Homework assignment – HW4

Flow Control, User-Defined Functions

1.
Condition statements, if and for

Use MATLAB in the two different ways, described below, to plot the function:

$$f(x) = \begin{cases} 4e^{x+2} & \text{for} \quad -6 \leq x \leq -2 \\ x^2 & \text{for} \quad -2 \leq x \leq 2 \\ (x+62)^{1/3} & \text{for} \quad 2 \leq x \leq 6 \end{cases}$$

a) Write a program in a script file, using conditional statements and loops.
b) Create a user-defined function for $f(x)$, and then use the function in a script file to make the plot.

2.
Write a user-defined function that sorts the elements of a vector (of any length) from the largest to the smallest. For the function name and arguments use y = downsort (x). The input to the function is a vector x of any length, and the output y is a vector in which the elements of x are arranged in descending order. Do not use the MATLAB sort function. Test your function on a vector with 14 numbers (integers) randomly distributed between –30 and 30. Use the MATLAB rand function to generate the initial vector.

3.
a) Use "for":

Write a program (using a loop) that determines the sum of the first m terms of the series:

$$\sum_{n=0}^{m} (-1)^n \frac{1}{2n+1} \quad (n = 0, 1, 2,..., m)$$

Run the program with $m = 10$, and $m = 500$. Compare the result with $\pi/4$. This series which is called the Leibniz series converges to $\pi/4$.

b) Use "while":

Repeat the exercise using the command "while"

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4.

Write a user-defined function "`binom`" that calculates the coefficients of Newton's binomial.
Remember that the coefficients of Newton's binomial are:

```
            1
          1   1
        1   2   1
      1   3   3   1
    1   4   6   4   1
  1   5  10  10   5   1
```

Note: that the value of each element in the pyramid is the sum of the two elements which are above it. Since a pyramid matrix can not be created in MATLAB, you have to create an LD matrix padded with zeros.
For example: the command "`binom(5)`" will result:

```
1   0   0   0   0
1   1   0   0   0
1   2   1   0   0
1   3   3   1   0
1   4   6   4   1
```

and the command "`binom(7)`" will result:

```
1   0    0    0    0   0   0
1   1    0    0    0   0   0
1   2    1    0    0   0   0
1   3    3    1    0   0   0
1   4    6    4    1   0   0
1   5   10   10    5   1   0
1   6   15   20   15   6   1
```
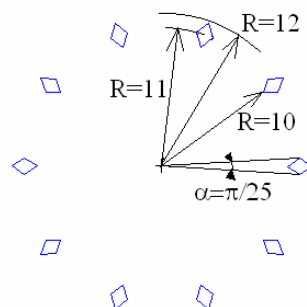
5.

Write a program that plots diamonds on a circle evenly spread out, where the diamonds' number is an input. Each diamond vertex has the following radius, relate to the circle center:
Internal vertex = 10.
External vertex = 12.
Two sided vertexes = 11 with an angle of $\alpha = \pi/25$ between them.
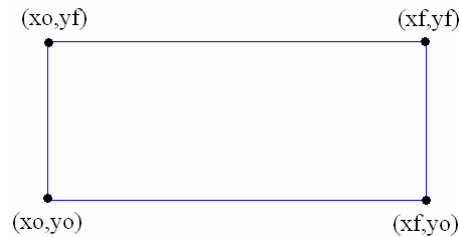An example of a plot with 10 diamonds:

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6.

Write a user-defined function with function-name `stair` that plots a rectangle.
The position of the rectangle's corners is given by the function input as follows:
`stair(xo,yo,xf,yf)` fits the following plot:

(xo,yf)   (xf,yf)

(xo,yo)   (xf,yo)

Then, write a program that receives an input from the user and uses the stair function to plot stairs as shown in the following example.
An example of eight stairs:
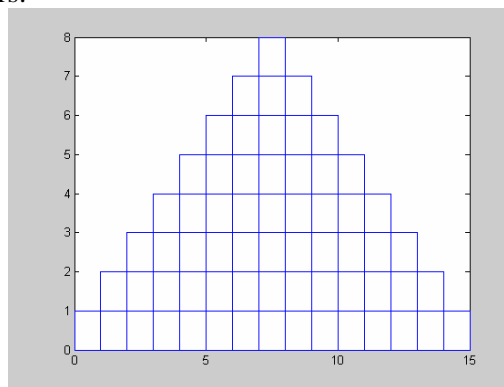
Note – the 1st stair width is 15 and the height is 1, the 2nd stair width is 13 and the height is 2, etc. etc.

Polynomials

Individual study:
Study individually the commands: `roots, conv, deconv, polyder`.

7.
a) Plot a graph of the polynomial $p = 2x^6 - 3x^5 + 4x^4 + x^3 + 1$ where 12<x<23.

b) Find the roots of the polynomial $x^4 - 13x^3 + 54x - 72 = 0$

c) Show that $w = (2x + 3)(x + 4) = 2x^2 + 11x + 12$

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8.

Write a user-defined function that calculates the maximum (or minimum) of a quadratic equation of the form:

$$f(x) = ax^2 + bx + c$$

Name the function $[x,y,w] = \text{maxormin}(a,b,c)$. The input arguments are the coefficients a, b, and c. The output arguments are x the coordinate of the maximum (or minimum), y the maximum (or minimum) value, and w which is equal to 1 if y is a maximum, and equal to 2 if y is a minimum.

Use the function to determine the maximum or minimum of the following functions:

a) $f(x) = 6x^2 - 18x + 6$
b) $f(x) = -4x^2 - 20x + 5$

9.

Write a user-defined function that receives a roots vector and calculates the polynomial from it. Find the roots of the following polynomials, and use your function to calculate the polynomials.

a) $\quad p_1 = x^4 - x^3 - 19x^2 - 11x + 30$
b) $\quad p_2 = x^5 + 6x^4 + 3x^3 - 10x^2$

Did you get the same original polynomials?

10.

a)

Divide the polynomial $15x^5 + 35x^4 - 37x^3 - 19x^2 + 41x - 15$ by the polynomial $5x^3 - 4x + 3$.

b) Calculate the product of $3x^2 + 6x + 9 = 0$ and $x^2 + 2x$. Find the derivative of the product.