Part 3.1.

In[1195]:=

$$\text{Clear}[\sigma, \text{E1}, \text{E2}, \mu 1, \mu 2, \mu 3, \epsilon]$$

bereinige

$$\text{DSolve}\left[\sigma'[t] + \frac{\text{E1} + \text{E2}}{\mu 1 + \mu 2 + \mu 3}\,\sigma[t] == \frac{\text{E1 E2}}{\mu 1 + \mu 2 + \mu 3}\,\epsilon, \sigma[t], t\right]$$

löse Differentialgleichung

Out[1196]=

$$\left\{\left\{\sigma[t] \to \frac{e^{-\frac{\text{E1}\,t}{\mu 1+\mu 2+\mu 3}-\frac{\text{E2}\,t}{\mu 1+\mu 2+\mu 3}+\frac{(\text{E1}+\text{E2})\,t}{\mu 1+\mu 2+\mu 3}}\,\text{E1 E2}\,\epsilon}{\text{E1} + \text{E2}} + e^{-\frac{\text{E1}\,t}{\mu 1+\mu 2+\mu 3}-\frac{\text{E2}\,t}{\mu 1+\mu 2+\mu 3}}\,\mathbb{C}_1\right\}\right\}$$

Part 3.2.

In[1197]:=

$$\text{Clear}[a, b, c, \text{E1}, \text{E2}, \text{m1}, \text{m2}, \text{m3}, \sigma, x]$$

bereinige

$$a = \frac{\text{E1 m3} + \text{E2 (m1 + m2)}}{2\,\text{m3 (m1 + m2)}};\ b = \frac{\text{E1 E2}}{\text{m3 (m1 + m2)}};\ c = \frac{\text{E1} + \text{E2}}{\text{(m1 + m2) m3}}\,\sigma;$$

$$\text{DSolve}[\{x''[t] + 2\,a\,x'[t] + b\,x[t] == c\}, x[t], t]$$

löse Differentialgleichung

Out[1199]=

$$\left\{\left\{x[t] \to \frac{\text{E1}\,\sigma + \text{E2}\,\sigma}{\text{E1 E2}} + e^{-\frac{\text{E2}\,t}{\text{m3}}}\,\mathbb{C}_1 + e^{-\frac{\text{E1}\,t}{\text{m1}+\text{m2}}}\,\mathbb{C}_2\right\}\right\}$$

In[1200]:=

$$x[t\_] = \frac{\text{E1}\,\sigma + \text{E2}\,\sigma}{\text{E1 E2}} - e^{-\frac{\text{E2}\,t}{\text{m3}}}\left(k + \frac{\text{E1} + \text{E2}}{\text{E1 E2}}\,\sigma\right) + e^{-\frac{\text{E1}\,t}{\text{m1}+\text{m2}}}\,k$$

Out[1200]=

$$e^{-\frac{\text{E1}\,t}{\text{m1}+\text{m2}}}\,k + \frac{\text{E1}\,\sigma + \text{E2}\,\sigma}{\text{E1 E2}} - e^{-\frac{\text{E2}\,t}{\text{m3}}}\left(k + \frac{(\text{E1} + \text{E2})\,\sigma}{\text{E1 E2}}\right)$$

In[1201]:=

$$\text{Simplify}[x[0]]$$

vereinfache

Out[1201]=

$$0$$

In[1202]:=

$$\text{Solve}[x'[0] == 0, k]$$

löse

Out[1202]=

$$\left\{\left\{k \to \frac{(\text{E1} + \text{E2})\,(\text{m1} + \text{m2})\,\sigma}{\text{E1}\,(-\text{E2 m1} - \text{E2 m2} + \text{E1 m3})}\right\}\right\}$$

Part 3.3.

In[1203]:=

```
Clear[ϵ0, ω, ϕ0]
bereinige

ϵ[t_] = ϵ0 Exp[I (ω t + ϕ0)];
              Ex⋯ imaginäre Einheit I

lhs = Simplify[(m1 + m2) m3 ϵ''[t] + (E1 m3 + E2 (m1 + m2)) ϵ'[t] + E1 E2 ϵ[t]]
      vereinfache
```

Out[1205]=

$$e^{i (\phi 0 + t\,\omega)}\, \epsilon 0\, (E1 + i\, (m1 + m2)\, \omega)\, (E2 + i\, m3\, \omega)$$

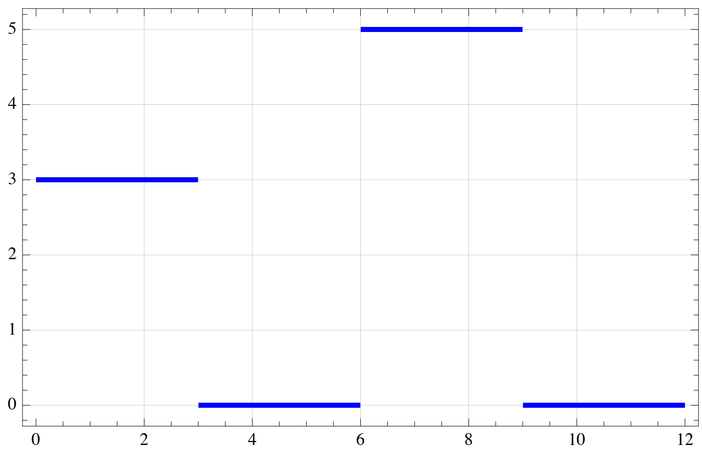
Plots

4.1. Piecewise Stress

In[1206]:=

```
E1 = 2.5; E2 = 3;
m1 = 1; m2 = 1; m3 = 1;
Clear[σ, ϵ, sol, t]
⌊bereinige
σ[t_] = Piecewise[
         ⌊stückweise
    {{3, t < 3},
     {0, 3 ≤ t < 6},
     {5, 6 ≤ t < 9},
     {0, t ≥ 9}}
  ];
Plot[σ[t], {t, 0, 12}, PlotTheme → "Scientific",
⌊stelle Funktion graphisch dar  ⌊Thema der graphischen Darstellung
 PlotStyle → Directive[Blue, Thickness[0.0075]], GridLines → Automatic]
 ⌊Darstellungsstil ⌊Anweisung ⌊blau ⌊Dicke          ⌊Gitternetzlinien ⌊automatisch
sol = NDSolve[{(m1 + m2) m3 ϵ''[t] + (E1 m3 + E2 (m1 + m2)) ϵ'[t] + E1 E2 ϵ[t] ==
      ⌊löse Differentialgleichung numerisch
     (E1 + E2) σ[t] + (m1 + m2 + m3) σ'[t], ϵ[0] == 0, ϵ'[0] == 0}, ϵ[t], {t, 0, 12}]
```

Out[1210]=



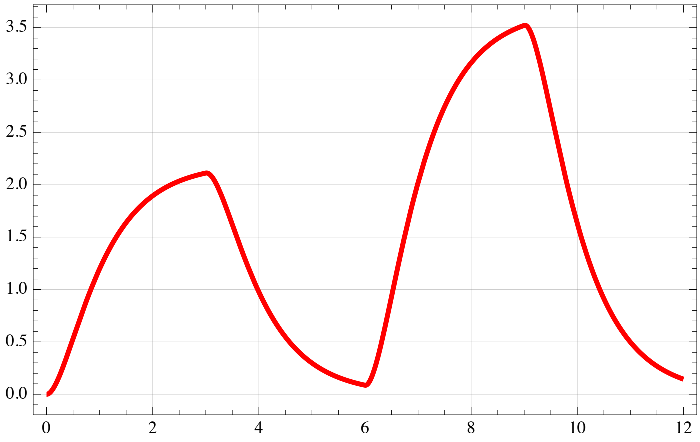
Out[1211]=

```
{{ϵ[t] → InterpolatingFunction[ Domain: {{0., 12.}} Output: scalar ][t]}}
```

In[1212]:=

```
Plot[Evaluate[ϵ[t] /. sol], {t, 0, 12}, PlotRange → All, PlotTheme → "Scientific",
stell··· werte aus                       Koordinatenbe·· alle   Thema der graphischen Darstellung
 PlotStyle → Directive[Red, Thickness[0.0075]], GridLines → Automatic]
 Darstellungsstil Anweisung rot Dicke                  Gitternetzlinien automatisch
```

Out[1212]=

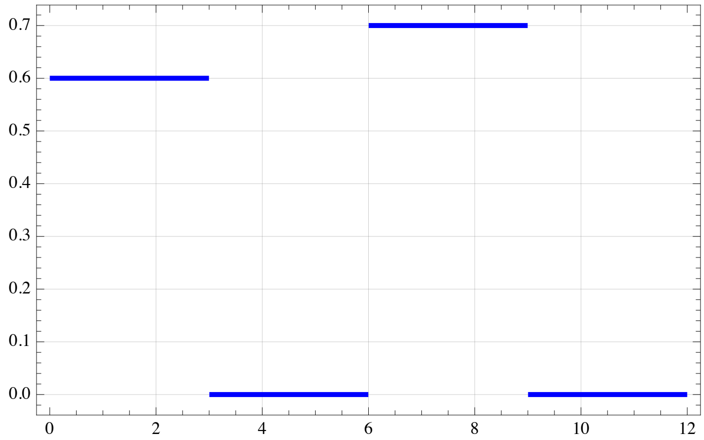


4.2. Piecewise Stretch

In[1213]:=

```
E1 = 2.5; E2 = 3;
m1 = 1; m2 = 1; m3 = 1;
Clear[σ, ϵ, sol, t]
⌊bereinige
ϵ[t_] = Piecewise[
          ⌊stückweise
    {{0.6, t < 3},
     {0, 3 ≤ t < 6},
     {0.7, 6 ≤ t < 9},
     {0, t ≥ 9}}
  ];
Plot[ϵ[t], {t, 0, 12}, PlotTheme → "Scientific",
⌊stelle Funktion graphisch dar   ⌊Thema der graphischen Darstellung
 PlotStyle → Directive[Blue, Thickness[0.0075]], GridLines → Automatic]
 ⌊Darstellungsstil ⌊Anweisung  ⌊blau  ⌊Dicke          ⌊Gitternetzlinien ⌊automatisch
sol = NDSolve[{(m1 + m2) m3 ϵ''[t] + (E1 m3 + E2 (m1 + m2)) ϵ'[t] + E1 E2 ϵ[t] ==
      ⌊löse Differentialgleichung numerisch
    (E1 + E2) σ[t] + (m1 + m2 + m3) σ'[t], σ[0] == 2}, σ[t], {t, 0, 12}]
```

Out[1217]=



Out[1218]=

```
{{σ[t] → InterpolatingFunction[ Domain: {{0., 12. }} Output: scalar ][t]}}
```

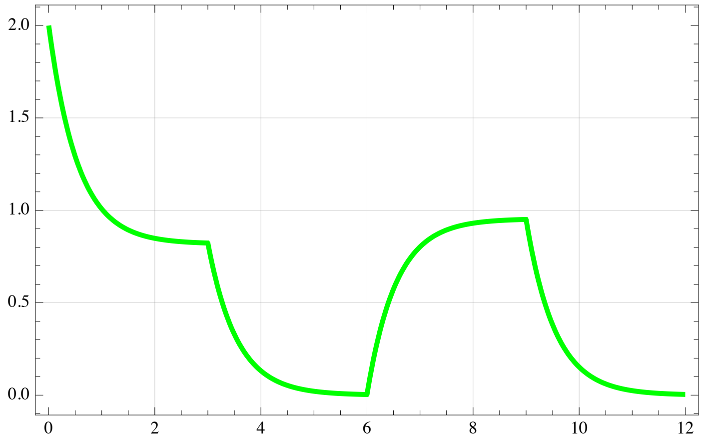
In[1219]:=

```
Plot[Evaluate[σ[t] /. sol], {t, 0, 12}, PlotRange → All, PlotTheme → "Scientific",
 PlotStyle → Directive[Green, Thickness[0.0075]], GridLines → Automatic]
```

stell··· werte aus Koordinatenbe·· alle Thema der graphischen Darstellung

Darstellungsstil Anweisung grün Dicke Gitternetzlinien automatisch

Out[1219]=



4.3. Harmonic Oscillations

In[1220]:=

```
E1 = 2.5; E2 = 3;
m1 = 1; m2 = 1; m3 = 1;
ω = 1; σ0 = 2;
Clear[σ, ϵ, sol, t]
⌊bereinige
σ[t_] = σ0 Exp[I ω t];
           ⌊Ex··· ⌊imaginäre Einheit I
```

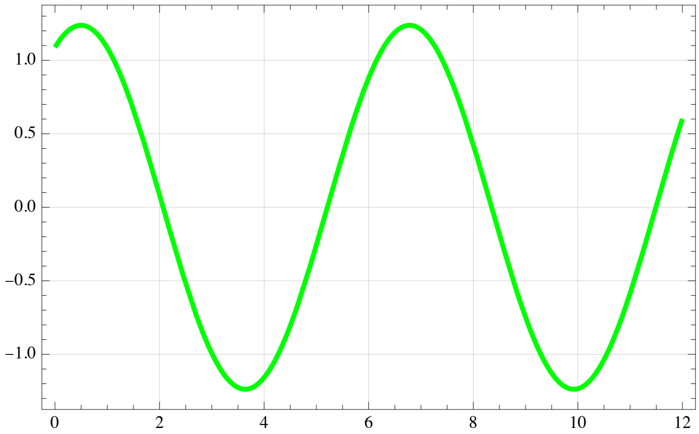
$$\epsilon 0 = \frac{\text{Sqrt}\left[(E1 + E2)^2 + \omega^2\,(m1 + m2 + m3)^2\right]\,\sigma 0}{\text{Sqrt}\left[\left(E1\,E2 - \omega^2\,m3\,(m1 + m2)\right)^2 + (E1\,m3 + E2\,(m1 + m2))^2\,\omega^2\right]};$$

$$\phi 0 = \text{Arg}\left[\left(\frac{\left(E1\,E2 - \omega^2\,(m1 + m2)\,m3\right) + (E1\,m3 + E2\,(m1 + m2))\,I\,\omega}{(E1 + E2) + (m1 + m2 + m3)\,I\,\omega}\right)^{-1}\sigma 0\right];$$

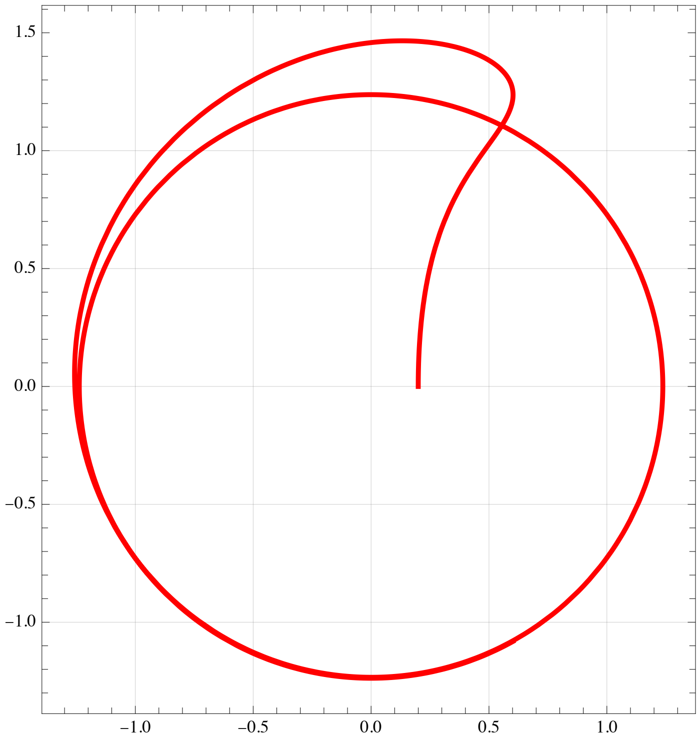
⌊komplexe Phase

```
solwrong = NDSolve[{(m1 + m2) m3 ϵ''[t] + (E1 m3 + E2 (m1 + m2)) ϵ'[t] + E1 E2 ϵ[t] ==
           ⌊löse Differentialgleichung numerisch
    (E1 + E2) σ[t] + (m1 + m2 + m3) σ'[t], ϵ[0] == 0.2, ϵ'[0] == 4 I}, ϵ[t], {t, 0, 12}];
                                                                 ⌊imaginäre Einheit I
solcorrect = NDSolve[{(m1 + m2) m3 ϵ''[t] + (E1 m3 + E2 (m1 + m2)) ϵ'[t] + E1 E2 ϵ[t] ==
             ⌊löse Differentialgleichung numerisch
    (E1 + E2) σ[t] + (m1 + m2 + m3) σ'[t],
   ϵ[0] == ϵ0 Exp[I ϕ0], ϵ'[0] == ϵ0 ω I Exp[I ϕ0]}, ϵ[t], {t, 0, 12}];
              ⌊Ex··· ⌊imaginäre Einheit I    ⌊· ⌊Ex··· ⌊imaginäre Einheit I
xs[t_] = Re[Evaluate[ϵ[t] /. solcorrect]];
         ⌊··· ⌊werte aus
ys[t_] = Im[Evaluate[ϵ[t] /. solcorrect]];
         ⌊I··· ⌊werte aus
xsyswrong[t_] = Evaluate[{Re[ϵ[t]], Im[ϵ[t]]} /. solwrong];
                ⌊werte aus  ⌊Realteil  ⌊Imaginärteil
xsyscorrect[t_] = Evaluate[{Re[ϵ[t]], Im[ϵ[t]]} /. solcorrect];
                  ⌊werte aus  ⌊Realteil  ⌊Imaginärteil
Plot[xs[t], {t, 0, 12}, PlotRange → All, PlotTheme → "Scientific",
⌊stelle Funktion graphisch dar  ⌊Koordinatenbe··· ⌊alle  ⌊Thema der graphischen Darstellung
 PlotStyle → Directive[Green, Thickness[0.0075]], GridLines → Automatic]
 ⌊Darstellungsstil ⌊Anweisung ⌊grün ⌊Dicke      ⌊Gitternetzlinien ⌊automatisch
ParametricPlot[xsyswrong[t], {t, 0, 12}, PlotRange → All, PlotTheme → "Scientific",
⌊parametrische Darstellung          ⌊Koordinatenbe·· ⌊alle  ⌊Thema der graphischen Darstellung
 PlotStyle → Directive[Red, Thickness[0.0075]], GridLines → Automatic]
 ⌊Darstellungsstil ⌊Anweisung ⌊rot ⌊Dicke      ⌊Gitternetzlinien ⌊automatisch
ParametricPlot[xsyscorrect[t], {t, 0, 12},
⌊parametrische Darstellung
 PlotRange → All, PlotTheme → "Scientific",
 ⌊Koordinatenbe·· ⌊alle ⌊Thema der graphischen Darstellung
 PlotStyle → Directive[Blue, Thickness[0.0075]], GridLines → Automatic]
 ⌊Darstellungsstil ⌊Anweisung ⌊blau ⌊Dicke      ⌊Gitternetzlinien ⌊automatisch
```

Out[1233]=



Out[1234]=



Out[1235]=