PID Control Parameters

- If the PID control constants are not selected properly, the control system may even drive your system to instability.

$$\theta_o = K_c \left[\theta_e + \frac{1}{\tau_I} \int_0^t \theta_e \, dt + \tau_D \frac{d\theta_e}{dt} \right]$$

Integral time constant (τ_I)

Derivative time constant (τ_D)

The methods used for calculation of optimum values of PID parameters are;

- TRIAL AND ERROR
- COHEN-COON METHOD
- YUWANA- SEBORG METHOD
- ZIEGLER-NICHOLS METHOD

Cohen-coon method is the oldest and the most commonly applied one. So we will focus on its application;

COHEN-COON METHOD

- Valid only for first order processes.

$$G_1(s) = \frac{K}{\tau s + 1}$$

- If time delay or dead time is also taken into consideration with a transfer function of ;

$$G_2(s) = e^{-\tau_{dead} s}$$

- The transfer function of the process can be rewritten as;

$$G_{process}(s) = \frac{K \times e^{-\tau_{dead} s}}{\tau s + 1}$$

I. The steady state values of the process are obtained.
II. The control system is cutout.
III. A step input with a known magnitude is applied to manipulated variable.
IV. The controlled variable is waited to reach the new steady state value.
V. The graph of the response of the process vs time is drawn.

- A tangent is drawn to the curve at its maximum ascent point. The point where the tangent crosses the x-axis is named as dead time (τ_{dead}).
- The slope of the tangent is given as $m = M_u/\tau$
- M_u is the final steady state value of the output variable
- τ is the time constant of the system.
- K (gain): can be calculated by using the following eqaution; $K = M_u/X_0$

where, M_u is the difference between second steady state value and the first steady state value of the controlled variable, X_0 is the magnitde of the step input.

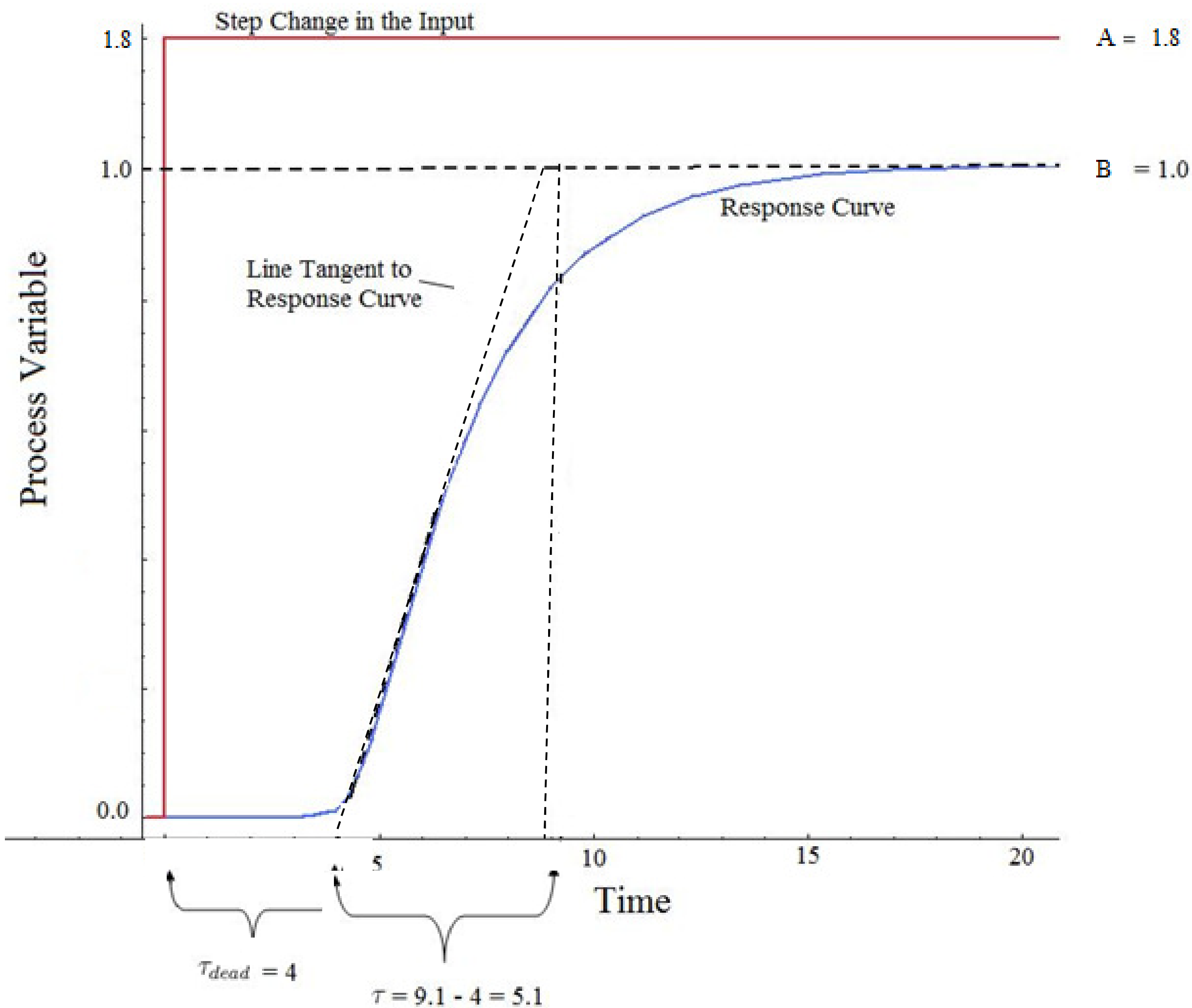
The equations used to calculate the optimum control parameters;

$$K_C = \frac{1}{K} - \frac{\tau}{\tau_{dead}} - \left[\frac{4}{3} \times \frac{\tau}{4\tau_{dead}} \right]$$

$$\tau_{Integral} = \left[\frac{32 + 6\left(\frac{\tau_{dead}}{\tau}\right)}{13 + 8\left(\frac{\tau_{dead}}{\tau}\right)} \times \tau_{dead} \right]$$

$$\tau_{Derivative} = \tau_{dead} \left[\frac{4}{11 + 2\left(\frac{\tau_{dead}}{\tau}\right)} \right]$$

Example:



The graph of process variables versus time (t) is given in the figure;

- Calculate the dead time, K (gain), and τ(time constant) values and write the transfer function of the system.
- Write down the transfer function of a PID control system applied to this process.