$\int_C \vec{A} \cdot d\vec{r}$ is called scalar line integral

$d\vec{r} = dx\,i + dy\,j + dz\,k$ is called differential displacement vector

$\therefore \hat{T}\,ds = d\vec{r}$

$\Rightarrow$ The line integral $\int A \cdot dr$ is independent of the path C

Thm $\int_{P_1}^{P_2} A \cdot dr$ to be independent of the path joining two point P_1 and P_2 in a given region is that $\oint A \cdot dr = 0$ for all closed path C in the region

$\Rightarrow$ Scalar potential function ϕ is a single valued function which there exist a continuous vector field $\vec{A}$

$\vec{A} = \nabla \phi$

Thm A vector field $\vec{A}$ be conservative is that $\nabla \times A = 0$ (irrotational)

$\Rightarrow$ $A \cdot dr = A_1 dx + A_2 dy + A_3 dz$ is an exact differential.