Homework 4

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1. INTRODUCTION

This homework involved solving nonlinear equations using various methods like relaxation, binary search, and Newton Raphson.

2. 6.12

For this problem we had to model the biochemical process of glycolysis. To do this we set up a set of coupled differential equations and converted them into a set of nonlinear equations. For part a we must show that the solutions are $x = b$ and $y = \frac{b}{a+x^2}$. This is done by solving for x^2y in equation 1 and plugging that into equation 2.

We begin with the first equation

$$-x + ay + x^2y = 0 \tag{1}$$

Solving for x gives

$$x^2 * y = b - ay \tag{2}$$

plug this into equation 2 gives $x = b$ plugging this into equation 1 gives equation 2

For part b we find that the given equations do not converge but a rearrangement of them into $x = \sqrt{\frac{b}{y} - a}$ and $y = \frac{x}{a+x^2}$ do converge. We find the this converges to $x = 2andy = 4$ because this is a coupled system we had to use a system version of newton raphson and relaxation and because of the system property of this problem we cannot use the binary search method according to newman page 266. I found that the relaxation method worked very well for this setup for quite large starting values of x. With a starting value of of $x = 100andy = 100$ the solution using relaxation method : [1.9999980105621868, 0.40000023873260093] with 41 iterations and this was the solution using newton raphson: [1.99999961 0.39999991] with 59 iterations.

3. 6.16

We are concerned with finding the lagrange point between the earth and the moon we can do this with a force balance we begin with force of gravity from the earth

$$f_E = \frac{GMm_{sat}}{r^2} \tag{3}$$

we also include the force of gravity from the moon

$$f_M = \frac{Gmm_{sat}}{(R-r)^2} \tag{4}$$

combining these forces gives the force on the satellite

$$f_s = f_E - f_M \tag{5}$$

Weknow the force on the satelite is

$$f_s = \omega^2 r * m_{sat} \tag{6}$$

Combining everything gives

$$\omega^2 r * m_{sat} = \frac{GMm_{sat}}{r^2} - \frac{Gmm_{sat}}{(R-r)^2} \tag{7}$$

divide both sides bym_{sat}

$$\omega^2 r = \frac{GM}{r^2} - \frac{Gm}{(R-r)^2} \tag{8}$$

$$\tag{9}$$

We use the secant method to solve this equation and found the value to be $3.26045071 * 10^8$

4. PROBLEM 3

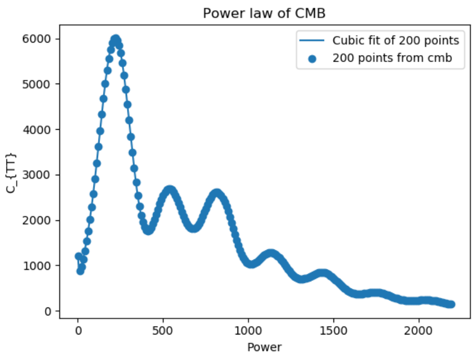

FIG. 1: Power law with spline fit

I found that the total error was 1.1455 which is in the tolerable range of l/3

5. CONCLUSIONS

I found this homework to be hard not because of the content but because of the circumstances surrounding the problem set. Because of the corona virus it was difficult to find the time to complete this problem set because of Internet issues, moving, and general unforeseen developments. Sorry for submitting this so late.

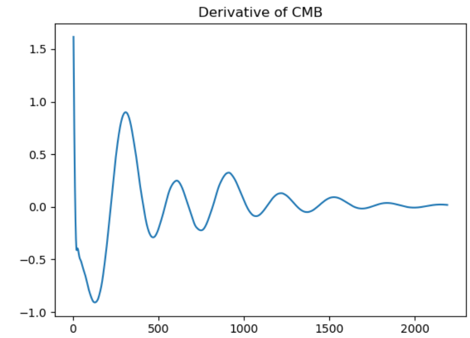

FIG. 2: Derivative

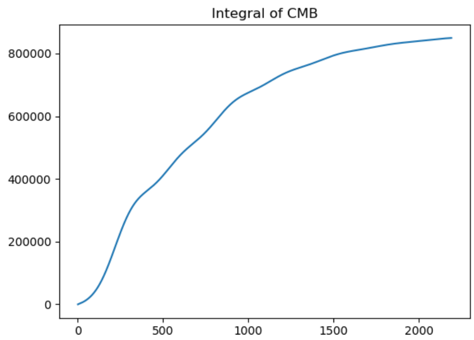

FIG. 3: Integral