Birla Insititute of Technology & Science – Pilani, K.K. Birla Goa Campus
First Semester 2020-21

PHY F313 | **Lab test-1 (Open Book)** | **Time: 120 mins**

Computational Physics 19 th September 2020

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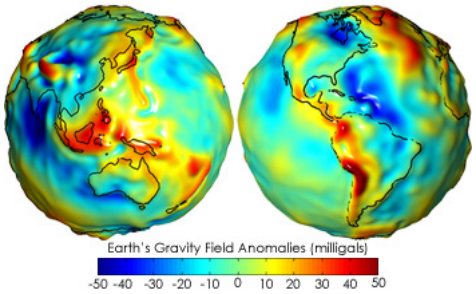
1. An object falling vertically through air is subjected to viscous forces as well as gravity. Assume that an object of mass $m = 0.1Kg$ is dropped from a height $h_0 = 10m$. The height of the object $h(t)$ after t seconds is (assuming damping force to be proportional to velocity) :

$$h(t) = h_0 - \frac{mg}{b}t + \frac{m^2 g}{b^2}(1 - e^{-bt/m}) \tag{1}$$

$b = 1.9 \times 10^{-4} Kgs^{-1}$ is the damping constant[1]. Acceleration due to gravity varies over the surface of the earth due to many factors - non-spherical shape, rotation, height above sea-level. Its variation from the earth's uniformly standard value is depicted below (see figure) from results obtained by NASA's Grace mission[2].

In today's exercise you have to determine the time of fall for the above mass to reach the ground at different cities around the world.



(a) Write down the equation whose roots will give you the time taken t_{fall} for mass to reach the ground.

(b) Write a code to implement **Secant method** for finding roots.

(c) Test your code for a $f(x)$ whose roots are known to you. In the answer sheet you will be required to describe the test that you carried out.

(d) Find the time of fall t_{fall} at the following cities around the world. The values of g are given in table below

City	Value of g (m/sec^2)
Helsinki	9.825
Toronto	9.807
Kuala-Lampur	9.776

Accuracy of t_{fall} value you compute is important here. It should be good enough to distinguish between time of falls at the above cities. Calculate your t_{fall} to an accuracy such t_{fall} differs

[1] Ref: Determining the damping coefficient of a simple pendulum oscillating in air, Luis A Ladino & Hermilda S Rondón, Physics Education, Vol. 52, 2017

[2] Ref: Wikipedia

at these 3 cities by atleast 2 significant figures. While terminating Secant method you should bear this in mind.

Note: In the final answer sheet (templated uploaded on Quanta) along with value of t_{fall} you also have to write down your initial two guesses in Secant method & the termination value for |x_{n+1}-x_{n}|. Additionally you also have to describe the test results.

UPLOAD THE FINAL ANSWER SHEET & YOUR CODE