Computational Physics

Chapter One: The Numerical Problem

– Radioactive Decay

• nuclei have the probability to split into two seperate nuclei → Ex/ ($^{235}U \rightarrow {}^{231}Th + \alpha$)

alpha particle

$$N(t) = N_0 \cdot e^{\frac{-t}{\tau}}$$

τ: life time
N_0: initial # of nuclei

# of nuclei at a given time

$$\frac{dN(t)}{dt} = -\frac{N}{\tau}$$ (rate of change of nuclei)

~> How do we approach solving?

• Taylor Expansion:

$$N(\Delta t) = N_0 + \frac{dN(t)}{dt} \cdot \Delta t + \frac{1}{2}\frac{d^2N(t)}{dt}(\Delta t)^2 + \ldots$$

* if we take Δt to be small (0.05 sec)...

$$N(t) \approx N_0 + \frac{dN(t)}{dt} \cdot \Delta t$$

↓

$$N(t+\Delta t) \approx N(t) + \frac{dN(t)}{dt} \cdot \Delta t$$

→ Also known as the euler method for approximating first order Differential equations!

↓

~> equations that use Euler Method usually require smaller time intervals → Why? → Reduce error in the approx.

↓

– these methods work but require us to be consious of their use cases and constraints

General Programming Philosophy and Guidelines:

~Program Structure: Make use of Subroutines to reduce repeated actions

~ Variable names: Use descriptive names when making variables and functions

~ Comment Statements: Write-in areas where you explain what a function/process is doing

~ Clarity is key: While compact code may look nice, readable and clear code always takes the cake

~ labeled Graphs: Make sure that graphs are accurately labeled and have proper axises!