The second-order ODE $\frac{d^2y}{dt^2} - 2\frac{dy}{dt} + 2y = 0$, $y(0) = 1$, $\left.\frac{dy}{dt}\right|_{t=0} = 0$, can be solved with MATLAB by:

```
>> dsolve('D2y-2*Dy+2*y=0','y(0)=1','Dy(0)=0')

ans =
exp(t)*cos(t)-exp(t)*sin(t)
>> factor(ans)
ans =
exp(t)*(cos(t)-sin(t))
```

The answer $y = e^t \cos t - e^t \sin t$ is displayed.

The answer can be simplified with the `factor` command.

The simplified answer $y = e^t (\cos t - \sin t)$ is displayed.

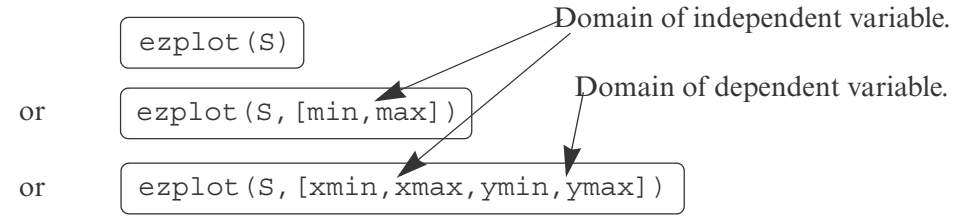
Additional examples of solving differential equations are shown in Sample Problem 11-5.

If MATLAB cannot find a solution, it returns an empty symbolic object and the message `Warning: explicit solution could not be found`.

11.7 PLOTTING SYMBOLIC EXPRESSIONS

In many cases, there is a need to plot a symbolic expression. This can easily be done with the `ezplot` command. For a symbolic expression `S` that contains one variable `var`, MATLAB considers the expression to be a function $S(var)$, and the command creates a plot of $S(var)$ versus *var*. For a symbolic expression that contains two symbolic variables `var1` and `var2`, MATLAB considers the expression to be a function in the form $S(var1,var2) = 0$, and the command creates a plot of one variable versus the other.

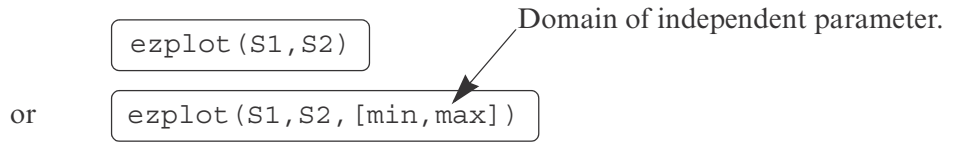
To plot a symbolic expression `S` that contains one or two variables, the `ezplot` command is:



- `S` is the symbolic expression to be plotted. It can be the name of a previously created symbolic expression, or an expression can be typed in for `S`.
- It is also possible to type the expression to be plotted as a string without having the variables in the expression first created as symbolic objects.
- If `S` has one symbolic variable, a plot of $S(var)$ versus (var) is created, with the values of *var* (the independent variable) on the abscissa (horizontal axis), and the values of $S(var)$ on the ordinate (vertical axis).

- If the symbolic expression `S` has two symbolic variables, `var1` and `var2`, the expression is assumed to be a function with the form $S(var1,var2) = 0$. MATLAB creates a plot of one variable versus the other variable. The variable that is first in alphabetic order is taken to be the independent variable. For example, if the variables in S are x and y, then x is the independent variable and is plotted on the abscissa and y is the dependent variable plotted on the ordinate. If the variables in S are u and v, then u is the independent variable and v is the dependent variable.
- In the `ezplot(S)` command, if `S` has one variable ($S(var)$), the plot is over the domain $-2\pi < var < 2\pi$ (default domain) and the range is selected by MATLAB. If `S` has two variables ($S(var1,var2)$), the plot is over $-2\pi < var1 < 2\pi$ and $-2\pi < var2 < 2\pi$.
- In the `ezplot(S,[min,max])` command the domain for the independent variable is defined by `min` and `max`:— $min < var < max$ —and the range is selected by MATLAB.
- In the `ezplot(S,[xmin,xmax,ymin,ymax])` command the domain for the independent variable is defined by `xmin` and `xmax`, and the domain of the dependent variable is defined by `ymin` and `ymax`.

The `ezplot` command can also be used to plot a function that is given in a parametric form. In this case two symbolic expressions, `S1` and `S2`, are involved, where each expression is written in terms of the same symbolic variable (independent parameter). For example, for a plot of y versus x where $x = x(t)$ and $y = y(t)$, the form of the `ezplot` command is:



- `S1` and `S2` are symbolic expressions containing the same single symbolic variable, which is the independent parameter. `S1` and `S2` can be the names of previously created symbolic expressions, or expressions can be typed in.
- The command creates a plot of $S2(var)$ versus $S1(var)$. The symbolic expression that is typed first in the command (`S1` in the definition above) is used for the horizontal axis, and the expression that is typed second (`S2` in the definition above) is used for the vertical axis.
- In the `ezplot(S1,S2)` command the domain of the independent variable is $0 < var < 2\pi$ (default domain).
- In the `ezplot(S1,S2,[min,max])` command the domain for the independent variable is defined by `min` and `max`: $min < var < max$.

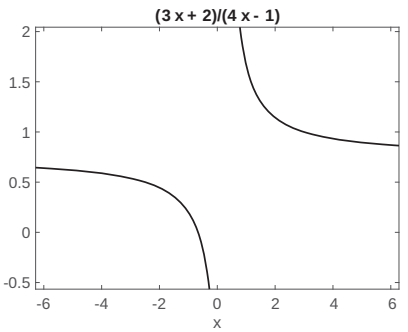
Additional comments:

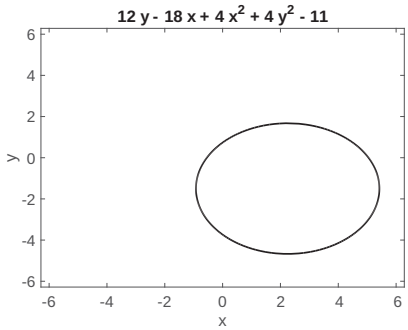
Once a plot is created, it can be formatted in the same way as plots created with the `plot` or `fplot` format. This can be done in two ways: by using commands or by using the Plot Editor (see Section 5.4). When the plot is created, the expression that is plotted is displayed automatically at the top of the plot. MATLAB has additional plot functions for plotting two-dimensional polar plots and for plotting three-dimensional plots. For more information, the reader is referred to the Help menu of the Symbolic Math Toolbox.

Several examples of using the `ezplot` command are shown in Table 11-1.

Table 11-1: Plots with the `ezplot` command

Command	Plot

`>> syms x`
`>> S=(3*x+2)/(4*x-1)`
`S =`
`(3*x+2)/(4*x-1)`
`>> ezplot(S)`
	

`>> syms x y`
`>> S=4*x^2-`
`18*x+4*y^2+12*y-11`
`S =`
`4*x^2-18*x+4*y^2+12*y-11`
`>> ezplot(S)`
	

`>> syms t`
`>> x=cos(2*t)`
`x =`
`cos(2*t)`
`>> y=sin(4*t)`
`y =`
`sin(4*t)`
`>> ezplot(x,y)`