EML3041 Computational Methods
Spring 2023
Week: Four

Answer the free-response questions starting on a fresh sheet of paper. Solve the problem as if you were submitting them for a test. Put your last name, first name, and your first letter of last name in bold on top of the page. Submit Q1 and Q2 at the end of the class.

1) Given the equation $x^3 = 6.4$ and an initial guess of $x_0 = 12$, what is the second iterative value of its root, x_2 by Newton-Raphson method?

Answer: 5.37

2) The square root of a positive real number *R* can be found iteratively by using the formula

$$x_{i+1} = \frac{1}{2}\left(x_i + \frac{R}{x_i}\right).$$

How much computational time does it take to conduct five iterations as given in the program below? Assume you are utilizing an AMD chip that uses 4 clock cycles to conduct one multiplication, 4 clock cycles to conduct one addition, 4 clock cycles to conduct one subtraction and 16 clock cycles to conduct one division. The computer uses a 2.5 GHz processor.

```
n=5
R=7
for i=1:1:n
  xnew=0.5*(xold+R/xold)
  xold=xnew
end
```

Answer: 4.8×10^{-8} seconds

3) **Background**: Deflate-Gate 2015 is an excellent lesson in why jumping to conclusions is a bad idea and appreciating thermodynamics' relevance to a practical problem. Physicist Neil deGrasse Tyson did not change gauge pressure to absolute pressure. Bill Nye, a mechanical engineer, who calls himself the science guy, did not give convincing arguments and took off 15% from the gauge pressure for his calculations. Others did not change temperature to absolute temperature. Variables like water vapor pressure and compressed air temperature (compressed air is hot) to inflate balls were not considered. The time interval between when balls were inflated to when balls were taken to the field was not accounted for.

I am also giving this problem with incomplete data so that you develop skills for formulating a problem. See this TED video on Math Needs a Makeover why incomplete date problems should be given to students.

Questions:

i. Assume the NFL football was inflated in a room at 80°F, left in the room for a while, brought to the field at 40°F, and left there for a while. The ideal gas law is given by $pv = RT$ where p is the pressure, v is the specific volume, R is the universal gas constant, and T is the absolute temperature.

(A) What variable values would you seek from the professor? Ask the professor or the TAs. You should seek the least number of variable values from them.

(B) What is the decrease in the pressure in psi?

ii. The above problem does not fall under any of the mathematical processes we talk about in class unless one wants to use the van der Waals equation. The ideal gas law equation is only accurate for a limited range of pressure and temperature. Johannes Diderik van der Waals came up with an empirical equation that was accurate for larger ranges of pressure and temperature given by

$$\left(p + \frac{a}{v^2}\right)(v - b) = RT$$

(A) What variable values would you seek from the professor or TAs?

(B) What mathematical process does the mathematical model fall under.

(C) Only outline the problem. What would your approach be in finding the decrease in the pressure in psi?

P.S. When you have time, watch a 2021 documentary, "Four Games in Fall", where the story is debunked.

Source of Photo: http://bostinno.streetwise.co/2015/01/23/nfl-deflate-gate-statement-full-text-of-nfls-statement-on-deflategate-investigation/)