Major Assignment 1

ENGINEER 1D04
Dr. Spencer Smith
McMaster University, Fall 2013

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Please use AutoMarker (`automarker.mcmaster.ca`) and Avenue to acquire, test, package and submit your assignment. The procedure for submitting assignments is summarized on Avenue, with additional details provided by AutoMarker. **Please frequently back up your work by creating a submission package in AutoMarker**. This will provide a chance to recover your work in the event of an equipment failure.

Background

A free-standing cylindrical column of uniform density will buckle under its own weight beyond a certain critical height. Your program will calculate the critical height h_{crit} of a column. Parameters for this calculation include the column's density ρ, modulus of elasticity E, radius R, and the acceleration due to gravity $g = 9.81\ \mathrm{m/s^2}$. The formula for the critical height (in metres) is:

$$h_{crit} = \sqrt[3]{\frac{6B_e^2}{14}\frac{ER^2}{\rho g}}$$

where B_e is a constant approximately equal to 1.866. Sample values are as follows: $\rho = 2400\ \mathrm{kg/m^3}$, $E = 3 \times 10^{10}\ \mathrm{Pa}$, and $R = 2\ \mathrm{m}$.
Design, implement, and test a program that satisfies the requirements below.

****Important**:** This assignment will be run through an automated testing program to be graded. The program will make the assumption that any output containing an equals sign (=) is an answer to be marked. **Do not** print output containing the equals sign, except where specified in the requirements below. Outputs must also be printed on separate lines. Additionally, input and output statements must be **exactly** in the order specified. Failure to precisely follow the requirements below will result in a significant loss of marks.

Requirements

1. The program asks the user to enter ρ, E and R, in this order.
2. The program computes:
    a. $A =$ The critical height calculated using ρ, E, and R.

b. $B =$ The critical height calculated using ρ, E, and $2R$.

3. The program prints the following values, in their given order, in the format
"*label* = `value`," where *label* is an appropriate description of `value` and "=" is the equals sign:

   a. A.

   b. B.

   c. $C = 100 \cdot \left|\frac{A-B}{B}\right|$, which is the *relative difference* between A and B expressed as a percentage.

   Do not print the units for A and B and the percent sign (%) for the relative difference (C).

4. The program is written in Python in a module, NOT in the Python Shell. To create a new module in IDLE, go to File → New Window. You must save this file with a .py extension. For more information on submitting your program, click the "AutoMarker Instructions" button above.

5. Your name, MacID, student number, and the date are given in comments at the top of your Python (.py) file before your program.

6. Your answers to the design questions and the test plan (see below) are given in comments at the bottom of your Python (.py) file after your program.

7. Your program MUST have valid Python syntax and it must run without errors. Ensure that your program runs properly by running it before you submit.

8. You must sign out with a TA or IAI after you have submitted your lab at the submission station. Failure to do so could result in a zero.

Design and Implementation Instructions

You do not need to use any for loops or functions in your program.

Design Question

This is a fairly complex formula, but requires few inputs. You will learn later how to code the formula for the height just once instead of once for A and once for B. What would the advantage be of coding the formula just once?

Test Plan

Produce a test plan for each test case `i` in the following form:

`Test: i`
`Input: [`ρ`,` E`,` R`]`
`Expected Output: [A, B, C]`

You must have no less than 3 test cases. Have at least 1 case where your program does not fail. For the other cases, we encourage you to seek out test cases where your program would fail. That is, where the expected output is a failure.