Line Integral: Given $\boxed{\text{curve } C}$: $\vec{r}(t)$, $a \le t \le b$

$$\int_C f \, ds$$

$$\underbrace{\int_C P(x,y) + Q(x,y)\,dy}_{= \int_C \vec{F} \cdot d\vec{r}} \quad \text{OR} \quad \underbrace{\int_C P(x,y,z)\,dx + Q(x,y,z)\,dy + R(x,y,z)\,dz}_{= \int_C \vec{G} \cdot d\vec{r}}$$

where $\vec{F} = \langle P, Q \rangle$, where $\vec{G} = \langle P, Q, R \rangle$.

* Note: If $\vec{F}$ (or $\vec{G}$) is conservative, we can use Fund Thm. of Line Int. to compute the line integral.

Surface Integral / Flux Integral: Given $\boxed{\text{surface } S}$: $\vec{r}(u,v)$, for $(u,v) \in D$ ← planar region in uv-plane

$$\iint_S f(x,y,z)\,dS = \iint_D f(\vec{r}(u,v))\,|\vec{r}_u \times \vec{r}_v|\,dA$$

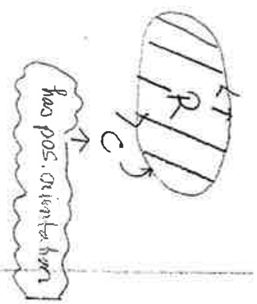
$$\iint_S \vec{F} \cdot d\vec{S} \quad (\text{flux integral}) = \iint_S \vec{F} \cdot \vec{n}\,dS = \iint_D \vec{F}(\vec{r}(u,v)) \cdot \vec{r}_u \times \vec{r}_v \, dA$$

* Note: Orientation of S matters for flux integral!

* Note: $\iint_S 1\,dS$ = surface area of S.

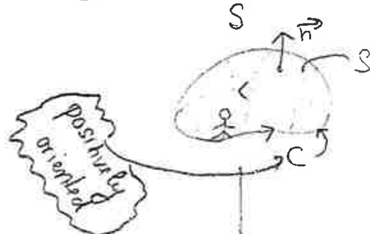
GREEN'S THM

$$\int_C P\,dx + Q\,dy = \iint_R \left(\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y} \right) dA$$



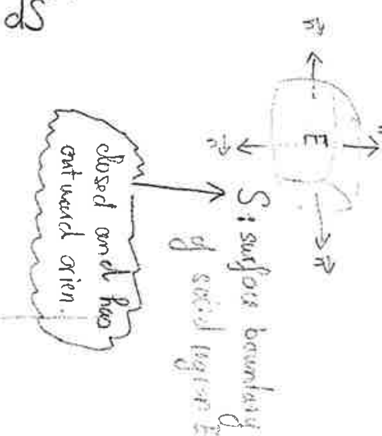
STOKES' THM

$$\int_C \vec{F} \cdot d\vec{r} = \iint_S \text{curl}\,\vec{F} \cdot d\vec{S}$$



DIVERGENCE THM

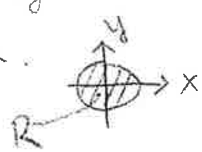
$$\iint_S \vec{F} \cdot d\vec{S} = \iiint_E \text{div}\,\vec{F}\,dV$$



Double Integral: R : 2-dim'l planar region

$$\iint_R f(x,y)\,dA$$

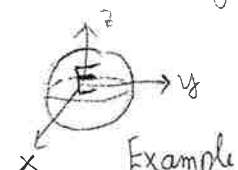
Example of R.



* Note: $\iint_R 1\,dA = \text{area}(R)$

Triple Integral: E : 3-dim'l solid region / object

$$\iiint_E f(x,y,z)\,dV$$



Example of E

* Note: $\iiint_E 1\,dV = \text{Vol}(E)$