Assignment 01: Iterations and control flow
Assigned: 15th September 2020
Due: 29th September 2020 at 5 PM

Note: Please upload your solution as an ipynb and pdf file to the Canvas page.

The purpose of this assignment is to develop your skills in writing iterations (for) and control flow (if/else).

1. Write a python code to calculate the sum of first n elements for the following series. Use $n = 15$.

   (a) Maclaurin series for $\sin(x)$.

   $$x - \frac{x^3}{3!} + \frac{x^5}{5!} - \dots$$

   for $x = 2.5$. Check your result using `math.sin(x)`. Hint. To calculate the factorial of a number use the inbuilt function in `math` module `math.factorial(x)`

   (b) For $a = 9$ and $r = 1/3$, evaluate the geometric series for the first n terms:

   $$a + ar + ar^2 + ar^3 + \dots + ar^{n-1}$$

   Check your solution using the geometric series formula:

   $$\sum_{k=0}^{n-1} ar^k = a\left(\frac{1-r^n}{1-r}\right)$$

2. Using control flow statements write a code that tests the location of a given point $P(x_p, y_p)$ with respect to an annular ring of inner radius R_i and outer radius R_o centered at point $C(x_c, y_c)$ and report if the point lies:

   (a) inside the annulus

   (b) on the annulus

   (c) beyond the outer radius

   (d) within the inner radius

   Test your code for the following annular ring with its center located at $(x_c, y_c) = (2.0, 3.0)$ and the outer radius is 2.0 and inner radius is 1.0. Test for all possible locations of point P (inside, outside, and on either of the two circles).

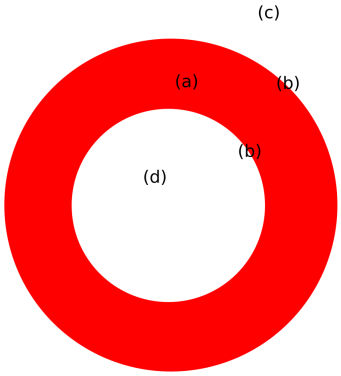
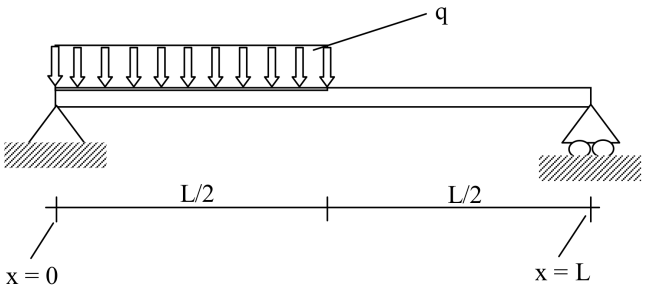


Figure 1: Q2: Annulus

3. A simply supported beam of length 20 feet is supporting a uniformly distributed load q of 4000 lb/ft to half its length as shown below. Write a Python code using conditional statements (if/else) to compute the deflection at any location x along the length of the beam.



For the given loading, the deflection $\delta(x)$ is:

$$\delta(x) = \frac{qx}{384EI}(9L^3 - 24Lx^2 + 16x^3) \qquad 0 \leq x \leq \frac{L}{2}$$

and

$$\delta(x) = \frac{qL}{384EI}(8x^3 - 24Lx^2 + 17L^2x - L^3) \qquad \frac{L}{2} \leq x \leq L$$

Note that $x < 0$ and $x > L$ are invalid locations. Use the following values for the various parameters involved in the above expressions:

$$q = 4000\ lb/ft$$
$$L = 20\ ft$$
$$EI = 1.2e8\ lb.ft^2$$

Using these values, obtain the deflection at 3 locations: $x = L/4, L/2, 3L/4$.

4. Modify the above code using a for-loop to plot the displacement of the beam along its length. Plot the displacement profile when calculating x at every $0.5, 1, 2$ and 5 feet (4 different plots).