# CS 222 - Homework 1
# Due in lecture Wednesday, July 11, 2001

The policies for this (and other problem sets) are as follows:

- The policies for turning in late HW assignments are outlined on the course information sheet passed out in class and on the class website.
- Problem sets may be done individually or in teams of two. Put your name or names on the front page. Re-read the academic integrity statement on the web (cited on the course information sheet).
- When MATLAB code is part of an assigned problem, you must turn in your code and all output required to receive credit. Points will be deducted for poorly commented code, redundant calculations, and inefficient code. All code should be vectorized as much as possible.

1. (10 points) You know from algebra that the roots of a quadratic polynomial can be found using the quadratic formula. The standard formula and an alternative formula that also works are below:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \tag{1}$$

$$x = \frac{-2c}{b \mp \sqrt{b^2 - 4ac}} \tag{2}$$

   Complete the following parts. Turn in all work and all MATLAB code and output.

   (a) (3 points) Find the roots of the equation

$$x^2 + 111.11x + 1.2121 = 0$$

   by hand using formula (1) and five-decimal digit floating point arithmetic (i.e., only five significant digits should be used in all calculations). Show all work.

   (b) (2 points) Find the roots of the equation in part (a) by hand using formula (2) and five-decimal digit floating point arithmetic. Show all work.

   (c) (2 points) Use `roots` in MATLAB to compute the true roots of the equation in part (a) (type `help roots` in MATLAB for the syntax). Turn in your MATLAB code and a printout of the roots of the equation displayed with 5 significant digits.

   (d) (3 points) Explain any differences in the roots calculated in parts (a),(b), and (c). What causes these differences? Is either formula (1) or (2) better than the other? Why or why not?

2. (10 points) Recall from calculus, that the mathematical constant, $e$, can be defined as

$$e = \lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$$

   This problem involves approximating the value of $e$ using the formula above. In MATLAB, write a script that performs the following tasks outlined in the commented code below. The following block of commented code should appear at the top of your script.

```
% Compute (1+1/n)^n for n=10^k and k=1:20.  Compute the absolute and
% relative error between your estimates with the actual value of e,
% exp(1).
%
% Display a table with the values of n, approximated value of e,
% actual value of e, absolute error, and relative error.
```

In addition, explain what happens to the error as $n$ increases. Explain why the error behaves as it does.

In your table, make sure you use formats that display the numbers appropriately. To receive credit, turn in your MATLAB code, your output table, and your explanation. Your explanation can be written as comments in your MATLAB code.

3. (20 points) In MATLAB, write a script that performs the following tasks outlined in the commented code and specifications below. The following block of commented code should appear at the top of your script.

```
% Let a and b be real numbers with b<a.  Let n be a positive
% integer.  Let r1=(a+b)/2 and r2=(a-b)/2.
% In the same figure, draw the following:
%   the ellipse with a dotted line
%
%       (a*cos(t),b*sin(t))        0<=t<=2*pi,
%
%   the ''big'' circle with a solid line
%
%       (r1*cos(t),r1*sin(t))      0<=t<=2*pi,
%
%   and n ''small'' circles with solid lines.
%
% The kth small circle should have radius
% r2 and center (r1*cos(2*pi*k/n),r1*sin(2*pi*k/n)).  A radius making
% angle -2*pi*k/n should be drawn inside the kth small circle.
```

***Specifications:***

The title of the graph is the student(s) name and the value of $n$, the x-axis of the graph should be labeled with the student(s) major, the y-axis of the graph should be labeled with the student(s) hobby.

Run your code for $a = 6$ and $b = 4$ and for $n = 5, 12, 25$. To receive credit, turn in your MATLAB code and your plots. Your program should only need to run once to produce all the plots.

***Helpful hints***:

(a) Use the `axis equal` command (type `help axis` in MATLAB to learn about it) to preserve aspect ratio

(b) To draw the small circles, you will need to parametrize the equation for a circle using the given center.

(c) Your plots should look similar to the cover of your text.