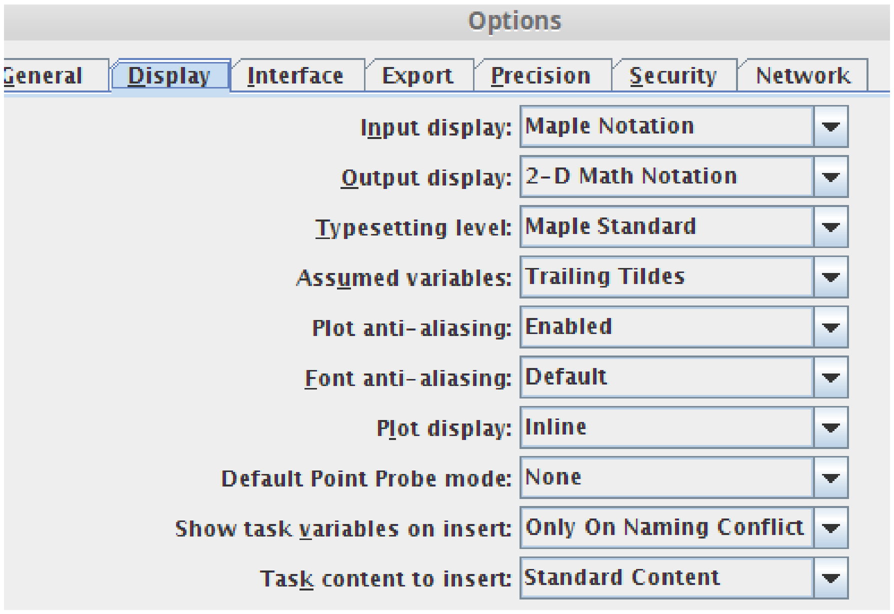
Maple Lab 1
Math 2270-2 Spring 2017

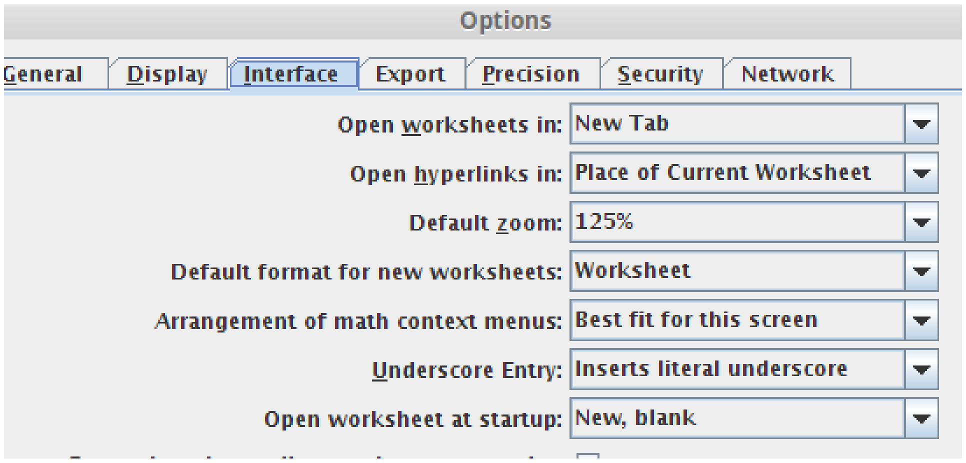
Your **Maple** typing lesson to be done in the computer lab classroom LCB 115. If you missed it, then do it on your own in the Math Center computer lab, lowest floor between buildings JWB and LCB. Report by email how it worked out.

Maple requires some setup to be useful as a programming tool. Expected is RED print for keystrokes and BLUE print for Maple's formatted output. The recommendations:

Open the Tools menu and select the **Options** item. A popup window will appear. Change the Maple option tabs **Display** and **Interface** to match the following screen shots:



Input display: Maple Notation
Output display: 2-D Math Notation
Typesetting level: Maple Standard
Assumed variables: Trailing Tildes
Plot anti-aliasing: Enabled
Font anti-aliasing: Default
Plot display: Inline
Default Point Probe mode: None
Show task variables on insert: Only On Naming Conflict
Task content to insert: Standard Content



Open worksheets in: New Tab
Open hyperlinks in: Place of Current Worksheet
Default zoom: 125%
Default format for new worksheets: Worksheet
Arrangement of math context menus: Best fit for this screen
Underscore Entry: Inserts literal underscore
Open worksheet at startup: New, blank

To make these settings your defaults for all future use of Maple on this computer, click the **Apply Globally** button at the bottom of the **Options** tab.

```
restart:
# First Computer Lab
# Math 2270-2 Spring 2017
# Use the pound sign "#" to make a comment. What follows # on that line is a comment.
# Use comments to put your name and the name of the assignment at the top of the worksheet.
# Use comments to introduce each problem. or major step.
# End each non-comment line with a semicolon (;) or a colon (:)
# A semicolon causes BLUE echo and a colon causes no echo.
```

```
;
2+2;
3*5;
3^6*5/2;
7*(9+11);
# Use the assignment operator ":=" (colon equals) to assign a value to a symbol.
x:=2;
x+3;
# Define a column vector with angle brackets.
v:=<1,2,3>;
w:=<1,0,0>;
#Use a period "." for dot products.
v.w;
v.v;
# Define a matrix using column vectors separated by a bar "|".
M:=<v|w|<1,1,0>>;
# Matrix multiplication and Matrix times vector also use a
period.
M.M;
M.v;
N:=<<1,2,3,4>|<5,6,7,8>|<9,10,11,12>>;
N.M;
M.N; # This should not work, the matrices have incompatible shapes.
# Matrices can also be entered in rows using square brackets with the "Matrix" function.
P:=Matrix([[1,2,3],[4,5,6],[7,8,9]]);
# Alternate entry by columns, then transpose the matrix.
P1:=<1,2,3|4,5,6|7,8,9>^+;
# Linear combinations of matrices can be computed using expected math-style operations.
2*P;
P-M;
5*P-3*M;
# The percent sign "%" recalls the result of the previous computation.
#This is useful for multi-step computations like Gaussian Elimination.
# Use Gaussian Elimination to reduce the following matrix to upper triangular form.
Q:=<<1,2,1>|<2,3,4>|<1,1,1>>;
E1:=<<1,-2,-1>|<0,1,0>|<0,0,1>>;
Q1:=%.Q; # Left multiple by Elimination matrix E1
E2:=<<1,0,0>|<0,1,2>|<0,0,1>>;
Q2:=%.Q1; # Left multiple by Elimination matrix E2
# "%" recalls the result of the last computation.
# "%%" recalls the result of the second to last computation.
# "%%%" recalls the result of the third to last computation.
# You can use up to 3 percent signs at a time.
%,%%,%%%;
# Using % is not recommended for rookies. Use instead LABELS, like (10).
#
# The matrix Q has three non-zero pivots, so it is invertible.
# You can ask for the inverse using two different notations.
# An answer check is inverse(Q) times Q = identity matrix.
Q^(-1); 1/Q; %.Q;
```

```
# We can also do symbolic computations.
# undefine symbols before starting ..
a:='a':b:='b':c:='c':
A:=Matrix([[a[1,1],a[1,2]],[a[2,1],a[2,2]]]);
B:=Matrix([[b[1,1],b[1,2]],[b[2,1],b[2,2]]]);
C:=Matrix([[c[1,1],c[1,2]],[c[2,1],c[2,2]]]);
# Verify associativity of matrix multiplication.
(A.B).C-A.(B.C);
# We expect to get the zero matrix.
# To encourage the maple engine to simplify algebraic expressions, use:
simplify(%);
# It's good practice to do elimination step by step, but of
# course we would like Maple to do it for us.
# Let's load the maple library for linear algebra, as follows.
# Only do this once per session. The colon is used remove BLUE printout.
with(LinearAlgebra):
# Perform Elimination, showing only the answer, no steps.
# We choose the system Qx=b, where b:=<1,2,3>:
b:=<1,2,3>:
Q;
Aug:=<Q|b>;
GaussianElimination(Aug);
ReducedRowEchelonForm(Aug);
#
 # Elimination steps with LinearAlgebra functions. Definitions:
 combo:=(a,s,t,c)->LinearAlgebra[RowOperation](a,[t,s],c);
 swap:=(a,s,t)->LinearAlgebra[RowOperation](a,[t,s]);
 mult:=(a,t,c)->LinearAlgebra[RowOperation](a,t,c);
 A1:=<Q|b>;           # Do 9-10 steps with combo, swap, mult.
 A2:=combo(A1,1,2,-2); # Invent the other steps.
# This is a good way to do homework problems. Answer check:
 ReducedRowEchelonForm (A1);
# Lay Linalg Package
# Functions: swap, replace, scale have different syntax than swap, combo, mult
# but give the same elementary row operation results.
with(laylinalg):
A1:=<Q|b>;             # Do 9-10 steps with swap, replace, scale
A2:=replace(A1,2,-2,1); # Means replace row 2 by row 2 plus (-2) times row 1
A3:=swap(A2,1,2); # Swap rows 1 and 2 of matrix A2
A4:=scale(A3,2,c); # Multiply row 2 of A3 by scalar = c
#
# There is an interactive Gauss-Jordan Elimination Tutorial
# in the Student[LinearAlgebra] package. Try it out by
# un-commenting the next line, then execute the line.
 #Student[LinearAlgebra][GaussJordanEliminationTutor](A1);
# End of lab1
```