Elementary maths

```
syms a b c x y z
foo = expand((a+b)^3);                                  % mat (ans.101,foo)
foo = factor(-2*x+2*x+a*x-x^2+a*x^2-x^3);               % mat (ans.102,foo)
foo = solve(x^2==4, x);                                 % mat (ans.103,foo)
foo = solve([2*a-b == 3, a+b+c == 1,-b+c == 6],[a,b,c]);
tmp = [foo.a, foo.b, foo.c];                            % mat (ans.104,tmp)
foo = vpa(pi,50);                                       % mat (ans.105,foo)
foo = partfrac(1/((1 + x)*(5 + x)));                    % mat (ans.106,foo)
foo = simplifyFraction((1/(1 + x) - 1/(5 + x))/4);      % mat (ans.107,foo)
foo = simplify(tanh(log(x)));                           % mat (ans.108,foo)
foo = simplify(tanh(i*x));                              % mat (ans.109,foo)
foo = simplify(sinh(3*x) - 3*sinh(x) - 4*(sinh(x))^3);  % mat (ans.110,foo)
foo = tanh(log(x));                                     % mat (lhs.108,foo)
foo = tanh(i*x);                                        % mat (lhs.109,foo)
foo = sinh(3*x) - 3*sinh(x) - 4*(sinh(x))^3 ;           % mat (lhs.110,foo)
```

```
\begin{align*}
   &\mat*{ans.101}\\
   &\mat*{ans.102}\\
   &\mat*{ans.103}\\
   &\mat*{ans.104}\\
   &\mat*{ans.105}\\
   &\mat*{ans.106}\\
   &\mat*{ans.107}\\
   \mat{lhs.108} &= \Mat{ans.108}\\
   \mat{lhs.109} &= \Mat{ans.109}\\
   \mat{lhs.110} &= \Mat{ans.110}\\
\end{align*}
```

$$\texttt{ans.101} := a^3 + 3\,a^2\,b + 3\,a\,b^2 + b^3$$

$$\texttt{ans.102} := \begin{pmatrix} x & x+1 & a-x \end{pmatrix}$$

$$\texttt{ans.103} := \begin{pmatrix} -2 \\ 2 \end{pmatrix}$$

$$\texttt{ans.104} := \begin{pmatrix} \frac{1}{5} & -\frac{13}{5} & \frac{17}{5} \end{pmatrix}$$

$$\texttt{ans.105} := 3.14159265358979323846264338327950288419716939937\!51$$

$$\texttt{ans.106} := \frac{1}{4\,(x+1)} - \frac{1}{4\,(x+5)}$$

$$\texttt{ans.107} := \frac{1}{(x+1)\,(x+5)}$$

$$\tanh\left(\ln\left(x\right)\right) = \frac{x^2-1}{x^2+1} \qquad (\texttt{ans.108})$$

$$\tanh\left(x\,1\mathrm{i}\right) = \tan\left(x\right)\,1\mathrm{i} \qquad (\texttt{ans.109})$$

$$-4\sinh\left(x\right)^3 - 3\sinh\left(x\right) + \sinh\left(3\,x\right) = 0 \qquad (\texttt{ans.110})$$

Linear Algebra

```
syms mat lambda
mat  = sym([[2,3]; [5,4]]);              % mat (ans.201,mat)
[vec,lam] = eig(mat);                    % eigenvalues
eig1 = lam(1,1);                         % 1st eigenvalue
eig2 = lam(2,2);                         % 2nd eigenvalue
v1   = vec(:,1);                         % 1st eigenvector
v2   = vec(:,2);                         % 2nd eigenvector
eigennums = sym([eig1,eig2]);            % mat (ans.202,eigennums)
eigenvecs = vec;                         % mat (ans.203,eigenvecs)
charpol   = charpoly(mat,lambda);        % mat (ans.204,charpol)
myrhs = sym([3;7]);                      % mat (ans.205,myrhs)
mysol = mat\myrhs;                       % mat (ans.206,mysol)
```

```
\begin{align*}
   &\mat*{ans.201}\\
   &\mat*{ans.202}\\
   &\mat*{ans.203}\\
   &\mat*{ans.204}\\
   &\mat*{ans.205}\\
   &\mat*{ans.206}
\end{align*}
```

$$\begin{aligned}
\texttt{ans.201} &:= \begin{pmatrix} 2 & 3 \\ 5 & 4 \end{pmatrix} \\
\texttt{ans.202} &:= \begin{pmatrix} -1 & 7 \end{pmatrix} \\
\texttt{ans.203} &:= \begin{pmatrix} -1 & \frac{3}{5} \\ 1 & 1 \end{pmatrix} \\
\texttt{ans.204} &:= \lambda^2 - 6\,\lambda - 7 \\
\texttt{ans.205} &:= \begin{pmatrix} 3 \\ 7 \end{pmatrix} \\
\texttt{ans.206} &:= \begin{pmatrix} \frac{9}{7} \\ \frac{1}{7} \end{pmatrix}
\end{aligned}$$

Limits

```
syms a n x dx
foo = limit(sin(4*x)/x,x,0);                % mat (ans.301,foo)
foo = limit(2^x/x,x,Inf);                   % mat (ans.302,foo)
foo = limit(((x+dx)^2 - x^2)/dx, dx,0);     % mat (ans.303,foo)
foo = limit((4*n + 1)/(3*n - 1),n,Inf);     % mat (ans.304,foo)
foo = limit((1+(a/n))^n,n,Inf);             % mat (ans.305,foo)
```

```
\begin{align*}
   &\mat*{ans.301}\\
   &\mat*{ans.302}\\
   &\mat*{ans.303}\\
   &\mat*{ans.304}\\
   &\mat*{ans.305}
\end{align*}
```

$$\begin{aligned}
\texttt{ans.301} &:= 4 \\
\texttt{ans.302} &:= \infty \\
\texttt{ans.303} &:= 2\,x \\
\texttt{ans.304} &:= \frac{4}{3} \\
\texttt{ans.305} &:= \mathrm{e}^{a}
\end{aligned}$$

Series

```
syms n x
foo = taylor((1 + x)^(-2), x, 1, 'Order', 6);   % mat (ans.401,foo)
foo = taylor(exp(x), x, 0, 'Order', 6);         % mat (ans.402,foo)
foo = symsum(1/n^2, n,1,50);                    % mat (ans.403,foo)
foo = symsum(1/n^4, n,1,Inf);                   % mat (ans.404,foo)
```

```
\begin{align*}
   &\mat*{ans.401}\\
   &\mat*{ans.402}\\
   &\mat*{ans.403}\\
   &\mat*{ans.404}
\end{align*}
```

$$\begin{aligned}
\texttt{ans.401} &:= \frac{3\,(x-1)^2}{16} - \frac{x}{4} - \frac{(x-1)^3}{8} + \frac{5\,(x-1)^4}{64} - \frac{3\,(x-1)^5}{64} + \frac{1}{2} \\
\texttt{ans.402} &:= \frac{x^5}{120} + \frac{x^4}{24} + \frac{x^3}{6} + \frac{x^2}{2} + x + 1 \\
\texttt{ans.403} &:= \frac{3121579929551692678469635660835626209661709}{1920815367859463099600511526151929560192000} \\
\texttt{ans.404} &:= \frac{\pi^4}{90}
\end{aligned}$$

Calculus

```
syms a b x y
foo = diff(x*sin(x),x);                    % mat (ans.501,foo)
foo = subs(foo,x,pi/4);                    % mat (ans.502,foo)
foo = int(2*sin(x)^2, x,a,b);              % mat (ans.503,foo)
foo = int(2*exp(-x^2),x,0,Inf);            % mat (ans.504,foo)
foo = int(int(x^2 + y^2, y,0,x), x,0,1);   % mat (ans.505,foo)
```

```
\begin{align*}
   &\mat*{ans.501}\\
   &\mat*{ans.502}\\
   &\mat*{ans.503}\\
   &\mat*{ans.504}\\
   &\mat*{ans.505}
\end{align*}
```

$$\texttt{ans.501} := \sin\left(x\right) + x\,\cos\left(x\right)$$

$$\texttt{ans.502} := \frac{\pi\,\sqrt{2}}{8} + \frac{\sqrt{2}}{2}$$

$$\texttt{ans.503} := b - a + \frac{\sin\left(2\,a\right)}{2} - \frac{\sin\left(2\,b\right)}{2}$$

$$\texttt{ans.504} := \sqrt{\pi}$$

$$\texttt{ans.505} := \frac{1}{3}$$

Differential equations

```
syms a x y(x)

ode = diff(y,x) + y(x) == 2*a*sin(x);
sol = dsolve(ode)                                   % mat (ans.601,sol)
sol = dsolve(ode,y(0) == 0)                         % mat (ans.602,sol)

ode = diff(y,x,x) + y(x) == 0;
ddx = diff(y,x)
bcs = [y(0)==0,ddx(0)==1]
sol = dsolve(ode)                                   % mat (ans.602,sol)
sol = dsolve(ode,bcs)                               % mat (ans.603,sol)

ode = diff(y,x,x) + 5*diff(y,x) - 6*y(x) == 0;
sol = dsolve(ode)                                   % mat (ans.604,sol)

syms C10 C11
sol = subs(subs(sol,C10,2),C11,3)                    % mat (ans.605,sol)
```

```
\begin{align*}
   &\mat*{ans.601}\\
   &\mat*{ans.602}\\
   &\mat*{ans.603}\\
   &\mat*{ans.604}\\
   &\mat*{ans.605}
\end{align*}
```

$$\texttt{ans.601} := C_4\,\mathrm{e}^{-x} - a\,\left(\cos\left(x\right) - \sin\left(x\right)\right)$$
$$\texttt{ans.602} := C_6\,\cos\left(x\right) - C_7\,\sin\left(x\right)$$
$$\texttt{ans.603} := \sin\left(x\right)$$
$$\texttt{ans.604} := C_{11}\,\mathrm{e}^{x} + C_{10}\,\mathrm{e}^{-6\,x}$$
$$\texttt{ans.605} := 2\,\mathrm{e}^{-6\,x} + 3\,\mathrm{e}^{x}$$