Solving Higher Order Equations

Of course we can use MATLAB to solve higher order equations. Let's try a cubic. Suppose we are told that:

$$(x + 1)2\ (x - 2) = 0$$

Solving an equation like this is no different than what we've done so far. We find that the roots are:

```
>> eq= (x + 1)2 (x – 2)
>> s = solve(eq)
s =
  2
 –1
 –1
```

EXAMPLE 5-2

Find the roots of the fourth order equation

x4 − 5x3 + 4x2 − 5x + 6 = 0

and plot the function for −10 < *x* < *10.*

>> eq1 = 'x^4–5*x^3+4*x^2–5*x+6';

Then we call solve to find the roots:

>> s = solve(eq1);

Now let's define some variables to extract the roots from *s. If you list them* symbolically, you will get a big mess. We show part of the first root here:

```
>> a = s(1)
a =
5/4+1/12*3^(1/2)*((43*(8900+12*549093^(1/2))^(1/3)+2*(8900+
12*549093^(1/2))^(2/3)+104)....
```

Try it and you will see this term goes on a long way. So let's use double to get a numerical result:

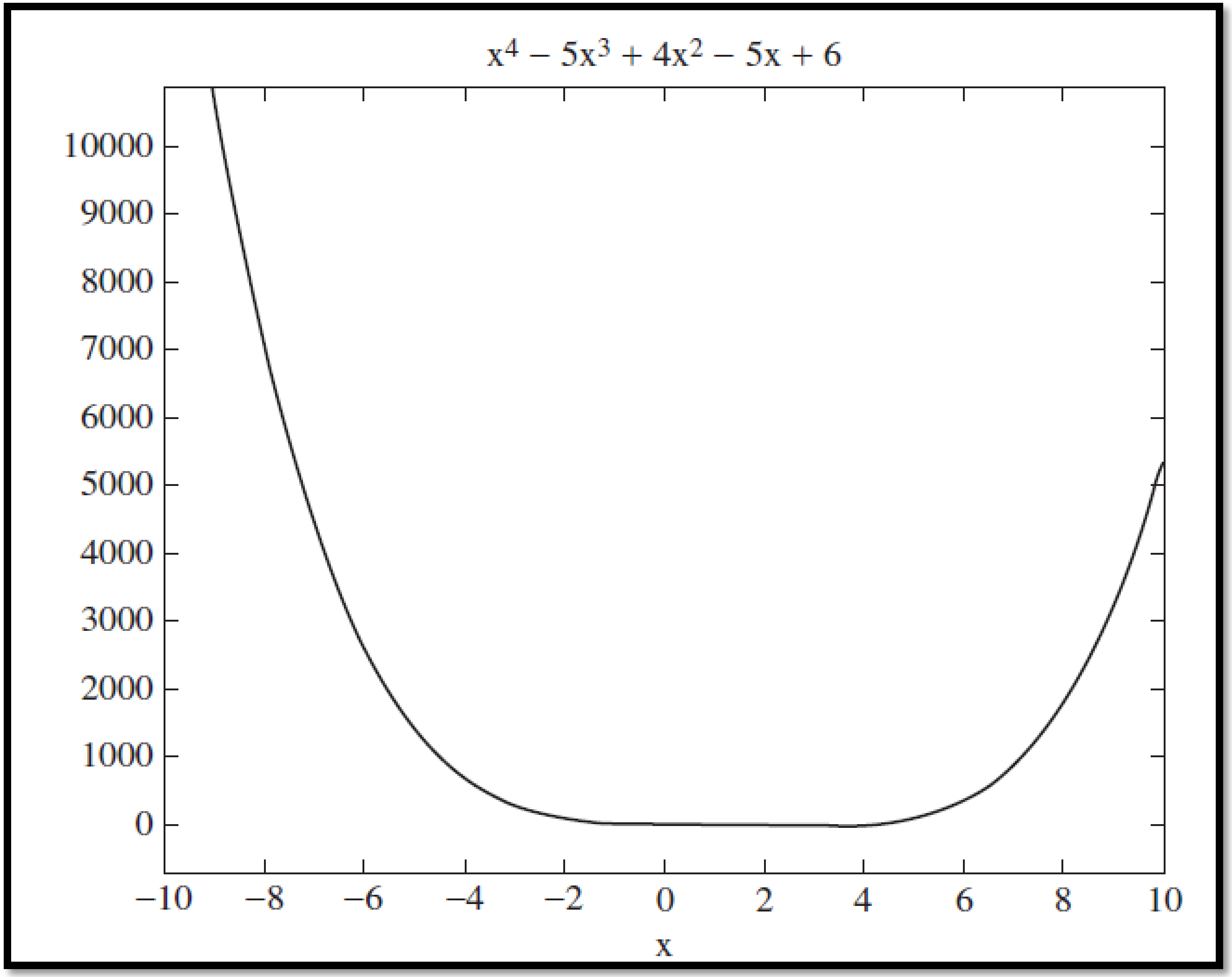
```
>> a = double(s(1))
a =
4.2588

>> b = double(s(2))
b =
1.1164

>> c = double(s(3))
c =
–0.1876 + 1.1076i

>> d = double(s(4))
d =
–0.1876 – 1.1076i
```

```
>> ezplot(eq1,[–10 10])
```



H.W

Find the roots of $x^3 + 3x^2 - 2x - 6$ and plot the function for $-8 < x < 8$, $-8 < y < 8$. Generate the plot with a grid.

Systems of Equations :

While appearing useful already, it turns out the solve command is more versatile than we have seen so far. It turns out that solve can be used to generate solutions of systems of equations. To show how this is done and how to get the solutions out, it's best to proceed with another simple example. Suppose that you were presented with the following system of equations:

$$5x + 4y = 3$$
$$x - 6y = 2$$

To use solve to find *x and y, we call it by passing two arguments—each one a* string representing one of the equations. In this case we type:

```
>> s = solve('5*x + 4*y = 3','x - 6*y = 2');
```

We can get the values of *x and y by using a "dot"* notation as follows. First let's get *x:*

```
>> x = s.x

x =

13/17
```

```
>> y = s.y

y =

-7/34
```

Note **: We can solve the previous equation by another method:**

```
> [x,y]=solve('5*x + 4*y=3','x - 6*y=2')

x =
13/17

y =
-7/34
```

H.W

Find the roots of the system equations

$$w + x + 4y + 3z = 5$$
$$2w + 3x + y - 2z = 1$$
$$w + 2x - 5y + 4z = 3$$
$$w - 3z = 9$$

Symbolic Toolbox

The ***syms*** statement makes all the variables listed with it into symbolic variables and gives each of the variables a value that is equal to its own name! Thus, the value of (a is a, the value of b is b, etc). The variable E is now symbolic because it was assigned to be equal to an expression that contained one or more symbolic variables. Its value is a*x^2 + b*x + 5.

```
>> syms a b x y;
>> c = 5;
>> E = a*x^2 + b*x + c;
```

Expanding Equations

In elementary school we learned how to expand equations. For instance:

$$(x + 2)(x - 3) = x^2 - x - 6$$

We can use MATLAB to accomplish this sort of task by calling the *expand* command.

```
>> syms x
>> expand((x–1)*(x+4))
ans = x^2 +3*x – 4
```

The expand function can be applied in other ways. For example, we can apply it to trig functions, generating some famous trig identities:

```
>> syms x y
>> expand(cos(x+y))
```

This gives us:

```
ans =

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

Or:

```
>> expand(sin(x-y))

ans =

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

Expand command can be used to expand the terms of any power equation

Factoring the equation

Another algebraic task we can do symbolically is **factoring**. To show that:

x2 – y2 = (x + y)(x – y)

Using MATLAB, we type:

```
>> Syms x  y
>> factor(x^2–y^2)
ans =
(x–y)*(x+y)
```

Simplify the equation

Finally, we can use the *simplify command. This command can be used to divide* polynomials. For instance, we can show that

(***x2 + 9)(x2 − 9) = x4 − 81*** *by writing:*

```
>> Syms x y
>> simplify((x^4–81)/(x^2–9))
ans =
x^2+9
```

H.W

1. Use MATLAB to enter $7\sqrt{2}-5\sqrt{60}+5\sqrt{8}$ as a string, then find the numerical value.
2. Use MATLAB to solve $3x^2 + 2x = 7$.
3. Find x such that $x^2+\sqrt{5}x-\pi=0$.
4. Find the solution of $\sqrt{2x-4}=1$ and symbolically plot the function for $2 < x < 4$, $0 < y < 1$.
5. Use solve to symbolically find the roots of $2t^3 - t^2 + 4t - 6 = 0$, then convert the answer into numerical values.
6. Find a solution of the system:

$$\begin{aligned} x - 3y - 2z &= 6 \\ 2x - 4y - 3z &= 8 \\ -3x + 6y + 8z &= -5 \end{aligned}$$

7. Does the equation $e^x - x^2 = 0$ have a real root?
8. Use MATLAB to find $\tan^2 x - \sec^2 x$.