Engineering Drawing and Computer Graphics
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Module – 02
Lecture – 09
Conic sections
Practice – I

Hello, everyone. Welcome to our NPTEL online certification courses on Engineering Drawing and Computer Graphics. I am Rajaram Lakkaraju from IIT, Kharagpur. We are covering module number 2 on Conic sections; we are at lecture number 9.

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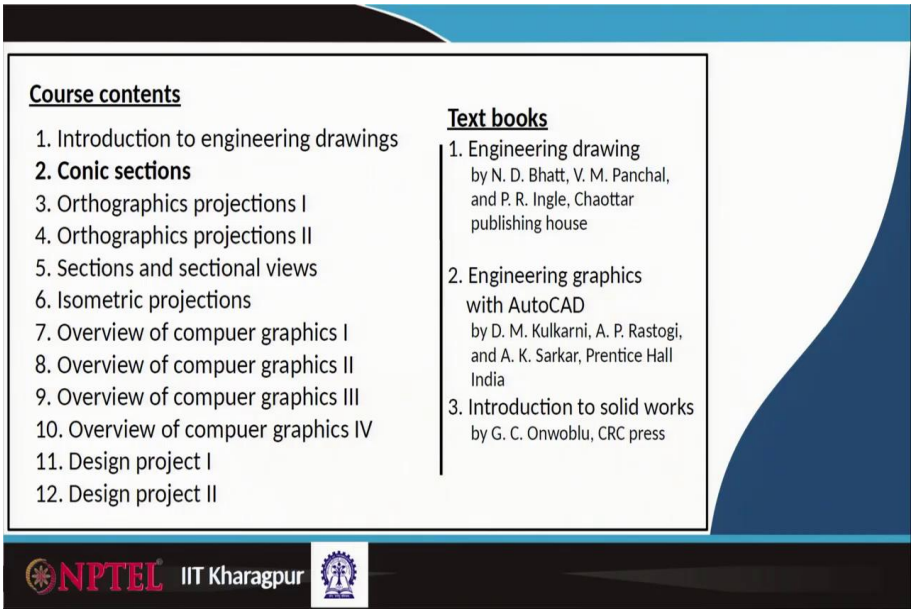

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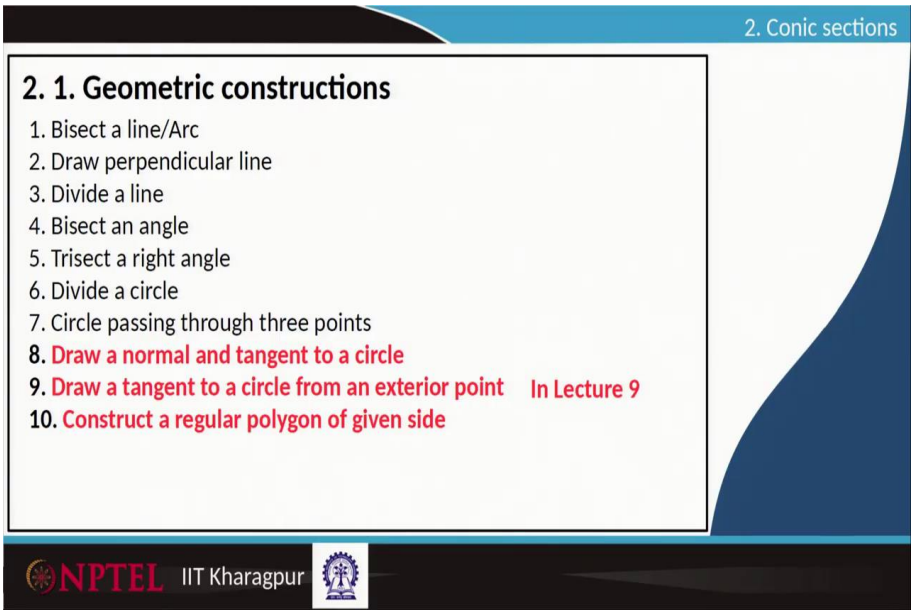

In module 2, conic sections, we have already covered some of the principles on geometric constructions. For example:

- how to bisect a line
- how to bisect an arc
- how to draw perpendicular lines
- how to divide a line
- how to bisect an angle
- how to trisect
- how to divide circles and circle through three points

In today's lecture 9, we will cover how to draw normal and tangent to a circle. The second part of how to draw a tangent to a circle from an exterior point; finally, we will cover how to construct a regular polygon of a given side.

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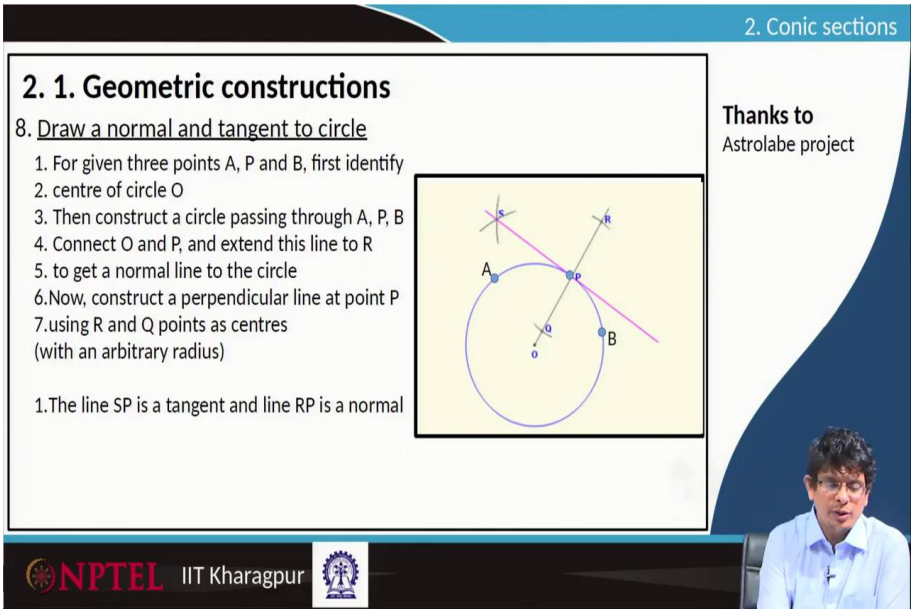

The first question that we will ask is if there is a circle on how to draw normal and tangent to that circle from a given point. In certain instances, we might be having only three points. So, using three points, first of all, we have to construct a circle then we will be in a position to identify the centre and then radius, once radius is done we will pick the point, normal direction vector we will write and also the tangent direction we will be in a position to do. Let us do that step by step.

Let us consider here three points are given A, P, B. First of all, we have to identify a circle passing through A, P, B points, and then the centre of the circle.

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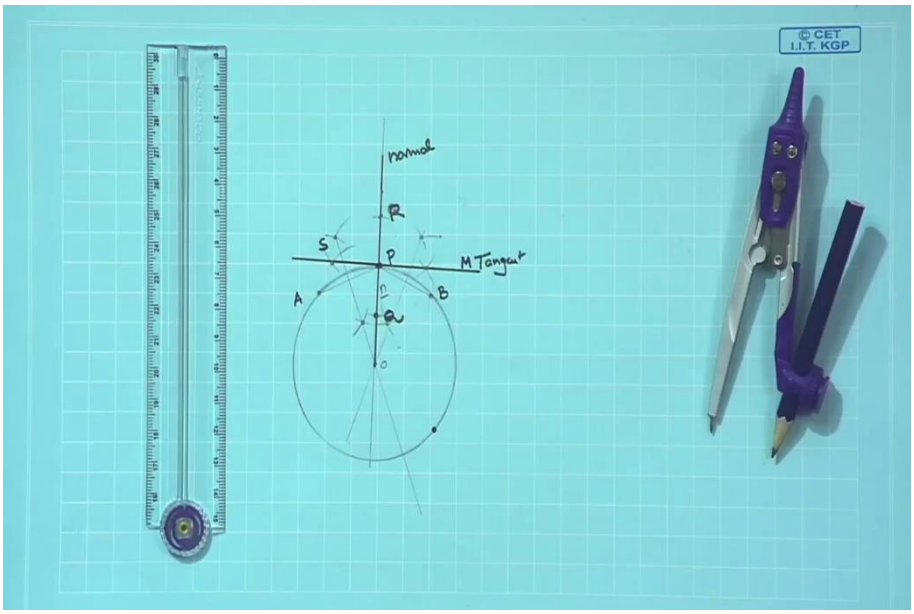

So, let us identify three points A, perhaps P, and point B. Let us name them A, P, B. These three points are given. First of all, we have to construct a circle through this AP and PB.

Now, let us construct perpendicular bisectors for P beginning with centre A and centre P. Similarly, construct the next perpendicular bisector from PB. So, identify these intersection points. These are perpendicular bisector lines for PB. So, the intersection point is O through which we have to construct a circle. We get a circle passing through A, P, B points.

We will now like to construct a perpendicular bisector for OP and R kind of the point, and this one what we are calling as normal. The tangent always is perpendicular to this normal.

So, for that purpose, what we will do is pick any length from perhaps this is the point Q what we are going to identify and again another point we are going to identify. From these two points, let us call these points Q and R. Let us call R and this point as Q. So, R, P, Q whatever the perpendicular bisector, that we will call as a tangent to that circle.

Again, we have to construct a similar way with radius more than half of it centre R with the same radius join these points which will pass through P. So, now, let us identify the tangent line and the normal line.

There are various ways of constructing tangent and normal in these directions. If you have a set-squares or mini-drafter, you can always align normal to that passing through that P point gives you a tangent and normal through that circle.

Let us look at the procedure. First of all, we have to construct a circle passing through A, P, B points. Once it is done, we have to construct a line from O to P and extend that O P line to R.

That line O, P, R whatever the line extended O to R we call normal to that circle and construct a tangent to the circle passing through P what we do is identify the P point around that an equal distance R and Q points first we will identify. Using Q and R as centers construct one more perpendicular bisector passing through P, so that S point we will be in a position to identify let us call, this is S.

So, S, P, M gives me tangent; Q, P, R gives me normal passing through point P, any other point on the circle also works similarly.

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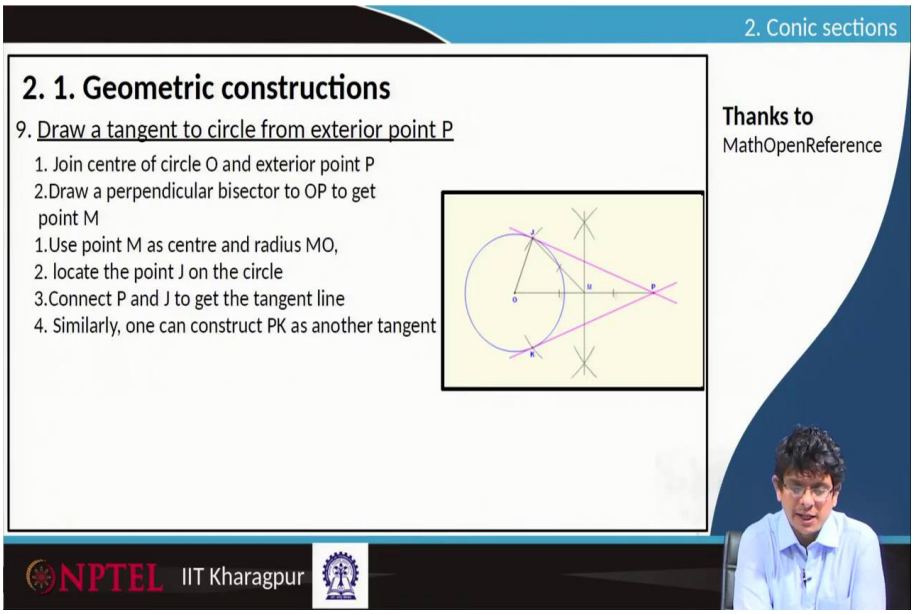

Let us look at the second problem. How to draw a tangent to a circle from an exterior point P? So, here what is given is there is a circle having a centre O, passing through points J and K with a specified radius, and there is an external point P. From point P, one has to draw a tangent passing through J or K. To do that, let us look at the procedure. First of all, what we have to do is join the centre of circle O and exterior point P, so that circle is given,

and we are going to extend it from O to P draw a perpendicular bisector to OP. So, OP length line we know, use equal distances O as centre P as centre draw a perpendicular bisector, and this perpendicular bisector cuts OP line at point M. Once M point is identified, use M point as the centre, and radius O to M pick that length M as the centre, cut the circle at point J. Now, we have that J point on the circle, connect P point, and J point to construct a tangent line. Similarly, one can construct PK also as another tangent.

Let us begin with one example.

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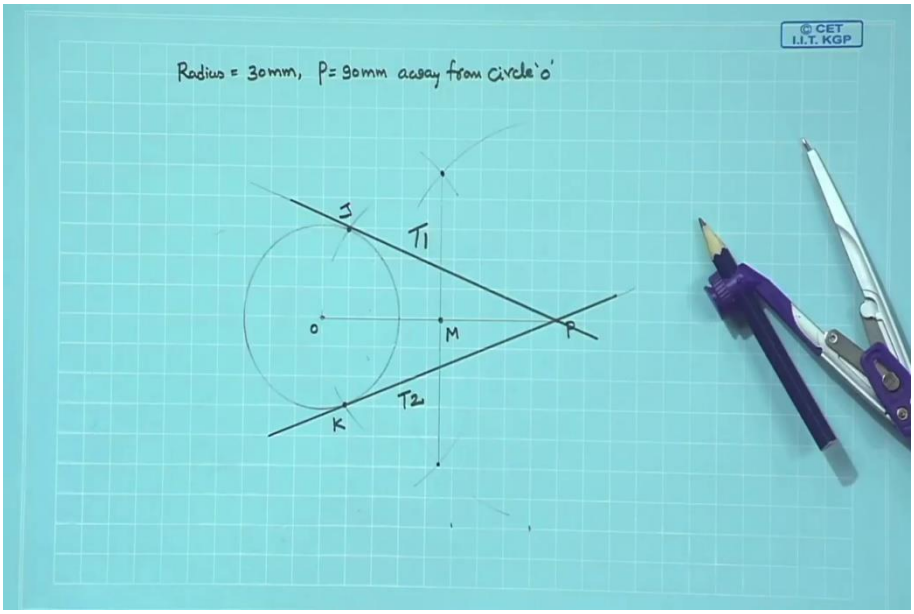

Let us pick radius of the circle as 30 mm, the point P for through which we will construct tangent is something about 90 mm away from circle centre O. So, first let us take the scale to pick a point, let us call that point as O P point is 90 mm away from centre O.

So, 90 mm, let us identify on a scale. Let us call point P, and the circle radius is 30 mm. So, draw a circle. We do not know where exactly J point will be there; to construct the J point. We join O and P points joined by a construction line. OP is identified.

Now, for point OP, we have to make a perpendicular bisector. For that, we pick P as centre more than half of the distance between O and P make arcs on both sides. Identify these points, then join them.

Now, the OP line intersected at point M. Once we identify M point, we have to use M as centre and radius MO to locate J point. For that, we pick M point pick OM as radius identify the point on both sides. Let us call this point J, this point, K.

Now, join point J and P. So, this is the tangent through that circle passing through point J and P. Similarly, join K and P; connect this by a line. This is the way we construct tangents to circles.

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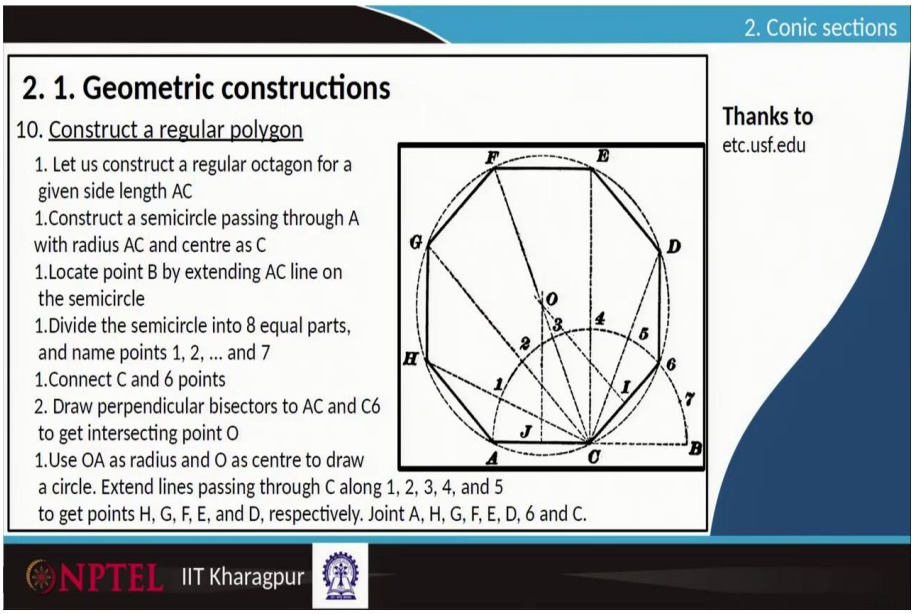

Let us construct a regular polygon; for example, we will like to make an octagonal polygon constructed from AC given side. So, the AC side is given for us and the same AC length we would like to have it on other sides. To construct that, let us look at the procedure. So, what is given is AC length is given as side length. First of all, we have to construct a semicircle passing through A with radius AC and centre as C.

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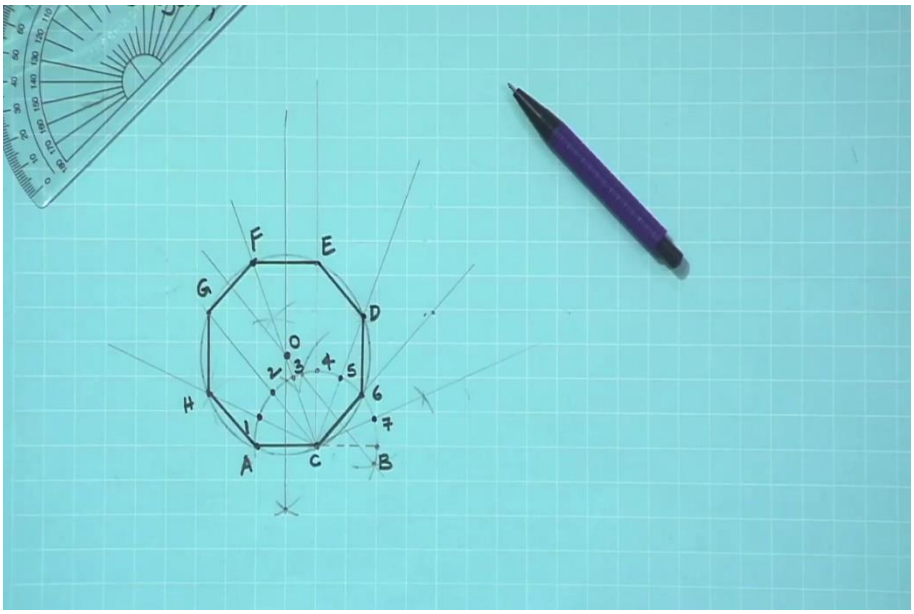

So, let us pick an example. With AC as side length, we are going to construct an octagon. So, it is supposed to have 8 sides AC side length is a 20 mm side we would like to construct.

Further, the first point is to draw a 20 mm side. So, we are going to construct from the baseline AC. So, P first identify point A here and a side length of 20 mm and name it C. Once that is done C as centre and AC as radius, we have to draw a semicircle. So, it is going to make a point B. Let us extend this one by construction lines, and we usually go with very thin dashed lines. So, a semicircle is constructed.

Now, we have to locate the remaining points like 1, 2, 3, and 7 points on the semicircle because we would like to construct an octagon of 8 equal sides. So, we are going to divide these semicircles into 8 equal parts. One, we can use our protractor divide these 180° into 8 parts. So, the resulting angle we can locate it, otherwise, we have seen how to divide these angle 180° by bisecting it, trisecting it, and so on, we can also go ahead.

So, as of now, we will go ahead first to divide this into different parts. So, the first part 90°; that means four zones we will be able to construct it. So, locate that fourth point. We have to divide that into three equal parts. So, the first part is something like constructing 1, 2, 3, and 4 parts we are going to construct. To construct these 1 2 3 parts, we will divide this 90 into 4 parts.

Similarly, divide this angle we have seen if we instead of approximating into half angles if we are not very careful about that we know how to divide this into two parts. So, pick a radius half of that, make an arc.

Similarly, construct which is going to intersect here only and join these points. So, we will be in a position to identify point 3 also. Sometimes our protractor cannot have the least count like 22.5, 20, and so on things. So, it is always easy for us to bisect that angle.

So, for 2 also we use a similar protocol make an arc, divide it, anyway it will pass through the centre extend that lines so that we have point 1 too. Similarly, if we would like to construct the other side 45° join them, make it part 6 and divide this into two equal parts. Likewise, make equal parts, extend these lines to locate points 5, 6, 7, and point B. Once we divide this into equal parts, connect C and 6th points.

Draw perpendicular bisectors to AC. So, for AC, we have to locate perpendicular bisector and C 6 perpendicular bisector, so that outside kind of circle, we will be able to connect. From there, it is relatively easy for us to calculate the octagon.

To construct perpendicular bisectors for AC, we intersect on both sides. Join these points to locate centre of that circle. Similarly, C 6 uses this. We have to construct perpendicular bisector using B and C and join them. So, one of the perpendicular bisectors is this one, and the other one is this. So, both of them are intersecting here. So, locate this one as a centre, name that centre as O.

Now, when we are going to construct an octagon, it is always B circumscribing A, C, and 6 points. So, if I am going to extend points from C all the way there, where it will intersect that point, we will be calling H; join A and H.

Similarly, from C point extend a line where it is going to intersect, call that one as G join H and G. From CO extension is going to intersect there join that, call point F.

Now, from C extend a line, it goes call this one as E; join F and E. Similarly, from C, it is going to intersect AD point join D and E; join 6 and D. This is the way we construct an octagon.

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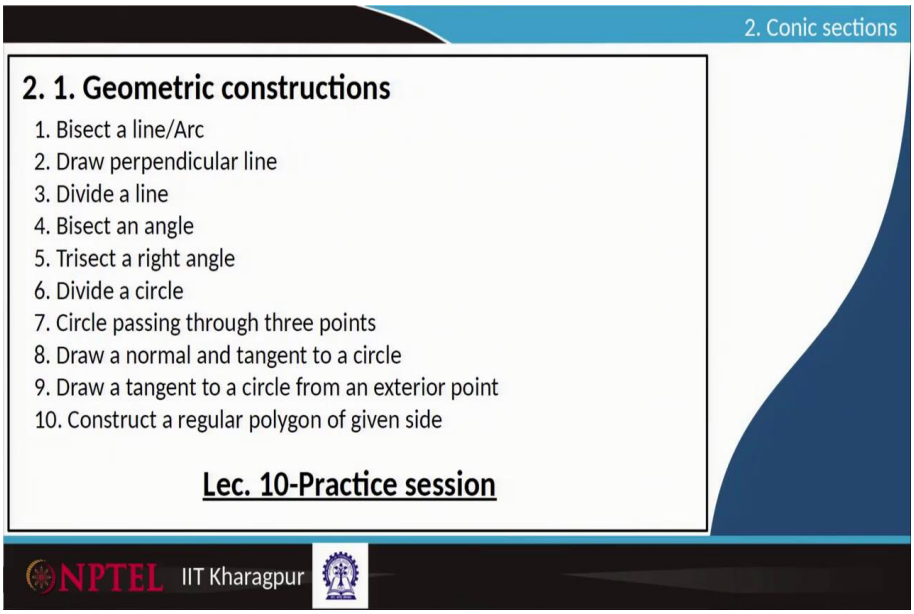

So, in lecture 9, we covered how to draw ah normal and tangent to a circle, draw a tangent to a circle from an exterior point, and construct a regular polygon, for example, like octagon of given side circumscribe ah inscribed in a circle. In lecture 10, we will practice more examples.

Thank you.