Complex integrals:

Curve (parameter description):

One dimensional curve

$x = x(t)$

Two-dimensional curve

$x = x(t), y = y(t)$

Three-dimensional curve

$x = x(t), y = y(t), z = z(t)$

What happens

$$\int f(x)dx \;\to\; x \to f'(x)$$

$$\int f(z)dz \;\to\; z \to f'(z)$$

Path-independent integrals: $\int_A f(z)dz = \int_B f(z)dz$

Conservative field: $\int_A^B f(z)dz = F(z)\big|_A^B$

Work done: $\int_A^B F \bullet dr$

Potential function: $\int_A^B F \bullet dr = \phi(B) - \phi(A)$

Green's theorem: $\int_C Pdx + Qdy = \iint_A \left(\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y}\right)dA$

Cauchy-Goursat theorem: $\oint_C f(z)dz = 0$ *f(z)* is analytic in the region bounded by *C*

Simply-connected domain and multiply-connected domain

Cauchy integral formula: $\frac{1}{2\pi i}\oint_C \frac{f(z)}{z-a}dz = f(a)$

Hadamard integral formula: $\frac{1}{2\pi i}\oint_C \frac{f(z)}{(z-a)^2}dz = f'(a)$

Residue: $\oint_C \frac{f(z)}{z-a}dz = 2\pi i f(a)$, $\oint_C \frac{f(z)}{(z-a)^2}dz = 2\pi i f'(a)$