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Fourier Series: Period-Shift Integral Property

If f is periodic with period $2p$ (i.e., $f(t+2p)=f(t)$), then for any $d \in \mathbb{R}$,

$$\int_d^{d+2p} f(t)\,dt \;=\; \int_0^{2p} f(t)\,dt.$$

Proof: Let $u = t - d$. Then

$$\int_d^{d+2p} f(t)\,dt = \int_0^{2p} f(u+d)\,du.$$

Set $g(u) = f(u+d)$. Since f is $2p$-periodic, g is also $2p$-periodic, hence

$$\int_0^{2p} g(u)\,du = \int_0^{2p} f(u)\,du,$$

so

$$\int_d^{d+2p} f(t)\,dt = \int_0^{2p} f(u)\,du.$$

Integration by Parts

$$\int u\,dv \;=\; uv - \int v\,du.$$

Exponential-Trigonometric Integrals

For $a, b \in \mathbb{R}$ with $a^2 + b^2 \neq 0$,

$$\int e^{ax}\cos(bx)\,dx = \frac{e^{ax}}{a^2+b^2}\big(a\cos(bx) + b\sin(bx)\big) + C,$$

$$\int e^{ax}\sin(bx)\,dx = \frac{e^{ax}}{a^2+b^2}\big(a\sin(bx) - b\cos(bx)\big) + C.$$

Signal and System

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