

# CLTI Correlation (2A)

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# Correlation

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How signals move  
relative to each other

Positively correlated      the same direction

Average of product  $>$  product of averages

Negatively correlated      the opposite direction

Average of product  $<$  product of averages

Uncorrelated

# Correlation Function

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t) y^*(t+\tau) dt = \int_{-\infty}^{+\infty} x(t-\tau) y^*(t) dt$$

Both real

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t) y(t+\tau) dt = \int_{-\infty}^{+\infty} x(t-\tau) y(t) dt$$

Uncorrelated

# Correlation and Convolution

Both real

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)y(t+\tau) dt = \int_{-\infty}^{+\infty} x(t-\tau)y(t) dt$$

Convolution

$$x(t)*y(t) = \int_{-\infty}^{+\infty} x(t-\tau)y(\tau) d\tau$$

$$R_{xy}(\tau) = x(-\tau)*y(\tau)$$

$$x(-t) \qquad X^*(f)$$

$$R_{xy}(\tau) \qquad X^*(f)Y(f)$$

# Power Signals

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t) y^*(t+\tau) dt = \int_{-\infty}^{+\infty} x(t-\tau) y^*(t) dt$$

$$R_{xy}(\tau) = \lim_{T \rightarrow \infty} \frac{1}{T} \int_T x(t) y^*(t+\tau) dt = \lim_{T \rightarrow \infty} \frac{1}{T} \int_T x(t-\tau) y^*(t) dt$$

Both real

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t) y(t+\tau) dt = \int_{-\infty}^{+\infty} x(t-\tau) y(t) dt$$

$$R_{xy}(\tau) = \lim_{T \rightarrow \infty} \frac{1}{T} \int_T x(t) y(t+\tau) dt = \lim_{T \rightarrow \infty} \frac{1}{T} \int_T x(t-\tau) y(t) dt$$

$$R_{xy}(\tau) = \lim_{T \rightarrow \infty} \frac{1}{T} \int_T x(t) y(t+\tau) dt \quad R_{xy}(\tau) = \frac{1}{T} \int_T x(t) y(t+\tau) dt$$

# Energy Signals

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$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)y(t+\tau) dt$$

$$R_{xy}(\tau) = \frac{1}{T} \int_T x(t)y(t+\tau) dt$$

# Autocorrelation

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$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)y(t+\tau) dt$$

$$R_{xy}(\tau) = \frac{1}{T} \int_T x(t)y(t+\tau) dt$$



## References

- [1] <http://en.wikipedia.org/>
- [2] M.J. Roberts, Signals and Systems,