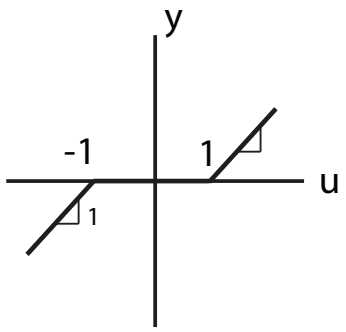
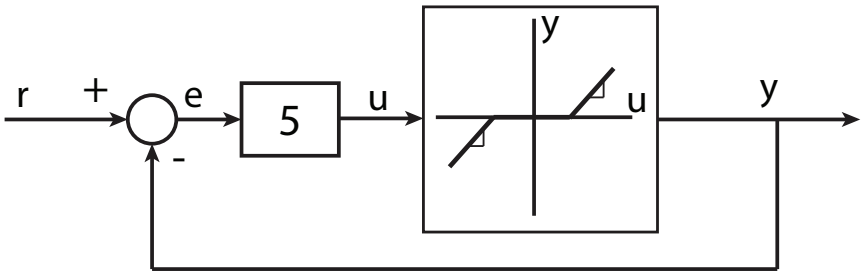
16.06 Principles of Automatic Control
Recitation 1





Find y as a function of r:

$$\left.\begin{aligned} u &= 5e \\ e &= r - y \end{aligned}\right\} \text{ These come from feedback diagram}$$

Now substitute $u = 5(r - y)$

y is a piecewise function.

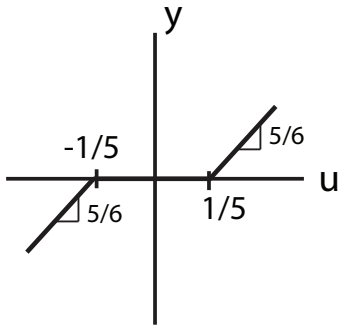
$$y=\begin{cases} u-1, & u>1 \\ 0, & -1<u<1 \\ u+1, & u<-1 \end{cases}$$

Now do a substitution for each of the regions:

$\mathbf{u>1}$	$\mathbf{-1<u<1}$	$\mathbf{u<-1}$
$y=5(r-y)-1$	$y=0$	$y=5(r-y)+1$
$6y=5r-1$		$6y=5r+1$
$y=\frac{5}{6}r-\frac{1}{6}$		$y=\frac{5}{6}r+\frac{1}{6}$

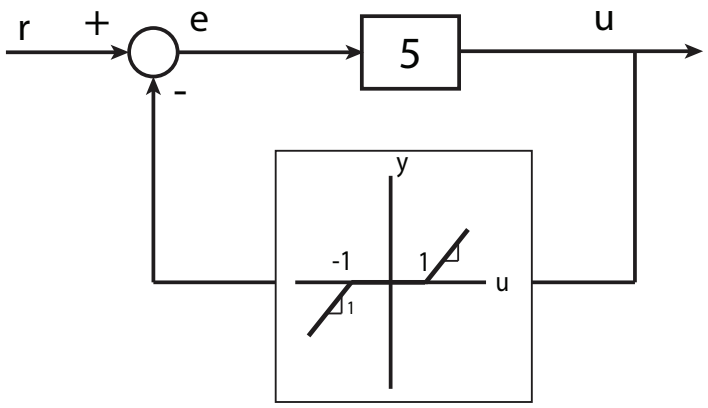
Last step is to find a breakpoint:

$\mathbf{u>1}$	$\mathbf{u<-1}$
$5(r-y)>1$	$5(r-y)<-1$
$r-\frac{5}{6}r+\frac{1}{6}>\frac{1}{5}$	$r-\frac{5}{6}r-\frac{1}{6}<-\frac{1}{5}$
$r>\frac{1}{5}$	$r<-\frac{1}{5}$



So the system becomes less non-linear. Increasing the gain would reduce the deadban area and increase the slope towards 1.

Now have non-linear portion in feedback loop.



So now output is u, and we want to find u as a function of r.

$$\left.\begin{aligned} u &= 5e \\ e &= r - y \end{aligned}\right\} \text{ equations from block diagram}$$

$u = 5(r - y) \rightarrow$ substitution

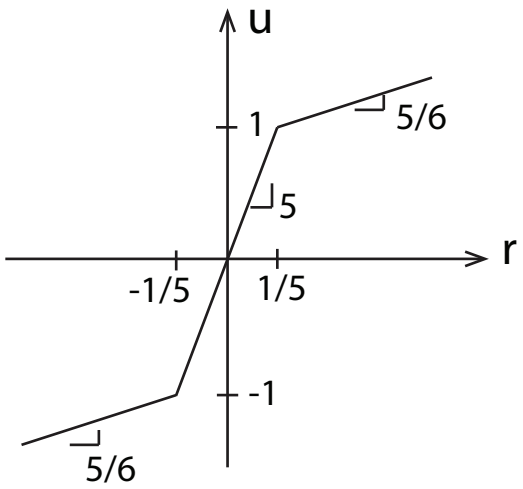
$$y = \begin{cases} u = 5e, u > 1 \\ e = r - y, -1 < u < 1 \rightarrow \text{these are equations of non-linear function} \\ u + 1, u < -1 \end{cases}$$

Substitute for y in each piece:

$\mathbf{u < -1}$	$\mathbf{-1 < u < 1}$	$\mathbf{u > 1}$
$u = 5r - 5u - 5$	$u = 5r$	$u = 5r - ru + 5$
$6y = 5r - 5$		$6y = 5r + 5$
$u = \frac{5}{6}r - \frac{5}{6}$		$u = \frac{5}{6}r + \frac{5}{6}$

For limits on r:

$\mathbf{u < -1}$	$\mathbf{u > 1}$
$\frac{5}{6}r - \frac{5}{6} < -1$	$\frac{5}{6}r + \frac{5}{6} > 1$
$r < -\frac{1}{5}$	$r > \frac{1}{5}$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