ANPA Python School for High-schoolers

Section: Grade 10 & Above **Homework: 2** **Due: July 01, 2021**

1. Class

Create a class to calculate the curved surface area and volume of an ice-cream cone of radius *r* and height *h* and determine values of them when *r* = 5, and *h* =7.

Hint: Curved surface area of a cone = $\pi\, r \sqrt{r^2 + h^2}$ and volume of a cone = $\frac{1}{3}\, \pi\, r^2\, h$

2. Catalan numbers

Catalan numbers are a sequence of natural numbers that are defined by the recursive formula

$$C_0 = 1 \text{ and } \quad C_{n+1} = \sum_{i=0}^{n} C_i C_{n-i} \quad \text{for } n \geq 0.$$

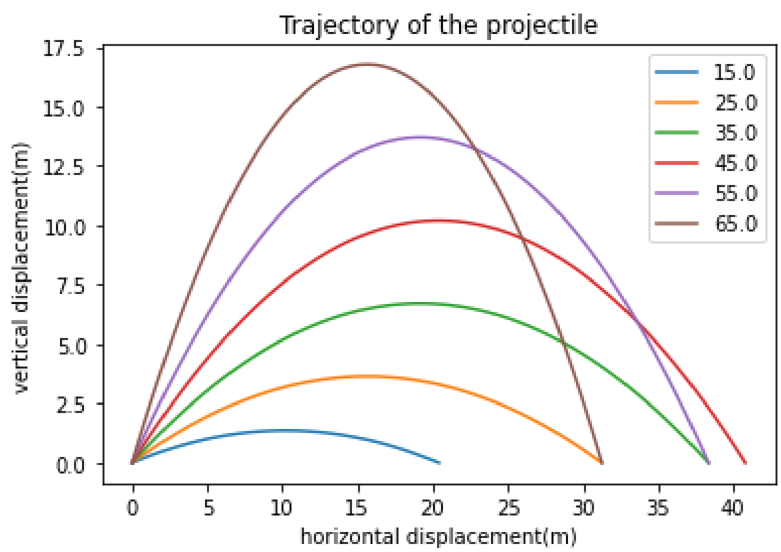
The first few Catalan numbers for n = 0, 1, 2, 3, … are 1, 1, 2, 5, 14, 42, 132, 429, 1430,4862,16796, ….

Write a program in Python to find first 12 Catalan number for n = 0, 1, 2, 3,4, …….

3. Projectile

Chandra threw an orange at certain angle θ with an initial velocity of 20 *m/s*. Draw a plot showing vertical and horizontal displacements if $\theta = 15^0, 25^0, 35^0, 45^0, 55^0, 65^0$, and 75^0. Use g=9.8 m/s^2.

(Hint: This is a generalization of the problem we did in the class. All you need to do is to plot at different angles as specified in the problem. Your plot looks as below.)



Your instructor: Chandra Mani Adhikari, PhD

4. Simple harmonic motion subjected to damping

The equation of SHM subjected to damping force $F = \gamma \frac{dx}{dt}$ is given by

$$\frac{d^2y}{dt^2} + 2k\,\frac{dy}{dt} + w^2 x = 0\,,$$

where k is damping constant, w is angular velocity with $w^2 = k/m$.

Its solution is given by

$$y = (C_1 e^{-\beta t} + C_2 e^{\beta t})e^{-kt}\,, \quad \text{where } \beta = \sqrt{k^2 - \omega^2}.$$

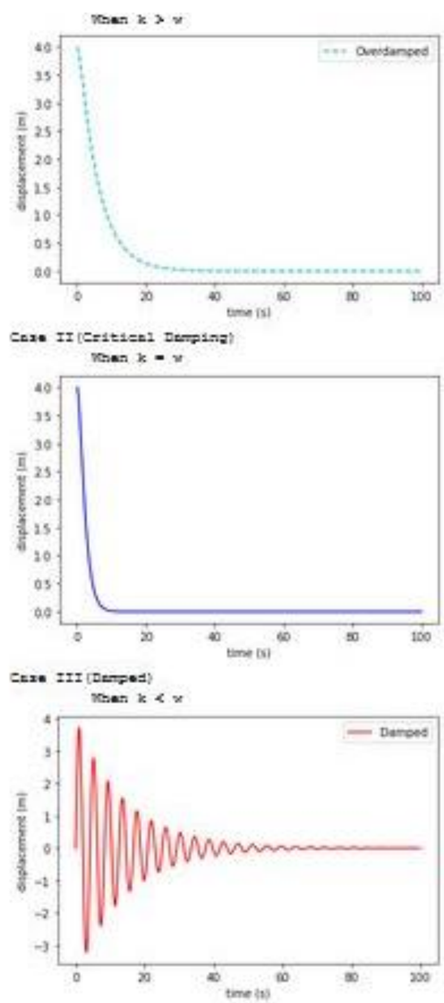
After using initial conditions one gets the displacement as

$$y(t) = \frac{a_0}{2} e^{-kt}\left[e^{-\beta t}(1 - \frac{\beta}{k}) + e^{\beta t}(1 + \frac{\beta}{k})\right].$$

Plot the displacement in the following conditions:

1. Overdamped $k > \omega$: for example $k = 0.8\,, \quad \omega = 0.5\,, \quad a_0 = 4.$
2. Critical damping $k = \omega$: for example $k = 0.8 = \omega\,, \quad a_0 = 4.$
3. Damped $k < \omega$: for example $k = 0.07\,, \quad \omega = 1.5\,, \quad a_0 = 4.$

You expect a plot similar to the following:



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