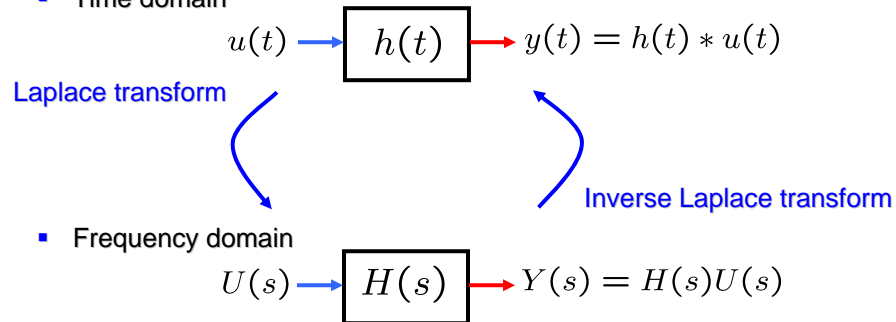


Transfer Function

- Defined as **the ratio** of the Laplace transform of the output signal to that of the input signal (think of it as a **gain factor!**)
- Contains information about dynamics of a Linear Time Invariant system
- Time domain



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Mass-Spring-Damper System

- ODE

$$M\ddot{y}(t) + b\dot{y}(t) + ky(t) = u(t)$$

- Assume all initial conditions are zero. Then take Laplace transform,

$$Ms^2Y(s) + bsY(s) + kY(s) = U(s)$$

$$\frac{Y(s)}{U(s)} = \frac{1}{Ms^2 + bs + k}$$

Labels: Output, Input, Transfer function

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Transfer Function

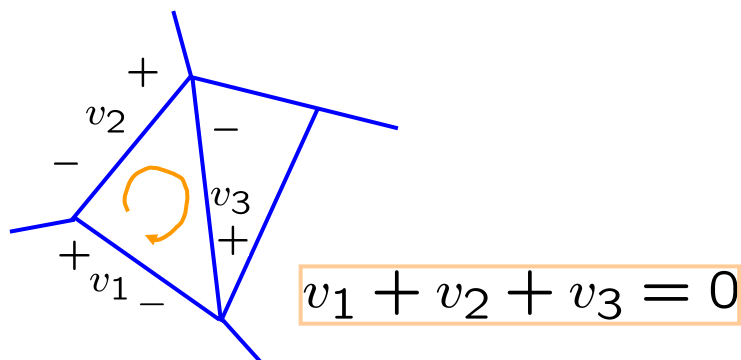
- Differential equation replaced by algebraic relation $Y(s)=H(s)U(s)$
- If $U(s)=1$ then $Y(s)=H(s)$ is the **impulse response** of the system
- If $U(s)=1/s$, the unit step input function, then $Y(s)=H(s)/s$ is the **step response**
- The **magnitude** and **phase shift** of the response to a **sinusoid at frequency ω** is given by the magnitude and phase of the complex number $H(j\omega)$

- Impulse: $\mathcal{L}[\delta(t)] = \int_0^{\infty} \delta(t)e^{-st} dt = 1$

- Unit step: $\mathcal{L}[1(t)] = \int_0^{\infty} e^{-st} dt = \frac{1}{s}$

Kirchhoff's Voltage Law

- The algebraic sum of voltages around any closed loop in an electrical circuit is zero.



Kirchhoff's Current Law

- The algebraic sum of currents into any junction in an electrical circuit is zero.

