterior tangents, what we have done is? Let us name these scales also. The diameter is 40 mm, for this diameter is 40 mm, the radius is 20, the diameter is 60, radius 30. This way, we have shown a drafter is very helpful to draw these vertical and horizontal lines; this is 90 mm.

Now, for the external exterior tangent, we calculated R 30 minus R 20 as R 10 radius around B, we have drawn internal circle. But, now, what we want to construct is from the external point all the way to down. So, now, what we have to do is calculate R 30, plus R 20, which is R 50 radius we have to construct a circle starting with B. So, let us do that.

So, 50 mm is located first. So, after drawing that bigger circle, let us take a circle of radius B, which will intersect the smaller one at this point. Let us call that point as C. So, basically, this circle that we are taking is from perpendicular bisectors, which pass through A point and going to intersect at C.

Now, join B and C points. So, that we will be in a position to construct a normal from there, we will be in a position to construct a tangent. So, this is the point through which we have to draw a tangent to it, but we have constructed normal. So, one more normal we

have to construct in line with this is the scale and normal passing through point A. So, construct this point.

So, it is going to intersect at this point. Now, join these 2 points A and C, and this is the way we construct a tangent line and let us call this point as D. Any normal is this one, and the tangent is going through point C; this is the way we construct.

So, one has to be careful while passing through this normal, translating this normal to A. Many drafters always be perpendiculars, and that would be useful; this is normal, another normal, and tangent.

Let us summarize the procedures to construct tangent and normal to this external circle and internal circles. So, let me write down the complete procedure to construct it

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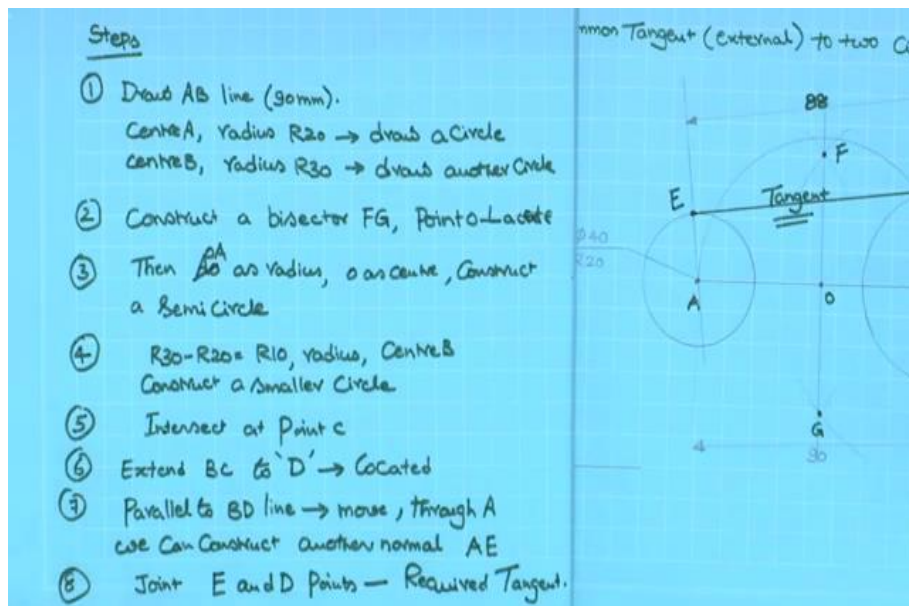
For this circle, the first steps to be followed: draw A B line of distance given between the circles. In this case, it is 90 mm and A as the centre, and whatever the radius is given here, R 20 draw a circle; similarly, B as the centre radius R 30 draw another circle.

Now, construct a perpendicular bisector, which is, in this case, FG, so that we will get the point O to locate this point. Then AO or OA as radius; that means, O as the centre, construct a semi-circle, passing through A and B points.

Then, with R 30 minus R 20 difference, which is R 10 radius, but around the centre, B constructs a smaller circle. Now, the small circle and the semi-circle intersect at point C, extending BC to the larger circle to that point 'D'.

So, once this point is located from there, we are going to draw tangent. Further, what we have to do is parallel to the BD line move. So, through point A, we can construct another normal ah that is A E. So, 8 finally, join E and D points, which is the required tangent. This is the way we construct tangent for two circles.

Now, let us write the steps for interior tangents for the system—the summary of steps for this picture and steps to follow.

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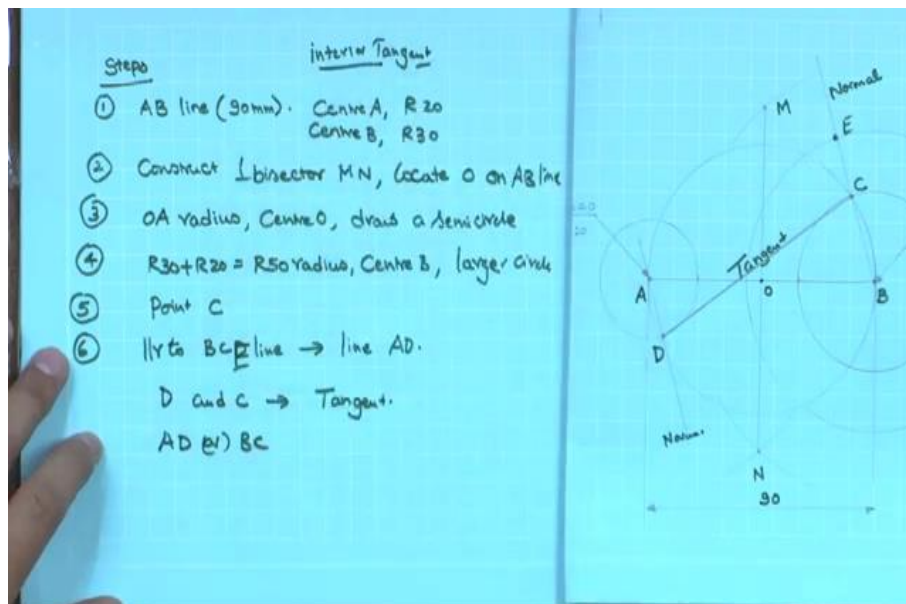
First, draw the AB line of required dimensions here 90 mm. Then draw a circle with centre A, radius 20 units, and centre as B radius 30 units. Then, construct perpendicular bisector, which is MN, and locate O on the AB line. Then OA as radius, centre as O, draw a semi-circle passing through A and B.

Because we want to draw interior tangents passing through C and D on opposite sides of the circle, we have to use R 30 plus R 20. These are the dimensions on which outside we will be in a position to construct a larger circle. So, with an R 50 radius centre around B, draw a larger circle. The intersection point between this semi-circle and this smaller circle gives a point C.

Once that is identified parallel to the BCD line because usually, the circles might be tiny. So, similar to BC, we are extending all the way to point let us call E. So, BCE line parallel to that we have to make one more line, which we are calling the AD line.

So, once it is done the intersection point D and C, we will construct it as a tangent, and any normal is AD or BC things. This is the way to construct interior tangents on opposite sides of the circle.

Thank you very much.