Tutorial 2 - Lecture

In[10]:=
```
Solve[x^2 + a x - 1 == 0, x]
```

Out[10]= $\left\{\left\{x \to \frac{1}{2}\left(-a - \sqrt{4 + a^2}\right)\right\}, \left\{x \to \frac{1}{2}\left(-a + \sqrt{4 + a^2}\right)\right\}\right\}$

In[11]:=
```
Eqn1[x_, y_] := x + y == 0
Eqn2[x_, y_] := x - y == 2
sysEqn = Eqn1[x, y] && Eqn2[x, y];
```

In[14]:=
```
Solve[sysEqn, {x, y}]
Solve[x + y == 0 && x - y == 2 , {x, y}]
```

Out[14]= $\{\{x \to 1, y \to -1\}\}$

Out[15]= $\{\{x \to 1, y \to -1\}\}$

In[16]:=
```
Solve[(x^2 + 2) (x^2 - 2 ) == 0, x ∈ Reals]
```

Out[16]= $\left\{\left\{x \to -\sqrt{2}\right\}, \left\{x \to \sqrt{2}\right\}\right\}$

In[17]:=
```
diffEqn1[f_, t_] := f'[t] == r f[t]
```

In[18]:=
```
DSolve[diffEqn1[f, t], f[t], t]
solDiff = DSolve[ {diffEqn1[f, t], f[0] == F}, f[t], t]
diffEqn1[f, t] /. solDiff[[1]]
```

Out[18]= $\left\{\left\{f[t] \to e^{r t} C[1]\right\}\right\}$

Out[19]= $\left\{\left\{f[t] \to e^{r t} F\right\}\right\}$

Out[20]= $f'[t] == e^{r t} F r$

In[21]:=
```
expRes = Series[Exp[x], {x, 0, 10}]
Normal[expRes]
serRes = Series[f[x], {x, a, 2}]
```

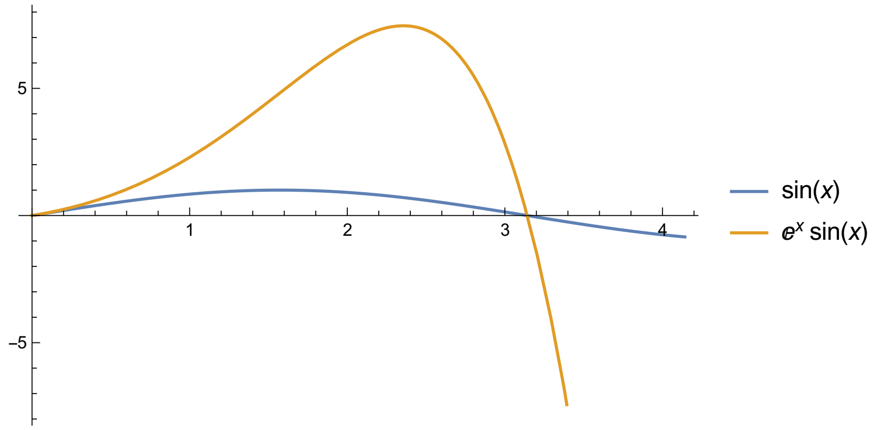
Out[21]= $1 + x + \frac{x^2}{2} + \frac{x^3}{6} + \frac{x^4}{24} + \frac{x^5}{120} + \frac{x^6}{720} + \frac{x^7}{5040} + \frac{x^8}{40320} + \frac{x^9}{362880} + \frac{x^{10}}{3628800} + O[x]^{11}$

Out[22]= $1 + x + \frac{x^2}{2} + \frac{x^3}{6} + \frac{x^4}{24} + \frac{x^5}{120} + \frac{x^6}{720} + \frac{x^7}{5040} + \frac{x^8}{40320} + \frac{x^9}{362880} + \frac{x^{10}}{3628800}$

Out[23]= $f[a] + f'[a]\,(x - a) + \frac{1}{2} f''[a]\,(x - a)^2 + O[x - a]^3$

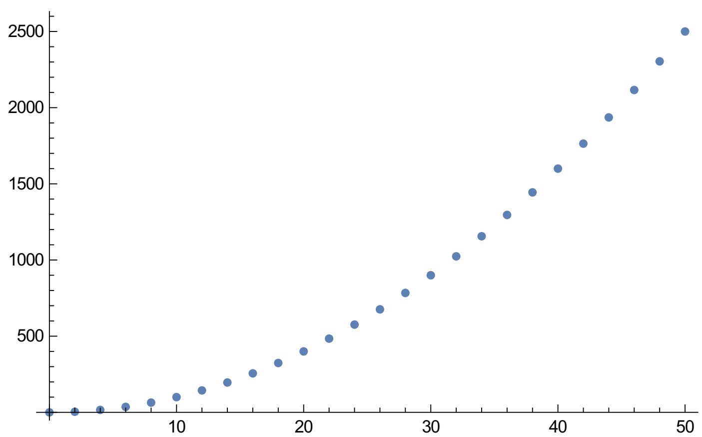
In[24]:=
```
plot1 = Plot[{Sin[x], E^x * Sin[x]}, {x, 0, π + 1}, PlotLegends → "Expressions"]
(*Export["Plot1.pdf", plot1]
 Directory[]*)
```

Out[24]=



In[25]:=
```
dataStruct = Table[{i, i^2} , {i, 0, 50, 2}];
plot2 = ListPlot[dataStruct]
(*Export["Plot2.pdf", plot2]*)
```

Out[26]=



Tutorial 2 - Exercises

In[27]:=
```
Solve[x + b y - c z == 0 && x + c z == 5 && a x - b y == 4, {x, y, z}]
```

Out[27]= $\left\{\left\{x \to \frac{9}{2+a},\ y \to -\frac{8-5a}{(2+a)\,b},\ z \to -\frac{-1-5a}{(2+a)\,c}\right\}\right\}$

In[28]:=
```
                    (*Unsupress ; for output*)
Solve[x^2 + 2 y^2 == 3681 && x > 0 && y > 0, {x ∈ Integers, y ∈ Integers}];
Solve[x^2 + 2 y^2 == 3681 && x > 0 && y > 0, {x ∈ Integers, y ∈ Reals}];
```

In[30]:=

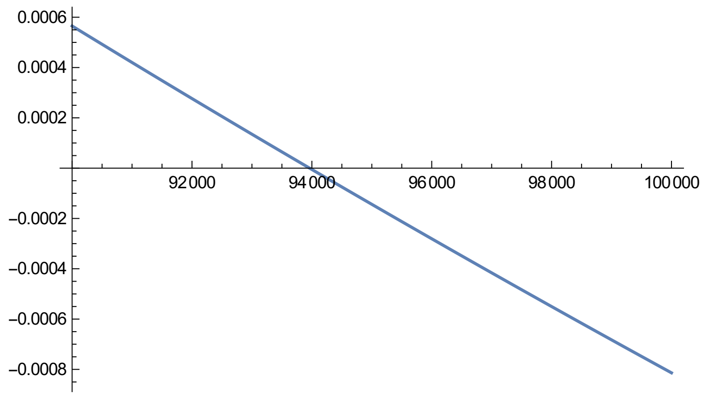
```
eqns = {
   μ ∂μ g1[μ] == (41 / 6) (g1[μ]^3 / (16 π^2)),
   μ ∂μ g2[μ] == -(19 / 6) (g2[μ]^3 / (16 π^2)),
   μ ∂μ g3[μ] == -7 (g3[μ]^3 / (16 π^2)),
   μ ∂μ y[μ] == ((9 y[μ]) / 2 - (17 g1[μ]^2) / 12 - (9 g2[μ]^2) / 4 - 8 g3[μ]^2) y[μ] / (16 π^2),
   μ ∂μ λ[μ] == (1 / (16 π^2)) ((3 g1[μ]^4) / 8 + (3 g1[μ]^2 g2[μ]^2) / 4 +
        (9 g2[μ]^4) / 8 - 6 y[μ]^4 - (3 g1[μ]^2 + 9 g2[μ]^2 - 12 y[μ]^2) λ[μ] + 24 λ[μ]^2)
  };

μMax = 10^5
numSoln =
 NDSolve[{eqns, g1[80] == 0.35, g2[80] == 0.62, g3[80] == 1.22, y[80] == 1, λ[80] == 0.13},
  {g1, g2, g3, λ, y}, {μ, 80, μMax}]

Plot[{λ[μ]} /. numSoln, {μ, 9 * 10^4, μMax}]
μSoln = FindRoot[(λ[μ]) /. numSoln[[1, 4]], {μ, 100}]
λ[μ] /. numSoln /. μSoln
```

Out[31]= 100 000

Out[32]=

```
{{g1 → InterpolatingFunction[ Domain: {{80., 1.00×10^5}} Output: scalar ],
  g2 → InterpolatingFunction[ Domain: {{80., 1.00×10^5}} Output: scalar ],
  g3 → InterpolatingFunction[ Domain: {{80., 1.00×10^5}} Output: scalar ],
  λ → InterpolatingFunction[ Domain: {{80., 1.00×10^5}} Output: scalar ],
  y → InterpolatingFunction[ Domain: {{80., 1.00×10^5}} Output: scalar ]}}
```

Out[33]=



Out[34]= $\{\mu \to 93962.5\}$

Out[35]= $\{-2.1684 \times 10^{-19}\}$

```
approx1 = Normal[Series[Sin[x], {x, 0, 1}]];
approx3 = Normal[Series[Sin[x], {x, 0, 3}]];
approx5 = Normal[Series[Sin[x], {x, 0, 5}]];


For[xi = 1.0, xi ≤ 2.5, xi = xi + 0.5,

 Print["Sin(x) value :", Sin[xi]];
 Print["Sin(x) To O(x^1) is accurate to : ",
  Abs[(Sin[x] - approx1) / Sin[x] * 100] /. {x → xi}, "% at x=", xi];
 Print["Sin(x) To O(x^3) is accurate to : ",
  Abs[(Sin[x] - approx3) / Sin[x] * 100] /. {x → xi}, "% at x=", xi];
 Print["Sin(x) To O(x^5) is accurate to : ",
  Abs[(Sin[x] - approx5) / Sin[x] * 100] /. {x → xi}, "% at x=", xi];
 Print[""]
]
plt1 = Plot[{approx1, approx3, approx5, Sin[x]},
   {x, 0, π}, PlotLegends → "Expressions" ];
lstPlt = ListPlot[{{1.5, Sin[x] /. {x → 1.5}}, {1.5, approx1 /. {x → 1.5}},
    {1.5, approx3 /. {x → 1.5}}, {1.5, approx5 /. {x → 1.5}}}];

Show[plt1, lstPlt]
```

```
Sin(x) value :0.841471
Sin(x) To O(x^1) is accurate to : 18.8395% at x=1.
Sin(x) To O(x^3) is accurate to : 0.967075% at x=1.
Sin(x) To O(x^5) is accurate to : 0.0232547% at x=1.

Sin(x) value :0.997495
Sin(x) To O(x^1) is accurate to : 50.3767% at x=1.5
Sin(x) To O(x^3) is accurate to : 6.01457% at x=1.5
Sin(x) To O(x^5) is accurate to : 0.329452% at x=1.5

Sin(x) value :0.909297
Sin(x) To O(x^1) is accurate to : 119.95% at x=2.
Sin(x) To O(x^3) is accurate to : 26.6833% at x=2.
Sin(x) To O(x^5) is accurate to : 2.64335% at x=2.

Sin(x) value :0.598472
Sin(x) To O(x^1) is accurate to : 317.73% at x=2.5
Sin(x) To O(x^3) is accurate to : 117.405% at x=2.5
Sin(x) To O(x^5) is accurate to : 18.5745% at x=2.5
```