Maynooth University
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OLLSCOIL NA hÉIREANN, MÁ NUAD
NATIONAL UNIVERSITY OF IRELAND, MAYNOOTH

BSc in Physics with Astrophysics
BSc in Experimental Physics

EP408 Computational Physics Class Test 2

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Answer ***both*** questions, Time allowed: 2 hours

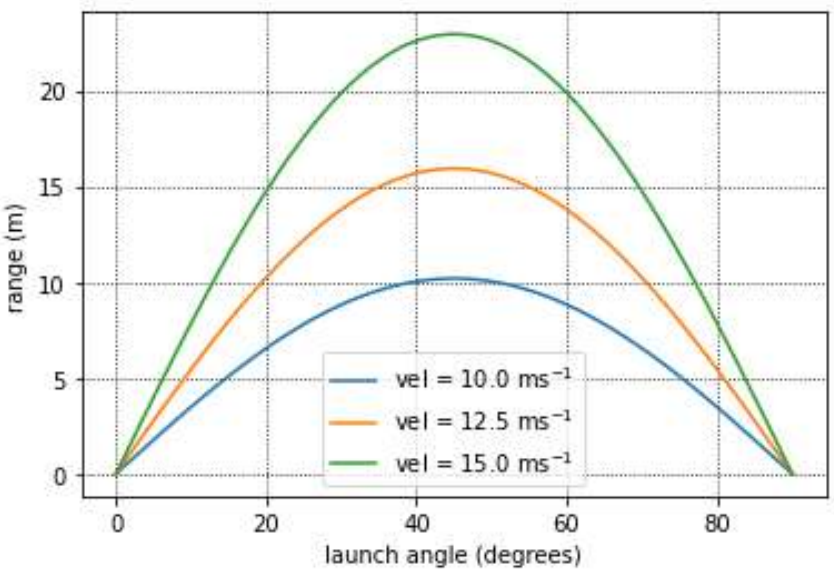
*Please **save your work regularly** - no credit can be given for work that is lost.*

Q.1 (Root Finding)

If a projectile is launched with a velocity v and at an angle θ then its vertical position is given by the equation

$$y(x) = x\tan\theta - \frac{1}{2}g\left(\frac{x}{v\cos\theta}\right)^2.$$

Solving for $y(x)$= 0 gives the range of the projectile. Use one of the root finding techniques we have studied (half-interval, bisection, the secant or Newton's method) to plot the range of a projectile, as a function of angle, for three launch velocities. You may use the plot below as a guide.



NOTE: *Marks will be given for the style, structure and **commenting** of your code. The plot should be labelled.*

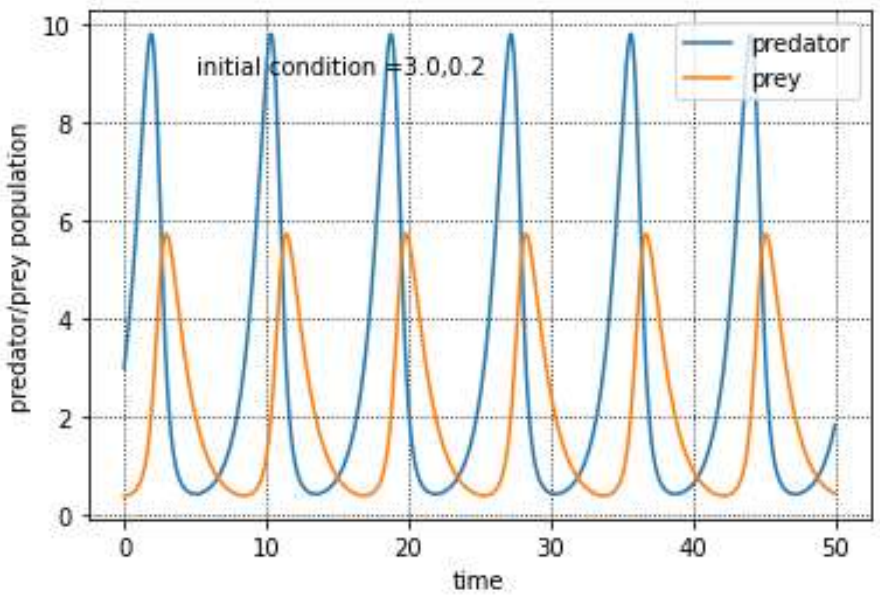
Q.2 (Solving coupled ODEs, RK4)

A simple model of predator (y) and prey (x) populations and their interactions can be described by

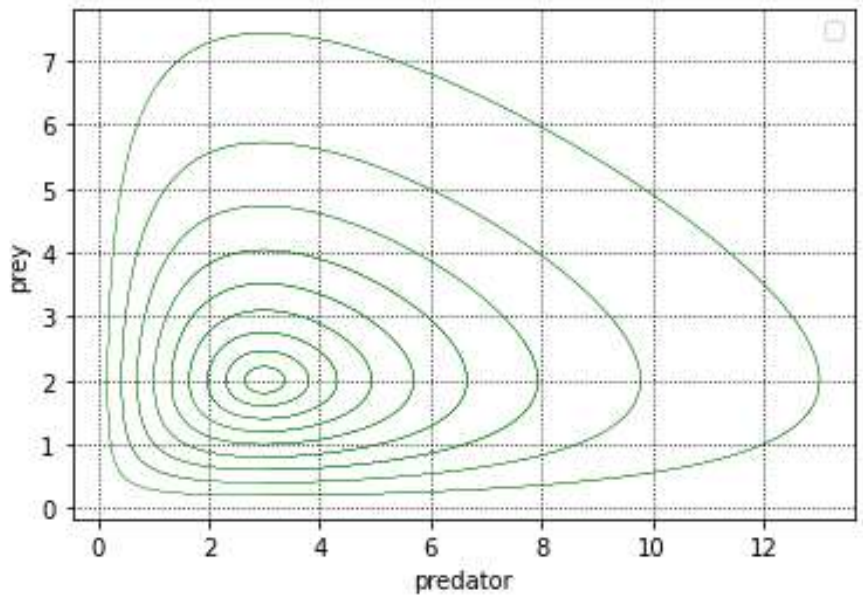
$$\frac{dx}{dt} = x - \frac{1}{2}xy$$

$$\frac{dy}{dt} = -\frac{3}{4}y + \frac{1}{4}xy\,.$$

Write a program to solve these coupled differential equations (use the RK4 method). (i) Plot the predator and prey populations as a function of time ($t = 0$ to 50) given initial values of $x = 3.0, y = 0.2$. You may base your layout on the one shown below.



(ii) Next, plot the phase space diagram (y vs x) for populations with initial conditions $x = 3$ and $y = 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8$. What happens if the initial condition is $x = 3, y = 2$?



NOTE: *Marks will be given for the style, structure and* ***commenting*** *of your code. The plot should be labelled. You must code the RK4 method yourself rather than make use of any python libraries.*