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

```
H =
y^4+(2*x^2+x+3)*y^2+2*x^2*(x+3)
```
> 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:

$$\boxed{\texttt{expand(S)}}$$

where S is the symbolic expression. Two examples are:

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

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

```
>> T=expand(S)
```
> Use the `expand` command.

```
T =
20*x-20*a-9*a*x-a*x^2+9*x^2+x^3
```
> MATLAB returns the expression $20x - 20a - 9ax - ax^2 + 9x^2 + x^3$.

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

```
ans =
cos(y)*sin(x)-cos(x)*sin(y)
```
> MATLAB uses trig identity for the expansion.

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:

$$\boxed{\texttt{factor(S)}}$$

where S is the symbolic expression. An example is:

```
>> syms x
```
Define x as a symbolic variable.

```
>> S=x^3+4*x^2-11*x-30
S =
x^3+4*x^2-11*x-30
```
Create the symbolic expression
$x^3 + 4x^2 - 11x - 30$ and assign it to S.

```
>> factor(S)
```
Use the factor command.

```
ans =
(x+5)*(x-3)*(x+2)
```
MATLAB returns the expression
$(x+5)(x-3)(x+2)$.

11.2.2 The simplify Command

The simplify command is a tool for simplifying the form of an expression. The simplify command uses mathematical operations (addition, multiplication, rules of fractions, powers, logarithms, etc.) and functional and trigonometric identities to generate a simpler form of the expression. The format of the simplify command is:

$$\boxed{\texttt{simplify(S)}}$$

where either S is the name of the   or   an expression to be simplified
existing expression to be simplified,   can be typed in for S.

Two examples are:

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

```
>> S=(x^2+5*x+6)/(x+2)
S =
(x^2+5*x+6)/(x+2)
```
Create the symbolic expression
$(x^2 + 5x + 6)/(x+2)$, and assign it to S.

```
>> SA = simplify(S)
```
Use the simplify command to simplify S.

```
SA =
x+3
```
MATLAB simplifies the expression to $x + 3$.

```
>> simplify((x+y)/(1/x+1/y))
```
Simplify $(x+y)/(\frac{1}{x}+\frac{1}{y})$.

```
ans =
x*y
```
MATLAB simplifies the expression to xy).

11.2.3 The pretty Command

The pretty command displays a symbolic expression in a format resembling the mathematical format in which expressions are generally typed. The command has the form

$$\boxed{\texttt{pretty(S)}}$$

Example: