Homework 2: Functions – Algorithm Development and Control Structures
(Version 1.0)
Release Date: 07.11.2016
Due On: 21.11.2016 @ 23:55
(LATE Submissions for ANY reasons will NOT be accepted)

Version history:
v1.0: Homework 1.0 is released.

Submission Rules:

Each student must submit individual solutions for these homework problems. You may use any source at your disposal—paper, electronic, or human—but you must cite every source that you use. Submit your solutions through **ODTUCLASS**. *While submitting, you should include the ".m" (for MATLAB) files with your printed results (i.e., screen shots) in a compressed file (*.zip, *.rar, etc.).*
WRITE COMMENTS IN YOUR CODES, USE VARIABLE NAMES AS DESCRIBED IN THE CLASS!

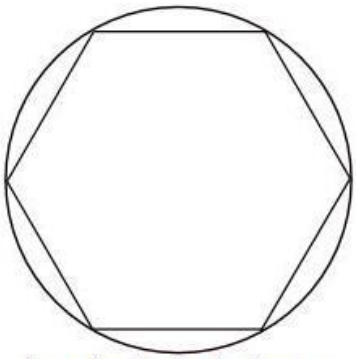
1. **(10 pts)** The well-known Fibonacci series is formed by the numbers starting from `1, 1,...` and by adding two previous values to find the new value. i.e.

   ```
   1,1,2,3,5,8,13,21...
   ```

   The proportion of any two adjacent numbers converges to well-known golden ratio.
   a) Find the elements of this series up to 25th element.
   b) Find the ratios for each pairs and draw these ratios using `plot` command.

2. **(25 pts)**

   a)



A regular six-sided polygon (hexagon) inscribed inside the circle

Archimedes, being one of the most brilliant human beings ever lived, found a way to calculate the well-known pi number by using an approximation in the 2nd century B.C. According to this approximation, if we use polygons with n sides and assume that the area of this polygon is equal to the area of the circle, we can calculate the value of pi. And if we increase the side number n, approximation will be more precise.

Using this information and assuming Radius=5, using a for loop with i=1,2,3 find pi values for n=6, n=20 and n=100 and store these values in an array. Use 16 decimal points and compare the results.

Hint: sine theorem

b) Archimedes' method was a graphical method mostly used in ancient times for mathematical operations. An analytical way to find pi is by using 'generalized continued fractions':

$$\pi = 3 + \cfrac{1^2}{6 + \cfrac{3^2}{6 + \cfrac{5^2}{6 + \cfrac{7^2}{6 + \ddots}}}}$$

Using a `while` loop, and relative true error 5e-6, compute the value of pi.

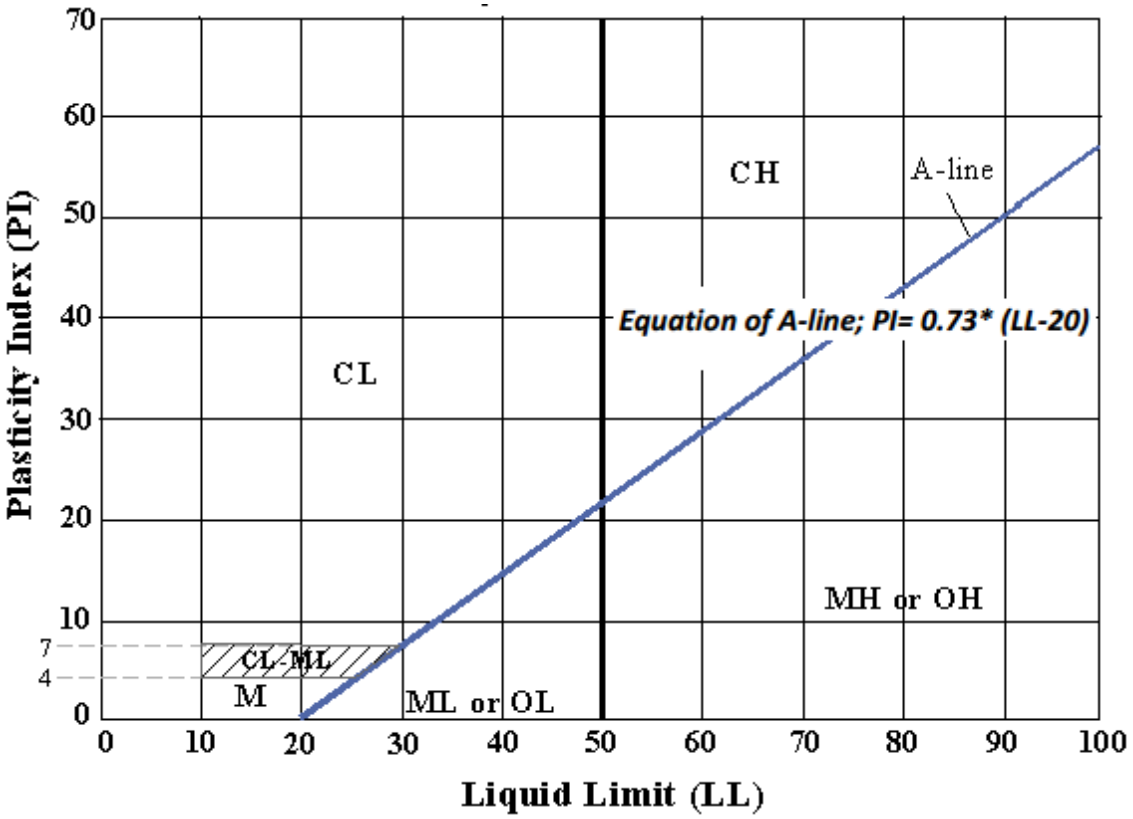
3. (15 pts) Write a MATLAB function that determines type of soil by taking soil particle size as input. For this question,

a) use `if - elseif - else` statement.
b) use `switch - case` statement.

You may refer to following soil classification table:

soil type	lower bound(mm)	upper bound(mm)
boulders	200	-
cobbles	60	200
gravel	2	60
sand	0.06	2
silt	0.002	0.06
clay	-	0.002

4. **(20 pts)** According to Unified Soil Classification System, types of soils which contain 50% or higher portion of fine grained particles (particles passing through No. 200 sieve) can be determined by referring to the following chart.



By referring to the plasticity chart given above, write a function which takes fine content and Atterberg Limits (Plastic Limit and Liquid Limit) of a soil sample as inputs and displays the soil type. Furthermore, your code should display an error (e.g. 'Plasticity chart cannot be used, fine content is below 50%') if the fine content is below 50%.

*Note: Make necessary assumptions at the boundaries of A-line, LL=50 line and boundaries around CL-ML zone. Your code should work with every reasonable input.

*Recall that PI = LL – PL

5. (30 pts) `find` is a built in function in MATLAB that takes a 2 dimensional matrix as input and returns indices & values of nonzero elements. It is able to return three kinds of outputs which are row (r) & column (c) indices of nunzero values and their values (v). Try the following:

```
>> A = [1 0 2; 5 8 0]

A =

     1     0     2

     5     8     0


>> [r, c , v] = find(A)

r =                c =                v =

     1                  1                  1

     2                  1                  5

     2                  2                  8

     1                  3                  2
```

a) Your first task is to write your find function called myFind which basically does the same opration as the built in `find` function. You can try your function with matrix A given before.

b) Compare the speed of your function with respect to the built in `find` function. Write a script that imports the test data given in the file (testData.txt), evaluates it with `find` and `myFind` and compares the speed of both functions with tic toc commands.

c) Use profiler to evaluate both functions.

6. Bonus Question (30 pts)

Please read to the Algorithm Development document that is provided before solving this question:

- y = humps(x) is a function with strong maxima near x = .3 and x = .9.

```
function [y] = humps(x)
   y = 1 ./ ((x-.3).^2 + .01) + 1 ./ ((x-.9).^2 + .04) - 6;
end
```

a) Plot the function in between [-2, 2].

b) Find the root of the function around x = 0 using the bisectionFunction. (Decide on your xl and xu values from the plot you have made in part a)

c) Modify the bisectionFunction to obtain a Regula Falsi algorithm. Then find the root around x = 0 with your new algorithm.

d) Find the minimum of the function within the domain (0.25, 1).

e) Calculate the integral of the function within the domain [0.5, 1] using "integral" function.

f) Write a Simpson's 1/3 Rule algorithm and use it to estimate the integral of the function within the domain [0.25, 1]. (Use step size 0.01)