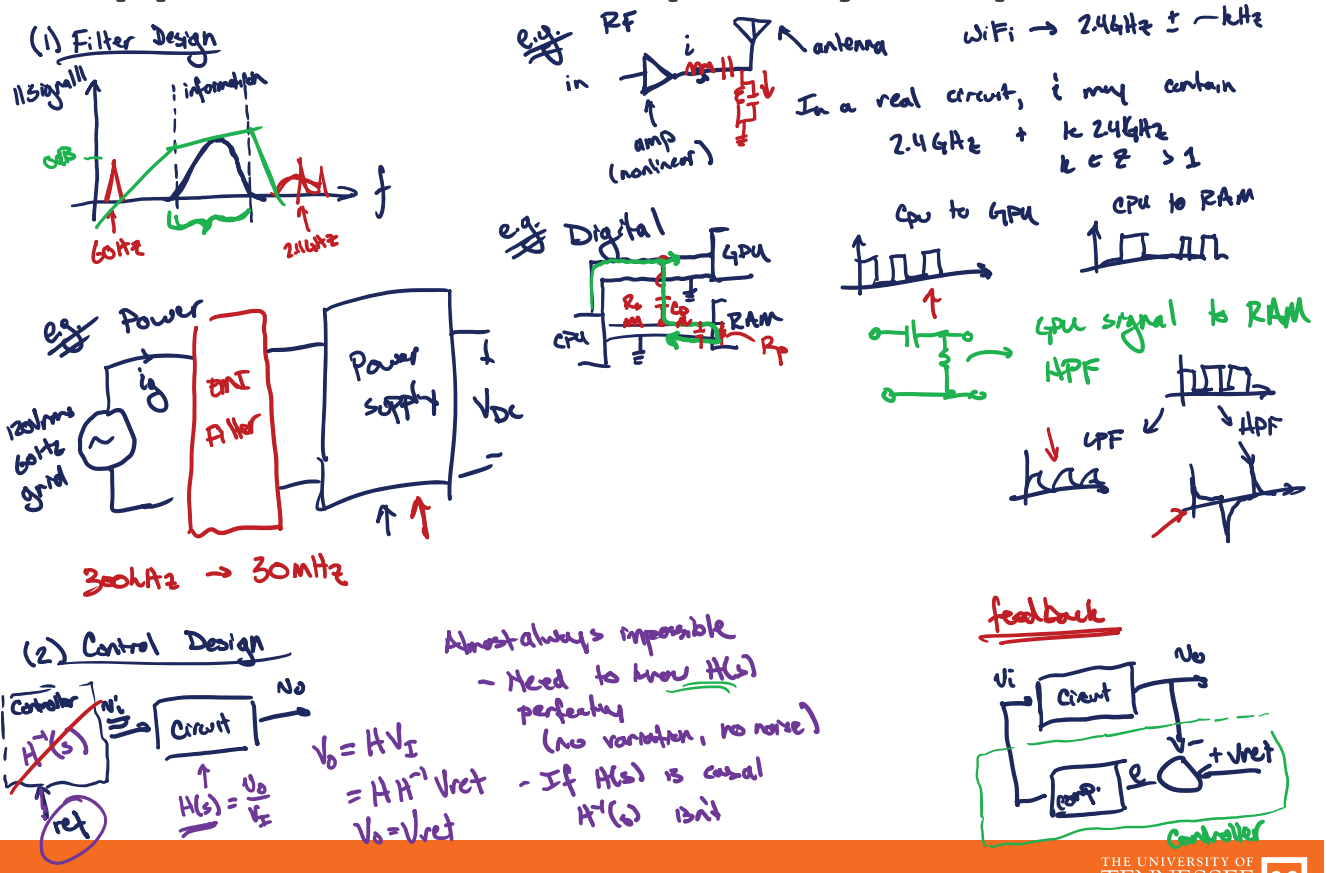
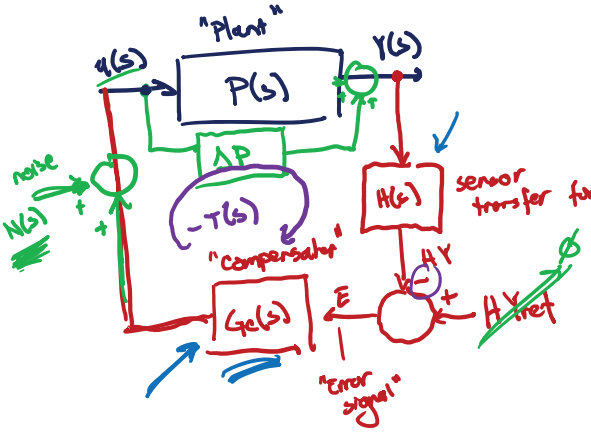
Applications of Frequency Response



Brief Introduction to Feedback



feedback (Negative) controller

Controls nomenclature
u → input (control) signal
y → output signal

E = 0 ⟺ Y = Yref

Design of Feedback control
→ (1) Drive E to zero
→ (2) Fast response
→ (3) Robust (to model error or noise)
→ (4) Stable
→ still needs to be addressed

Note: in open loop input u, output y
in closed loop input yref, output y

$$Y(s) = P(s)U(s)$$
$$= P(s)\left[G_c(s)\left(H(s)Y_{ref}(s) - H(s)Y(s)\right)\right]$$

Benefits of Negative Feedback

$$Y = PG_c(-HY + HY_{ref})$$

$$Y(1 + PG_cH) = PG_cH\,Y_{ref}$$

closed-loop $\Rightarrow \frac{Y}{Y_{ref}} = \frac{PG_cH}{1+PG_cH}$

Define $T(s) \equiv$ "Loop Gain"

$T(s) = PG_cH$

target: $Y = Y_{ref}$

$$Y = \frac{T}{1+T} Y_{ref} + \frac{1}{1+T} PN$$

$\frac{T}{1+T}$: effect of feedback

PN: by what the impact would be w/ no feedback

$\frac{T}{1+T} = \begin{cases} 1, & T \gg 1 \\ T, & T \ll 1 \end{cases}$

$\frac{1}{1+T} = \begin{cases} 0, & T \gg 1 \\ 1, & T \ll 1 \end{cases}$

Include Noise (by superposition)

$Y = P(N + G_c(-HY))$

$Y(1 + PG_cH) = PN$

$\frac{Y}{N} = \frac{P}{1+PG_cH}$

We want a large $T(s)$ for

(1) Good tracking ($E \to 0$)

(2) Good rejection of disturbances

want Large $T(s)$ over a wide frequency range