$$9 = A\left(5\left(-\frac{4}{5}\right)+4\right) + B\left(-\frac{4}{5}\right)$$

$$9 = A(-4+4) + B\left(-\frac{4}{5}\right)$$

$$9 = -\frac{4}{5}B$$

$$B = \frac{45}{4}$$

$$\frac{9}{4}\cdot\frac{1}{s} - \frac{45}{4}\cdot\frac{1}{(5s+4)}$$

$$y(t) = \mathcal{L}^{-1}[Y(s)] = \mathcal{L}^{-1}\left[\frac{9}{4s} - \frac{45}{4(5s+4)}\right]$$

$$\mathcal{L}^{-1}\left[\frac{9}{4s}\right] - \mathcal{L}^{-1}\left[\frac{45}{4(5s+4)}\right]$$

$$\mathcal{L}^{-1}\left[\frac{9}{4s}\right] - \mathcal{L}^{-1}\left[\frac{45}{4\times 5\left(s+\frac{4}{5}\right)}\right]$$

$$\frac{9}{4}\mathcal{L}^{-1}\left[\frac{1}{s}\right] - \frac{45}{20}\mathcal{L}\left[\frac{1}{s+\frac{4}{5}}\right]$$

$$y(t) = \frac{9}{4}\cdot 1 - \frac{9}{4}e^{-\frac{4}{5}t}$$

$$y(t) = \frac{9}{4} - \frac{9}{4}e^{-\frac{4}{5}t}$$

$$y(t) = \frac{9}{4}\left(1 - e^{-\frac{4}{5}t}\right)$$

$$\frac{3/5s+1}{1+\frac{3}{5s+1}} \cdot \frac{3}{s}$$

$$= \frac{\frac{3}{5s+1}}{\frac{5s+1+3}{5s+1}} \cdot \frac{3}{s}$$

$$= 3/5s+1 \div \frac{5s+1+3}{5s+1} \cdot \frac{3}{s}$$

$$= \frac{3}{5s+1} \div \frac{5s+1}{5s+4} \cdot \frac{3}{s}$$

$$= \frac{3}{5s+4} \cdot \frac{3}{s}$$

$$y(s) = \frac{9}{s(5s+4)}$$

$$y(s) = \frac{9}{s(5s+4)} = \frac{A}{s} + \frac{B}{5s+4}$$

$$y(s) = \frac{9}{s(5s+4)} = \frac{A(5s+4) + Bs}{s(5s+4)}$$

$$y(s) = 9 = A(5s+4) + Bs$$

when $s = 0$

$$9 = A(5(0) + 4) + B(0)$$

$$A = \frac{9}{4}$$

when $s = -\frac{4}{5}$

$$A\frac{d(h-h_s)}{dt} + \frac{B}{2\sqrt{h_s}}(h-h_s) = F_1 - F_{1s}$$

$$A\frac{d\bar{h}}{dt} + \frac{B}{2\sqrt{h_s}}\bar{h} = \bar{F_1}$$

$$A[s\bar{h}(s) - \cancel{\bar{h}(0)}^{\,0}] + \frac{B}{2\sqrt{h_s}}\bar{h}_s = \bar{F_1}$$

$$As\bar{h}(s) + \frac{B}{2\sqrt{h_s}}\bar{h}_s = \bar{F_1}$$

$$\bar{h}_s\left(As + \frac{B}{2\sqrt{h_s}}\right) = \bar{F_1}$$

$$G(s) = \frac{h(s)}{F_1} = \cancel{\frac{2\sqrt{h_s}}{As + B}} \qquad \frac{1}{As + \frac{B}{2\sqrt{h_s}}}$$

$$= \frac{1}{\frac{As\,2\sqrt{h_s} + B}{2\sqrt{h_s}}} = \boxed{\frac{2\sqrt{h_s}}{As\,2\sqrt{h_s} + B}}$$ — Transfer function

2) $G_p(s) = \frac{2}{5s+1}$ $\quad G_f(s) = G_m(s) = 1$

$K_c = 1.5$

Using a P only controller

$$y(s) = \frac{G_p(s)\,G_f(s)\,G_c(s)}{1 + G_p(s)\,G_f(s)\,G_m(s)}$$

$$y(s) = \frac{G_p(s)\,G_c(s)}{1 + G_p(s)\,G_c(s)}\,y_{sp}(s)$$

$$y(s) = \frac{2/5s+1 \cdot 1.5}{1 + 2/5s+1 \cdot 1.5} \cdot \frac{3}{s}$$

NGOCHINDO JIMA FESTUS
13/ENG01/008
CHEMICAL ENGINEERING

CHE 531 ASSIGNMENT SOLUTIONS

1) $\frac{dV}{dt} = F_1 - F$ Since $F = B\sqrt{h}$

$$\frac{d(Ah)}{dt} = F_1 - B\sqrt{h}$$

$$A\frac{dh}{dt} = F_1 - B\sqrt{h} \quad \text{——} ①$$

linearizing $B\sqrt{h}$ we have

$$F(x) = f(x_s) + \left.\frac{df}{dx}\right|_{x=x_s}(x - x_s)$$

$$B\sqrt{h} = B\sqrt{h_s} + \frac{1}{2\sqrt{h_s}}B(h - h_s)$$

substituting

$$A\frac{dh}{dt} = F_1 - B\sqrt{h_s} + \frac{1}{2\sqrt{h_s}}B(h - h_s)$$

$$A\frac{dh}{dt} = F_1 - B\sqrt{h_s} + \frac{B}{2\sqrt{h_s}}B(h - h_s) \quad \text{——} *$$

At steady state eqn ① is

$$A\frac{dh_s}{dt} = F_{1s} - B\sqrt{h_s} \quad \text{——} ②$$

Subtracting * from ②

$$A\frac{dh}{dt} - A\frac{dh_s}{dt} + \left(B\sqrt{h_s} + \frac{B}{2\sqrt{h_s}}(h - h_s) - B\sqrt{h_s}\right) = (F_1 - F_{1s})$$