Hi everyone In this video, we will be talking about two topics of 3D chapter for mathematics of JEE preparation.

The topics are: doing problems on finding perpendicular distance of a point from line and we will be finding equations of a line perpendicular to two lines given.

These are small topics but as in other maths topics, you should learn the approach to solve problems like these.

Let us start by finding perpendicular distance of a point from a line.

We have a line given.

Let us saw we have point A, and that is a_vector, and we have been given b_vector, which is the parallel vector.

And we have been given a point P. Let us call it p_vector.

And we have been asked to find the perpendicular distance of the point from the line.

You may recall these kind of problems in 2D in straight lines.

But now its 3D or 3-Dimensinal Geometry.

So how will we solve this problem?

One of the approaches to start this to think that there is a point C here, let us call it c_vector.

And the idea is that we know, c_vector=a_vector + \lambda b_vector because this point is on the line.

And, PC_vector is perpendicular to b_vector.

This is what we know, right?

These are the two conditions we know for the PC_vector to be perpendicular to the parallel vector because this is perpendicular to the line, so it has to be perpendicular to the parallel vector.

It should flash to you that the condition of perpendicularity it PC_vector \dot b_vector = 0.

Again, the knowledge of vectors is super critical in this chapter.

I have emphasized that many times in the last two videos also.

PC_vector is nothing but c_vector - p_vector.

Thus, c_vector-p_vector \dot b_vector = 0.

And c_vector is nothing but (a_vector + \lambda b_vector - p_vector) \dot b =0.

If you were to find the value of \lambda, you will get, \lambda = ((p_vector - a_vector) \dot b_vector, divided by |b|^2.

Now you have got the value of \lambda, so you can calculate the point, and then you can calculate the distance.

I hope you are able to understand and follow what we are doing here. You can solve this equation using the associative property by opening the brackets, and rearranging, you get this.

Let us do a problem on this so that you can quickly understand.

You have been given P=(1,2,3). And the line is (x-6)/3 = (y-7)/2 = (z-7)/(-2).

How will we find \lambda? I will suggest you to remember this but you may want to derive it in the paper.

It is up to you. I will recommend you to remember this, it is very easy to remember ((p_vector - a_vector) \dot b_vector) / |b_vector|^2.

Here, p_vector = i_cap + 2j_cap+ 3k_cap a_vector = 6i_cap + 7j_cap+ 7k_cap b_vector = 3i_cap + 2j_cap - 2k_cap If I were to find \lambda here, this would become p_vector - a_vector is -5i - 5j - 4k \dot with 3i + 2j -2k ((p_vector - a_vector) \dot b_vector) / |b_vector|^2.

|b_vector|^2 = 3^2 + 2^2 + 2^2 = 8 + 9 = 17.

If you will do this, this will become: -15-10+8 = -17.

Thus \lambda = -1.

The point c_vector = a_vector - b_vector, and it comes out to be, 3i_cap + 5j_cap + 9k_cap.

And the distance |PC| = (2^2+3^2+6^2)^(1/2) = 7.

You know the vector PC now, so you can find the distance by taking the sum of x_component^2, y_component^2 and z_component^2, and that comes out to be 7.

And I hope that is very obvious for you to solve these types of problems. If you are still not very comfortable, please practice. Just make some problems yourself, make an equation of a line, find a point, and then do the problem. It is very easy. If you do this several times, it should be quick for you to remember.

Let me give you one more HW problem so that you can do it on your own. And the HW problem is: Find a point on y_axis such that perpendicular distance from the point to line x=y=z is unity.

So this is an opposite question. You have been given the task to find the point on y-axis such that the perpendicular distance from the line to the point is unity. So, how will you do this problem?

You can assume a point: (0, k, 0), and proceed now, completely the same way. You can very quickly find the value of this thing (\lambda), and then you can calculate PC, and you can equate it to 1, to find the value of k.

Please do this problem. This will give you a nice practice to solve the problems of perpendicular distance of a point from a line.

Let us do another problem which I wanted to do. I will not be giving you any method, I just want to do an example problem since that example will be enough to understand the topic.

The question says we have been given two lines: (x-1)/1 = (y-2)/2 = (z-3)/3, L1 is this L2 has been given as (x-2)/4 = (y-3)/5 = (z-1)/6.

The question says find the line perpendicular to L1 and L2 and passing through 1,1,1. How to solve this problem?

So you have been given line L1. Let me write answer here: Let us say this is L1 and this is L2. You have been given a1_vector, b1_vector, a2_vector, b2_vector. You have been asked to find line 3 for which you know that it is perpendicular to both, and it passes through the point.

To find the equation of line, you need a point, which you already have, and you need a parallel vector. What is speciality of parallel vector? That the line is perpendicular to line L1 and L2. Hence, the parallel vector will be perpendicular to both b1 and b2.

And as soon as I say this, it should flash into your mind, that this is basically asking you to take a cross product. Thats it.

If you cannot recall this, please become more thorough with understanding the physical meaning of dot product and cross product. We have discussed here dot product: perpendicularity condition of dot product already. We have done in the last video, that dot product is used for finding angles. So as soon as I say, it should come to your mind, the vector perpendicular to two vectors is the cross product of two vectors.

So what you have to do is that you have to find b3_vector = b1 \cross b2, and if you do, you should remember that for cross product you have to do this i, j, k â€” and opening up the determinant.

So if you do that, this will be: i(-3) + j(6) + k(-3). Is this perpendicular to b1 and b2?

You should remember that condition of perpendicularity is dot product is zero.

So if you take -3 + 12 - 9, that is dotted with b1, it comes out to be 0.

If you dot with b2, -12 + 30 -18, so 30 - 30 = 0. So it is perpendicular to both b1 and b2.

And you already have point.

So the equation of line L3 could be easily written as: (x-1)/3 = (y-1)/6 = (z-1)/(-3).

This line is perpendicular to both the lines and passes through (1,1,1).

I hope that you are able to understand this, understand how important the understanding of vectors is, and how to solve the problems. We discussed two things here: how to find the perpendicular distance of a point from a line. For that, we can remember this formula of \lambda. Calculate \lambda, calculate the point, and when you get the coordinates of the point, you subtract from the original point to get the distance. I have given you a homework problem, so please do that at home.

And then we did a problem of finding a line perpendicular to two lines. For that you are taking the cross product of the parallel vectors, and then you will get the equation of the line.

I hope you enjoyed this video. There are a lot more interesting videos and topics in this chapter. So I hope to see you in the next video. Thank you.