Scientific Computing for DPhil Students II
Assignment 1

Due at lecture at 10:00 on Tuesday, 28 January 2020.
This is the first of four assignments this term.
It will count for 10% of the overall mark for the term.

In this as in all assignments in this course, the answers you turn in should be attractive and brief but complete, and should include program listings and plots where appropriate.

Three unit masses are fixed at positions $(1, 0)$, $(\cos 120°, \sin 120°)$ and $(\cos 240°, \sin 240°)$ in the plane. Another unit mass p starts motionless at $(2, -2)$ at $t = 0$ and then moves around freely under the influence of inverse-square forces attracting it to the three fixed masses. Where is p at $t = 40$?

Use either Matlab's `ode113` or Chebfun (or both!) to solve this numerically as an ODE problem. In addition to determining the required pair of numbers, make plots of the orbit in the plane and of $\theta(t)$, the angle of the particle with respect to the origin as a function of t. For this, find a way to define $\theta(t)$ as a continuous function, i.e., avoiding jumps of 2π. (One way to do this is via the Matlab or Chebfun `unwrap` functions. Another is to add θ as an extra variable in your differential equation and track it that way.)

For 2D problems like this it can be very convenient to use complex arithmetic rather than track x and y components separately. Either way is fine.

Be careful to check that your trajectory has been computed accurately enough that it comes out correct to at least several digits of precision. To adjust error tolerances for `ode113` you can use `help odeset`, and for Chebfun, try `chebopprefto` determine current tolerances and e.g. `chebopprefto.setDefaults('ivpAbsTol',1e-10)` to change them.