Assignment 1

AI1110: Probability and Random Variables

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Question 7) A 13 m long ladder is leaning against a wall, touching the wall at a certain height from the ground level.The bottom of the ladder is pulled away from the wall,along the ground at the rate of 2 m/s. How fast is the height of the ladder decreasing when the foot of the ladder is 5 m away from the wall?

Solution. The various parameters involved in this question are listed in Table

TABLE I
VARIABLES USED

Parameter	Variable	value
length of the rod	l	13 m
height from ground level to tip of rod	h	???
distance from the wall to foot of rod	x	???

From Pythagoras Theorem, we can say that at any point of time

$$h^2 + x^2 = l^2 \tag{1}$$

in this equation l is always constant
$\because$ length of rod never changes
Now differentiating the equation on both sides with respect to time gives us

$$\frac{d(h^2 + x^2)}{dt} = \frac{d(l^2)}{dt} \tag{2}$$

$$2h\frac{dh}{dt} + 2x\frac{dx}{dt} = 0 \tag{3}$$

$$h\frac{dh}{dt} = -x\frac{dx}{dt} \tag{4}$$

Given, at some time t=t_0
$\frac{dx}{dt}$=2 m/s and $x = 5m$
From Pythagoras Theorem , at time t_0

$$5^2 + h^2 = 13^2 \tag{5}$$

$\therefore h = 12m$
Now from equation (4) substituting $h, x, \frac{dx}{dt}$,we get

$$\frac{dh}{dt}\text{=-}\frac{5}{6}m/s$$

The negative sign indicates that h is decreasing, $\therefore$ the height of the ladder is decreasing at a rate of $\frac{5}{6}m/s$