

1. Find $y'''|_{x=1}$ if y is a differentiable function of x satisfying the identity $y^3 + xy + x^2 = 1$.

$$\begin{aligned} & \text{Graph of } y^3 + xy + x^2 = 1 \quad |x=1 \\ & y^3 + y + 1 = 1 \\ & \Downarrow \\ & y(y^2 + 1) = 0 \\ & \Downarrow \\ & y = 0 \end{aligned}$$

$$\begin{aligned} & 3y^2y' + y + xy' + 2x = 0 \quad |x=1, y=0 \\ & 0 + 0 + y' + 2 = 0 \\ & \Downarrow \\ & y' = -2 \end{aligned}$$

$$\begin{aligned} & 6y(y')^2 + 3y^2y'' + y' + y' + xy'' + 2 = 0 \quad |x=1, y=0, y'=-2 \\ & 0 + 0 + (-2) + (-2) + y'' + 2 = 0 \\ & \Downarrow \\ & y'' = 2 \end{aligned}$$

$$\begin{aligned} & 6(y')^3 + 12yy'y'' + 6yy'y'' + 3y^2y''' + 2y'' + y'' + xy''' = 0 \\ & |x=1, y=0, y'=-2, y''=2 \end{aligned}$$

$$-48 + 0 + 0 + 0 + 4 + 2 + y''' = 0$$

$$\begin{aligned} & \Downarrow \\ & y''' = 42 \quad \text{when } x=1 \end{aligned}$$