```
(*                  CSS221 Computer Graphics with Applications
                                  Lab 1
                         Introduction into Mathematica
 *)
```

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

```
SetOptions[{Plot, Plot3D, ContourPlot, DensityPlot, ParametricPlot,
   ParametricPlot3D, ListPlot, ListLinePlot}, ImageSize → Small];
```

```
(* Comments are in (**) In order to see the output run
  the Mathematica Notebook: Evaluation Evaluate Cells (OR) press
    Shift Enter In order to evaluate the entire notebook run Evaluation→
 Evaluate Notebook. To start a new cell press down arrow and press
   Enter. To evaluate the cell press Shift+Enter.
*)
```

```
(* Note. Sometimes there are too many mistakes in the Lab solution. IN this
 case save your work. Quit Mathematica. Load your file again and run it *)
```

```
(* Basics of Mathematical Calculations *)
```

```
(* Problem(1) Define a variable x equal to 3 and y equal to 2. Find x+y,
x^2+y^2,   x*y,  x/y. Type every line in a different cell  *)
```

```
x = 3 (* press shift +enter to run the cell *)
```

3

```
y = 2
```

2

```
x + y
```

5

[redacted]

13

[redacted]

6

[redacted]

$\frac{3}{2}$

```
(* Problem(2) First letters of the built in
 functions are capitalized. Use[] around the arguments Find
 Sqrt[5],Sqrt[5.],Exp[3.],Sin[Pi/3],
ArcTan[Sqrt[3]] Assign these numerical values to varibles.
   Type them in different cells *)
```

```
xs1 = Sqrt[5]
```

$\sqrt{5}$

```
xs2 = Sqrt[5.]
```

2.23607

```
xe1 = Exp[3.]
```

20.0855

```
xs3 = Sin[Pi / 3]
```

$$\frac{\sqrt{3}}{2}$$

```
xa1 = ArcTan[Sqrt[3]]
```

$$\frac{\pi}{3}$$

```
(* Find xs1+xs2+xe1+xs3+xa1 *)
```

[redacted]

26.4709

```
(* Functions. 2D plots  *)
```

```
(* Problem(3) Define f[x_]:=
 x^2+0.8 Note the underscore x_ denotes the argument. Call f[x] with x=3,
x=Pi.x=(1+t) and x=Sin[t*Pi]. Find f[f[4.5]]  *)
```

```
f[x_] := x^2 + 0.8
```

```
f[3]
```

9.8

```
f[Pi]
```

10.6696

```
f[1 + t]
```

$0.8 + (1 + t)^2$

```
f[Sin[t * Pi]]
```

$0.8 + \mathrm{Sin}[\pi\, t]^2$

```
f[f[4.5]]
```

443.903

```
(* Problem(4) Define a function  given by f[a_]:=
 Sin[a^2]+ Cos[a]  and call with  a=1 ,  a=1. and  a=1.*Pi    *)
```

[redacted]

Cos[1] + Sin[1]

[redacted]

1.38177

[redacted]

-1.4303

```
(* Problem(5) A function with more than one argument. Define the Function,
f5[u_,v_]:= u/v
Call f5[21, 5]   *)
```

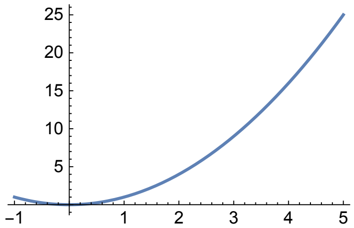
[redacted]

4.2

```
(* Problem(6) Plot f6[a_]:=a^2 as Plot[ function,{x,xmin,xmax}, Options] ,
the argument x ranges from xmin to xmax. *)
```

```
f6[a_] := a^2
```

```
Plot[f6[a], {a, -1, 5}]
```

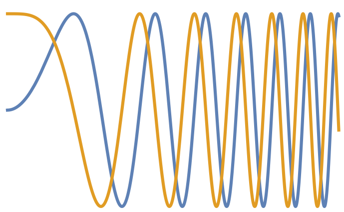



```
(* Problem(6)
Plotting several functions. 1) Plot the function Sin[x^2] and Cos[x^2]
    with the range {0,2Pi},and with Axes->False. 2) Use Options Axes->True,
use PlotStyle→{Blue, Red} BaseStyle→{FontSize→14} and observe the difference *)
```

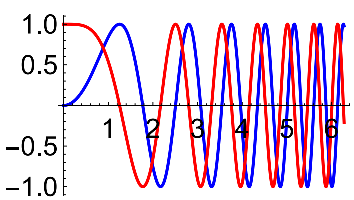
[redacted]

```
f82[x_] := Cos[x^2]

Plot[{f81[x], f82[x]}, {x, 0, 2 Pi}, Axes → False]
```



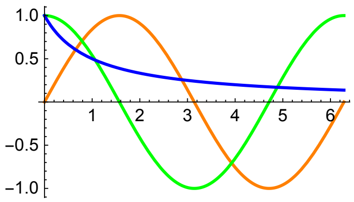
[redacted]




```
(* Problem (7) Plot three functions: Sin[x], Cos[x],
1/(x+1) on interval {x,0,2Pi} using {Orange, Green, Blue}  *)
```

[redacted]

[redacted]



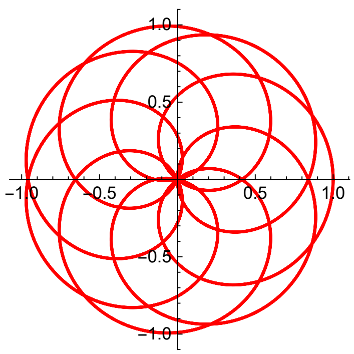

```
(* Problem(8) Plot a parametric function using the ParametricPlot *)
(* Parametric function is specified
  by a pair {x(t),y(t)} of a parametric variable  t.
   Define x[t_]:=Cos[7t]Cos[11t], y[t_]:=Cos[7t]Sin[11t],  t ranges from 0 to 2Pi,
Use AspectRatio→1. It specifies the ratio of height to width for a plot. *)
```

```
x10[t_] := Cos[7 t] Cos[11 t]

y10[t_] := Cos[7 t] Sin[11 t]

p10[t_] := {x10[t], y10[t]}

ParametricPlot[p10[t], {t, 0, 2 Pi}, PlotStyle -> Red, AspectRatio → 1]
```



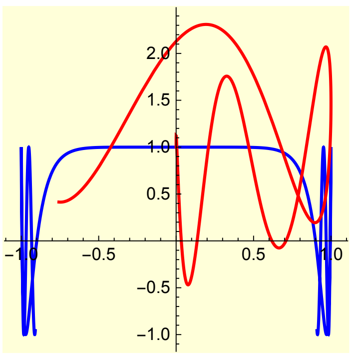

```
(* Problem(9) Plot the following two parametric functions
x111[t_]:= Sin[t]; y111[t_]:=Cos[t^4]  and x112[t_]:=Sin[t^2];
y112[t_]:=Cos[11*t]+Sqrt[t] on one graph, {t,-2,2}, use PlotStyle→ {Blue, Red}
Background→LightYellow  AspectRatio→1  *)
```

[redacted]

[redacted]

[redacted]

[redacted]

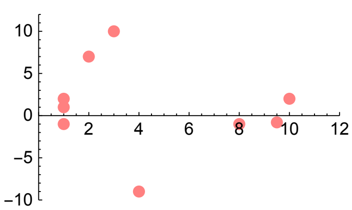



```
(*2D  Plotting lists *)
```

```
(*  Problem(10) ListPlot is designed for plotting a discrete data. The list is
 composed of the x and y coordinates. The size and color of the points are
 controlled by the PlotStyle Options.  Practice with the following list *)
```

```
G = {{1, 1}, {1, 2}, {1, -1}, {2, 7}, {3, 10}, {4, -9}, {8, -1}, {9.5, -0.8}, {10, 2}}
{{1, 1}, {1, 2}, {1, -1}, {2, 7}, {3, 10}, {4, -9}, {8, -1}, {9.5, -0.8}, {10, 2}}
```

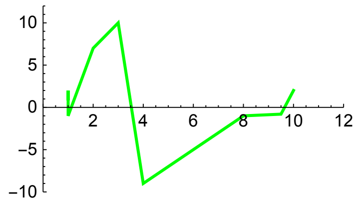
```
Plot1 = ListPlot[G, PlotStyle → {PointSize[0.04], Pink}, PlotRange → {{0, 12}, {-10, 12}}]
```




```
(* Note that the above plot has been now associated with the variable Plot1 *)
```

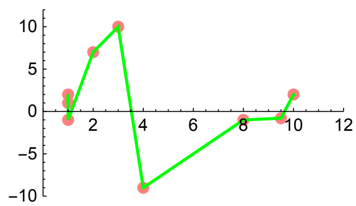
```
(*  Problem(11) Plot list G again with options PlotJoined->True,
PlotStyle->{Green ,Thickness[0.01]},
PlotRange->{{0,12},{-10,12}} and superimpose Plot1 and Plot2 *)
```

```
Plot2 = ListPlot[G, Joined → True,
  PlotStyle → {Green , Thickness[0.01]}, PlotRange → {{0, 12}, {-10, 12}}]
```



```
(* Superimpose Plot1 and Plot2 *)
```

```
Show[Plot1, Plot2]
```

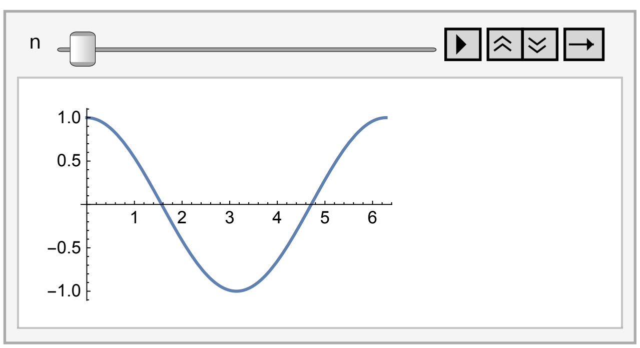


```
(* Animating 2D  Plots *)
```

```
(* Problem(12) Use Animate[Plot[function],{parameter,pmin,pmax,step}]
 to animate Cos[n x] {x,0,2Pi} {n,1,6,1}
 from 1 to 6 with the step 1 *)
```

```
f16[x_, n_] := Cos[n x]
```

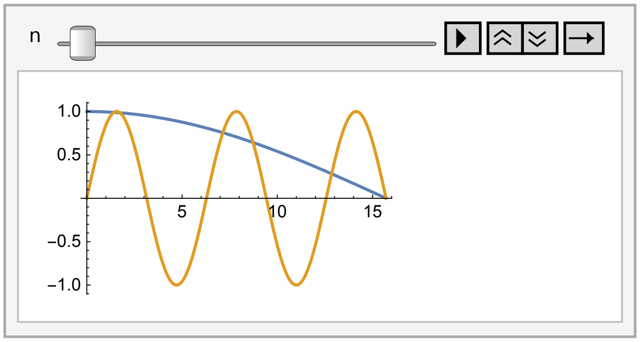
```
Animate[Plot[f16[x, n], {x, 0, 2 Pi}], {n, 1, 6, 1}, AnimationRunning → False]
```




```
(* Problem(13) Use Animate[Plot[function],{parameter,pmin,pmax,step}] to animate
 two explicit functions Cos[n x/10] and Sin[n^2 x]  {x,0,5Pi} {n,1,10,1} *)
```

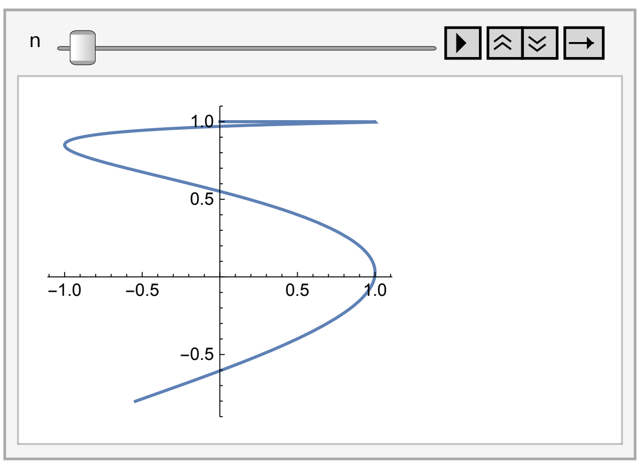
[redacted]

[redacted]




```
(* Problem(14) Use ParametricPlot to
  animate a parametric plot of a function given by
  xp[t_,n_]:=Sin[2t*n],yp[t_,n_]:=Cos[t^2*n/10],
{t,0,5} {n,1,10,1}.Use PlotPoints→100 *)
```

[redacted]

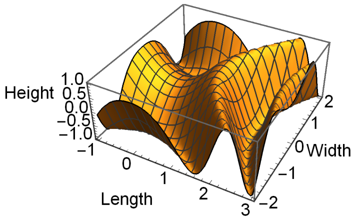



```
(* 3D  Plots *)
```

```
(* Problem(15) Plot a  3D function  given by  Sin[x^2-y^2]
 on {x,-1,3} {y,-2,2} and note options such as  AxesLabel and
 the number of points in each direction given by PlotPoints. *)
```

```
f19[x_, y_] := Sin[x^2 - y^2]
```

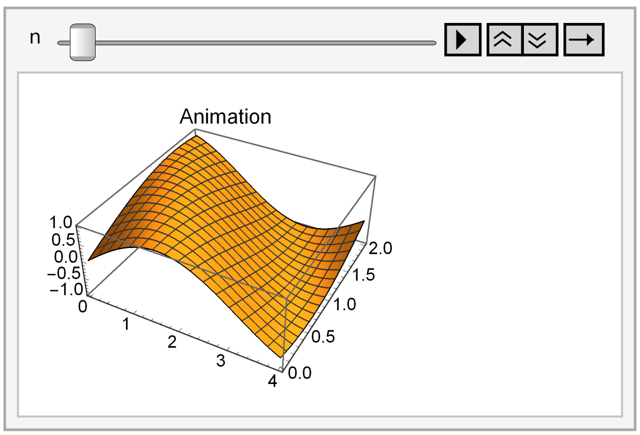
```
Plot3D[f19[x, y], {x, -1, 3}, {y, -2, 2},
 PlotPoints → {20, 20}, AxesLabel → {"Length", "Width", "Height"}]
```




```
(* Problem(16) Animate a family of surfaces given by Sin[x+y*n] on {x,0,4},
{y,0,2} {n,1,15,2}*)
```

```
f21[x_, y_, n_] := Sin[x + y * n]
```

```
Animate[Plot3D[f21[x, y, n], {x, 0, 4}, {y, 0, 2}, PlotPoints → 40, PlotLabel → "Animation"],
 {n, 1, 15, 2}, AnimationRunning → False]
```

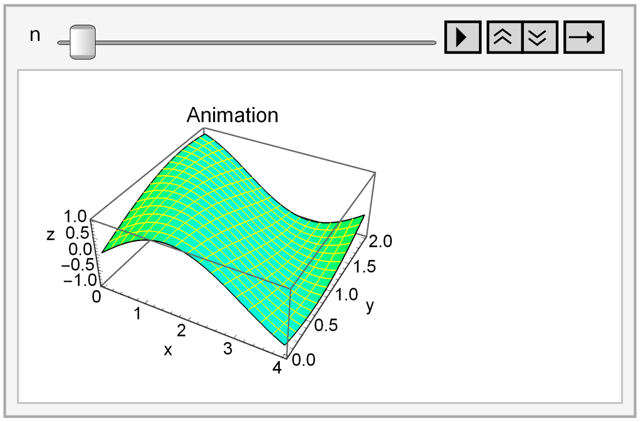



```
(* The entire set of options is given using: *)
```

```
Options[Plot3D];
```

```
(* Problem(17) Beatify the graph above. Select 3 additional options or change
 the existing ones and animate the result. Your graph may look different *)
```

[redacted]




```
(* Your graph may look different *)
```

```
(* Problem(18) Using ParametricPlot3D plot a spiral below  *)
```

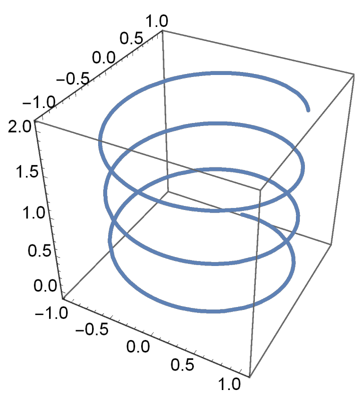
```
x22[u_] := Sin[u]

y22[u_] := Cos[u]

z22[u_] := u/10

spiral[u_] := {x22[u], y22[u], z22[u]}        (*vector function *)

 ParametricPlot3D[spiral[u], {u, 0, 20}]
```



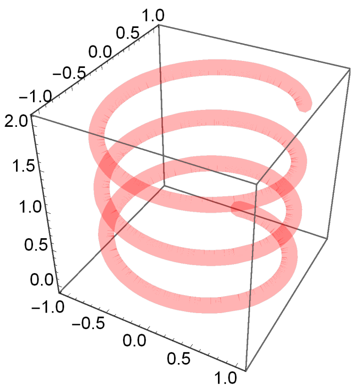
```
(* Problem (19) Beatify the graph using 3 new
 options. Use Options[ParametricPlot3D] and  Mathematica help,
for example, change PlotStyle→  AxesLabel→ and Opacity.  *)
```

```
(* The entire set of options is given using: *)
```

```
Options[ParametricPlot3D];
```

```
(* your graphs may look different *)
```

[redacted]




```
(* Problem(20) Animate a parametric function
       x23[u_,v_]:=u
        y23[u_,v_]:=v
        z23[u_,v_,n_]:=n*(u^2 + v^2)/10
 on 1 graph , n is the animation parameter {n,1,3,0.5}.  Fix the PlotRange →
     {{-5, 5}, {-5, 5}, {0, 10}}) to
  avoid changing the graphics box. Use PlotPoints→20 *)
```

[redacted]

```
[redacted] {u, -5, 5},
[redacted] {v, -5, 5} [redacted] {{-5, 5}, {-5, 5}, {0, 15}} [redacted]
```