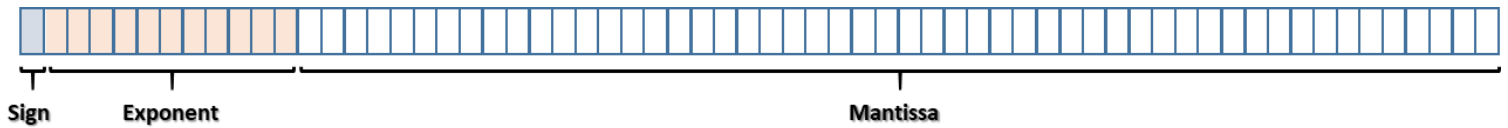# EM486A Assignment #1

Problem Statements

1. (Based on problem 1.8) Write the number 38.8125 as a 64-bit double-precision string using the IEEE-754 standard. If you wish, you may use the bitfield template below.

Sign   **Exponent**   **Mantissa**

2. (Based on problem 1.12) In single precision (IEEE-754 standard), 8 bits are used for storing the exponent (the bias is 127), and 23 bits are used for storing the mantissa. What (approximately) are the smallest and largest positive numbers that can be stored in single precision?

3. (Problem 1.41) The value of π can be calculated with the series:

$$\pi = 4\sum_{n=1}^{\infty}(-1)^{n-1}\frac{1}{2n-1} = 4\left(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \cdots\right)$$

Write a MATLAB script that calculates the value of π by using n terms of the series and calculates the corresponding true relative error. Calculate π and the true relative error for n = 10, 20, and 40. [**note:** Implement the partial series summation as a *local function* named **piApprox** that takes one argument – the number of terms n - and returns the estimated value of π and the true relative error. Use MATLAB's built-in constant **pi** for the "true" value of π]

4. (Based on Problem 3.2) Using a hand calculator, determine the root of $f(x) = x - 2e^{-x}$ with the bisection method. Start with $a = 0$ and $b = 1$, and carry out the first three iterations to determine an estimated root and bracket within the root lies.

5. (Based on problem 3.16) Write a MATLAB user-defined function that solves for a root of a nonlinear equation $f(x) = 0$ using the bisection method. Implement the function as a **local function** that takes three arguments: **fun**, **a**, and **b**, where **fun** is a handle to the nonlinear function for which a root is to be found and **a**, and **b** bracket the root. The bisection iterations should stop when $f(x_{BS}) \leq 0.000001$ where x_{BS} is the midpoint of the current bracket. The function should also check if points a and b do indeed bracket a root; if not, the function should return an error message. Use your function to find the root of $f(x) = x - 2e^{-x}$.

6. (Based on problem 3.30) The van der Waals equation gives a relationship between the pressure P (in atm.), volume V (in liters), and temperature T (in K) for a real gas:

$$P = \frac{nRT}{V - nb} - \frac{n^2 a}{V^2}$$

where n is the number of moles, $R = 0.08206$ (L-atm) / (mole-K) is the gas constant, and a (in L^2-atm/mole^2) and b (in L/mole) are material constants. Consider 1.5 moles of nitrogen ($a = 1.39$ L^2-atm/mole^2, $b = 0.03913$ L/mole) at 25ºC stored in a pressure vessel. Use the function you created for problem #5 to determine the volume of the vessel if the pressure is 13.5 atm.