Fig.1 heating tank without Temperature Controller
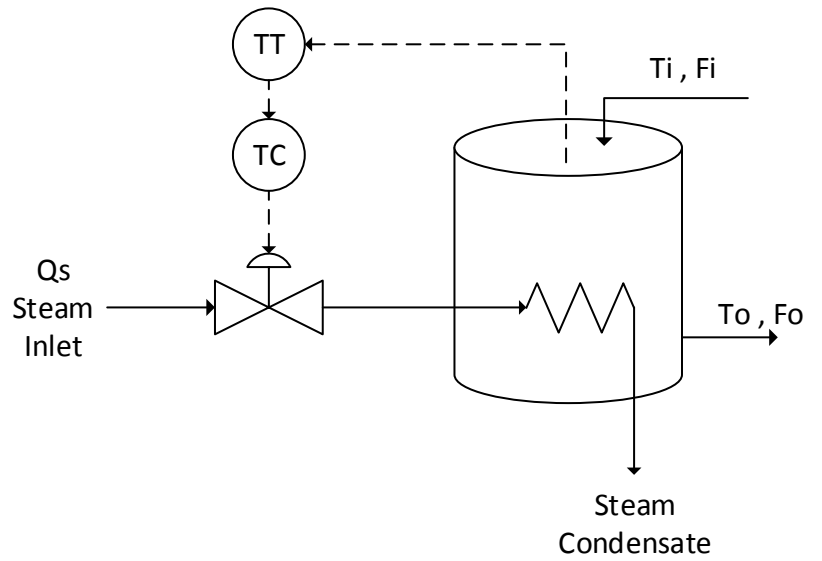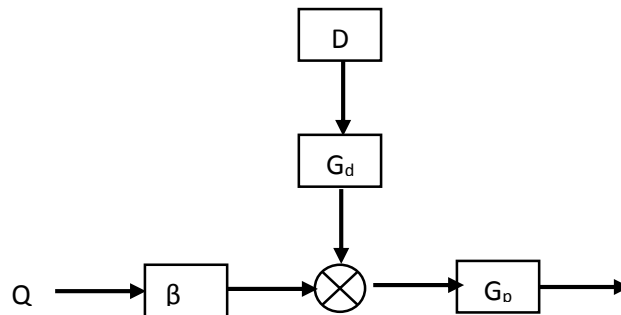

Fig.2 heating tank with Temperature Controller

w=200 l/min, T_i=60 ^{0}C, T_o=80 ^{0}C, V=1000 L, $\tau = \dfrac{\rho V}{w}$

Energy Balance Equation:

$$T'(s) = \frac{1/wC}{\tau s + 1} Q(s) + \frac{1}{\tau s + 1} T_i'(s)$$
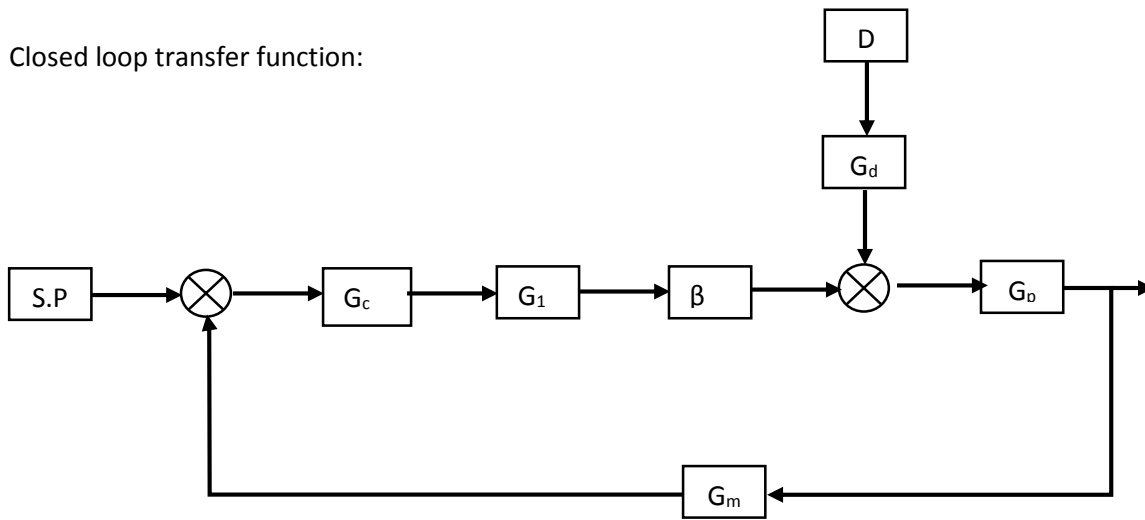
Open Loop transfer Function

G_d=1

$G_p = \dfrac{1}{\tau s + 1}$,

$\beta = \dfrac{1}{wC}$

Closed loop transfer function:

$G_m = G_1 = G_d = 1$

$$G_c = k_c / k_c(1+\frac{1}{\tau_I s})/k_c(1+\frac{1}{\tau_I s}+\tau_D s)$$

$$G_p = \frac{1}{\tau s+1}, \quad \beta = \frac{1}{wC}$$