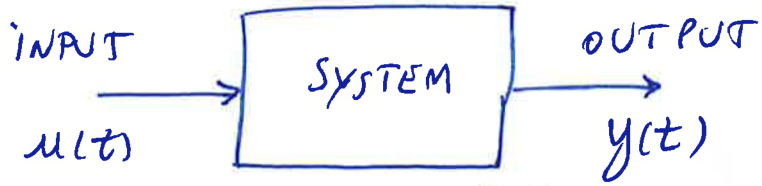
# SYSTEM IDENTIFICATION




differential equations

↓

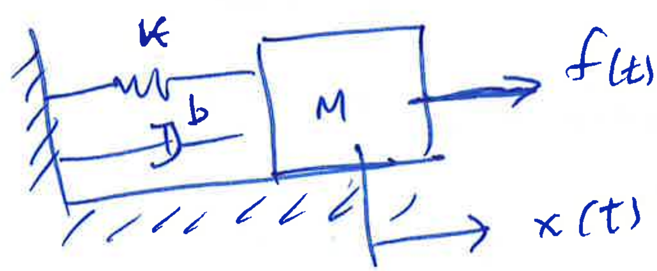
LINEAR

↓

Laplace Model (TRANSFER FUNCTION)

linear diff. eq. $\xrightarrow{\mathcal{L}}$ $\boxed{P(s) = \dfrac{Y(s)}{U(s)}}$ $\dfrac{(\text{OUTPUT})}{(\text{INPUT})}$ = TRANSF. FUNCT.

EXAMPLE :




motion equation

$$m\ddot{x} + b\dot{x} + kx = f(t)$$

$\downarrow \mathcal{L}$

$$ms^2 X(s) + bs\, X(s) + K X(s) = F(s)$$

$$X(s)\left(ms^2 + bs + K\right) = F(s)$$

$$\underset{\text{OUTPUT}}{X(s)} = \underbrace{\boxed{\frac{1}{ms^2+bs+K}}}_{\text{TRANSFER FUNCTION}} \cdot \underset{\text{INPUT}}{F(s)}$$

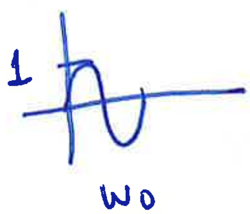
INVERSE LAPLACE $\mathcal{L}^{-1}$

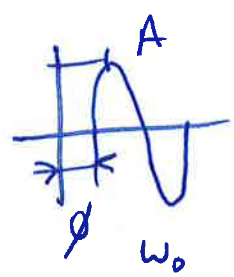
$$X(s) \xrightarrow{\mathcal{L}^{-1}} x(t)$$

## THE FREQUENCY RESPONSE OF A SYSTEM

LINEAR SYSTEM

$$\underset{\text{INPUT}}{U(s)} \longrightarrow \boxed{G(s)} \longrightarrow \underset{\text{OUTPUT}}{Y(s)}$$



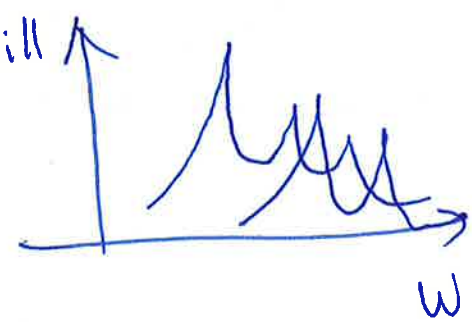

TRANSFER FUNCTION

$$G(s) = \frac{B(s)}{A(s)}$$

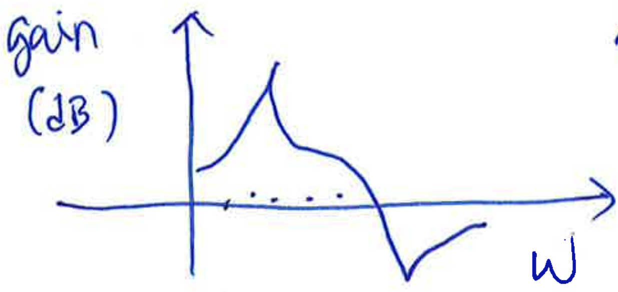
any signal : $y(t) = \underbrace{\sum^{n} a_i \sin(\quad) + b_i \cos(\quad)}_{\text{FOURIER SERIES}}$

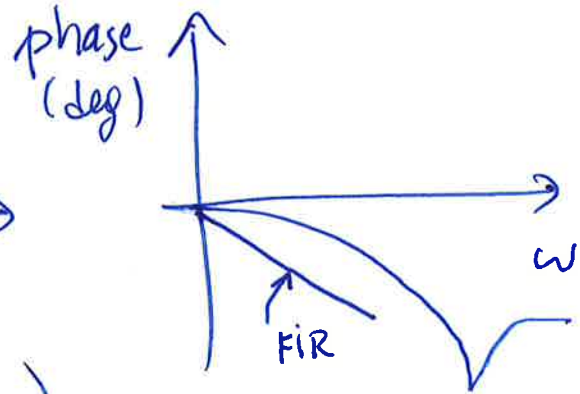
FOURIER TRANSFORM

SPECTRUM of $y(t)$



THE FREQUENCY RESPONSE OF A SYSTEM IS A SET OF PLOTS THAT SHOW THE RESPONSE OF A SYSTEM TO SINE WAVES




$$\# dB = 20 \log_{10} \left( \frac{OUT}{INP} \right)$$

THE FREQUENCY RESPONSE IS OBTAINED BY REPLACING $s = j\omega$ IN THE TRASFER FUNCTION $G(s)$

$G(j\omega)$ → $\| G(j\omega) \|$ gives you the gain plot

$G(j\omega)$ → $\operatorname{atan}\left( \frac{Im(G(j\omega))}{Re(G(j\omega))} \right)$ → phase plot

the experimental transfer function is obtained by using the spectrum of INPUT and OUTPUT

$$\| G(j\omega) \| = \frac{\| Y(j\omega) \|}{\| U(j\omega) \|} \dashrightarrow \boxed{G(s)}$$

EXPERIMENTAL TRANSFER FUNCTION