# Notes in ECEN 5448

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## Bureaucrucy

she will be gone Thursday through Sunday
office hours: Friday (11am-12pm) in ECEE 1b85

## Unstable Zeros

sometimes digital controllers will have unstable zeros that don't exist in the original system.

## Difference Equations

$$u_k = u_{k-1} + \text{area of tapezoid}$$

## Analysis of Systems

Transfer functions, state-space representations, block diagram manipulation,

### Transfer Function

Z-transform is directly analagous to the Laplace transform

Z-transform of difference equation and solve for $\frac{U(z)}{E(z)}$

$u_{k-1} \to z^{-1}U(z)$

$$H(z) = \frac{b(z)}{a(z)}$$

solutions of $b(z) = 0$ are zeros, solutions of $a(z) = 0$ are poles.

special case where $H(z) = z^{-1}$ all constant except $b_1$ are zero. This is a unit delay, $u_k = e_{k-1}$.

state space, converting from nth order difference equation to n 1st order difference equations.

remember that state-space representations are not unique.

Controllable canonical form.

if you only use simple delays, gains and summers in a state-space rep, you will have a uniquely corresponding state-space representation.

look at the notes online for an example of converting high order difference equations to first order ones.

feedback loop transfer function, plant $H_1$ and positive feedback $H_2$. Transfer function is:

$$\frac{U}{E} = \frac{H_1}{1 - H_1 H_2}$$

so negative feedback would be:

$$\frac{U}{E} = \frac{H_1}{1 + H_1 H_2}$$

moving nodes across blocks.
for multi-path, multi-loop block diagrams can be simplified using this or Mason's rule.

stability

for now, only bibo stab

bibo stab test in notes, good stuff.