Homework #7 Planet Orbits

Computational Physics: Fall 2023: Professor Coan & Olness
Due Wednesday 11 October 11:59pm in Canvas upload

EXTRA NOTES:**If you use Python, please convert the notebook to a PDF and turn in BOTH.**

We will begin with the Kepler potential V= -k/r.

1) [20 points] Solve the differential equation y'[x]=Cos[x] using:
a) the zero-step method (we evaluate the slope at x0): y1=y0+y'[x0]*dx
b) the half-step method (we evaluate the slope at x0+dx/2): y1=y0+y'[x0+dx/2]*dx
c) the average method (we average the slope at x0 and x1): y1=y0+(y'[x0]+y'[x1])/2*dx
For each one, plot the result for a few cycles.
For a selected point (your choice) compare your answer with the exact answer; which method is most accurate?

2) [20 points] For the Kepler potential V=-k/r.
a) Plot the orbit using the 1-step Euler method. Be sure to have at least 3 revolutions.
b) Repeat with a different time step and comment on the difference.
c) If we could solve this exactly, the orbit would close. How close did you come???
Please turn in both your code/notebook and the plot in PDF or PNG.

3) [20 points] For the Kepler potential V=-k/r.
a) Plot the orbit using the 2-step Runge Kutta method using the SMALLER time step you used in #1 (so we can compare). Be sure to have at least 3 revolutions.
b) Compare the 2-step method here with the 1-step method in #1. Be sure to match the time step and # of iterations.
c) If we could solve this exactly, the orbit would close. How close did you come???
Please turn in both your code/notebook and the plot in PDF or PNG.

GRAD STUDENTS ONLY:

4) [20 points]
Repeat #3 using the 4-step Runga Kutta method

Next, we use the potential V= +k r^2. (Note the + sign)

5) [20 point] Repeat #3 using V = + k r^2 using your best method: (Ugrads, 2-step, Grads, 4-step)
Note: in the perfect case, this should be a closed orbit. Comment.

Next, we use the potential V= -k/$r^{2/9}$.

6) [20 point] Repeat #3 using V = - k/$r^{2/9}$ using your best method: (Ugrads, 2-step, Grads, 4-step)
Note: in the perfect case, this should be a closed orbit. Comment.