Student Packages

Maple 2021 includes many updates to the Student package, including an entirely new ODEs package for students, the ability to see step-by-step solutions to various problems from algebra problems to solving ODEs, and improved access to Linear Algebra commands through the context panel. Maple 2021 also allows you to work with trig functions in degrees instead of radians.

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Student ODEs package

There is a new Student:-ODEs package for working with, plotting, and solving individual ordinary differential equations and systems of ordinary differential equations.

The package includes the following components:

- **ODESteps** shows the step-by-step solving of an ODE or system of ODEs in the following categories:

  - **First Order ODEs**
  - **Second Order ODEs**
  - **Cauchy-Euler Equations**
  - **First Order IVPs**
  - **Second Order IVPs**
  - **Series Solutions**
  - **Special Function Solutions**
  - **Systems of ODEs**
  - **Systems of ODEs with IVP**

- **Student[ODEs]** includes two subpackages. The first, Solve, consists of commands for solving ODEs and systems according to various methods:

  - **Bessel**
  - **CauchyEuler**
  - **Chebyshev**
  - **Exact**
  - **FirstOrder**
  - **FirstOrderLinear**
  - **HighOrder**
  - **ByLaplaceTransform**
  - **ByPerturbation**
  - **SecondOrder**
  - **LinearConstantCoefficients**
  - **Separable**
  - **BySeries**
  - **System**
  - **ByUndeterminedCoefficients**

- The second Student[ODEs] subpackage, ReduceOrder, consists of commands for reducing the order of ODEs using three possible methods:

  - **LinearParticularSolution**
  - **NoDependentVariable**
  - **NoIndependentVariable**

- There are also a number of extra commands which are useful in solving ODEs and systems interactively:
• **ODEPlot** produces an interactive plot of a 1st order differential equation system of two equations, along with controls to explore and manipulate the plot, or adjust the input ODE or system and its parameters.

**Note:** Open this help page as a worksheet in order to interact with the example below.

> with(Student:-ODEs):

\[ ODEPlot( ) \]

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**Solution Steps**

The Student Basics package includes new commands for stepping through arithmetic and algebra problems:

• **LongDivision** finds the solution to an arithmetic or polynomial long division problem.
• **FactorSteps** shows the steps in factoring a polynomial.
• **SolveSteps** shows the steps in solving an equation.
• **ODESteps** shows the steps in solving an ordinary differential equation (ODE).

Many other solution steps commands also produce better, more detailed steps in Maple 2021. See the Solution Steps page for more details.

There's a connection to the new product Maple Learn as well. This command can output a link to a Maple Learn document containing the solution steps. Maple Learn is a dynamic online environment for teaching and learning math, focused on high-school to second year university. For more about Maple Learn, visit [https://www.maplesoft.com/products/learn/](https://www.maplesoft.com/products/learn/)

### Working in Degrees

By default, Maple does trigonometric computations in radians. With the new Degrees package and commands for doing the trig functions in degrees, you can now work in degrees instead if you prefer.

These trig functions accept input in degrees instead of radians: cosd, secd, sind, cotd, tand, cscd

```
with(Degrees):

cosd(90);
0
```

(3.1)

```
sind(90);
1
```

(3.2)

```
plot(sind(x));
```

![Graph of sind(x)](image)
These inverse trig functions produce output in degrees instead of radians: \( \text{arccosd}, \text{arccotd}, \text{arccscd}, \text{arcsecd}, \text{arcsind}, \text{arctand} \)

\[
\text{arcsind}(\sin(30)) ;
\]

\[
30
\]

\[
\text{arccosd}(0) ;
\]

\[
90
\]

\[
\text{arcsind}(-1) ;
\]

\[
-90
\]

Commands in the Degrees package help with conversion back and forth from radians and degrees forms.

\[
\text{ConvertToDegreeForm}(\sin(x)) ;
\]

\[
\sin\left(\frac{180 x}{\pi}\right)
\]

\[
\text{ConvertToRadForm}(3.7) ;
\]

\[
\sin(x)
\]

After loading the Degrees package, some commands can work directly with the symbolic forms of degrees-based trig functions.

\[
\text{solve}(\cosd(x), x) ;
\]

\[
90
\]

\[
\int(\sin(x), x) ;
\]

\[
-\cosd(x)
\]

\[
\text{diff}(-\cosd(x), x) ;
\]

\[
\sin(x)
\]

\[
\text{trigsubs}(\sin(x)^2) ;
\]

\[
\left[1 - \cosd(x)^2, \frac{1}{2} - \frac{\cosd(2 x)}{2}\right]
\]

\[
\text{trigsubs}(\sin(180 (a + b)))
\]
Improvements to Linear Algebra and Student Linear Algebra

The SingularValues command has been added to the Student[LinearAlgebra] package. The main difference between this command and LinearAlgebra[SingularValues] is that the use of hardware floats and conjugates have been disabled by default. For example:

```plaintext
> with(Student[LinearAlgebra]) :

> A := Matrix([[1.0, -2.1], [3.6, 4.0]])

A :=

\[
\begin{bmatrix}
1.0 & -2.1 \\
3.6 & 4.0
\end{bmatrix}
\]  

> SingularValues(A, output = ['U', 'S', 'Vt'])

\[
\begin{bmatrix}
0.1923330297 & -0.9813297139 \\
-0.9813297139 & -0.1923330302
\end{bmatrix}
\begin{bmatrix}
5.468159000 \\
2.114057033
\end{bmatrix}
\begin{bmatrix}
-0.6108918810 & -0.7917140331 \\
-0.7917140331 & 0.6108918810
\end{bmatrix}
\]
```

To make the student experience more seamless, this Student version of SingularValues
is now used for all Student Linear Algebra > Solvers and Forms > Singular Value Decomposition entries in the Context Panel. The Frobenius Form and Smith Form entries have also been removed from the Context Panel for Student Linear Algebra to simplify the options, since they are usually not taught in a first or second course on Linear Algebra. On the other hand, entries for Adjoint, Characteristic Matrix, and Minimal Polynomial have been added to the main Context Panel for (non-Student) Linear Algebra to enhance the options available to more advanced users.