Wolfram Cloud Einführung

Fahrzeug

Wir schreiben die Fahrzeug Differentialgleichung (DGL)

In[106]:=
```
Proc = v'[t] == -b / m v[t] + Fu / m
```

Out[106]=
$$v'[t] == \frac{Fu}{m} - \frac{b\, v[t]}{m}$$

Werte Standardparameter festlegen

In[107]:=
```
dfltParams = {b → 50, m → 1000, v0 → 5}
```

Out[107]=
```
{b → 50, m → 1000, v0 → 5}
```

DLG lösen

In[108]:=
```
ProcSol = DSolve[{Proc, v[0] == v0}, v[t], t]
```

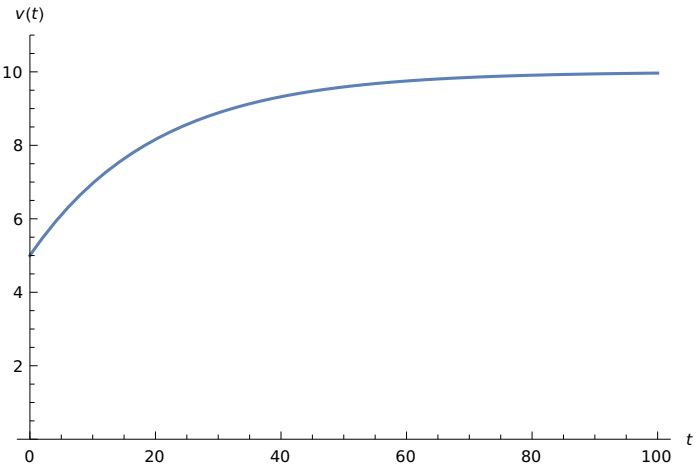
Out[108]=
$$\left\{\left\{v[t] \to \frac{e^{-\frac{b\,t}{m}}\left(-Fu + e^{\frac{b\,t}{m}}\, Fu + b\, v0\right)}{b}\right\}\right\}$$

In[109]:=
```
ProcSolVal = ProcSol /. Append[dfltParams, Fu → 500]
```

Out[109]=
$$\left\{\left\{v[t] \to \frac{1}{50}\, e^{-t/20}\left(-250 + 500\, e^{t/20}\right)\right\}\right\}$$

In[110]:=
```
Plot[v[t] /. ProcSolVal, {t, 0, 100}, PlotRange → {0, 11}, AxesLabel → {t, v[t]}]
```

Out[110]=



P-Regler

Wechsel in 'regelungstechnische' Variablennamen:

In[111]:=
```
Procy = Proc /. {v → y, Fu → u[t]}
```

Out[111]=
$$y'[t] == \frac{u[t]}{m} - \frac{b\, y[t]}{m}$$

Definition des Stellgesetzes:

In[112]:=
```
Pctrl = u[t] → K * (w[t] - y[t])
```

Out[112]=
$$u[t] \to K\,(w[t] - y[t])$$

Definition der Führungsgröße

In[119]:=
```
RefVal = 5 + 3 * HeavisideTheta [t]
```

Out[119]=
$$5 + 3\ \text{HeavisideTheta}\,[t]$$

Einsetzen und lösen:

In[120]:=
```
CtrlLoop = Procy /. Pctrl /. w[t] → RefVal
CtrlLoopSol = DSolve[{CtrlLoop , y[0] == 5}, y[t], t]
```

Out[120]=
$$y'[t] == \frac{K\,(5 + 3\ \text{HeavisideTheta}\,[t] - y[t])}{m} - \frac{b\, y[t]}{m}$$

Out[121]=
$$\left\{\left\{y[t] \to \frac{5\, e^{-\frac{b\,t}{m} - \frac{K\,t}{m}} \left(b + e^{\frac{(b+K)\,t}{m}} K\right)}{b + K} + \left(-\frac{5\, e^{-\frac{b\,t}{m} - \frac{K\,t}{m}} \left(b + e^{\frac{(b+K)\,t}{m}} K\right)}{b + K} + \frac{e^{-\frac{b\,t}{m} - \frac{K\,t}{m}} \left(5\, b - 3\, K + 8\, e^{\frac{(b+K)\,t}{m}} K\right)}{b + K}\right) \text{HeavisideTheta}\,[t]\right\}\right\}$$

Standardparameter einsetzen:

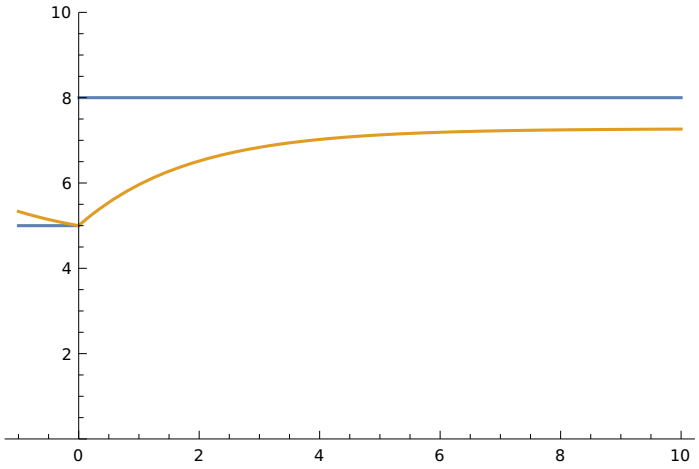
In[130]:=
```
CtrlLoopSolVal = CtrlLoopSol /. dfltParams
FullSimplify [%]
```

Out[130]=
$$\left\{\left\{y[t] \to \frac{5\, e^{-\frac{t}{20} - \frac{K\,t}{1000}} \left(50 + e^{\frac{(50+K)\,t}{1000}} K\right)}{50 + K} + \left(-\frac{5\, e^{-\frac{t}{20} - \frac{K\,t}{1000}} \left(50 + e^{\frac{(50+K)\,t}{1000}} K\right)}{50 + K} + \frac{e^{-\frac{t}{20} - \frac{K\,t}{1000}} \left(250 - 3\, K + 8\, e^{\frac{(50+K)\,t}{1000}} K\right)}{50 + K}\right) \text{HeavisideTheta}\,[t]\right\}\right\}$$

Out[131]=
$$\left\{\left\{y[t] \to \frac{K\,(5 + 3\ \text{HeavisideTheta}\,[t]) + e^{-\frac{(50+K)\,t}{1000}} (250 - 3\, K\ \text{HeavisideTheta}\,[t])}{50 + K}\right\}\right\}$$

In[138]:=
```
Plot[{RefVal , y[t] /. CtrlLoopSolVal /. K → 500}, {t, -1, 10}, PlotRange → {0, 10}]
```

Out[138]=



Bitte berechnet die Stellgröße.

PI-Regler

In[284]:=
```
DGLs = {Procy ,  x1 '[t] == (w[t] - y[t])} /. u[t] → Kp * (w[t] - y[t]) + Ki * x1[t]
```

Out[284]=
$$\left\{y'[t] == \frac{Ki\ x1[t] + Kp\ (w[t] - y[t])}{m} - \frac{b\ y[t]}{m},\ x1'[t] == w[t] - y[t]\right\}$$

In[285]:=
```
DGLsMostVal = DGLs /. dfltParams
DGLsMostVal /. w[t] → 8
Sys = Join[%, {y[0] == 5,  x1[0] == 0}]
```

Out[285]=
$$\left\{y'[t] == \frac{Ki\ x1[t] + Kp\ (w[t] - y[t])}{1000} - \frac{y[t]}{20},\ x1'[t] == w[t] - y[t]\right\}$$

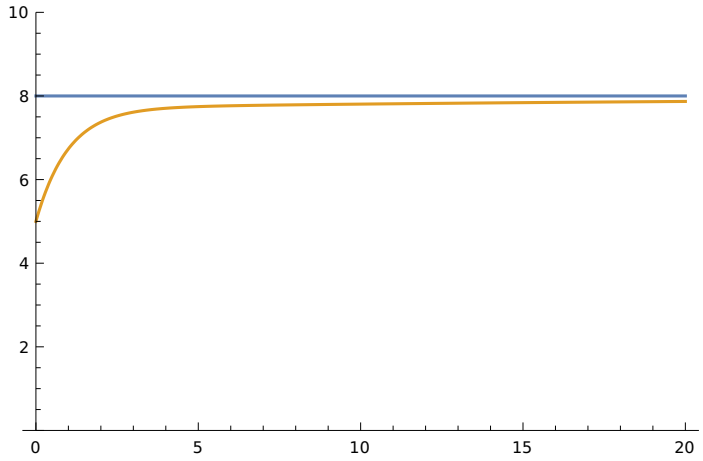
Out[286]=
$$\left\{y'[t] == \frac{Ki\ x1[t] + Kp\ (8 - y[t])}{1000} - \frac{y[t]}{20},\ x1'[t] == 8 - y[t]\right\}$$

Out[287]=
$$\left\{y'[t] == \frac{Ki\ x1[t] + Kp\ (8 - y[t])}{1000} - \frac{y[t]}{20},\ x1'[t] == 8 - y[t],\ y[0] == 5,\ x1[0] == 0\right\}$$

In[312]:=
```
Sol = DSolve[Sys, {y[t], x1[t]}, t];
FullSimplify[y[t] /. Sol /. {Ki → 40, Kp → 1000}]
Plot[{RefVal, %}, {t, 0, 20}, PlotRange → {0, 10}]
```

Out[313]=
$$\left\{8+\frac{1}{377}e^{-21\,t/40}\left(-1131\,\text{Cosh}\left[\frac{\sqrt{377}\,t}{40}\right]+47\,\sqrt{377}\,\text{Sinh}\left[\frac{\sqrt{377}\,t}{40}\right]\right)\right\}$$

Out[314]=



In[283]:=
```
Ki =.
```