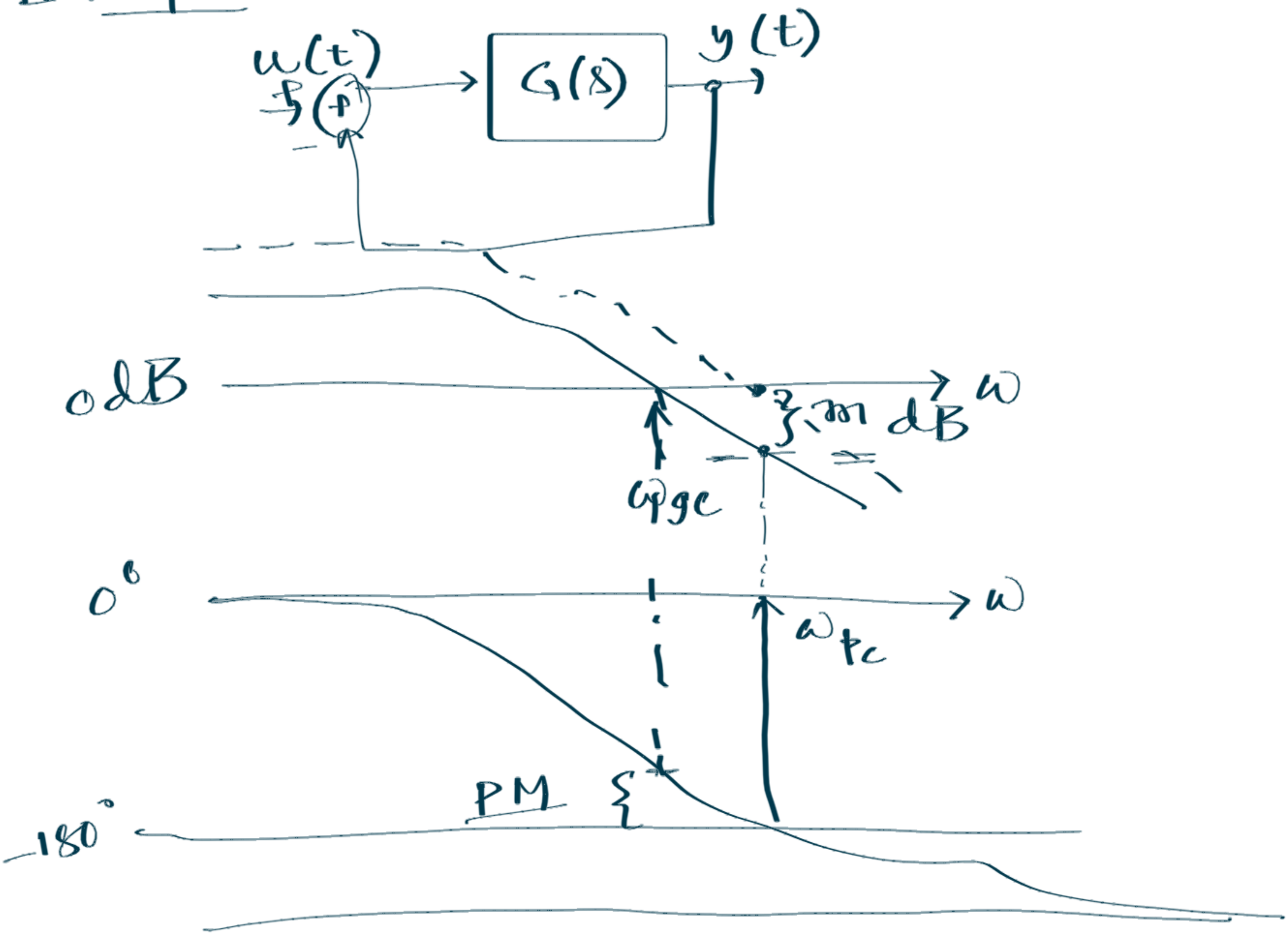
9 April:



$\angle G(j\omega_{pc}) = -180^\circ$ def^n

From the plot (magnitude) we see that

$|G(j\omega_{pc})| < 0$ (in dB)

$\Rightarrow \quad |G(j\omega_{pc})| < 1$

$G(j\omega_{pc})$ is a negative real no. with the magnitude of the real part < 0.

let $K > 0$ be s.t.

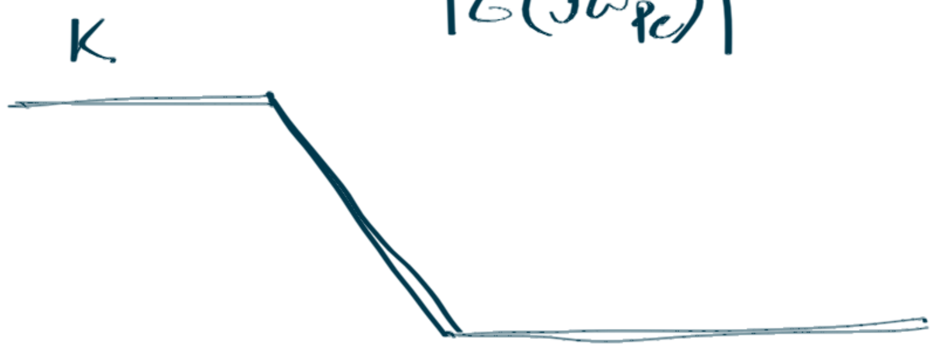
$$20 \log K = m$$

$$20 \log |G(j\omega_{pc})| + m = 0$$

$$\Rightarrow 20\log|G(j\omega_{pc})| + 20\log K = 0$$

$$\Rightarrow 20\log|K\,G(j\omega_{pc})| = 0$$

$$K = \frac{1}{|G(j\omega_{pc})|}$$ Gain margin



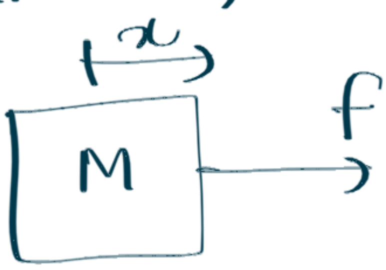
State space theory:

$$\left.\begin{aligned} \frac{dx}{dt} &= Ax + Bu \\ y &= Cx + Du, \end{aligned}\right] \quad x \text{ is called the STATE vector}$$

$$x : [0, \infty) \to \mathbb{R}^n$$

$$A \in \mathbb{R}^{n\times n},\ B \in \mathbb{R}^{n\times 1}$$

$$C \in \mathbb{R}^{1\times n},\ D \in \mathbb{R}.$$



$$\ddot{x} = \frac{1}{M} f$$

$$v := \dot{x}$$

$$\dot{v} = \frac{1}{M} f$$

$$\Rightarrow \begin{bmatrix} \dot{x} \\ \dot{v} \end{bmatrix} = \frac{d}{dt}\begin{bmatrix} x \\ v \end{bmatrix} = \begin{bmatrix} v \\ \frac{1}{M} f \end{bmatrix}$$

$$\Rightarrow \frac{d}{dt}\begin{bmatrix} x \\ v \end{bmatrix} = \underbrace{\begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}}_{A} \begin{bmatrix} x \\ v \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \\ \frac{1}{M} \end{bmatrix}}_{B} f$$

$$Y = x = \underbrace{\begin{bmatrix} 1 & 0 \end{bmatrix}}_{C} \begin{bmatrix} x \\ v \end{bmatrix} + \underbrace{0}_{D} \cdot f.$$

Here, the state vector is

$$\begin{bmatrix} x \\ v \end{bmatrix}$$