Calculator

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Note: remove/add “ ; ” in order to see/hide the output of the desired cell

Derivatives

In[1]:=
```
(*Function to derive*)
f = Tan[Log[x^(-1/3)]];
Print["The function to derive is: ", f]
(*1st derivative*)
S = D[f, x];
Print["The 1st derivative of ", f, " is: ", S]
(*2nd derivative*)
S2 = D[D[f, x], x] ;
Print["The 2nd derivative of ", f, " is: ", S2]
```

The function to derive is: $\mathrm{Tan}\left[\mathrm{Log}\left[\frac{1}{x^{1/3}}\right]\right]$

The 1st derivative of $\mathrm{Tan}\left[\mathrm{Log}\left[\frac{1}{x^{1/3}}\right]\right]$ is: $-\frac{\mathrm{Sec}\left[\mathrm{Log}\left[\frac{1}{x^{1/3}}\right]\right]^2}{3\,x}$

The 2nd derivative of $\mathrm{Tan}\left[\mathrm{Log}\left[\frac{1}{x^{1/3}}\right]\right]$ is: $\frac{\mathrm{Sec}\left[\mathrm{Log}\left[\frac{1}{x^{1/3}}\right]\right]^2}{3\,x^2}+\frac{2\,\mathrm{Sec}\left[\mathrm{Log}\left[\frac{1}{x^{1/3}}\right]\right]^2\,\mathrm{Tan}\left[\mathrm{Log}\left[\frac{1}{x^{1/3}}\right]\right]}{9\,x^2}$

Integrals

In[7]:=
```
(*Function to integrate*)
f = 1/(x^2 + 1);
Print["The function to integrate is: ", f]
(*Indefinite integral*)
S = Integrate[f, x];
Print["The integral of ", f, " is: ", S]
(*Definite integral a → b*)
a = 0;
b = 1;
S2 = Integrate[f, {x, a, b}];
Print["The integral of ", f, " between ", a, " and ", b, " is: ", S2]
(*Wavefunction normalization*)
c = Infinity;
S3 = Integrate[f * Conjugate[f], {x, -c, c}];
Print["The normalization factor of the wavefunction ", f, " is: ", S3]
```

The function to integrate is: $\frac{1}{1+x^2}$

The integral of $\frac{1}{1+x^2}$ is: ArcTan[x]

The integral of $\frac{1}{1+x^2}$ between 0 and 1 is: $\frac{\pi}{4}$

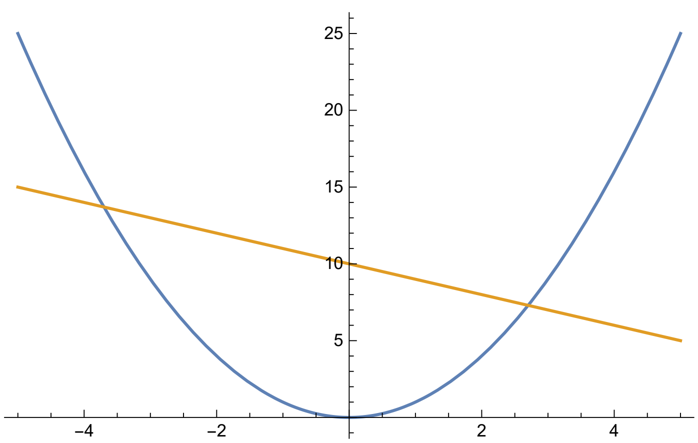
The normalization factor of the wavefunction $\frac{1}{1+x^2}$ is: $\frac{\pi}{2}$

Plots

In[18]:=

```
(*1st function to plot*)
f1 = x^2;
(*1st function to plot*)
f2 = 10 - x;
(*Plot range*)
a = 5;
(*2D Plot*)
Plot[{f1, f2}, {x, -a, a}]
(*Approx. value of intersection between functions*)
b = 2;
(*Find the exact intersection point value*)
S = FindRoot[f1 == f2, {x, b}];
Print["The intersection point between ", f1, " and ", f2, " near x=", b, " is: ", S]
(*FOR Loop*)
b = Table[4 * (-1 + 2 * n), {n, 0, 1}];
S2 = FindRoot[f1 == f2, {x, b}];
Print["The intersection points between ", f1, " and ", f2, " near x=", b, " are: ", S2]
(*2D Plot*)
ContourPlot[Cos[x] + Cos[y], {x, -2 Pi, 2 Pi}, {y, -2 Pi, 2 Pi}, PlotLegends → Automatic]
(*3D Plot (sphere example)*)
f = x^2 + y^2 + z^2;
ContourPlot3D[f == 1, {x, -2, 2}, {y, -2, 2}, {z, -2, 2}]
```

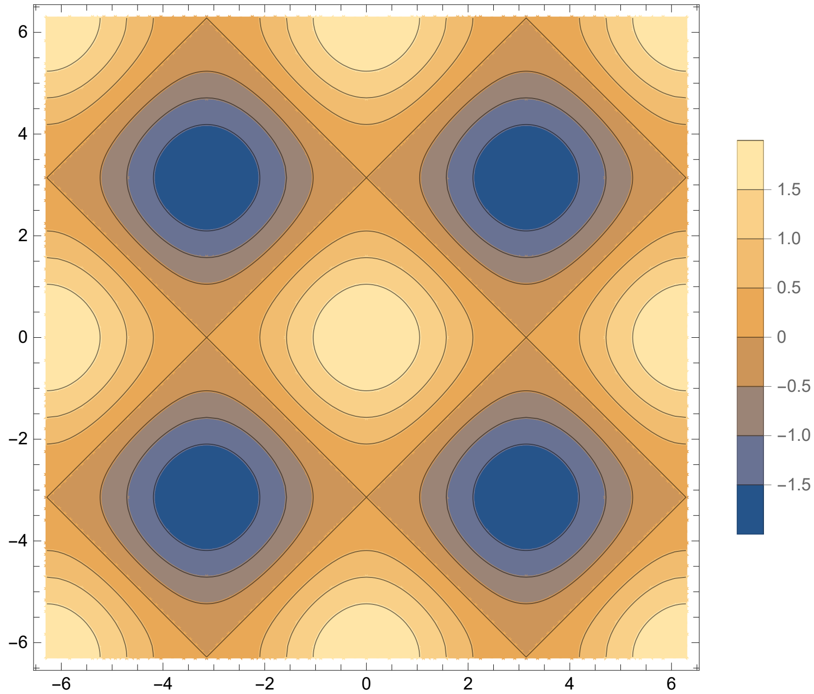
Out[21]=



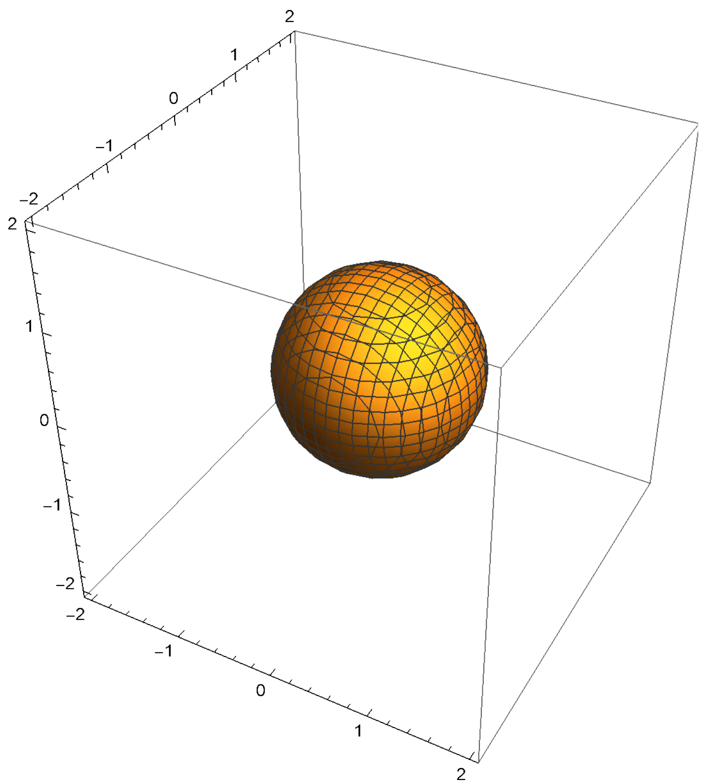
The intersection point between x^2 and $10 - x$ near x=2 is: {x → 2.70156}

The intersection points between x^2 and $10 - x$ near x={-4, 4} are: {x → {-3.70156, 2.70156}}

Out[28]=



Out[30]=



Eigenvalue problems

In[31]:=
```
(*Matrix*)
     0  1  2
H = -4  1  4;
    -5  1  7
H2 = MatrixForm[H];
Print["Matrix: ", H2]

(*En = eigenvalues (Energy)*)
(*c = eigenvectors*)
{En, c} = Eigensystem[H];
c = c[[Ordering[En]]];
En = En[[Ordering[En]]];
TableForm[En];
c = Transpose[c];
MatrixForm[c];
Print["1st eigenvalue: ", Part[En, 1]]
Print["1st eigenvector: ", Part[c, 1]]
Print["2nd eigenvalue: ", Part[En, 2]]
Print["2nd eigenvector: ", Part[c, 2]]
Print["3rd eigenvalue: ", Part[En, 3]]
Print["3rd eigenvector: ", Part[c, 3]]
```

Matrix: $\begin{pmatrix} 0 & 1 & 2 \\ -4 & 1 & 4 \\ -5 & 1 & 7 \end{pmatrix}$

1st eigenvalue: 1

1st eigenvector: {1, 1, 1}

2nd eigenvalue: 2

2nd eigenvector: {-1, 0, 1}

3rd eigenvalue: 5

3rd eigenvector: {1, 1, 2}

Matrix operations

```
In[46]:=
A = {{5, 0, 0}, {0, 1, 0}, {2, 0, 1}};
B = {{2, 0, 0}, {0, 2, 0}, {0, 0, 1}};
(*Addition*)
S = MatrixForm[A + B];
(*Multiplication*)
S2 = MatrixForm[A.B];
(*Normalization*)
S3 = MatrixForm[Normalize[B, Norm]];
(*Transpose*)
S4 = MatrixForm[Transpose[A]];
(*Determinant*)
S5 = Det[A];
(*Inverse*)
S6 = MatrixForm[Inverse[A]];
(*Characteristic Polynomial*)
S7 = CharacteristicPolynomial[A, x];
```

Systems of equations

In[55]:=
```
(*Solve single equation*)
Solve[x^2 + x == 0, x]
(*System to solve*)
(* x +  y +  z = 1 *)
(* 2x + 9y + 2z = 0 *)
(* 3x + 4y + 5z = 2 *)
```
$$A = \begin{pmatrix} 1 & 1 & 1 \\ 2 & 9 & 2 \\ 3 & 4 & 5 \end{pmatrix};$$
```
(*Variable names*)
```
$$V = \begin{pmatrix} x \\ y \\ z \end{pmatrix};$$
```
(*Right part of the equations*)
```
$$S = \begin{pmatrix} 1 \\ 0 \\ 2 \end{pmatrix};$$
```
(*With FindRoot*)
```
$$Pr = \text{FindRoot}\left[A.V == S, \left\{V, \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}\right\}\right]$$
```
(*With Solve*)
Solve[x + y + z == 1 && 2 x + 9 y + 2 z == 0 && 3 x + 4 y + 5 z == 2, {x, y, z}]
```

Out[55]= $\{\{x \to -1\}, \{x \to 0\}\}$

Out[59]= $\{\{\{x\}, \{y\}, \{z\}\} \to \{\{1.64286\}, \{-0.285714\}, \{-0.357143\}\}\}$

Out[60]= $\left\{\left\{x \to \frac{23}{14}, y \to -\frac{2}{7}, z \to -\frac{5}{14}\right\}\right\}$