Due: Wednesday, May 6, beginning of class. This time a late project will not be accepted.
You can use a computer package of your choice or Algorithm 5.7 from our book’s website.

Background: The sun and nine planets form a system of “masses” moving under the law of
gravitation. The position vectors of the planets constitute a system of 27 functions (ask yourself
why) and Newton’s Laws can be written as a system of 54 first order differential equations (ask
yourself why). These equations can be solved for the past and future positions of the planets. The
corresponding problem with two co-planar masses, sometimes called a “Two Body Problem”
(Hydrogen Atom) takes the form: \( x'(t) = f(x,y,t), \ y'(t) = g(x,y,t) \) with initial conditions, \( x(0) = a, \ y(0) = b \). The vector form of these equations is: \( X' = F(X) \), with an initial vector \( X(v) = S \).
Notice that \( F(X) \) and \( S \) will be given.

The purpose of this project is to solve a “Four Body Problem” by the following methods:
Method 2 Extra Credit 10 Points: Use Adams-Moulton predictor-corrector method. For
reference Adams-Bashforth predictor method is given below:
\[
X_{AB}(t+h) = X(t) + \left\{ 55F[X(t)] - 59F[X(t-h)] + 37F[X(t-2h)] - 9F[X(t-3h)] \right\} h/24
\]
Adams-Moulton Corrector formula is:
\[
X(t+h) = X(t) + \left\{ 9 F[(X_{AB}(t+h))] + 19 F[X(t)] - 5 F[X(t-h)] + F[X(t-2h)] \right\} h/24
\]

Problem:
The vector form of our initial value problem is:
\[
X'(t) = F(X) = \begin{bmatrix} z \\ u \\ -x(x^2 + y^2)^{-\frac{3}{2}} \\ -y(x^2 + y^2)^{-\frac{3}{2}} \end{bmatrix}
\]
with initial condition, \( X(0) = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 1 \end{bmatrix} \). Clearly, \( X(t) = \begin{bmatrix} x(t) \\ y(t) \\ z(t) \\ u(t) \end{bmatrix} \).

On the interval \( 0 \leq t \leq 2\pi \), compute the values of \( x(t), \ y(t), \ z(t), \ u(t) \) using a step size \( h = 0.1 \).
Then plot the resulting curves, \((x,y) \) “x versus y” and \((z,u) \) “z versus u”.

Output: Turn in the following, stapled in order:
(i) This sheet as cover page.
(ii) Your handwritten notes, construction and modification of the algorithm. Which program did
you use?
(iii) A table of values for \( t, x(t), y(t), z(t), u(t) \).
(iv) A graph for pairs, \((x,y)\).
(v) A graph for pairs \((z,u)\).

For comparison purposes, it will be best to include items (iii), (iv) and (v) on a single page, the
graphs drawn with the same scale.