IIT Madras

ONLINE DEGREE

Mathematics for Data Science 1
Week 05 - Tutorial 06

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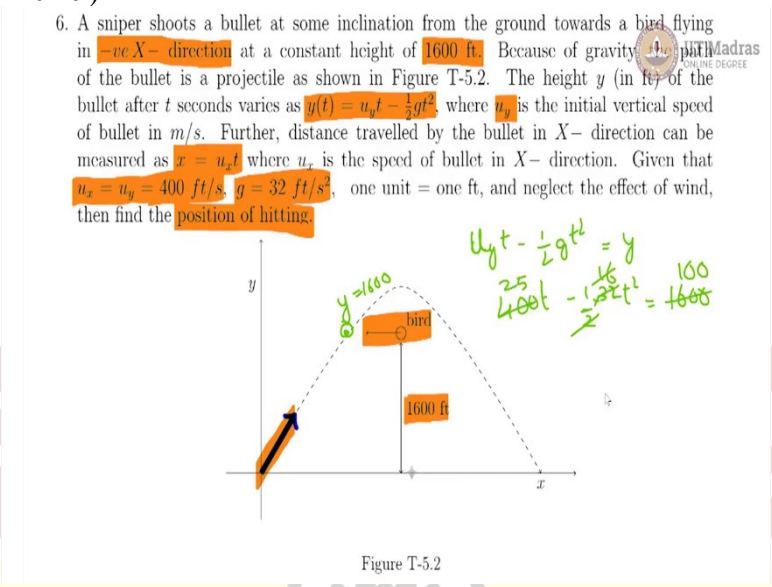

Figure T-5.2

In our sixth question, there is a sniper who shoots a bullet at some inclination from the ground towards a bird flying in the $-x$ direction, some bird is flying in the $-x$ direction at a constant height of 1600 feet. Because of gravity, the path of the bullet is projected as shown in this diagram. So, this is the bullet, it is going in this particular parabolic path and this is the bird which is going in the $-x$ direction at a constant height of 1600 feet.

Now, they have given the height y of the bullet at t seconds as this function, this is a quadratic function $y = u_y t - \frac{1}{2}gt^2$, where u_i is the initial vertical speed and that is also given here, it is equal to 400 feet per second and the value of g is also given here, 32 $feet/s^2$. And then, the distance travelled by the bullet in x direction is given by $x = u_x t$ and $u_x = u_y$ = 400 feet per second, neglecting the effect of the wind and everything, find the position of hitting?

Where will the bullet hit the bird and that would be here where y = 1600 for the bullet. So, let us use the y equation and the y equation is $u_y t - \frac{1}{2}gt^2$. So, $u_y t - \frac{1}{2}gt^2 = y$, so we know y is supposed to be 1600 and u_i is 400, so we get $400t - \frac{1}{2}g, g\ is\ 32t^2$. So, 2 ones and 2 16s, now you can cancel off 16 here with this is equal to and this becomes 100 and this becomes 25.

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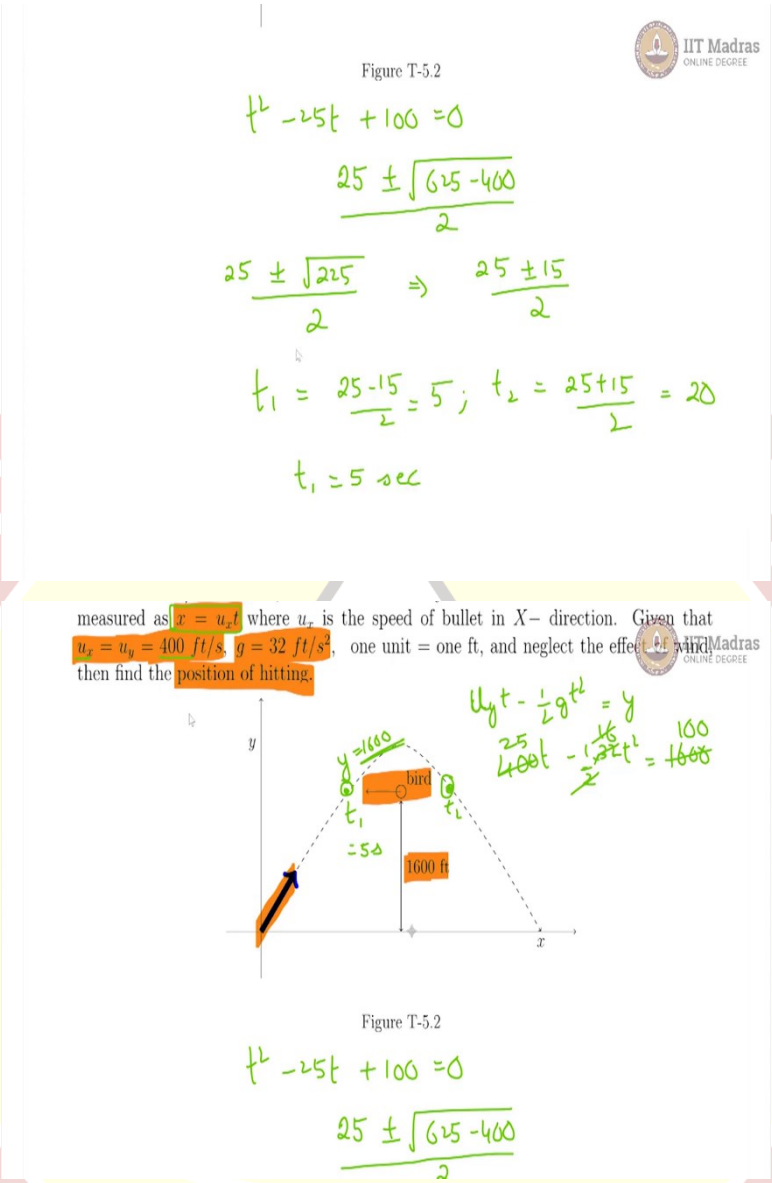

So, we get a quadratic equation which is $t^2 - 25t + 100 = 0$ and if we solve for the roots of this equation, we get the time when y is 1600 and we will get 2 times because y is 1600 twice on this path. So, we will get t_1 and t_2, we are looking for t_1 because that is where the bullet will hit the bird. So, your two roots are using the formula $\frac{-b \pm \sqrt{b^2-4ac}}{2a}$, here you will get it as $\frac{25 \pm \sqrt{625-400}}{2}$.

So, that gives us $\frac{25 \pm \sqrt{225}}{2}$ which then given us $\frac{25 \pm 15}{2}$. So, we have one solution, $t_1 = \frac{25-15}{2}$ and $t_2 = \frac{25+15}{2}$. So, this is equal to 5 and this is equal to 20. Clearly, t_1 =5 seconds is where our bullet will hit the bird. This is t_1 =5 seconds. And we already know the y coordinate of this

place so, for finding the position what is left is to find the x coordinate which we will get from $x = u_x t$ where, u_x is already given to be 400.

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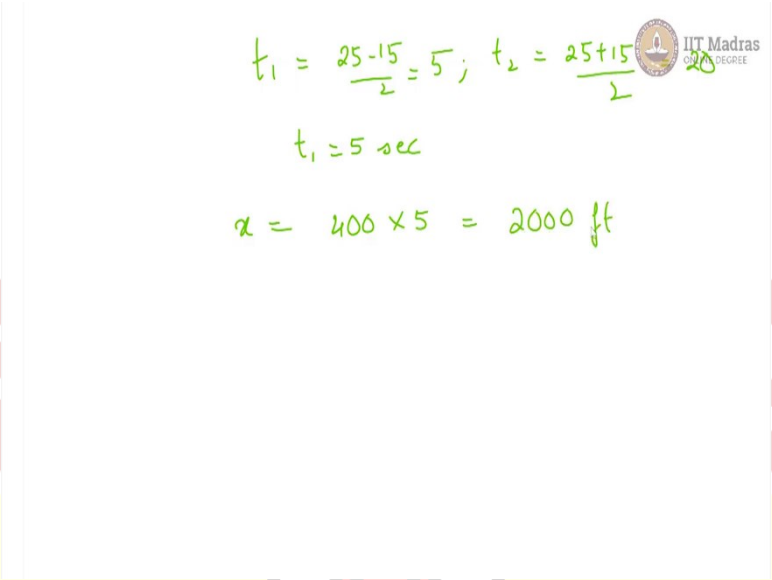

So, $x = 400 \times t_1$ which is 5 and that is equal to 2000 feet.

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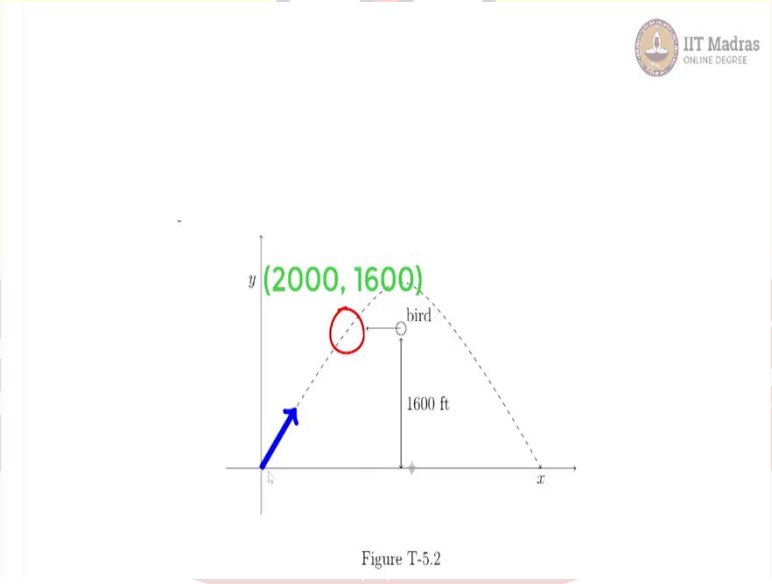

Figure T-5.2

Thus, the x coordinate for the point of hitting is 2000 and the y coordinate is 1600 feet. And this is the point where it hits.