

# Electric Potential from Electric Field in Two Dimensions



- Given is the electric field:  $\vec{E} = -(2ax + by^3)\hat{i} - 3bxy^2\hat{j}$  with  $a = 1\text{V/m}^2$ ,  $b = 1\text{V/m}^4$ .
- Find the electric potential  $V(x, y)$  via integral along a specific path:

Red path  $(0, 0) \rightarrow (0, y) \rightarrow (x, y)$ :

$$\begin{aligned} V(x, y) &= -\int_0^y E_y(0, y)dy - \int_0^x E_x(x, y)dx \\ &= 0 + \int_0^x (2ax + by^3)dx = ax^2 + bxy^3 \end{aligned}$$

Blue path  $(0, 0) \rightarrow (x, 0) \rightarrow (x, y)$ :

$$\begin{aligned} V(x, y) &= -\int_0^x E_x(x, 0)dx - \int_0^y E_y(x, y)dy \\ &= \int_0^x (2ax)dx + \int_0^y (3bxy^2)dy = ax^2 + bxy^3 \end{aligned}$$

