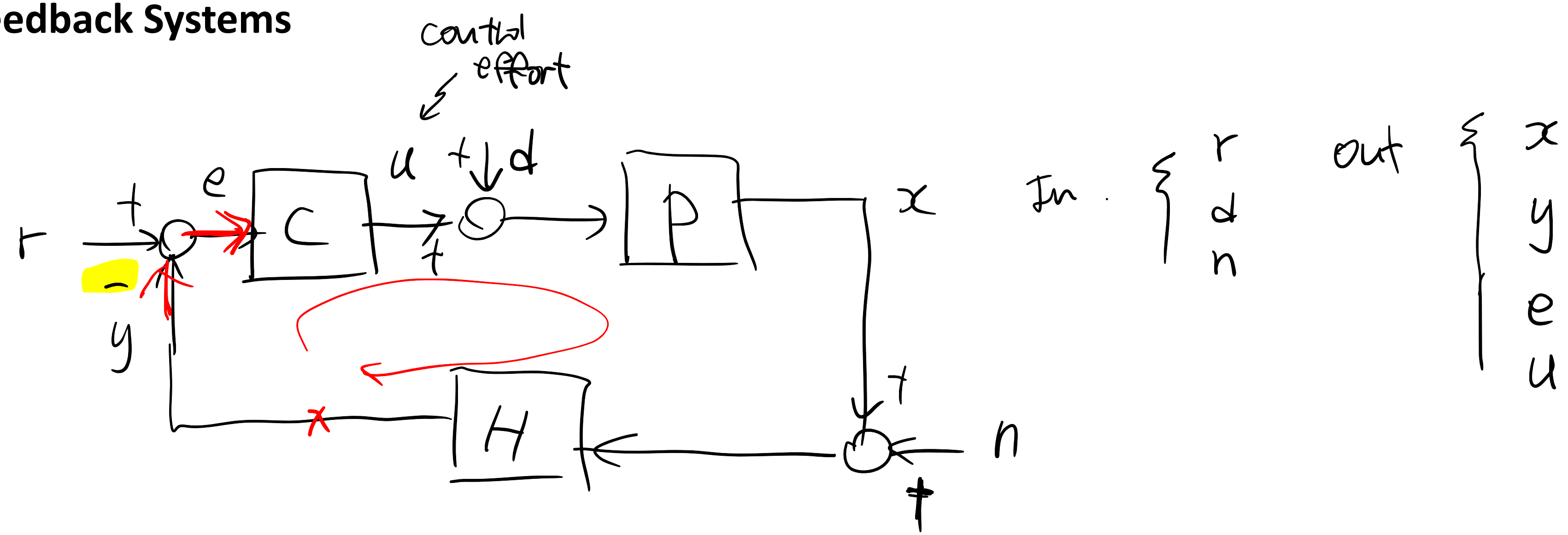
L1 – Feedback Systems



Transfer function "Matrix"

$$\frac{X}{R} = \frac{CP}{1 - L.T.} = \frac{CP}{1 + CPH} \qquad \frac{E}{R} = \frac{1}{1 + CPH}.$$

$$L.T. = (-1)\,CPH = -CPH \qquad \frac{U}{N} = \frac{-HC}{1 + CPH}.$$

Loop transmission

$$\begin{bmatrix} X \\ Y \\ E \\ U \end{bmatrix} = \underbrace{\begin{bmatrix} 4 \times 3 \end{bmatrix}}_{} \begin{bmatrix} R \\ D \\ N \end{bmatrix}.$$

- Loop Transmission (L.T.)

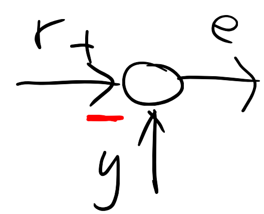
Bell Labs { Nyquist – Math, Bode – Engineer, Black – Inventor

- **Black's Formula**

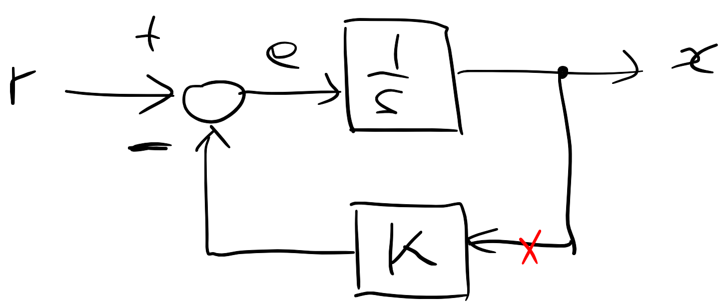
$$G = \frac{\text{Forward-path Gain}}{1 - \text{L.T.}}$$

- Loop Return Ratio: $L(s)$. "Loop Transfer function"

$$L(s) \triangleq -\text{L.T.} \qquad \text{"}\frac{Y}{E}\text{"}$$



Example: Sigle Integrator Feedback.

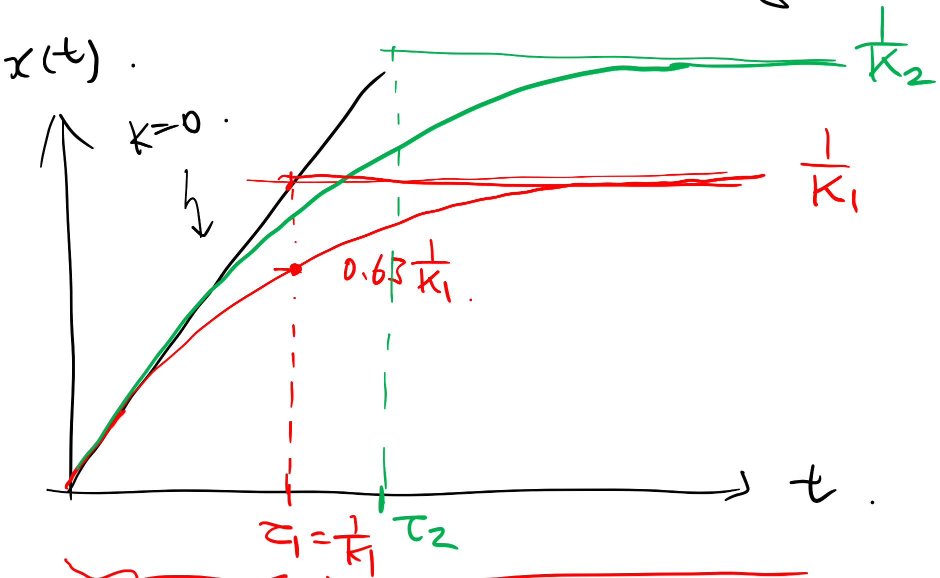


$$\text{L.T.} = K \cdot (-1) \cdot \frac{1}{s} = -\frac{K}{s}.$$

$$L(s) = \frac{K}{s}.$$

$$G \triangleq \frac{X}{R} = \frac{\frac{1}{s}}{1 + \frac{K}{s}} = \frac{1}{s+K}. \quad \text{"Evan's Form"}$$

$$= \underbrace{\left(\frac{1}{K}\right)}_{\text{DC gain}} \underbrace{\frac{1}{\frac{1}{K}s + 1}}_{\text{unity-dc-gain dynamics}} \quad \text{"Bode's Form"}$$



Feedback not effective

Feedback effective.

$G(s)\Big|_{s \to 0}$: DC gain.

Steady-state value of step resp.

$$= G_0 \frac{1}{\tau s + 1} \qquad \tau = \frac{1}{K}.$$

"Time const"

① $K = 0$.

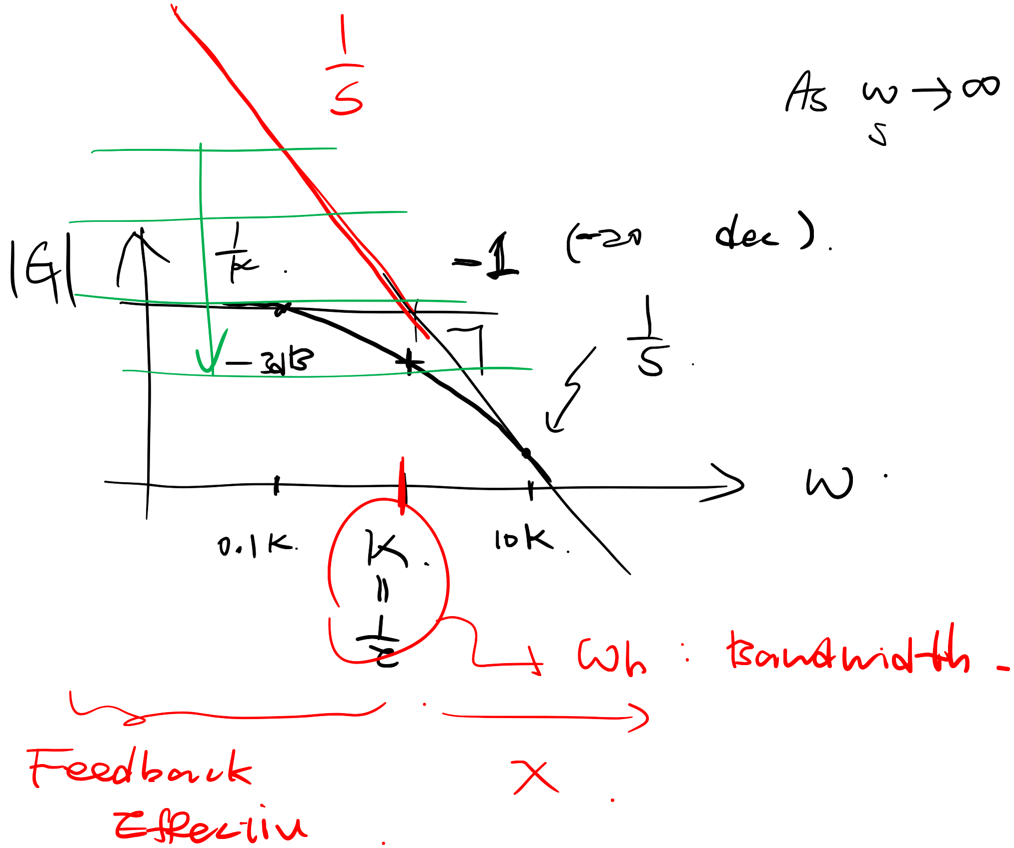
② $K = K_1$

③ $K = K_2 < K_1$.

< Bode Plot >.

$$G(s) = \frac{1}{K} \frac{1}{\frac{1}{K}s + 1}.$$

As $\omega \to \infty$. $G(s) \to \frac{1}{s}$.

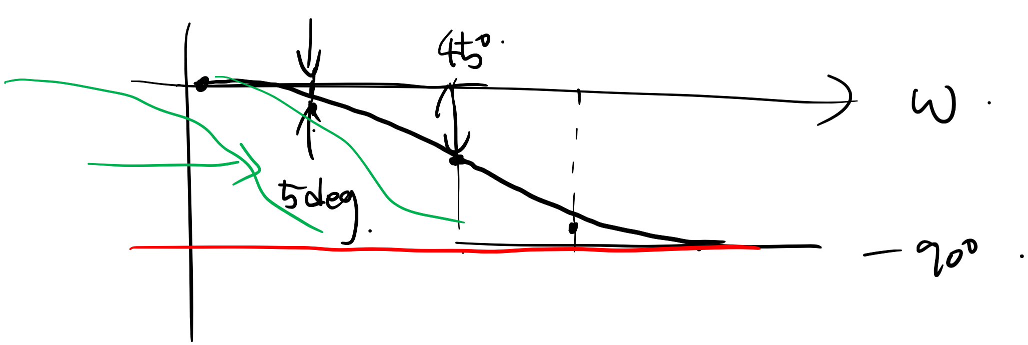


20dB → 10 dec .

$\frac{10dec}{10dec} = 1$.

① K=0

② K varies .



Questions

- Lab schedules
- Pset out
- Tutorial schedules.