11.2 Changing the Form of an Existing Symbolic Expression

Symbolic expressions are either created by the user or by MATLAB as the result of symbolic operations. The expressions created by MATLAB might not be in the simplest form or in a form that the user prefers. The form of an existing symbolic expression can be changed by collecting terms with the same power, by expanding products, by factoring out common multipliers, by using mathematical and trigonometric identities, and by many other operations. The following subsections describe several of the commands that can be used to change the form of an existing symbolic expression.

11.2.1 The `collect`, `expand`, and `factor` Commands

The `collect`, `expand`, and `factor` commands can be used to perform the mathematical operations that are implied by their names.

The `collect` command:

The `collect` command collects the terms in the expression that have the variable with the same power. In the new expression, the terms will be ordered in decreasing order of power. The command has the forms

`collect(S)` `collect(S, variable_name)`

where `S` is the expression. The `collect(S)` form works best when an expression has only one symbolic variable. If an expression has more than one variable, MATLAB will collect the terms of one variable first, then those of a second variable, and so on. The order of the variables is determined by MATLAB. The user can specify the first variable by using the `collect(S, variable_name)` form of the command. Examples: $x^3 + 4x^2 + (3 - e^x)x - 3e^x$

```
>> syms x y
```
Define x and y as symbolic variables.

```
>> S=(x^2+x-exp(x))*(x+3)
S =
(x + 3)*(x - exp(x) + x^2)
```
Create the symbolic expression $(x+3)(x-e^x+x^2)$ and assign it to S.

```
>> F = collect(S)
```
Use the collect command.

```
F =
x^3+4*x^2+(3-exp(x))*x-3*exp(x)
```
MATLAB returns the expression: $x^3 + 4x^2 + (3 - e^x)x - 3e^x$.

```
>> T=(2*x^2+y^2)*(x+y^2+3)
T =
(2*x^2+y^2)*(y^2+x+3)
```
Create the symbolic expression T $(2x^2 + y^2)(y^2 + x + 3)$.

```
>> G=collect(T)
```
Use the collect(T) command.

MATLAB returns the expression $x^3 + (2y^2 + 6)x^2 + y^2x + y^2(y^2 + 3)$.

```
G =
2*x^3+(2*y^2+6)*x^2+y^2*x+y^2*(y^2+3)
>> H=collect(T,y)
H =
y^4+(2*x^2+x+3)*y^2+2*x^2*(x+3)
```

Use the `collect(T,y)` command.

MATLAB returns the expression $y^4 + (2x^2 + x + 3)y^2 + 2x^2(x + 3)$.

Note that when `collect(T)` is used, the reformatted expression is written in order of decreasing powers of x, but when `collect(T,y)` is used, the reformatted expression is written in order of decreasing powers of y.

The `expand` command:

The `expand` command expands expressions in two ways. It carries out products of terms that include summation (used with at least one of the terms), and it uses trigonometric identities and exponential and logarithmic laws to expand corresponding terms that include summation. The form of the command is:

```
expand(S)
```

where `S` is the symbolic expression. Two examples are:

Define `a`, `x`, and `y` as symbolic variables.

Create the symbolic expression $-(a - x)(x + 4)(x + 5)$ and assign it to `S`.

Use the `expand` command.

MATLAB returns the expression $20x - 20a - 9ax - ax^2 + 9x^2 + x^3$.

Use the `expand` command to expand $\sin(x - y)$.

MATLAB uses trig identity for the expansion.

```
>> syms a x y
>> S=(x+5)*(x-a)*(x+4)
S =
-(a-x)*(x+4)*(x+5)
>> T=expand(S)
T =
20*x-20*a-9*a*x-a*x^2+9*x^2+x^3
>> expand(sin(x-y))

ans =
cos(y)*sin(x)-cos(x)*sin(y)
```

The `factor` command:

The `factor` command changes an expression that is a polynomial to a product of polynomials of a lower degree. The form of the command is:

```
factor(S)
```

where `S` is the symbolic expression. An example is: