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.

Student ODEs package

Solution Steps

Working in Degrees

Improvements to Linear Algebra and Student Linear Algebra

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	First Order IVPs	Second Order ODEs
Second Order IVPs	Series Solutions	Special Function Solutions
Cauchy-Euler Equations	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:

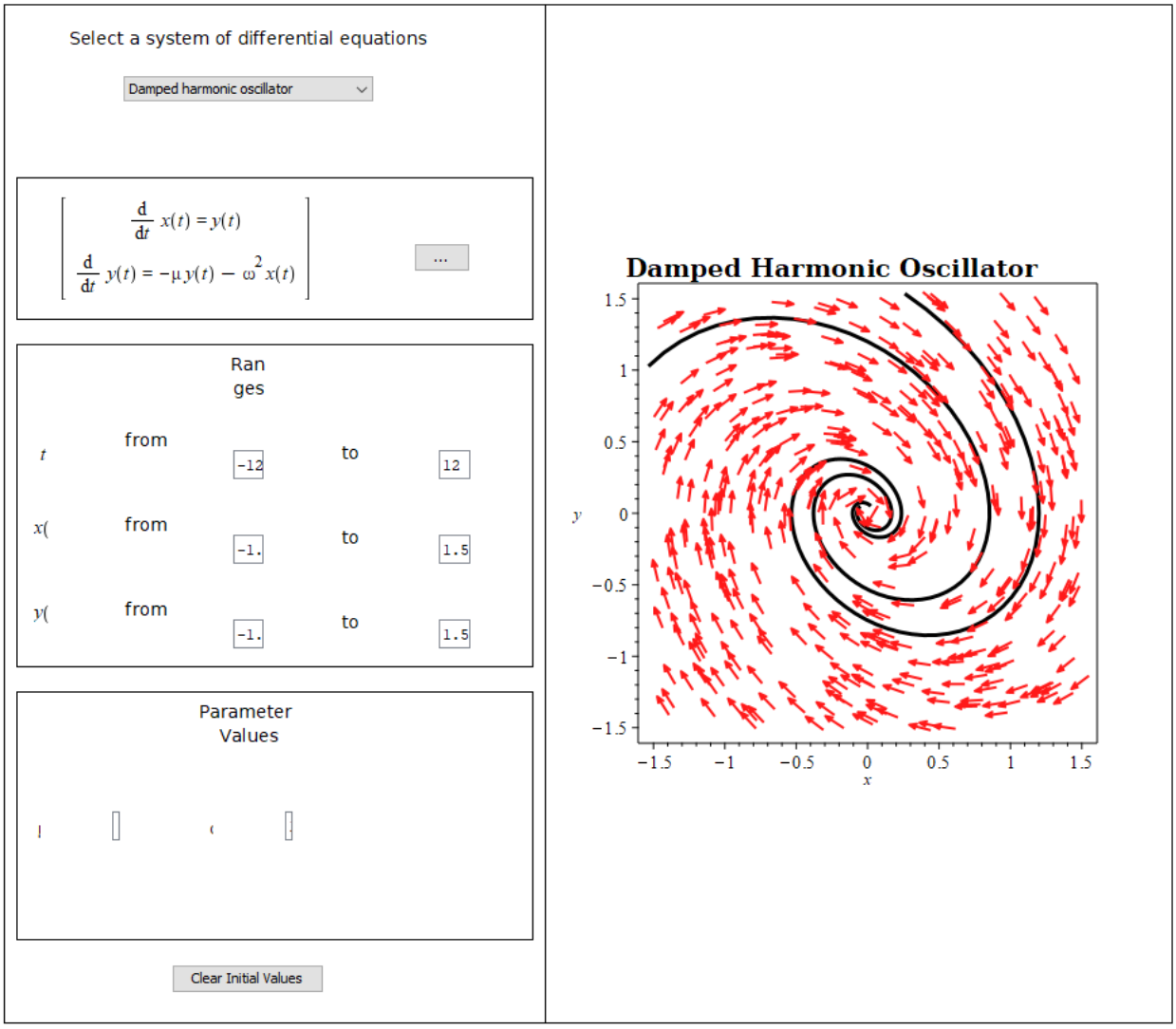
LinearParticularSolution	NoDependentVariable	NoIndependentVariable

- There are also a number of extra commands which are useful in solving ODEs and systems interactively:

ChangeVariables | DifferentialOrder | Integrate | IntegratingFactor
IsolateHighestDerivative | LinearForm | SeparateVariables | Solve
Test | Type

- 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( )
```



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/

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

$with(Degrees)$:

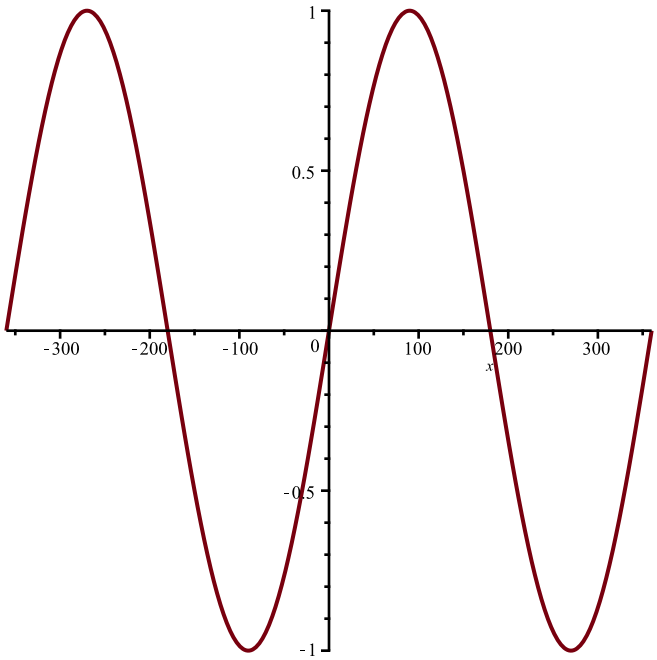
$cosd(90)$;

$$0 \quad \textbf{(3.1)}$$

$sind(90)$;

$$1 \quad \textbf{(3.2)}$$

$plot(sind(x))$;



$$sind(400);$$

$$sind(40) \tag{3.3}$$

These inverse trig functions produce output in degrees instead of radians: arccosd, arccotd, arccscd, arcsecd, arcsind, arctand

$$arcsind(sind(30));$$

$$30 \tag{3.4}$$

$$arccosd(0);$$

$$90 \tag{3.5}$$

$$arcsind(-1);$$

$$-90 \tag{3.6}$$

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

$$ConvertToDegreeForm(\sin(x));$$

$$sind\left(\frac{180\,x}{\pi}\right) \tag{3.7}$$

$$ConvertToRadForm(\mathbf{(3.7)});$$

$$\sin(x) \tag{3.8}$$

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

$$solve(\ cosd(x), x\ );$$

$$90 \tag{3.9}$$

$$int(\ sind(x), x\ );$$

$$-cosd(x) \tag{3.10}$$

$$diff\,(-cosd(x), x\ );$$

$$sind(x) \tag{3.11}$$

$$trigsubs\left(sind(x)^2\right);$$

$$\left[1 - cosd(x)^2,\ \frac{1}{2} - \frac{cosd(2\,x)}{2}\right] \tag{3.12}$$

$$trigsubs(sind(180\ (a+b)))$$

$$\left[sind(180\,a + 180\,b),\ 2\,sind(90\,a + 90\,b)\,cosd(90\,a + 90\,b),\ sind(180\,a + 180\,b),\ \frac{2\,tand(90\,a + 90\,b)}{1 + tand(90\,a + 90\,b)^2},\ -\frac{I}{2}\left(e^{\frac{I}{180}\pi(180\,a + 180\,b)} - e^{-\frac{I}{180}\pi(180\,a + 180\,b)}\right)\right] \tag{3.13}$$

$expand(sind(x + y))$

$$sind(x)\,cosd(y) + cosd(x)\,sind(y) \tag{3.14}$$

$evalf(sind(12));$

$$0.2079116909 \tag{3.15}$$

$Simplify(\sin(x)^2 + \cos(x)^2);$

$$1 \tag{3.16}$$

$\mathrm{floor}(sind(12));$

$$\lfloor sind(12) \rfloor \tag{3.17}$$

$Simplify(\mathrm{floor}(sind(12)));$

$$0 \tag{3.18}$$

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:

> $with(Student[LinearAlgebra])$:

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

$$A := \begin{bmatrix} 1.0 & -2.1 \\ 3.6 & 4.0 \end{bmatrix} \tag{4.1}$$

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

$$\begin{bmatrix} 0.1923330297 & -0.9813297139 \\ -0.9813297136 & -0.1923330302 \end{bmatrix}, \begin{bmatrix} 5.468159000 \\ 2.114057033 \end{bmatrix}, \begin{bmatrix} -0.6108918810 & -0.7917140331 \\ -0.7917140331 & 0.6108918810 \end{bmatrix} \tag{4.2}$$

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.