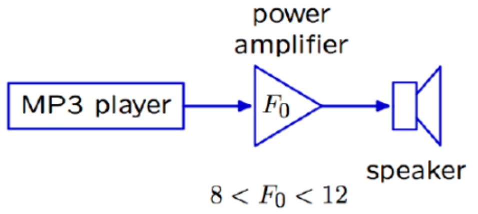
VE216 Lecture 13

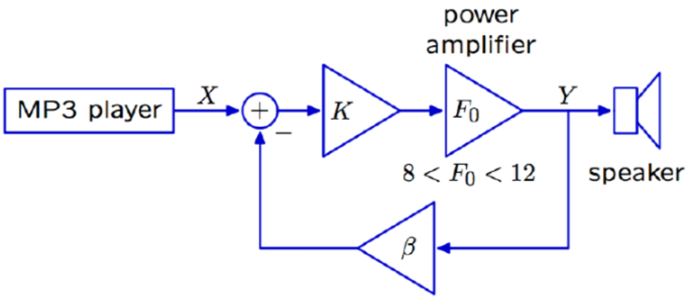
> CT Feedback and Control

Reducing sensitivity to unwanted parameter variation

Change the original form of

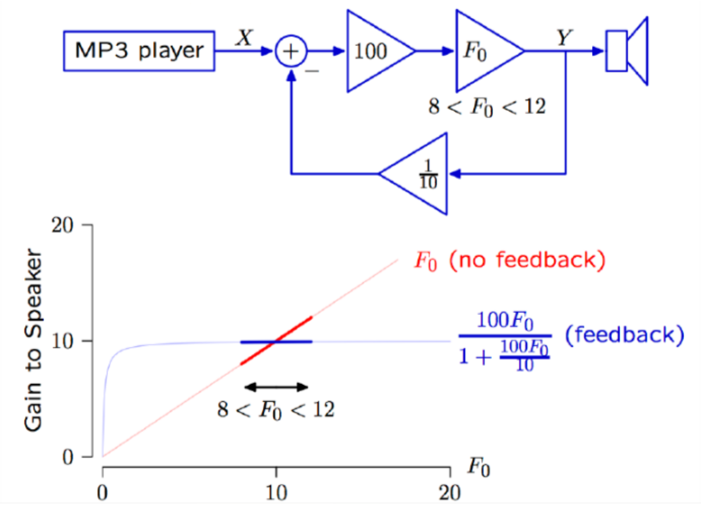


into the form of



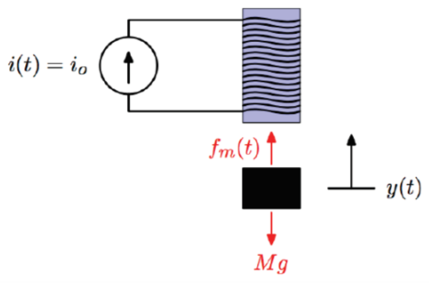
with the system function $H(s) = \frac{KF_0}{1+\beta KF_0}$ (if K is large, then $H(s) \to \frac{1}{\beta}$).

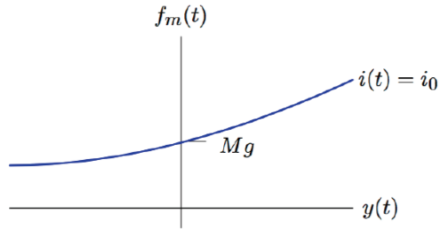
Example

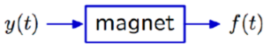


Stabilize unstable Systems

Magnetic Levitation Modeling







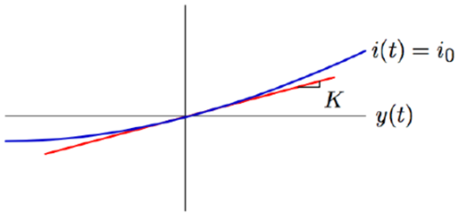
This kit is unstable:

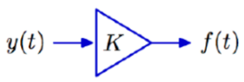
- increase $y(t) \rightarrow$ increase force $\rightarrow$ further increase $y(t)$.
- decrease is vise versa.

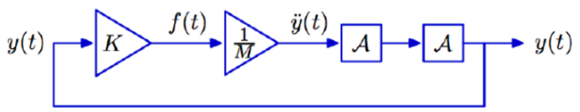
So we need a feedback system for the magnet block.

Then we list the force balance function (for small distance we can do linear approximation) and generate a block diagram:

$$f(t) = f_m(t) - Mg = Ma = M\ddot{y}(t)$$



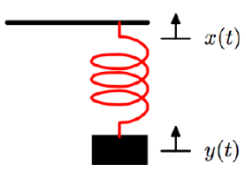


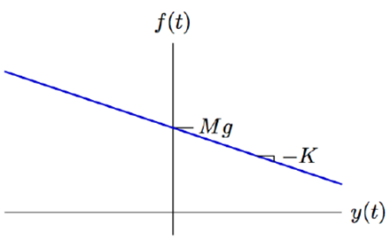


Since the $y(t)$ indicates location, transfer back into the magnet block, output the force $f(t)$ and through $\frac{1}{M}$ block to get the acceleration.

Spring Levitation Modeling

With the balance function $F = K(x(t) - y(t)) = M\ddot{y}(t)$.

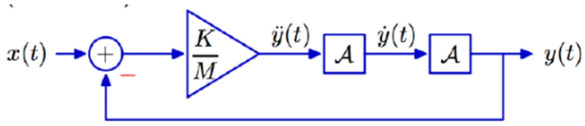




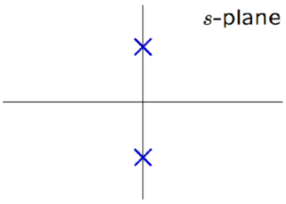
Difference Between Block Diagrams

Spring and Mass

$F = K(x(t) - y(t)) = M\ddot{y}(t)$

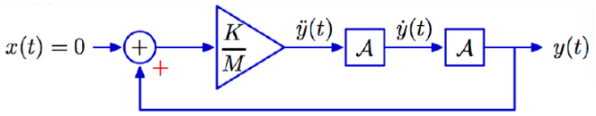


$$\frac{Y}{X} = \frac{\frac{K}{M}}{s^2 + \frac{K}{M}} \to s = \pm j\sqrt{\frac{K}{M}}$$

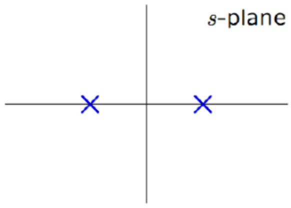


Magnetic Levitation

$F = Ky(t) = M\ddot{y}(t)$



$$K = Ms^2 \to s = \pm\sqrt{\frac{K}{M}}$$



So this system is unfortunately unstable... A zero is positive.

Still need improvement.

Remark on S-plane

If you forget something, notice that we first derive a $H(s)$ from frequency response require.

Then we get the $H(s)$ to get poles of forms $\sigma + j\omega$.

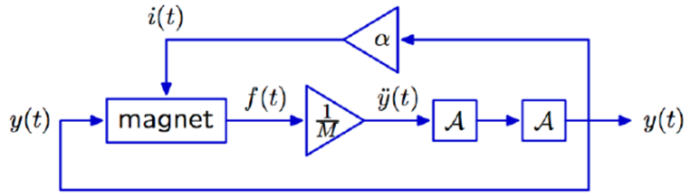
The imaginary part is causing the oscillating.

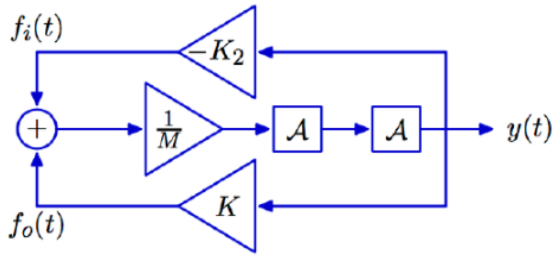
The real part is indicating the system's divergence of convergence, separate into DT and CT situation:

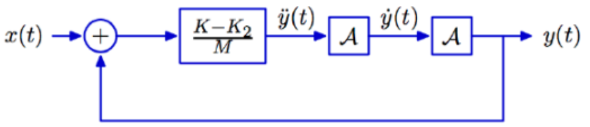
- DT: p^n is mainly in each part of $a[n]$.
- CT: e^{pt} is mainly in each part of $a(t)$.

So the convergence is depending on the signal categories, then we choose the p's scope.

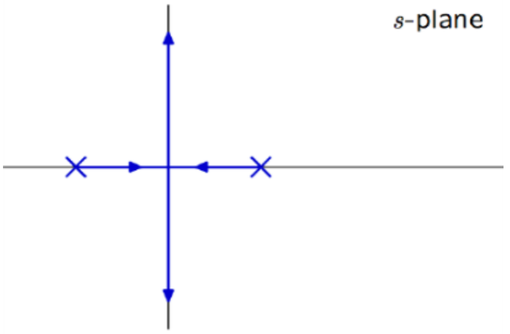
Stabilizing Magnetic Levitation





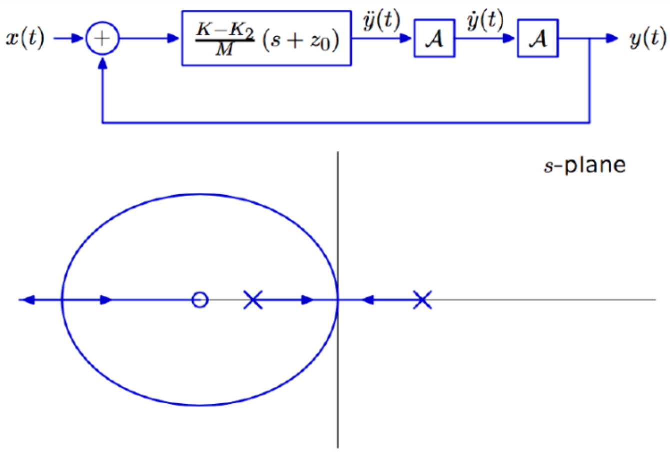


Thus we get the s-plane plot, increase K_2 moves the poles together, collide, on $j\omega$ axis.



It is marginally stable (all the poles are 0-real part, so to say all imaginary part; the poles are all different).

So we need to do something more.



Adding a zero may band the scope of poles to make the system stable.