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13/ENG01/005

CHE 531 ASSIGNMENT III

QUESTION TWO

1. Gf(s) = Gm(s) = 1

y(s) = $\frac{Gp\left(s\right)Gf\left(s\right)Gc(s)}{1+Gp\left(s\right)Gf\left(s\right)Gc\left(s\right)Gm(s)}∙ysp(s)$

y(s) = $\frac{Gp\left(s\right)Gc(s)}{1+Gp\left(s\right)Gc\left(s\right)} ∙ ysp(s)$

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

y(s) = $\frac{\frac{3}{5s+1}}{1+ \frac{3}{5s+1}}∙\frac{3}{s}$

y(s) = $\frac{\frac{3}{5s+1}}{\frac{5s+1+ 3}{5s+1}}∙\frac{3}{s}$

y(s) = $\frac{\frac{3}{5s+1}}{\frac{5s+4}{5s+1}}∙\frac{3}{s}$

y(s) = $\left(\frac{3}{5s+1} ÷ \frac{5s+4}{5s+1}\right)∙\frac{3}{s}$

y(s) = $\left(\frac{3}{5s+1} × \frac{5s+1}{5s+4}\right)∙\frac{3}{s}$

y(s) = $\frac{3}{5s+4}∙\frac{3}{s}$

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

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

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

$$9=A\left(5s+4\right)+Bs$$

$$9=5sA+4A+Bs$$

$$9=s\left(5A+B\right)+4A$$

$$9=4A$$

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

$$5A+B=0$$

$$5\left(\frac{9}{4}\right)+B=0$$

$$\frac{45}{4}+B=0$$

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

y(s) = $\frac{\frac{9}{4}}{s}+\frac{\left(-\frac{45}{4}\right)}{5s+4}$

y(s) = $\frac{9}{4}∙\frac{1}{s}- \frac{45}{4}∙\frac{1}{5s+4}$

y(s) = $\frac{9}{4}\left[\frac{1}{s}-\frac{5}{5s+4}\right]$

y(s) = $\frac{9}{4}\left[\frac{1}{s}-\frac{\frac{5}{5}}{\frac{5s}{5}+\frac{4}{5}}\right]$

y(s) = $\frac{9}{4}\left[\frac{1}{s}-\frac{1}{s+\frac{4}{5}}\right]$

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

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

1. Given: $τ\_{i}=5min$, $τ\_{D}=0.01min $and $k\_{c}$ = 1.5

Recall,

for P: $Gc\left(s\right)=k\_{c} $;

I: $Gc\left(s\right)=\frac{k\_{c}}{τ\_{i}}$;

D: $Gc\left(s\right)= k\_{c}τ\_{D}$

Therefore,

for P, $Gc\left(s\right)=1.5$

for I, $Gc\left(s\right)= \frac{1.5}{5}=0.3$

for D, $Gc\left(s\right)=1.5\*0.01=0.015$

QUESTION ONE

F = $β\sqrt{h}$

$$\frac{dv}{dt}=f\_{i}-f$$

$$A\frac{dh}{dt}=f\_{i}-β\sqrt{h}$$

$$A\frac{dh}{dt}+β\sqrt{h}=f\_{i}$$

Using Taylor’s series

$$β\sqrt{h}≅ β\sqrt{h\_{s}}+\frac{d}{dh}\left(β\sqrt{h}\right)|\_{h=h\_{s}}^{(h-h\_{s})}$$

$$β\sqrt{h}≅ β\sqrt{h\_{s}}+\frac{β}{\sqrt{h\_{s}}}\left(h-h\_{s}\right)$$

$$A\frac{dh}{dt}+β\sqrt{h\_{s}}-\frac{1}{2}\sqrt{h\_{s}}∙β(h-h\_{s})=f\_{i}$$

$$A\frac{dh\_{s}}{dt}+β\sqrt{h\_{s}}=f\_{i\_{s}}$$

$$A\frac{d(h-h\_{s})}{dt}+\frac{β(h-h\_{s})}{2\sqrt{h\_{s}}}=f\_{i}-f\_{i\_{s}}$$

$$A\frac{\overbar{dh}}{dt}+\frac{β\overbar{h}}{2\sqrt{h\_{s}}}=\overbar{f}\_{i}$$

Multiply through by $2\sqrt{h\_{s}}$

$$A2\sqrt{h\_{s}}\frac{\overbar{dh}}{dt}+β\overbar{h}=\overbar{f}\_{i}2\sqrt{h\_{s}}$$

$$A2\sqrt{h\_{s}}\left[s\overbar{h}\left(s\right)-\overbar{h}(0)\right]+β\overbar{h}\left(s\right)=2\sqrt{h\_{s}}\overbar{f\_{i}}(s)$$

$$A2\sqrt{h\_{s}}\overbar{h}\left(s\right)+ β\overbar{h}\left(s\right)=2\sqrt{h\_{s}}\overbar{f\_{i}}(s)$$

$$\overbar{h}\left(s\right)\*\left(As2\sqrt{h\_{s}}+β\right)=2\sqrt{h\_{s}}\overbar{f\_{i}}(s)$$

$$\frac{\overbar{h}(s)}{\overbar{f\_{i\_{s}}}}=\frac{2\sqrt{h\_{s}}}{As2\sqrt{h\_{s}}+β}$$

$$\frac{\overbar{h}(s)}{\overbar{f\_{i\_{s}}}}=\frac{2\sqrt{h\_{s}}}{A2\sqrt{h\_{s}.s}+β}$$

$$\frac{\overbar{h}(s)}{\overbar{f\_{i\_{s}}}}=\frac{2\sqrt{h\_{s}}}{2A\sqrt{h\_{s}}+β}$$

$$\frac{\overbar{h}(s)}{\overbar{f\_{i\_{s}}}}=\frac{2\sqrt{4}}{2(2.5)\left(\sqrt{4}\right)s+2}$$

$$\frac{\overbar{h}(s)}{\overbar{f\_{i\_{s}}}}=\frac{2×2}{(5×2)s+2}$$

$$\frac{\overbar{h}(s)}{\overbar{f\_{i\_{s}}}}=\frac{4}{10s+2}=\frac{2}{5s+1}$$

$$\overbar{h}\left(s\right)=\frac{2}{5s+1}∙\overbar{f\_{i\_{s}}}$$

$$\overbar{h}\left(s\right)=\frac{2}{5s+1}∙\frac{1}{s}$$

$$\overbar{h}\left(s\right)=\frac{2}{s\left(5s+1\right)}$$

$$\overbar{h}\left(s\right)=\frac{2}{s\left(5s+1\right)}=\frac{A}{s}+\frac{B}{5s+1}$$

$$\frac{2}{s\left(5s+1\right)}=\frac{A\left(5s+1\right)+Bs}{s\left(5s+1\right)}$$

$$2=A\left(5s+1\right)+Bs$$

$$2=5As+A+Bs$$

$$2=s\left(5A+B\right)+A$$

$$A=2$$

$$5A+B=0$$

$$5\left(2\right)=-B$$

$$B=-10$$

$$\overbar{h}\left(s\right)=\frac{2}{s}-\frac{10}{5s+1}$$

$\overbar{h}\left(s\right)=$L-1$\left[\frac{2}{s}-\frac{10}{5s+1}\right]$

$\overbar{h}\left(s\right)=$ L-1$\left[\frac{2}{s}\right]-$ L-1$\left[\frac{10}{5s+1}\right]$

$\overbar{h}\left(s\right)=2-$ L-1$\left[\frac{\frac{10}{5}}{\frac{5s}{5}+\frac{1}{5}}\right]$

$\overbar{h}\left(s\right)=2-$ L-1$\frac{2}{s+\frac{1}{5}}$

$$\overbar{h}\left(s\right)= 2-2e^{-\frac{t}{5}}$$