**Math 1200 -College Algebra for Business names**

**Introduction to Excel III: Goal Seek**

0. Housekeeping – Put the names of all the group members on the first sheet of an Excel workbook. Save the file with the name Excel2Name1Name2Name3.xlsx where Name1, Name2, etc are group member names,

1. Solving one equation with Goal Seek

When we are given a function, $f(x)$, we often want to find the $x$-value that gives a specified $y$-value. We want to solve the equation $f(x)=b$. In Excel this is called what-if analysis and is done with a tool called Goal Seek.

1. Following the normal pattern of a math class, we start by solving an equation that is easier to do by hand, without invoking Goal Seek. We start with $f(x)=2x+3$ and want to solve $f(x)=15$. A simple computation tells us the answer is $x=6$. However, we want Excel to find the answer. We start by building a table of values for $x$ and $f(x)$ that includes our guessed answer. I am going to start with a guess of $x=1$. I reproduce the following table in Excel

|  |  |  |
| --- | --- | --- |
|  | A | B |
| 1 | x | f(x) |
| 2 | 1 | =2\*A2+3 |

Now I invoke Goal Seek. I look in the data tab and find the what-if-analysis drop down menu. I select Goal Seek. I would like to change the value of B2 to 15 by changing cell A2. Click OK and Excel solves the problem

1. Now I use Goal Seek on a problem that I can’t do by hand I want to solve

$f(x)=(x-4)(x+1)(x+6)=2$.

Looking at the graph or a table of the function, I have solutions near
$x=4, -1, -6$. (Produce a table with $x$ going from -10 to 10 by 1 and see where the value of $f(x)$ changes sign.) Once again, I produce a table. I have double rows so I will remember my starting points after doing the computation.

|  |  |  |
| --- | --- | --- |
|  | A | B |
| 1 | x | f(x) |
| 2 | 4 | =(A2-4)\*(A2+1)\*(A2+6) |
| 3 | 4 | =(A3-4)\*(A3+1)\*(A3+6) |
| 4 | -1 | =(A4-4)\*(A4+1)\*(A4+6) |
| 5 | -1 | =(A5-4)\*(A5+1)\*(A5+6) |
| 6 | -6 | =(A6-4)\*(A6+1)\*(A6+6) |
| 7 | -6 | =(A7-4)\*(A7+1)\*(A7+6) |

With Goal Seek, change B3, B5, and B7 to 2 by changing cells A3, A5, and A7 respectively. Note that we do not get an exact answer.

It should be noted that Goal Seek “slides down the graph to a solution. Starting at different points gets us to different solutions.

1. Intersecting two curves. A second use of Goal Seek is to find the intersection of two curves.
2. Once again, I start with an easy example that I could do by hand. I want to find the x values where $y=x+2$ and $y=x\^2$ intersect. Looking at a graph or table I see they intersect at $x=-1$ and $x=2$. I am going to guess (badly) that they intersect near x=-3 and x=3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | A | B | C | D |
| 1 | x | f(x) | g(x) | f(x)-g(x) |
| 2 | -3 | = A2+2 | =A2^2 | =B2-C2 |
| 3 | -3 | = A3+2 | =A3^2 | =B3-C3 |
| 4 | 3 | = A4+2 | =A4^2 | =B4-C4 |
| 5 | 3 | =A5+2 | =A5^2 | =B5-C5 |

1. Now repeat the process with a more complicated set of functions. Finds the intersections of $f(x)=x\^2-4x-20$, and $g(x)=-2x\^2+4x+50$.
2. Variables and Parameters. When we graph with Desmos we are typically looking at a function of 1 variable. (The input is $x$ and the output is $y$.) In the homework we have looked at cases where we have several inputs. For example, the monthly payment on a loan is

$$M=\frac{P r \left(1+r\right)^{t}}{\left(1+r\right)^{t}-1}$$

Where $M$ is the monthly payment, $r$ is the monthly interest rate, and $t$ is the length of the loan in months. In practice, two of those three values will be fixed (parameters) and we will be looking at the third as the variable. Goal Seek lets us make each value into the variable to be solved for in turn.

1. I can afford a monthly payment of $200 and the interest rate is 8% annually. How much can I borrow for a 4-year loan?
2. I can afford a monthly payment of $200 and the interest rate is 8% annually. I need to borrow $5,000 How long will I be paying off the loan?
3. I can afford a monthly payment of $200 and the loan is for 4 years. I need to borrow $5,000. What is the annual interest rate?

[Optional technical point. The equation above is a relation of the variables M, P, r, and t with M expressed as a function of the other three. In turn we made M a function of one variable by holding two of P, r, and t constant. We used Goal Seek to solve for the variable as a function of M. If we want to make one of P, r, and t a function of another one of those three letters, we need to use a tool, Solver, that we have not gotten to yet.]

1. Goal seek for a more complicated setup.
2. Producing a loan table. The book has given formulas for finding loan payments and balances. It is relatively easy to make a loan table with Excel. The end of period balance is the beginning of period balance plus the interest minus the payment. The new beginning of period balance is the old end of period balance. We produce a table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
| 1 | Principal | $200000 |  | Final Balance | =OFFSET(E6,B2,0) |
| 2 | Months | 180 |  |  |  |
| 3 | Rate | =0.04/12 |  |  |  |
| 4 | Payment | $2000 |  |  |  |
| 5 |  |  |  |  |  |
| 6 | Period | Begin Balance | Interest | Payment | End Balance |
| 7 | 1 | =B1 | =B7\*B$3 | =B$4 | =B7+C7-D7 |
| 8 | 2 | =E7 | =B8\*B$3 | =B$4 | =B8+C8-D8 |

We extend the table through 180 periods. Offset is a command that lets us move an entry to a nice place rather than search through pages of numbers. The entry in E1 says, go to cell E6, then go down B2 rows and over 0 columns. Put the value of that cell in E1. The initial payment was a guessed number. Now we want to make the Final Balance 0 by changing the payment with Goal Seek. Record that payment.

1. Reset the table and answer following questions
2. If I can afford a $2,000 monthly payment and 15-year mortgages charge an annual rate of 4%, how big a principal can I afford?
3. If the loan is for $200,000 and my payment is $2,000, what is the interest rate?

When you finish your worksheet, make sure to share copies with the group and then submit it on blackboard.