In[1]:=
```
NotebookDirectory[]
```

Out[1]=
```
C:\Dropbox\Work\myweb\Courses\Math_pages\Math_430\
```

In[2]:=
```
Clear[NMVC, NMVS, x, t, n, ρ, T0, lL];
NMVC[x_, t_, n_, T0_, ρ_, lL_] :=
  Sin[(n Pi)/lL x] Cos[(n Pi Sqrt[T0])/(Sqrt[ρ] lL) t];

NMVS[x_, t_, n_, T0_, ρ_, lL_] := Sin[(n Pi)/lL x] Sin[(n Pi Sqrt[T0])/(Sqrt[ρ] lL) t]
```

In[5]:=
```
?NumberForm
```

Out[5]=

Symbol

NumberForm[*expr*, *n*] prints with approximate real numbers in *expr* given to *n*-digit precision.

NumberForm[*expr*, {*n*, *f*}] prints with approximate real numbers having *n* digits, with *f* digits to the right of the decimal point.

NumberForm[*expr*] prints using the default options of NumberForm.

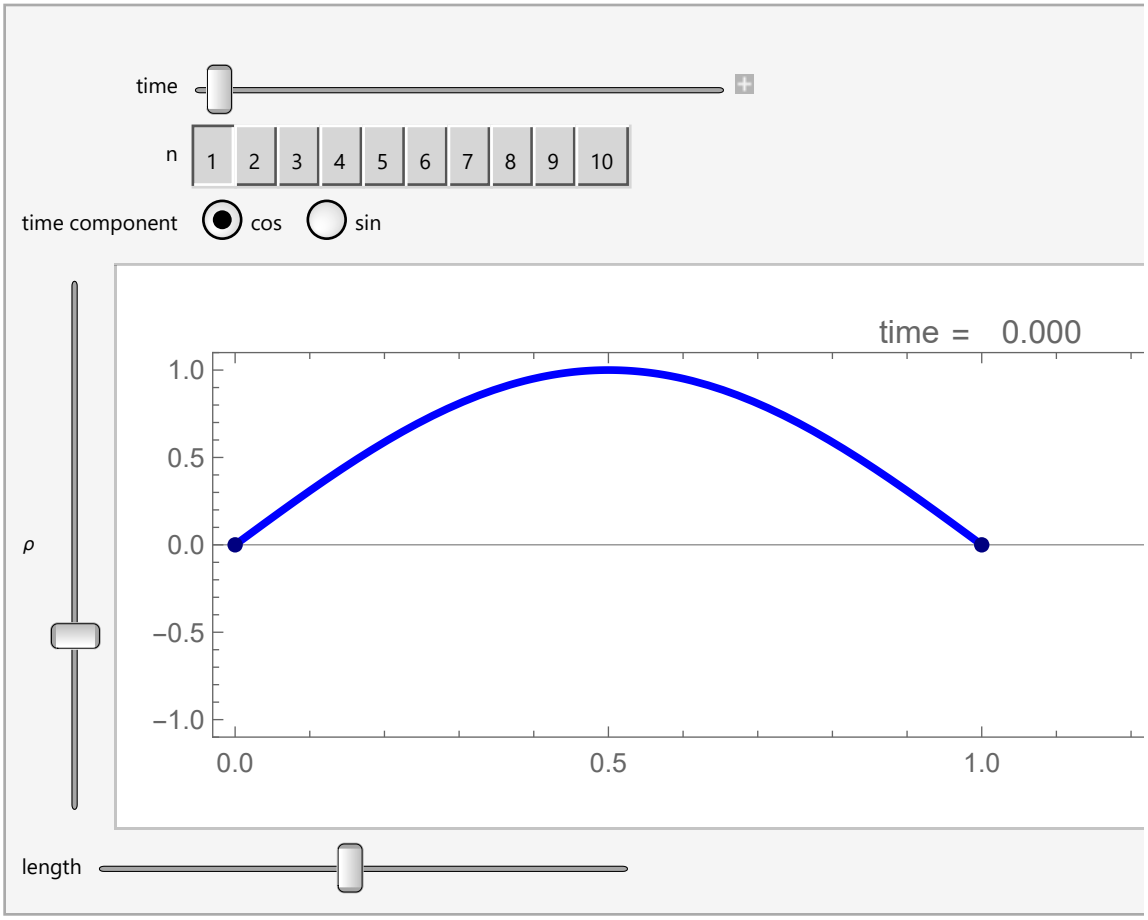
In[6]:=
```
Clear[T0, lL, tc]; Manipulate[
 Which[tc == "cos",
  Plot[
   Evaluate[NMVC[x, t, n, T0, ρ, lL]], {x, 0, lL},
   PlotStyle → {{Blue, Thickness[0.005]}},
   Epilog → {RGBColor[0, 0, .5], PointSize[0.01],
     Point[{0, 0}], Point[{lL, 0}]},
   PlotRange → {{-0.03, 2.03}, {-1.1, 1.1}},
   PlotLabel → TableForm[
```

```
    {"time", "=",
     NumberForm[N[t], {5, 3},
      NumberPadding → {" ", "0"}]},
    TableDirections → Row,
    TableAlignments → {Left, Left, Right},
    TableSpacing → {0.5, .3}],

  Frame → True, AspectRatio → 1 / 4, ImageSize → 600
 ],
 tc == "sin", Plot[
  Evaluate[NMVS[x, t, n, T0, ρ, lL]], {x, 0, lL},
  PlotStyle → {{Blue, Thickness[0.005]}},
  Epilog → {RGBColor[0, 0, .5], PointSize[0.01],
    Point[{0, 0}], Point[{lL, 0}]},
  PlotRange → {{-0.03, 2.03}, {-1.1, 1.1}},
  PlotLabel → TableForm[
    {"time", "=",
     NumberForm[N[t], {5, 3},
      NumberPadding → {" ", "0"}]},
    TableDirections → Row,
    TableAlignments → {Left, Left, Right},
    TableSpacing → {0.5, .3}],
  Frame → True, AspectRatio → 1 / 4, ImageSize → 600
 ]
]
,
{{t, 0, "time"}, 0, 8 Pi, N[Pi / 128]},
{{n, 1}, Range[10], ControlType → Setter},
{{tc, "cos", "time component"}, {"cos", "sin"},
 ControlType → RadioButton},
{{T0, 1}, 0.1, 3, ControlType → VerticalSlider,
 ControlPlacement → Right},
{{ρ, 1}, 0.1, 3, ControlType → VerticalSlider,
```

```
 ControlPlacement → Left},
{{lL, 1, "length"}, 0.1, 2, ControlType → Slider,
 ControlPlacement → Bottom}, ContinuousAction → True]
```

Out[6]=

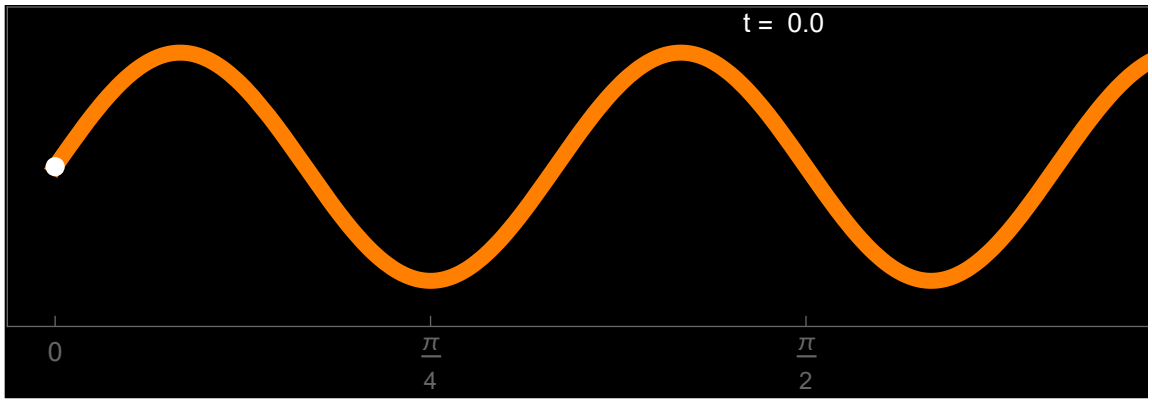


In[7]:=
```
NMVC[x, t, 1, 1, 1, Pi]
```

Out[7]=
```
Cos[t] Sin[x]
```

In[8]:=
```
Module[{t}, t = 0;
 Plot[Evaluate[NMVC[x, t, 6, 1, 1, Pi]], {x, 0, Pi},
  PlotStyle → {{Thickness[0.01], RGBColor[1, 0.5, 0]}},
  Epilog → {
    {PointSize[0.012], White,
     Point[#] & /@ {{0, 0}, {Pi, 0}}},
    {Text["t =", {Pi / 2 - 0.1, 1.26},
      BaseStyle → {FontWeight → "Normal",
        FontColor → RGBColor[1, 1, 1]}],
     Text[NumberForm[N[2 t], {3, 1}], {Pi / 2, 1.26},
      BaseStyle → {FontWeight → "Normal",
        FontColor → RGBColor[1, 1, 1]}]}
   },
  PlotRange → {{-0.1, Pi + 0.1}, {-1.4, 1.4}},
  AspectRatio → 1 / 5, Frame → True,
  FrameTicks → {{{}, {}}, {Range[0, Pi, Pi / 4], {}}},
  Axes → False, ImageSize → 600, Background → Black]]
```

Out[8]=



In[9]:=
```
Table[Table[{j, k}, {j, 1, 4}], {k, 4, 8}]
```

Out[9]=
```
{{{1, 4}, {2, 4}, {3, 4}, {4, 4}},
 {{1, 5}, {2, 5}, {3, 5}, {4, 5}},
 {{1, 6}, {2, 6}, {3, 6}, {4, 6}},
 {{1, 7}, {2, 7}, {3, 7}, {4, 7}},
 {{1, 8}, {2, 8}, {3, 8}, {4, 8}}}
```

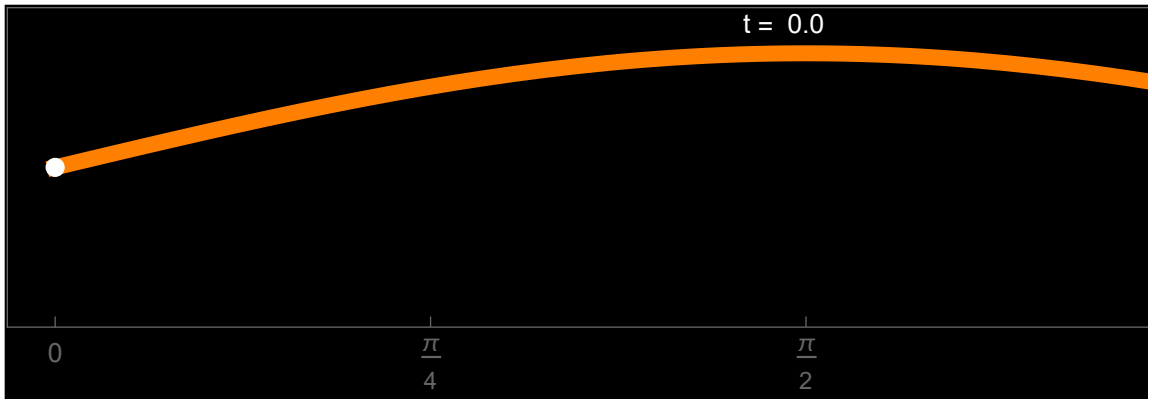
In[10]:=
```
NMV1 = Table[Plot[Evaluate[NMVC[x, t, 1, 1, 1, Pi]],
    {x, 0, Pi},
    PlotStyle → {{Thickness[0.01], RGBColor[1, 0.5, 0]}},
    Epilog → {
      {PointSize[0.012], White,
       Point[#] & /@ {{0, 0}, {Pi, 0}}},
      {Text["t =", {Pi / 2 - 0.1, 1.26},
        BaseStyle → {FontWeight → "Normal",
          FontColor → RGBColor[1, 1, 1]}],
       Text[NumberForm[N[t], {3, 1}], {Pi / 2, 1.26},
        BaseStyle → {FontWeight → "Normal",
          FontColor → RGBColor[1, 1, 1]}]}
     },
    PlotRange → {{-0.1, Pi + 0.1}, {-1.4, 1.4}},
    AspectRatio → 1 / 5, Frame → True,
    FrameTicks → {{{}, {}}, {Range[0, Pi, Pi / 4], {}}},
    Axes → False, ImageSize → 600, Background → Black],
   {t, 0, 2 Pi, 0.05}];
```

In[11]:=
```
Length[NMV1]
```

Out[11]= 126

In[12]:=
```
NMV1[[1]]
```

Out[12]=



In[13]:=
```
NMVC[x, t, n, 1, 1, Pi]
```

Out[13]=
```
Cos[n t] Sin[n x]
```

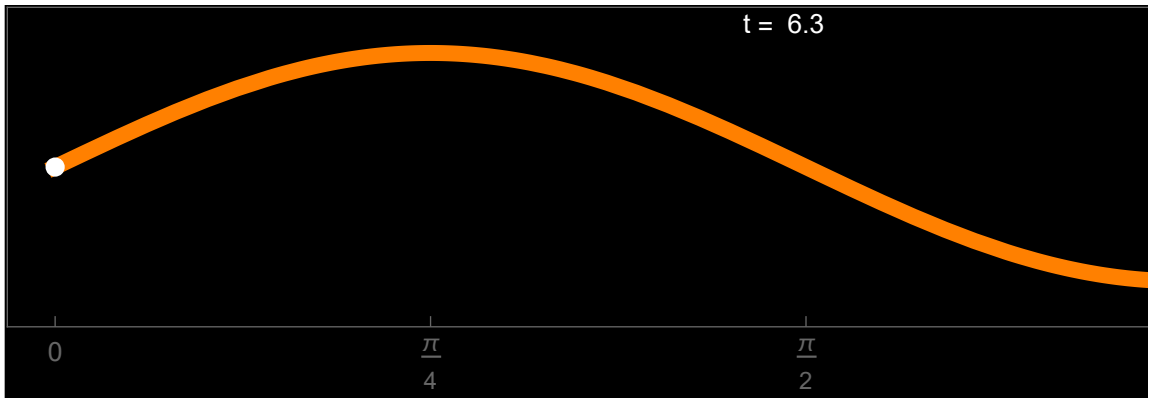
In[14]:=
```
NMVtt =
  Table[Table[Plot[Evaluate[NMVC[x, t, n, 1, 1, Pi]],
    {x, 0, Pi},
    PlotStyle → {{Thickness[0.01], RGBColor[1, 0.5, 0]}},
    Epilog → {
      {PointSize[0.012], White,
       Point[#] & /@ {{0, 0}, {Pi, 0}}},
      {Text["t =", {Pi / 2 - 0.1, 1.26},
        BaseStyle → {FontWeight → "Normal",
          FontColor → RGBColor[1, 1, 1]}],
       Text[NumberForm[N[t], {3, 1}], {Pi / 2, 1.26},
        BaseStyle → {FontWeight → "Normal",
          FontColor → RGBColor[1, 1, 1]}]}
     },
    PlotRange → {{-0.1, Pi + 0.1}, {-1.4, 1.4}},
    AspectRatio → 1 / 5, Frame → True,
    FrameTicks → {{{}, {}}, {Range[0, Pi, Pi / 4], {}}},
    Axes → False, ImageSize → 600, Background → Black],
   {t, 0, 2 Pi, 2 Pi / 120.}], {n, 1, 6}];
```

In[15]:=
```
Length[NMVtt[[2]]]
```

Out[15]=
```
121
```

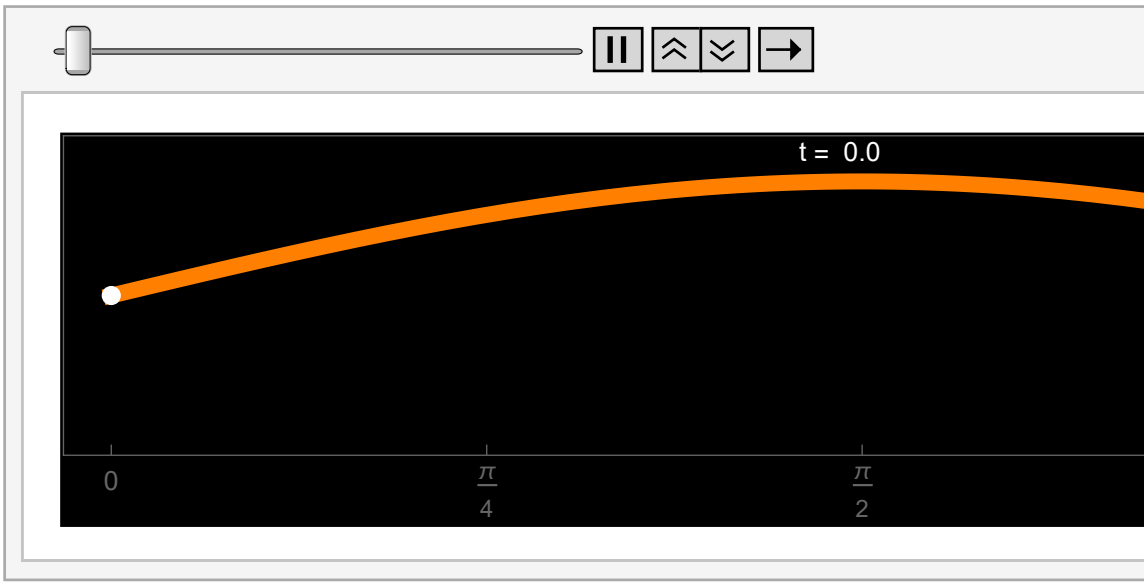
In[16]:=
```
Show[NMVtt[[2, 121]], ImageSize → 600]
```

Out[16]=



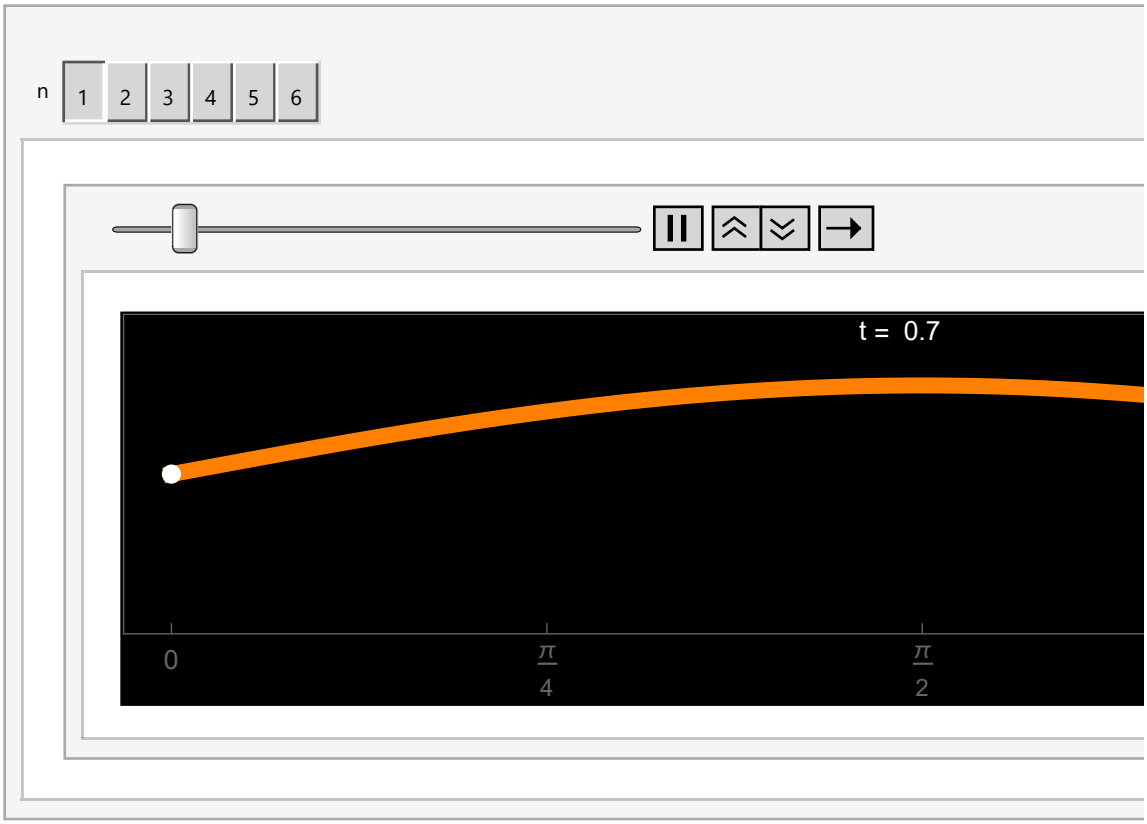
In[17]:=
```
ListAnimate[Show[#, ImageSize → 600] & /@ NMV1,
 ControlPlacement → Top]
```

Out[17]=



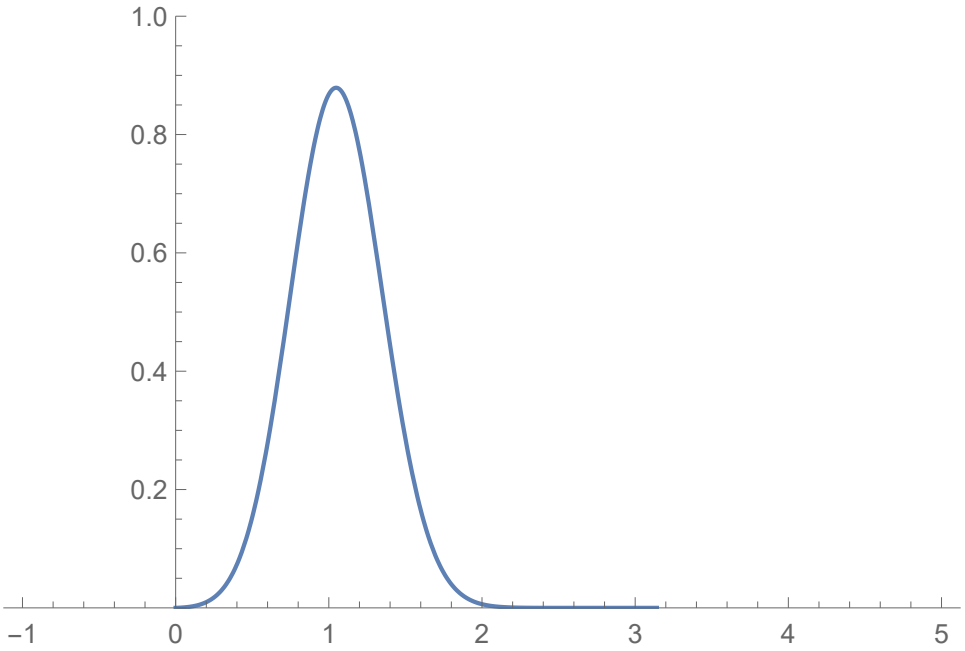
In[18]:=
```
Manipulate[
 ListAnimate[Show[#, ImageSize → 600] & /@ NMVtt[[n]],
  AnimationRunning → True, ControlPlacement -> Top],
 {n, Range[1, 6]}, ControlType → Setter]
```

Out[18]=



In[19]:=
```
Plot[4/Pi^2 x (Pi - x) Exp[-5 (x - 1)^2], {x, -1, 5},
 PlotRange → {0, 1}]
```

Out[19]=



In[20]:=
```
D[NMVS[x, t, n, 1, 1, Pi], t]
```

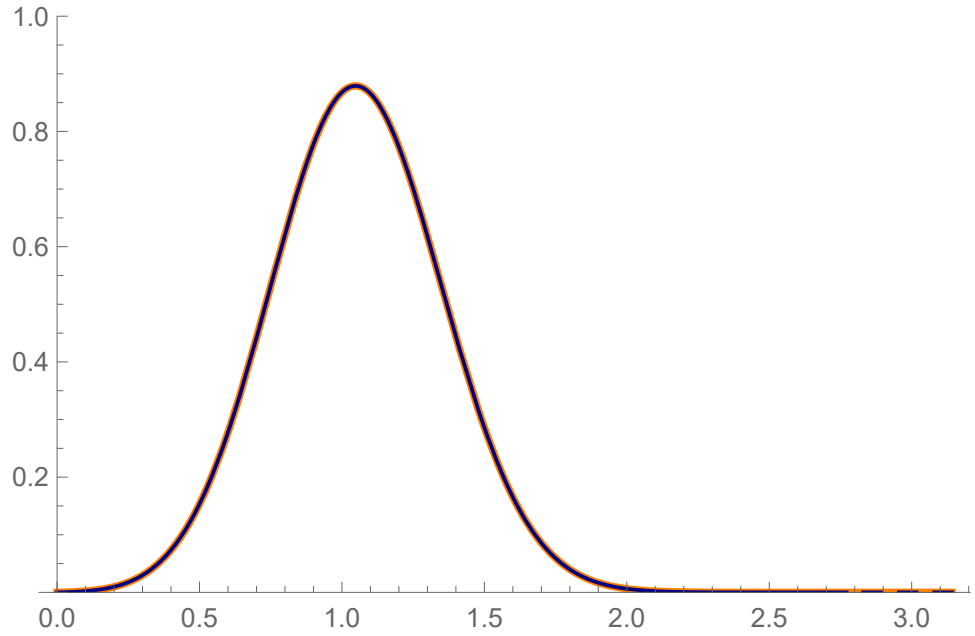
Out[20]=
```
n Cos[n t] Sin[n x]
```

In[21]:=
```
Clear[aat];
aat =
 Table[
  2/Pi NIntegrate[4/Pi^2 x (Pi - x) Exp[-5 (x - 1)^2] Sin[n x],
    {x, 0, Pi}], {n, 1, 50}];
```

In[22]:=
```
uup[x_, t_] = Sum[aat[[n]] Cos[n t] Sin[n x],
   {n, 1, Length[aat]}];
```

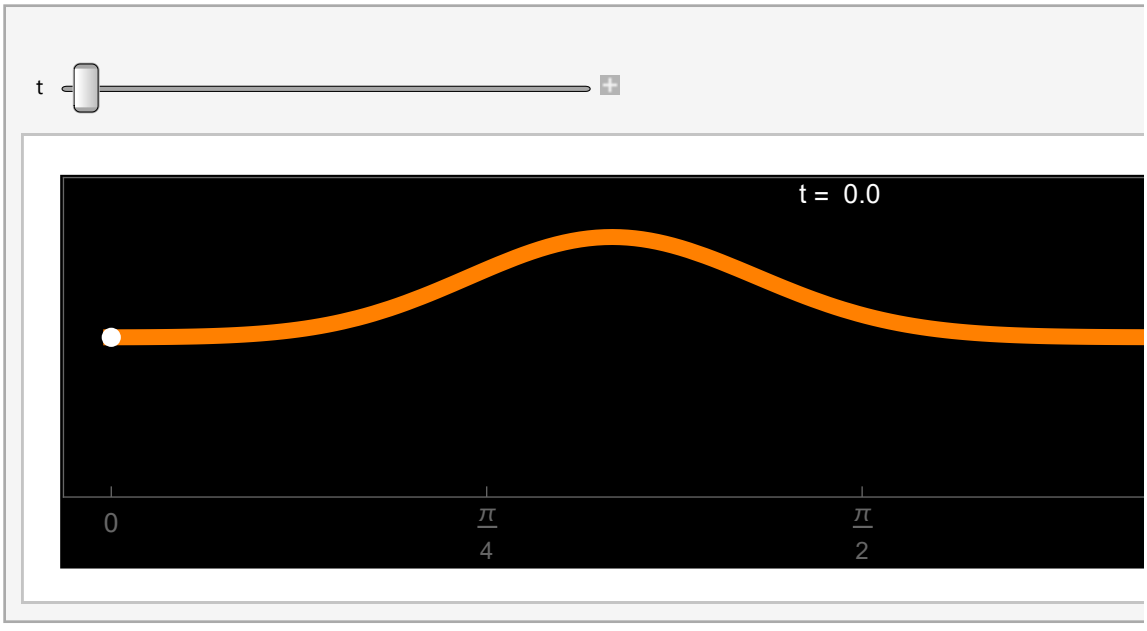
In[23]:=
```
Plot[{4/Pi^2 x (Pi - x) Exp[-5 (x - 1)^2], Evaluate[uup[x, 0]]},
 {x, 0, Pi},
 PlotStyle → {{Thickness[0.008], RGBColor[1, 0.5, 0]},
   {Thickness[0.004], RGBColor[0, 0, 0.5]}},
 PlotRange → {0, 1}]
```

Out[23]=



In[24]:=
```
Manipulate[Plot[Evaluate[uup[x, t]], {x, 0, Pi},
  PlotStyle → {{Thickness[0.01], RGBColor[1, 0.5, 0]}},
  Epilog → {
    {PointSize[0.012], White,
     Point[#] & /@ {{0, 0}, {Pi, 0}}},
    {Text["t =", {Pi / 2 - 0.1, 1.26},
      BaseStyle → {FontWeight → "Normal",
        FontColor → RGBColor[1, 1, 1]}],
     Text[NumberForm[N[t], {3, 1}], {Pi / 2, 1.26},
      BaseStyle → {FontWeight → "Normal",
        FontColor → RGBColor[1, 1, 1]}]}
   },
  PlotRange → {{-0.1, Pi + 0.1}, {-1.4, 1.4}},
  AspectRatio → 1 / 5, Frame → True,
  FrameTicks → {{{}, {}}, {Range[0, Pi, Pi / 4], {}}},
  Axes → False, ImageSize → 600, Background → Black],
 {t, 0, 20}, ControlPlacement → Top]
```

Out[24]=



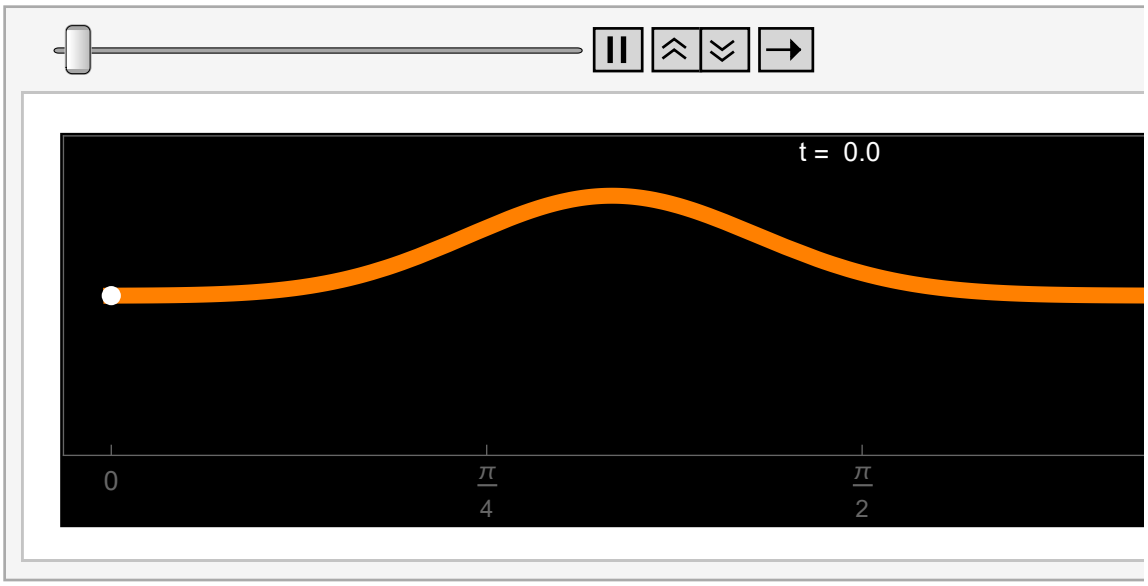
In[25]:=
```
uuptt = Table[Plot[Evaluate[uup[x, t]], {x, 0, Pi},
    PlotStyle → {{Thickness[0.01], RGBColor[1, 0.5, 0]}},
    Epilog → {
      {PointSize[0.012], White,
       Point[#] & /@ {{0, 0}, {Pi, 0}}},
      {Text["t =", {Pi / 2 - 0.1, 1.26},
        BaseStyle → {FontWeight → "Normal",
          FontColor → RGBColor[1, 1, 1]}],
       Text[NumberForm[N[t], {3, 1}], {Pi / 2, 1.26},
        BaseStyle → {FontWeight → "Normal",
          FontColor → RGBColor[1, 1, 1]}]}
     },
    PlotRange → {{-0.1, Pi + 0.1}, {-1.4, 1.4}},
    AspectRatio → 1 / 5, Frame → True,
    FrameTicks → {{{}, {}}, {Range[0, Pi, Pi / 4], {}}},
    Axes → False, ImageSize → 800, Background → Black],
   {t, 0, 6.4, 6.4 / 240}];
```

In[26]:=
```
Length[uuptt]
```

Out[26]= 241

In[27]:=
```
ListAnimate[Show[#, ImageSize → 600] & /@ uuptt,
 ControlPlacement → Top]
```

Out[27]=



In[28]:=
```
NMVttime =
  Table[Table[Plot[Evaluate[NMVC[x, t, n, 1, 1, Pi]],
     {x, 0, Pi},
     PlotStyle → {{Thickness[0.01], RGBColor[1, 0.5, 0]}},
     Epilog → {
       {PointSize[0.012], White,
        Point[#] & /@ {{0, 0}, {Pi, 0}}},
       {Text["t =", {Pi / 2 - 0.1, 1.26},
         BaseStyle → {FontWeight → "Normal",
           FontColor → RGBColor[1, 1, 1]}],
        Text[NumberForm[N[t], {3, 1}], {Pi / 2, 1.26},
         BaseStyle → {FontWeight → "Normal",
           FontColor → RGBColor[1, 1, 1]}]}
      },
     PlotRange → {{-0.1, Pi + 0.1}, {-1.4, 1.4}},
     AspectRatio → 1 / 5, Frame → True,
     FrameTicks → {{{}, {}}, {Range[0, Pi, Pi / 4], {}}},
     Axes → False, ImageSize → 800, Background → Black],
    {t, 0, 2 Pi, 2 Pi / 240.}], {n, 1, 6}];
```

In[29]:=
```
Length[NMVttime[[1]]]
```

Out[29]= 241

In[30]:=
```
dds = 0.1 & /@ Range[Length[NMVttime[[1]]];
(* duration of each frame that we want*)
```

In[31]:=
```
NotebookDirectory[]
```

Out[31]= C:\Dropbox\Work\myweb\Courses\Math_pages\Math_430\

In[32]:=
```
(* SetDirectory[NotebookDirectory[]] *)
```

In[33]:=
```
(* Export["NMVttime1s1.gif",NMVttime[[1]][[1]],
 "ImageSize"→800];
Export["NMVttime1.gif",NMVttime[[1]],
 "AnimationRepetitions"→Infinity,"ImageSize"→800,
 "DisplayDurations"→dds] ;
  Export["NMVttime2s1.gif",NMVttime[[2]][[1]],
 "ImageSize"→800];
Export["NMVttime2.gif",NMVttime[[2]],
 "AnimationRepetitions"→Infinity,"ImageSize"→800,
 "DisplayDurations"→dds] ;
Export["NMVttime3s1.gif",NMVttime[[3]][[1]],"ImageSize"→800];
Export["NMVttime3.gif",NMVttime[[3]],
 "AnimationRepetitions"→Infinity,"ImageSize"→800,
 "DisplayDurations"→dds] ;
Export["NMVttime4s1.gif",NMVttime[[4]][[1]],"ImageSize"→800];
Export["NMVttime4.gif",NMVttime[[4]],
 "AnimationRepetitions"→Infinity,"ImageSize"→800,
 "DisplayDurations"→dds] ;
Export["NMVttime5s1.gif",NMVttime[[5]][[1]],"ImageSize"→800];
Export["NMVttime5.gif",NMVttime[[5]],
 "AnimationRepetitions"→Infinity,"ImageSize"→800,
 "DisplayDurations"→dds] ;
Export["NMVttime6s1.gif",NMVttime[[6]][[1]],"ImageSize"→800];
Export["NMVttime6.gif",NMVttime[[6]],
 "AnimationRepetitions"→Infinity,"ImageSize"→800,
 "DisplayDurations"→dds]  *)
```

In[34]:=
```
(* Export["uuptts1.gif",uuptt[[1]],"ImageSize"→800];
Export["uupttAni.gif",uuptt,
 "AnimationRepetitions"→Infinity,"ImageSize"→800,
 "DisplayDurations"→dds] ; *)
```