```
(*       Computer Graphics with Applications of Dr. Makhanov.
                         Lab 3
               "Flying" Objects and Rotations. *)
```

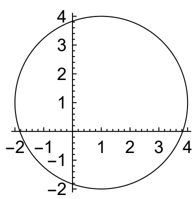
```
SetOptions[EvaluationNotebook[], ShowCellLabel → False];
```

```
SetOptions[{Graphics, Plot, Plot3D, ContourPlot, ContourPlot3D, DensityPlot, ParametricPlot,
   ParametricPlot3D, ListPlot, ListLinePlot, VectorPlot, VectorPlot3D, StreamPlot,
   ListPointPlot3D, RegionPlot, RegionPlot3D, Graphics, Graphics3D}, ImageSize → Small];
```

```
(* This introduces graphics primitives such as  Circle[{x,y},Rc],
Sphere[{x,y,z},Rs], Cuboid[{xc,yc,zc}] (there aree many others) where {x,y} and
 {x,y,z} is the center of the circle and sphere/cuboid respectively and Rc
 Rs the radius. Cuboid[{xc,yc,zc}] represents a unit cuboid with a corner at
 {xc,yc,zc}. These functions must be called with displaying functions Graphics
 and Graphics3D. See the examples below (you do not need to replicate them) *)
```

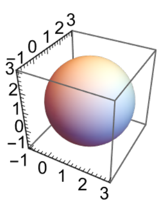
```
(* Circle, radius 3 and the center at {1,1} use Graphics *)
```

```
Graphics[Circle[{1, 1}, 3], Axes → True, ImageSize → Tiny]
```



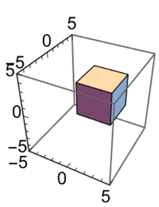

```
(* Sphere radius 2 and the center at {1,1,1} use Graphics3D*)
```

```
Graphics3D[Sphere[{1, 1, 1}, 2], Axes → True, ImageSize → Tiny]
```




```
(* Cube, centered at {1,1,1} with the side 4 *)
```

```
Graphics3D[Cube [{1, 1, 1}, 4], Axes → True,
 ImageSize → Tiny, PlotRange → {{-5, 5}, {-5, 5}, {-5, 5}}]
```



```
(* --------------------------- PART 1 ----------------------------*)
```

```
(* Problem (1) Animate a growing parametric curve given by x1[t_]:=Cos[7t]Cos[11t]
   y1[t_]:=Cos[7t]Sin[11t] {t,0,Pi}. The animation parameter s: {s,0.1,Pi,0.001}
      Note the animation parameter s included as follows
      plot1[s_]:=ParametricPlot[p1[t],{t,0,s}] *)
```

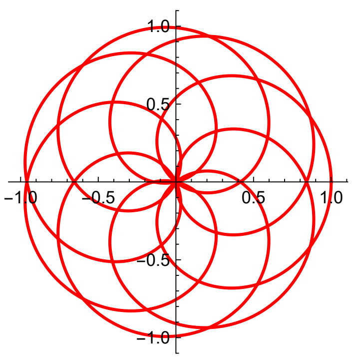
```
x1[t_] := Cos[7 t] Cos[11 t]

y1[t_] := Cos[7 t] Sin[11 t]

p1[t_] := {x1[t], y1[t]}
```

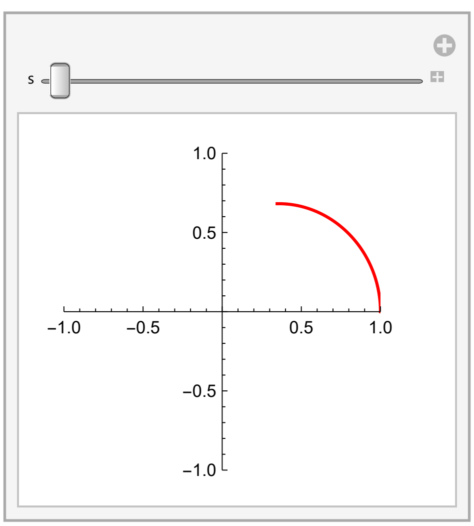
```
(* Here is the entire curve. We will need it later *)
```

```
plotg1 = ParametricPlot[p1[t], {t, 0, Pi}, PlotStyle → Red]
```




```
plot1[s_] := ParametricPlot[p1[t], {t, 0, s},
  PlotStyle → Red, PlotRange → {{-1, 1}, {-1, 1}}, PlotPoints → 100]

Manipulate[plot1[s], {s, 0.1, Pi, 0.1}]
```

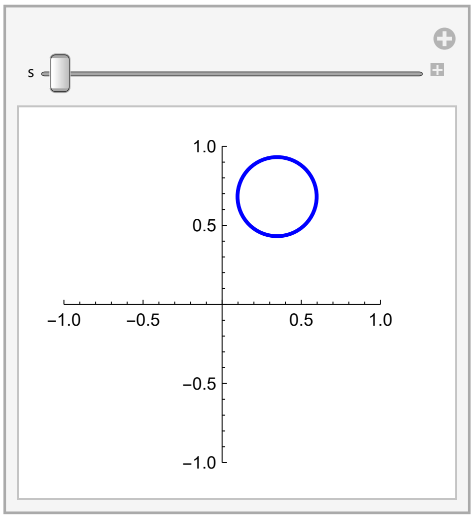


```
(* Problem (2) Animate a circle with the radius 0.25 moving along
 a curve from problem 1 use Circle[{x,y},Rss]. Plot the curve and the
 moving circle on the same graph. Animation parameter s: {s,0.1,Pi,0.001}
   Note, Graphics[Circle[p1[s],Rs], where p1[s] is the trajectory *)
```

```
Rss := 0.25
```

```
plot2[s_] :=
 Graphics[{Blue, Thick, Circle[p1[s], Rss]}, PlotRange → {{-1, 1}, {-1, 1}}, Axes → True]
```

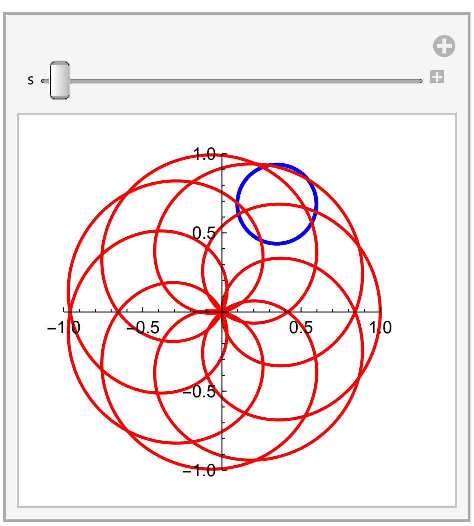
```
Manipulate[plot2[s], {s, 0.1, Pi, 0.001}]
```




```
(* Plot with the trajectory *)
```

```
plot1and2[s_] := Show[plot2[s], plotg1]
```

```
Manipulate[plot1and2[s], {s, 0.1, Pi, 0.001}]
```



```
(* Problem (3) Construct a 2D trajectory based on
 data3 using the parametric 2D spline. data3 is given in the attached .nb file *)
```

```
data3 = {{-3, -1}, {-1, -2}, {1, -2}, {2, -3}, {1, -4}, {-1, -4}, {-2, -5}, {-2, -6},
   {-1, -6}, {-1, -5}, {2, -5}, {3, -4}, {6, -5}, {7, -7}, {6, -8}, {6, -9},
   {7, -9}, {7, -8}, {8, -7}, {7, -4}, {6, -4}, {6, -2}, {5, 0}, {10, -1}, {7, 0},
   {10, 0}, {7, 1}, {10, 2}, {8, 2}, {10, 3}, {6, 2}, {5, 0}, {3, 0}, {1, 2}, {1, 3},
   {-2, 6}, {-3, 6}, {-4, 7}, {-4, 6}, {-6, 4}, {-6, 3}, {-5, 3}, {-3, 4}, {-2, 2},
   {-3, 1}, {-5, 2}, {-7, 0}, {-7, -1}, {-6, -1}, {-6, 0}, {-5, 1}, {-4, 0},
   {-5, -2}, {-3, -4}, {-2, -4}, {-2, -3}, {-3, -3}, {-4, -2}, {-3, -1}};
```

```
x3 = Transpose[data3][[1]]
```

```
{-3, -1, 1, 2, 1, -1, -2, -2, -1, -1, 2, 3, 6, 7, 6, 6, 7, 7, 8,
 7, 6, 6, 5, 10, 7, 10, 7, 10, 8, 10, 6, 5, 3, 1, 1, -2, -3, -4, -4, -6, -6,
 -5, -3, -2, -3, -5, -7, -7, -6, -6, -5, -4, -5, -3, -2, -2, -3, -4, -3}
```

[redacted]

```
{-1, -2, -2, -3, -4, -4, -5, -6, -6, -5, -5, -4, -5, -7, -8,
 -9, -9, -8, -7, -4, -4, -2, 0, -1, 0, 0, 1, 2, 2, 3, 2, 0, 0, 2, 3, 6, 6,
 7, 6, 4, 3, 3, 4, 2, 1, 2, 0, -1, -1, 0, 1, 0, -2, -4, -4, -3, -3, -2, -1}
```

```
sx3 = Interpolation[x3]
```

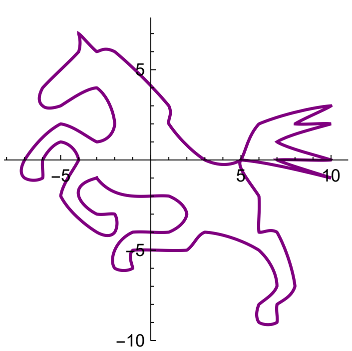
```
InterpolatingFunction[ Domain: {{1, 59}} Output: scalar ]
```

[redacted]

```
InterpolatingFunction[ Domain: {{1, 59}} Output: scalar ]
```

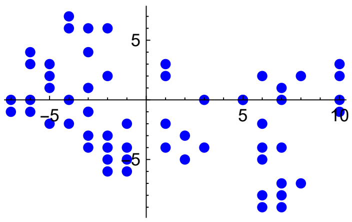
```
s3[t_] := {sx3[t], sy3[t]}
```

```
plot31 = ParametricPlot[s3[t], {t, 1, Length[x3]}, PlotStyle → Purple]
```



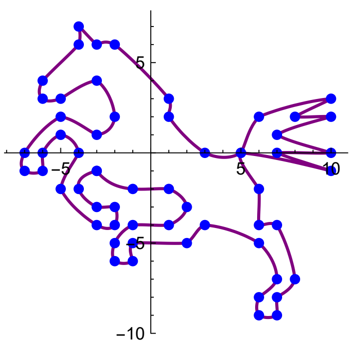
```
(* Plot the points using ListPlot *)
```

[redacted]




```
(* Superimpose *)
```

[redacted]



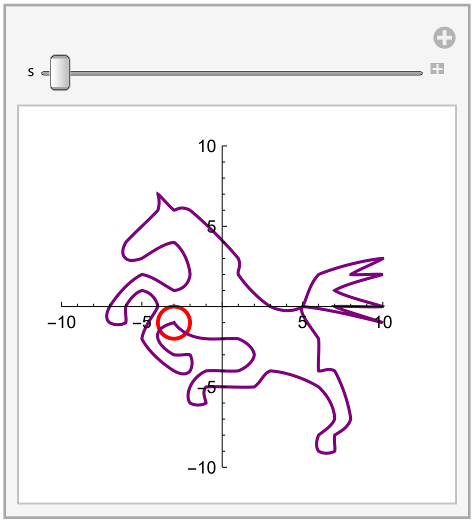

```
(* Problem (4) Animate a Circle of the radius 1 moving along the trajectory from
 Problem 3. Use Graphics[???] The animation parameter s runs from 1 to Length[x3]
 Fix the PlotRange *)
```

```
Rs4 := 1.0
```

[redacted]

```
plot41[s_] :=
```

[redacted]




```
(* Problem (5) Construct a 3D trajectory based on data5=
 {{1,1,1},{2,3,1},{1,3,2},{4,3,3},{4,4,4},{5,3,2},{7,5,6},{5,5,5}}
  using parametric 3D spline.
   Adapt the solution from Problems 1  and 3 to the 3D case Use
   ListPointPlot3D instead of ListPlot
  and ParametricPlot3D  instead of ParametricPlot  *)
```

data5 = {{1, 1, 1}, {2, 3, 1}, {1, 3, 2}, {4, 3, 3}, {4, 4, 7}, {5, 3, 2}, {7, 5, 6}, {5, 5, 5}}

{{1, 1, 1}, {2, 3, 1}, {1, 3, 2}, {4, 3, 3}, {4, 4, 7}, {5, 3, 2}, {7, 5, 6}, {5, 5, 5}}

x5 = Transpose[data5][[1]]

{1, 2, 1, 4, 4, 5, 7, 5}

[redacted]

{1, 3, 3, 3, 4, 3, 5, 5}

[redacted]

{1, 1, 2, 3, 7, 2, 6, 5}

sx5 = Interpolation[[redacted]

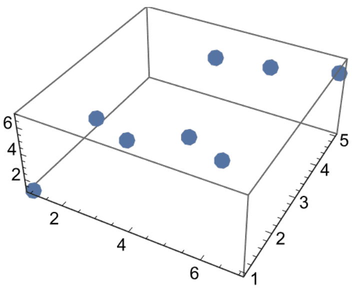
InterpolatingFunction[Domain: {{1, 8}} Output: scalar]

[redacted]

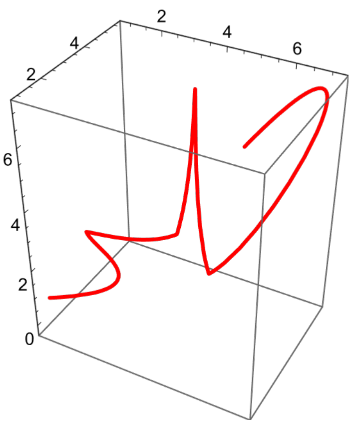
```
InterpolatingFunction[ Domain: {{1, 8}} Output: scalar ]
```

```
s5[t_] := {sx5[t], sy5[t], sz5[t]}
```

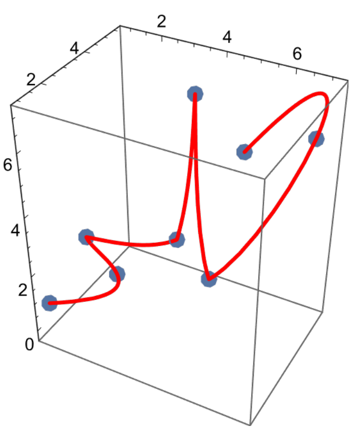
```
plotl5 = ListPointPlot3D[data5, PlotStyle → PointSize[0.05]]
```



```
plotg5 = ParametricPlot3D[s5[t], {t, 1, Length[x5]}, PlotStyle → {Red, Thick}]
```



[redacted]



```
(* Problem (6) Using the 3D spline from problem 5 as the design trajectory
  construct an animation of a 3D sphere moving along the trajectory s5[t].
   Use plotc7[s_]:=Graphics3D[Sphere[s5[t],Rs6],PlotRange→{{0,8},{0,8},{0,7}}],
where s5[t] is the required trajectory. The radius of the sphere Rs6=0.8 *)
```

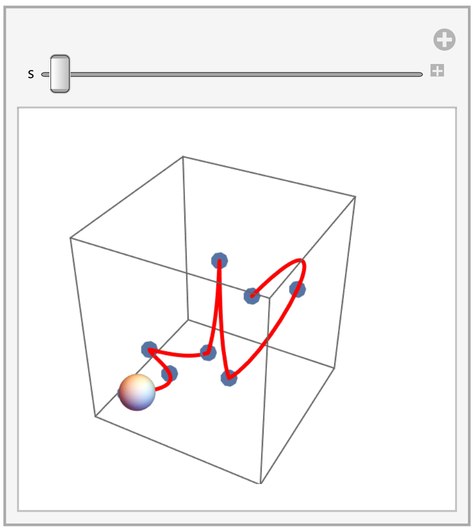
```
Rs6 = 0.8
```

```
0.8
```

```
plotc6[s_] := Graphics3D[Sphere[s5[s], Rs6], PlotRange → {{0, 8}, {0, 8}, {0, 7}}]
```

```
plot6show[s_] := Show[{plotc6[s], plotg5, plotl5}, PlotRange → {{0, 8}, {0, 8}, {0, 9}}]
```

Manipulate




```
(* Problem (7) Using the methods from the previous problems animate a sphere Rs7=
 0.5  moving along  a trajectory defined by the parametric equations
   x7[t_]:=R7*Cos[t]
   y7[t_]:=R7*Sin[t/1.2]
   z7[t_]:=t/5,
   R7=1.5,
  {s,0,smax,2}
  smax=20
  Fig the PlotRange *)
```

```
smax = 20
```

```
20
```

```
Rs7 = 0.5
```

```
0.5
```

```
R7 = 1.5
```

```
1.5
```

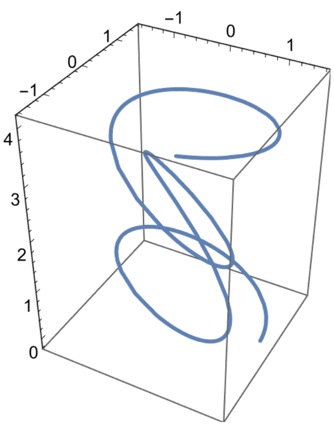
```
x7[t_] := R7 * Cos[t]
```

```
y7[t_] := R7 * Sin[t / 1.2]
```

```
z7[t_] := t / 5
```

```
trajectory7[t_] := {x7[t], y7[t], z7[t]}
```

```
plotg7 = ParametricPlot3D[trajectory7[t], {t, 0, smax}]
```




```
plot7[s_] :=
```

[redacted]

[redacted]

[redacted]