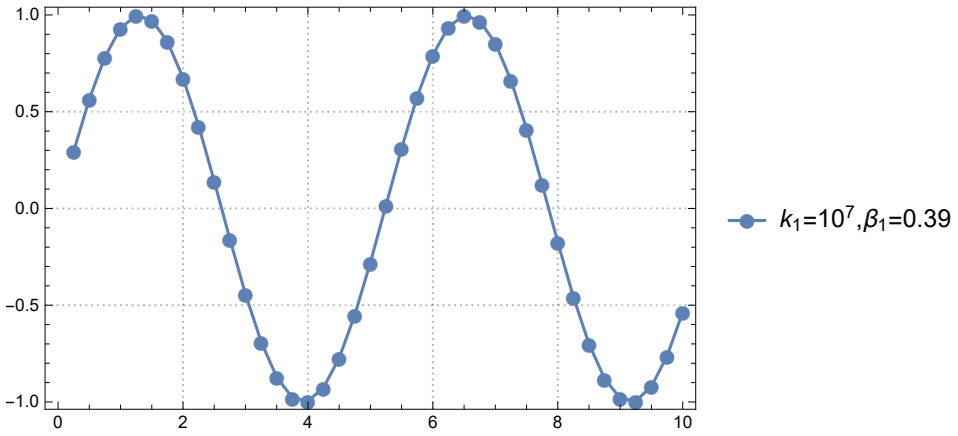
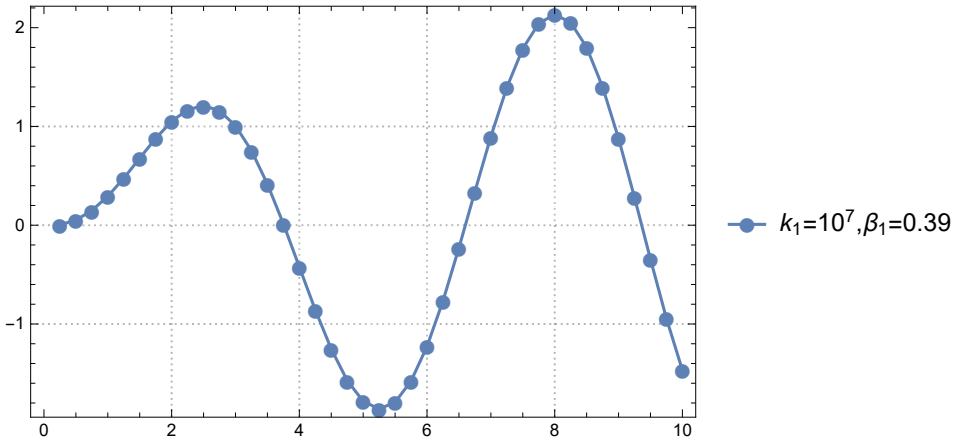
```
<< Notation`;

Symbolize[ u_1^t ]; Symbolize[ u_2^t ]; Symbolize[ u_3^t ]; Symbolize[ u̇_1^t ];

Symbolize[ u̇_2^t ]; Symbolize[ u̇_3^t ]; Symbolize[ ü_1^t ]; Symbolize[ ü_2^t ];

Symbolize[ ü_3^t ]; Symbolize[ u_1^{t+Δt} ]; Symbolize[ u_2^{t+Δt} ]; Symbolize[ u_3^{t+Δt} ];

Symbolize[ u̇_1^{t+Δt} ]; Symbolize[ u̇_2^{t+Δt} ]; Symbolize[ u̇_3^{t+Δt} ]; Symbolize[ ü_1^{t+Δt} ];

Symbolize[ ü_2^{t+Δt} ]; Symbolize[ ü_3^{t+Δt} ]; Symbolize[ u_1^{t+γΔt} ];

Symbolize[ u_2^{t+γΔt} ]; Symbolize[ u_3^{t+γΔt} ] ; Symbolize[ u̇_1^{t+γΔt} ];

Symbolize[ u̇_2^{t+γΔt} ]; Symbolize[ u̇_3^{t+γΔt} ]; Symbolize[ ü_1^{t+γΔt} ];

Symbolize[ ü_2^{t+γΔt} ]; Symbolize[ ü_3^{t+γΔt} ]; Symbolize[ β_1 ]; Symbolize[ β_2 ];
```

```
For[
  ClearAll["Global`*"];
γ = 1/2; Δt = 0.25; β2 = 2 β1;
m2 = 1;
  m3 = 1;
  k2 = 1;
  ω = 1.2;
  u1^(t+Δt) = Sin[ω p];
  u1^(t+γΔt) = Sin[ω (p - Δt/2)];
eq112 = m2 u2''^(t+γΔt) + (k1 + k2) u2^(t+γΔt) + (-k2) u3^(t+γΔt) == k1 u1^(t+γΔt);
  eq113 = m3 u3''^(t+γΔt) + (-k2) u2^(t+γΔt) + k2 u3^(t+γΔt) == 0;
  eq122 = u2^(t+γΔt) == u2^t + γ Δt/2 (u2'^t + u2'^(t+γΔt));
  eq123 = u3^(t+γΔt) == u3^t + γ Δt/2 (u3'^t + u3'^(t+γΔt));
  eq132 = u2'^(t+γΔt) == u2'^t + γ Δt/2 (u2''^t + u2''^(t+γΔt));
  eq133 = u3'^(t+γΔt) == u3'^t + γ Δt/2 (u3''^t + u3''^(t+γΔt));
  eq212 = m2 u2''^(t+Δt) + (k1 + k2) u2^(t+Δt) + (-k2) u3^(t+Δt) == k1 u1^(t+Δt);
  eq213 = m3 u3''^(t+Δt) + (-k2) u2^(t+Δt) + k2 u3^(t+Δt) == 0;
  eq222 = u2^(t+Δt) == u2^t + γ Δt ((1 - β1) u2'^t + β1 u2'^(t+γΔt)) + (1 - γ) Δt ((1 - β2) u2'^(t+γΔt) + β2 u2'^(t+Δt));
  eq223 = u3^(t+Δt) == u3^t + γ Δt ((1 - β1) u3'^t + β1 u3'^(t+γΔt)) + (1 - γ) Δt ((1 - β2) u3'^(t+γΔt) + β2 u3'^(t+Δt));
  eq232 = u2'^(t+Δt) == u2'^t + γ Δt ((1 - β1) u2''^t + β1 u2''^(t+γΔt)) + (1 - γ) Δt ((1 - β2) u2''^(t+γΔt) + β2 u2''^(t+Δt));
  eq233 = u3'^(t+Δt) == u3'^t + γ Δt ((1 - β1) u3''^t + β1 u3''^(t+γΔt)) + (1 - γ) Δt ((1 - β2) u3''^(t+γΔt) + β2 u3''^(t+Δt));
s1and2 = Solve[eq112 && eq113 && eq122 && eq123 && eq132 &&
     eq133 && eq212 && eq213 && eq222 && eq223 && eq232 && eq233,
    {u2''^(t+γΔt), u3''^(t+γΔt), u2'^(t+γΔt), u3'^(t+γΔt), u2^(t+γΔt), u3^(t+γΔt), u2''^(t+Δt), u3''^(t+Δt), u2'^(t+Δt), u3'^(t+Δt), u2^(t+Δt), u3^(t+Δt)}];
u2''^(t+Δt) = u2''^(t+Δt) /. s1and2[[1, 7]];
  u3''^(t+Δt) = u3''^(t+Δt) /. s1and2[[1, 8]];
  u2'^(t+Δt) = u2'^(t+Δt) /. s1and2[[1, 9]];
  u3'^(t+Δt) = u3'^(t+Δt) /. s1and2[[1, 10]];
  u2^(t+Δt) = u2^(t+Δt) /. s1and2[[1, 11]]; u3^(t+Δt) = u3^(t+Δt) /. s1and2[[1, 12]];
  k1 = 10^7; β1 = 0.39;
  p = 0.25; u2''^t = 0; u3''^t = 0; u2'^t = 0; u3'^t = 0; u2^t = 0; u3^t = 0,
  p ≤ 30,
  p = p + 0.25,
  uk107b0392_p = u2^(t+Δt);
  uk107b0393_p = u3^(t+Δt);
  uk107b039d2_p = u2'^(t+Δt);
  uk107b039d3_p = u3'^(t+Δt);
  uk107b039dd2_p = u2''^(t+Δt);
  uk107b039dd3_p = u3''^(t+Δt);
  u2''^t = u2''^(t+Δt); u3''^t = u3''^(t+Δt); u2'^t = u2'^(t+Δt); u3'^t = u3'^(t+Δt); u2^t = u2^(t+Δt); u3^t = u3^(t+Δt)
 ];
```

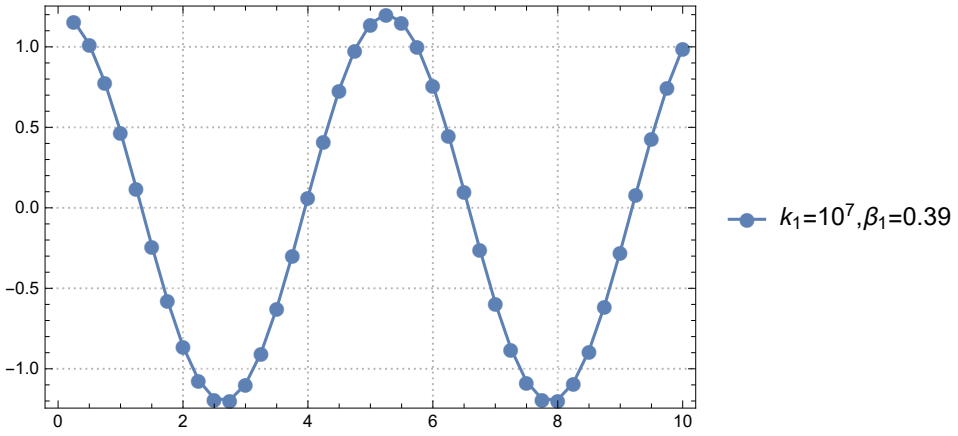
```
DiscretePlot[{uk107b0392p}, {p, 0, 10, Δt},
 PlotLegends -> {"k1=10^7,β1=0.39"}, PlotTheme -> "Detailed",
 Joined → True, PlotMarkers -> {Automatic, 12}, FillingStyle → White]
```



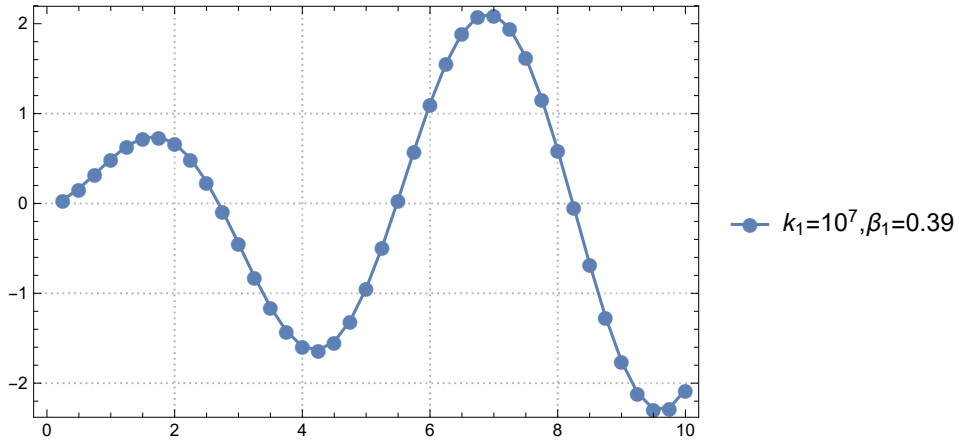

```
DiscretePlot[{uk107b0393p}, {p, 0, 10, Δt},
 PlotLegends -> {"k1=10^7,β1=0.39"}, PlotTheme -> "Detailed",
 Joined → True, PlotMarkers -> {Automatic, 12}, FillingStyle → White]
```



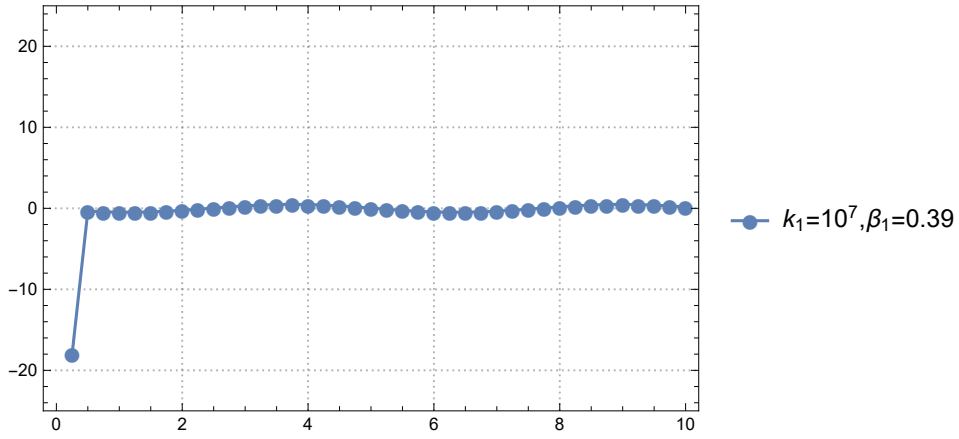

```
DiscretePlot[{uk107b039d2p}, {p, 0, 10, Δt},
 PlotLegends -> {"k1=10^7,β1=0.39"}, PlotTheme -> "Detailed",
 Joined → True, PlotMarkers -> {Automatic, 12}, FillingStyle → White]
```



```
DiscretePlot[{uk107b039d3p}, {p, 0, 10, Δt},
 PlotLegends -> {"k1=10^7,β1=0.39"}, PlotTheme -> "Detailed",
 Joined → True, PlotMarkers -> {Automatic, 12}, FillingStyle → White]
```




```
DiscretePlot[{uk107b039dd2p}, {p, 0, 10, Δt},
 PlotLegends -> {"k1=10^7,β1=0.39"}, PlotTheme -> "Detailed", Joined → True,
 PlotMarkers -> {Automatic, 12}, FillingStyle → White, PlotRange → 25]
```




```
DiscretePlot[{uk107b039dd3p}, {p, 0, 10, Δt},
 PlotLegends -> {"k1=10^7,β1=0.39"}, PlotTheme -> "Detailed",
 Joined → True, PlotMarkers -> {Automatic, 12}, FillingStyle → White]
```