Log in to your umich account, open Maple (from the dock or applications folder), then click on File, then select New, then click on Worksheet Mode. Type each command below and hit return to get the result. You may use the arrow keys or mouse to maneuver.

**arithmetic**

> 2+2
> 2^6
> sqrt(64)
> a:=3  
*Be sure to include the colon before the equal sign.*
> a^2
> Pi
> evalf(Pi)
*evalf = evaluate*

You can put several commands on a single line.

> sin(Pi); cos(Pi); tan(Pi)
> erf(0); erf(1); evalf(erf(1))
> abs(-1)
> I; I^2
*I = \sqrt{-1}, an imaginary number, written “i” in math books*
> exp(1); evalf(exp(1))
> exp(Pi*I)
*that’s right, e^{\pi i} = -1; you’ll learn why in December*

**limits**

> with(student)  
*This loads the student commands.*
> Limit(1/x,x= infinity)
*Use the right arrow key after 1/x.*
> value(%)  
*“%” refers to the expression on the previous line.*
> limit(1/x,x= infinity)
*Limit displays the limit, limit evaluates it.*
> limit(1/x,x=0)
> limit(1/x,x=0, left); limit(1/x,x=0, right)
*This gives the one-sided limits.*
> limit(x*exp(-x),x= infinity)
*Maple knows l’Hopital’s rule.*

**plotting**

At the top of the screen, click Maple 2018, then Preferences, then Display, then in the Plot display menu, change Inline to Window, and click Apply to Session. This opens each plot in a separate window.

> plot(1/x,x=0..5,y=0..5)
*After viewing, close the window to avoid clutter.*
> plot([1/x,1/x^2],x=0..5,y=0..5)
*Which curve is $1/x$? \ldots $1/x^2$?*
> plot(tan(x),x=-2*Pi..2*Pi,y=-4..4)
*tan(x) has vertical asymptotes at $x = \pm \pi/2,$ \ldots*
> limit(tan(x),x=Pi/2)
> limit(tan(x),x=Pi/2, left); limit(tan(x),x=Pi/2, right)
> plot(arctan(x), x=-2*Pi..2*Pi,y=-4..4)
*arctan(x) has horizontal asymptotes as $x \to \pm \infty$*
> limit(arctan(x),x= infinity)
> plot([exp(-x),exp(-x^2)],x=0..3,y=0..1)
*Which curve is $e^{-x}$? \ldots $e^{-x^2}$?*

The next plot is an example of a parametric curve using polar coordinates.

> plot([sin(4*t),t,t=0..2*Pi],coords=polar)
*Try changing 4 to 7 (for example).*

Maple has a help facility, e.g. the next command opens a window with help about plotting.

> ?plot
Riemann sums

This plots the right-hand Riemann sum for \( \int_0^1 x^2 \, dx \) with \( n = 2 \).

Repeat for \( n = 4, 8, 16 \) (use the arrow keys or mouse to maneuver). Do the results converge to the correct value as \( n \) increases? The commands for the left-hand and midpoint Riemann sums are leftbox, leftsum, middlebox, middlesum. Repeat the previous commands, substituting left and middle in place of right. For a given value of \( n \), which sum is the most accurate?

antiderivatives

\( \int x^n \, dx \); value(%)

\( \int (\ln(x)) \, dx \); diff(%,x)

\( \int (1/\sqrt{x^2+1}) \, dx \); diff(%,x)

\( \int (\exp(-x^2)) \, dx \); diff(%,x)

\( f:=x^3/\sqrt{1-x^8} \); int(f,x) We can also substitute to find the antiderivative, as follows.

\( a:=\text{Int}(f,x) \)

\( b:=\text{changevar}(x^4=a,a) \)

\( c:=\text{value}(b) \)

\( d:=\text{subs}(u=x^4,c); \text{diff}(d,x) \)

We’ll discuss \( \sinh(x) \) later in the semester.

\( \int (\exp(-x^2)) \, dx \);

\( \text{recall} : \text{erf}(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} \, dt \)

\( f:=x^3/\sqrt{1-x^8} \); int(f,x) We can also substitute to find the antiderivative, as follows.

\( a:=\text{Int}(f,x) \)

\( b:=\text{changevar}(x^4=u,a) \)

\( u = x^4, \, du = 4x^3 \, dx \)

\( c:=\text{value}(b) \)

\( d:=\text{subs}(u=x^4,c); \text{diff}(d,x) \)

This returns to the original variable and checks the answer.

definite integrals

\( \int (x-x=a..b) \); value(%)

\( a:=a'; \, b:=b'; \text{Int}(x=a..b); \text{value}(%) \)

\( \int (\sqrt{1-x^2}) \, dx = 1..1 \); value(%)

\( \int (1/x^2, x=1..\infty) \); value(%)

\( \int (1/x^2, x=-1..1) \); value(%)

\( \int (\exp(-x)) \, dx = 1..\infty \); value(%)

\( \int (\exp(-x)) \, dx = 0..\infty \); value(%)

\( \int (\exp(-x)) \, dx = 0..\infty \); value(%)

\( \int (\exp(-x^2)) \, dx = 0..\infty \); value(%)

Maple knows integration by parts.

\( \int (\exp(-x^2)) \, dx \)

This requires multivariable calculus (Math 255).

surfaces in 3D (try these for fun, use the mouse to rotate the surface)

\( \text{with(plots)} \)

\( \text{sphereplot}(1, \theta=0..\pi, \phi=0..\pi) \quad \text{sphere}, \theta \text{ is longitude, } \phi \text{ is latitude} \)

\( \text{plot3d}(x^2-y^2, x=-1..1, y=-1..1) \quad \text{saddle} \)

\( \text{plot3d}([r*\cos(\theta), r*\sin(\theta), r], r=0..1, \theta=0..2*\pi) \quad \text{cone} \)

\( \text{plot3d}([[1+2*\cos(a)], [2*\sin(a), (1+2*\cos(a))\sin(b)], a=0..2*\pi, b=0..2*\pi]) \quad \text{torus} \)

Homework Assignment (hand in with hw4 on Tuesday Oct 2)

In class and on hw we computed Riemann sums for the integral \( I = \int_0^1 f(x) \, dx \) with \( f(x) = e^x, e^{-x} \), and found that if \( \Delta x \) decreases by a factor of 1/2, then the error in the right-hand Riemann sum \( R_n \) decreases by about 1/2 and the error in the midpoint Riemann sum \( M_n \) decreases by about 1/4. Is the same true for \( f(x) = \sqrt{x} \)? To answer this question, construct a table with the following data (you may use Maple or a calculator), column 1: \( n \) (take \( n = 2, 4, 8, 16 \)), column 2: \( \Delta x \), column 3: \( R_n \), column 4: \( |I - R_n| \), column 5: \( M_n \), column 6: \( |I - M_n| \). For a given value of \( n \), which method gives a more accurate answer? How do the results for \( \sqrt{x} \) compare with the results for \( e^x, e^{-x} \)? What is similar? . . . different? Explain your observations.