$$u(t) = K_c \left[\varepsilon(t) + \frac{1}{T_i}\int_0^t \varepsilon(t')\,dt' + T_d \frac{d\varepsilon(t)}{dt} \right] + b$$

$\varepsilon = \mu - X$: FOLLOWING ERROR

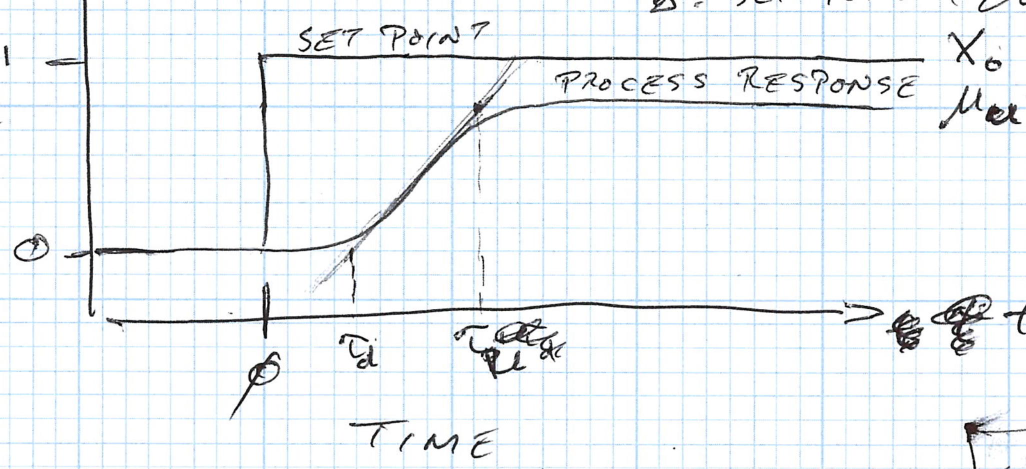
u : CONTROL SIGNAL

T_i = INTEGRAL SCALING TERM

T_d : DERIVATIVE " "

b : CONTROL VARIABLE SET POINT (ALSO $u(t_0)$)

PROCESS VARIABLE $\mu(t)$



$$K = \frac{d\,\text{OUTPUT}}{d\,\text{INPUT}}$$

τ_d : DEAD TIME (MEASURED)

τ_{RL} : TIME TO ~~SATURATE RESPONSE~~ FOR RESPONSE TO OCCUR (MEASURED)

X_o : CHANGE IN SET POINT

μ_{ei} : CHANGE IN PROCESS RESPONSE (NEW STEADY-STATE VALUE)

$$\tau = \tau_{RL} - \tau_d$$

$$R = \frac{\tau_d}{\tau} \qquad K_o = \frac{X_o}{\mu_{ei}} \frac{\tau}{\tau_d}$$

K_{pid}	UM
K_p	K_c
K_I	$\frac{K_c}{T_i}$
K_D	$K_c T_d$

OPEN-LOOP ZIEGLER-NICHOLS

	K_c	T_i	T_d
P:	K_o	—	—
PI:	$0.9K_o$	$3.3\tau_d$	—
PID:	$1.2K_o$	$2\tau_d$	$0.5\tau_d$

COHEN-COON

P = % CHANGE OF INPUT

N = % " " OUTPUT / τ

$L = \tau_d$

$R = \tau_d/\tau$ (AS ABOVE

	K_c	T_i	T_d
P	$\frac{P}{NL}\left(1+\frac{R}{3}\right)$	—	—
PI	$\frac{P}{NL}\left(0.9+\frac{R}{12}\right)$	$L\frac{30+3R}{9+20R}$	—
PID	$\frac{P}{NL}\left(\frac{4}{3}+\frac{R}{4}\right)$	$L\frac{30+3R}{9+20R}$	$\frac{4L}{11+2R}$