

# 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*}

```

$$\text{ans.101} := a^3 + 3a^2b + 3ab^2 + b^3$$

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

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

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

$$\text{ans.105} := 3.1415926535897932384626433832795028841971693993751$$

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

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

$$\tanh(\ln(x)) = \frac{x^2 - 1}{x^2 + 1} \quad (\text{ans.108})$$

$$\tanh(ix) = \tan(x) i \quad (\text{ans.109})$$

$$-4\sinh(x)^3 - 3\sinh(x) + \sinh(3x) = 0 \quad (\text{ans.110})$$

# Linear Algebra

```

syms mat lambda
mat = sym([[2,3]; [5,4]]);
[vec,lam] = eig(mat);
eig1 = lam(1,1);
eig2 = lam(2,2);
v1 = vec(:,1);
v2 = vec(:,2);
eigennums = sym([eig1,eig2]);
eigenvecs = vec;
charpol = charpoly(mat,lambda);
myrhs = sym([3;7]);
mysol = mat\myrhs;

```

*% mat (ans.201,mat)*  
*% eigenvalues*  
*% 1st eigenvalue*  
*% 2nd eigenvalue*  
*% 1st eigenvector*  
*% 2nd eigenvector*  
*% mat (ans.202,eigennums)*  
*% mat (ans.203,eigenvecs)*  
*% mat (ans.204,charpol)*  
*% mat (ans.205,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*}

```

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

# 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*}
```

```
ans.301 := 4
ans.302 := ∞
ans.303 := 2 x
ans.304 :=  $\frac{4}{3}$ 
ans.305 := ea
```

# 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*}
```

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

# 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*}
```

$$\text{ans.501} := \sin(x) + x \cos(x)$$

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

$$\text{ans.503} := b - a + \frac{\sin(2a)}{2} - \frac{\sin(2b)}{2}$$

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

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

# 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 C1 C2
sol = subs(subs(sol,C1,2),C2,3)                  % mat (ans.605,sol)

```

```

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

```

```

ans.601 := C_1 e^{-x} - a (\cos(x) - \sin(x))
ans.602 := C_1 \cos(x) - C_2 \sin(x)
ans.603 := \sin(x)
ans.604 := C_2 e^x + C_1 e^{-6x}
ans.605 := 2 e^{-6x} + 3 e^x

```