Spring 2021
PHYS 377 Advanced Computational Physics
HW # 3a

<u>Problem 1:</u> Write a program, or modify an earlier one, to once more calculate the value of the integral

$$\int_0^2 (x^4 - 2x + 1)dx$$

using the ***trapezoidal rule*** with 20 slices, but this time have the program also print an estimate of the **error on the result**, calculated using the method discussed in class. *i.e.* using the equation

$$\epsilon_2 = ch_2^2 = \frac{1}{3}(I_2 - I_1)$$

To do this you will need to evaluate the **integral twice**, once with $N_1 = 10$ slices and then again with $N_2 = 20$ slices. Then the equation given above gives the error. How does the error calculated in this manner compare with a direct computation of the error as the difference between your value for the integral and the true value of **4.4**? Why do the two not agree perfectly?

<u>Problem 2:</u> Given below is a *differential equation*

$$\frac{dx}{dt} = -x^3 + \sin(t)$$

with the **initial condition** $\boldsymbol{x = 0}$ at $\boldsymbol{t = 0}$. Use various ***Runge-Kutta (R-K)*** set of methods to solve the above differential equations.

(a) Write a **program** that uses ***Euler's method*** (***1st order R-K method***) to solve the differential equation.
(b) Write a **program** that uses ***midpoint method*** (***2nd order R-K method***) to solve the differential equation.
(c) Write a **program** that uses ***4th order R-K method*** to solve the differential equation.
(d) **Plot** the results for each of the methods. Do you see improved accuracy with higher order ***R-K methods***? **Why**?

For all the programs, calculate from $\boldsymbol{t = 0}$ to $\boldsymbol{t = 10}$ using a reasonable number of steps.