

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

$E = X - u$: FOLLOWING ERROR

u : CONTROL SIGNAL

T_i : INTEGRAL SCALING TERM

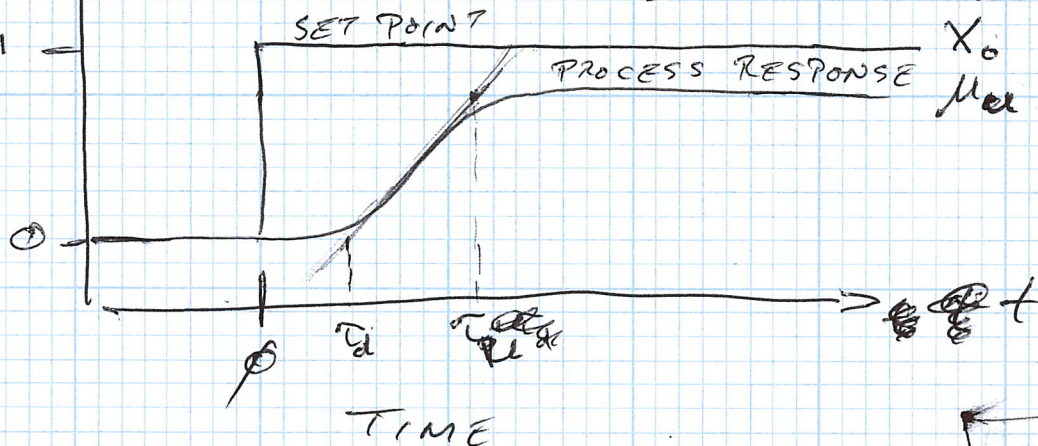
T_d : DERIVATIVE " " " "

b : SET POINT (OR SEVERAL $u(t_0)$)

PROCESS 1
VARIABLE

$u(t)$

$$K = \frac{\Delta \text{Output}}{\Delta \text{Input}}$$



T_d : DEAD TIME (MEASURED)

τ : TIME TO SATURATE RESPONSE (MEASURED)
FOR RESPONSE TO OCCUR

X_0 : CHANGE IN SET POINT

u_{max} : CHANGE IN PROCESS RESPONSE
(NEW STEADY-STATE VALUE)

$$\tau = \tau_{total} - T_d$$

$$R = \frac{T_d}{\tau}$$

$$K_0 = \frac{X_0}{u_{max}} \frac{\tau}{T_d}$$

$\frac{K_p}{K_c}$	$\frac{u_m}{K_c}$
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_0	—	—
PI:	$0.9 K_0$	$3.3 \tau_d$	—
PII:	$1.2 K_0$	$2 \tau_d$	$0.5 \tau_d$

COHEN-COON

P : % CHANGE OF INPUT
 N : % " " OUTPUT / τ

$$L = \tau_d$$

$$R = T_d / \tau \text{ (AS ABOVE)}$$

	K_c	T_i	T_d
P	$\frac{P}{N L} (1 + \frac{R}{3})$	—	—
PI	$\frac{P}{N L} (0.9 + \frac{R}{12})$	$L (30 + 3R)$	—
PII	$\frac{P}{N L} (\frac{4}{3} + \frac{R}{9})$	$L (30 + 3R)$	$4L$

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