



# IIT Madras

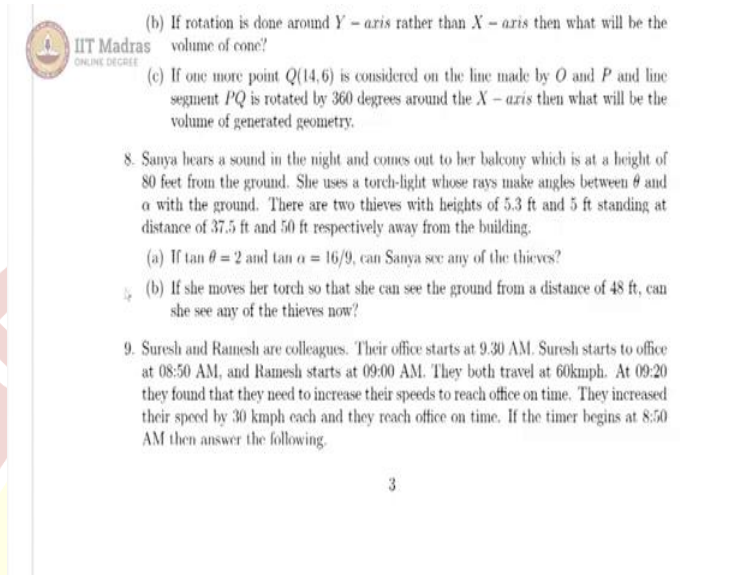
ONLINE DEGREE

# Mathematics for Data Science 1

## Week 02

### Tutorial 01

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(b) If rotation is done around  $Y$ -axis rather than  $X$ -axis then what will be the volume of cone?

(c) If one more point  $Q(14, 6)$  is considered on the line made by  $O$  and  $P$  and line segment  $PQ$  is rotated by 360 degrees around the  $X$ -axis then what will be the volume of generated geometry.

8. Sanya hears a sound in the night and comes out to her balcony which is at a height of 80 feet from the ground. She uses a torch-light whose rays make angles between  $\theta$  and  $\alpha$  with the ground. There are two thieves with heights of 5.3 ft and 5 ft standing at distance of 37.5 ft and 50 ft respectively away from the building.

(a) If  $\tan \theta = 2$  and  $\tan \alpha = 16/9$ , can Sanya see any of the thieves?

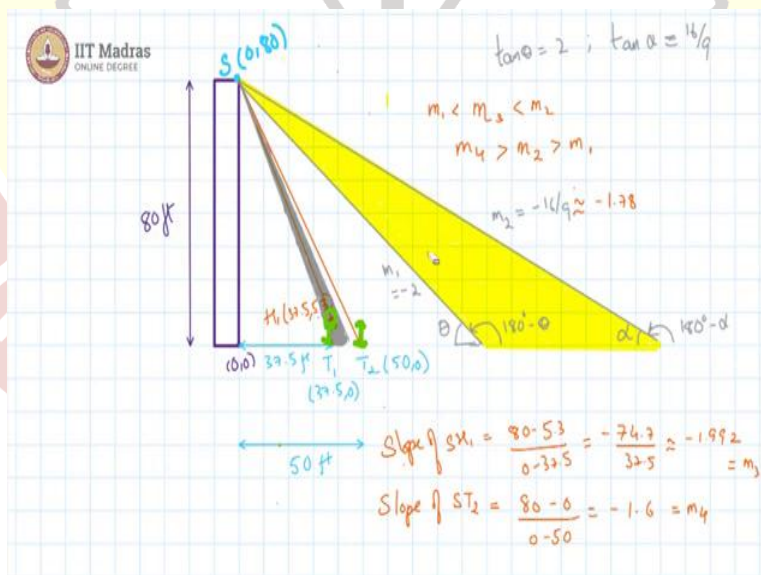
(b) If she moves her torch so that she can see the ground from a distance of 48 ft, can she see any of the thieves now?

9. Suresh and Ramesh are colleagues. Their office starts at 9.30 AM. Suresh starts to office at 08:50 AM, and Ramesh starts at 09:00 AM. They both travel at 60kmph. At 09:20 they found that they need to increase their speeds to reach office on time. They increased their speed by 30 kmph each and they reach office on time. If the timer begins at 8:50 AM then answer the following.

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The 8th problem is pretty interesting. So, we have Sania who hears a sound in a night, and she comes out to her balcony, which is at a height of 80 feet from the ground.

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- (a) If  $\tan \theta = 2$  and  $\tan \alpha = 16/9$ , can Sanya see any of the thieves?
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So, let this be our tower, which has a height 80 feet. So, if we take this point to be origin (0, 0), Sania is here, which would be (0, 80). And she uses a torch light which makes angles  $\theta$  and  $\alpha$  with the ground, so the rays from the torch light make angles between these two.

So, this angle here, this is  $\theta$  and this angle here it is  $\alpha$ . And the two thieves, their heights are given and they are standing at these distances from the buildings. So, thief  $T_1$  is somewhere here and  $T_2$  is here, what is given to us is this distance is 37.5. So,  $T_1$  is (37.5, 0), and this distance is 50 feet, so this is 37.5 feet, this is 50 feet. So,  $T_2$  will be the point (50, 0). And we are also given to understand that  $T_1$  is standing at a certain height,  $T_2$  is standing at a certain height, which are roughly the same; one is 5 feet, the other is 5.3 feet.

In our diagram, we have drawn the rays of light as though they are passing away from the 2 thieves, however that we need to find out. So, if  $\tan \theta$  is 2, and  $\tan \alpha$  is 16/9, can Sania see any of the thieves? so it is given to us that  $\tan \theta = 2$  whereas,  $\tan \alpha = 16/9$ .

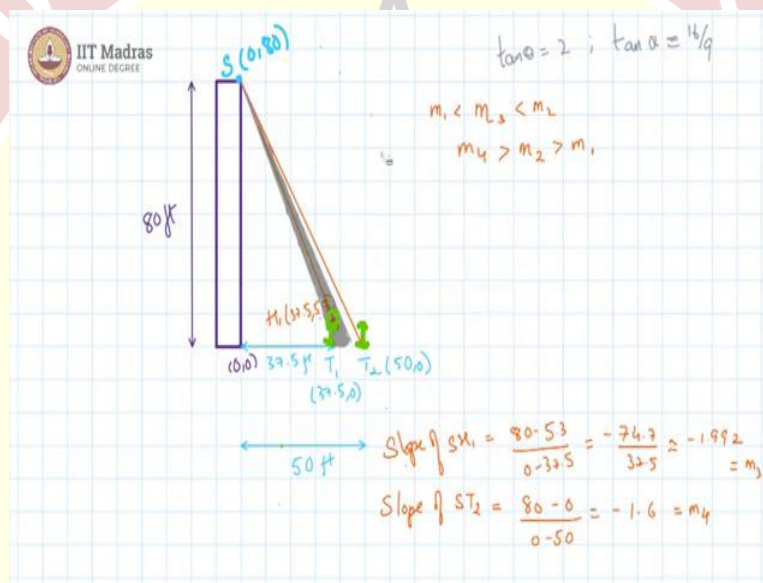
So, that means we can find the slope of this line, which is the lowest ray of the torch, and this line which is the farthest ray from the torch, and these slopes would be  $m_1 = -2$  and the minus is because the standard angle here, which is angle from the posture x axis is actually  $180^\circ - \theta$ . As you can see, it is clearly a line with the negative slope.

Likewise, this also is  $180^\circ - \alpha$ , thus this slope  $m_2 = -16/9$ . In our diagram, we have drawn it as though the 2 thieves are safe. But this is only a rough schematic diagram, we did not draw  $\theta$  and  $\alpha$  accurately. What we need to do now is to check if the line from Sania to the head of thief 1 or the line from Sanya to the foot of thief 2. If these 2 lines have slopes between  $m_1$  and  $m_2$ , then the 2 thieves are likely to be seen. So, we need to calculate these slopes, let us

call the head of thief 1 as  $H_1$  and that point will be  $(37.5, 5.3)$ . So, slope of  $SH_1 = (80-5.3)/(0-37.5)$ , which is  $-(74.7 / 37.5)$ , which is roughly  $-1.992$ .


And slope of  $ST_2$ , which is to the foot of thief 2 is  $(80 - 0) / (0 - 15)$ , which is equal to  $-1.6$ . So, I want to call this  $m_3$  and this is  $m_4$ . And here  $m_2$  is roughly equal to  $-1.78$ . So, clearly  $m_3$  is greater than  $m_1$  and lesser than  $m_2$ , but  $m_4$  is greater than  $m_2$  and also greater than  $m_1$  which means  $m_4$  that is the foot of thief 2 is not visible to Sania, the actual light cone looks something like this. So, thus we can say the head of thief 1 is visible whereas thief 2 is not visible.

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And this light cone that we have drawn earlier it is wrong.

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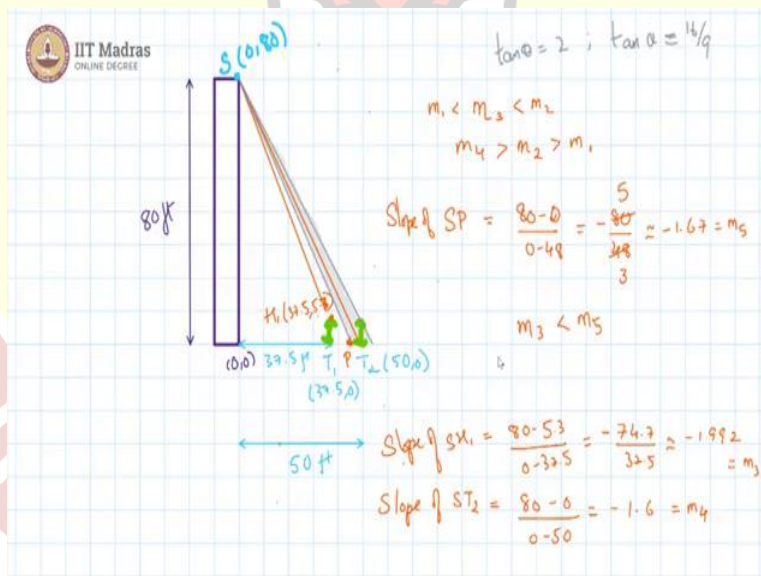
(b) If she moves her torch so that she can see the ground from a distance of 48 ft, can she see any of the thieves now?

9. Suresh and Ramesh are colleagues. Their office starts at 9.30 AM. Suresh starts to office at 08:50 AM, and Ramesh starts at 09:00 AM. They both travel at 60kmph. At 09:20 they found that they need to increase their speeds to reach office on time. They increased their speed by 30 kmph each and they reach office on time. If the timer begins at 8:50 AM then answer the following.

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Now, she moves her torch so that she can see the ground from a distance of 48 feet. Can she see thieves or not?

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That would mean she is able to see from some point here to some point beyond. From the diagram, it is pretty clear that thief 2 is going to be visible, we do not know if thief 1 will be visible though we have to check for thief 1's head. So, this point that we are talking about, which is let us call it  $P$  gives us a slope with  $S$  as  $SP$ , the slope is equal to  $(80 - 0) / (0 - 48)$  because point  $P$  is basically  $(48, 0)$ .

So, that gives us -  $(80 / 48)$  which is divisible by 16, both of them are divisible by 16. This would be 5 and this would be 3, so this is roughly -1.67. That would give us  $m_3$  is let us call this now  $m_5$ .  $m_3$  is lesser than  $m_5$ . And that means the head of thief 1 is not visible now, but thief 2 is visible.

