**ChE 310 Problem Set 2 (15 pts) Due Wed 1/30/19**

Collect all m-files in a single .zip file and upload the .zip file to the course webpage by midnight on Wednesday, January 30 2019. Please note any collaborations in the header comments of your m-files. Each student must upload their own individual copy of the work.

**2.1 (3 pts)** Evaluate the following mathematical expression using MATLAB:

Write your solution in an m-file named PS2\_1.m that displays only the final calculated value of the expression in the command window. Use a relative error tolerance of 10-7 as needed. (Hint: your final answer should be about 15.)

**2.2 (3 pts)** A *piecewise function* is useful when the relationship between dependent and independent variables cannot be adequately represented by a single equation. The velocity of a rocket might be described by:

where is time in seconds and is velocity in m/s. Develop an M-file function to compute as a function of , and then create a script file PS2\_2.m to plot versus for . Suppress all output from the code, except for the final plot. Ensure your plot is properly labeled.

**2.3 (4 pts)**

(A) - You have opened a consulting firm that specializes in chemical engineering insight for agriculture applications. A client comes to you seeking help in determining flow rates through an open, rectangular, passive irrigation channel to his field. Thankfully you kept your ChE 310 Textbook and notice that Problem 3.9 details Manning’s equation which can be used for this solution. You visit the client’s field and make the following measurements:

* slope = 0.01 (rise over run)
* width = 2m
* depth = 0.5m
* roughness coefficient = 0.03

Create a MATLAB *function* that calculates the velocity of water through this channel (output) given the above inputs (slope, width, depth, roughness).

(B) - News quickly spreads of your firm’s expertise in culvert calculations. You open your email one day to find an invitation from the UAE to design all of their state funded culverts. They attach the following Excel file with all their measurements – ‘culverts.xls’ (Column 1-4 are roughness, slope, width, and depth respectively). They are offering a nice payment if you can get calculations back to their engineers by this afternoon. Make a new M-file PS2\_3bc.m that imports the data from the Excel sheet, uses the function in part (A) to help calculate the volumetric flow rate (NOTE: not velocity), and then exports the calculated flow rate vector as a new Excel file.

(C) - Adding on to PS2\_3bc.m, use MATLAB to count the number of channels with flow rates greater than 100 m3/s, which we consider to be poorly designed. What percentage of the designs fall in this poor category?



**2.4 (5 pts)** A cylindrical storage tank has a conical bottom to facilitate drainage. One particular tank design specifies a radius of *R*, a total height of 4*R*, and the height of the conical­­ bottom to be *R*. Write an m-file function tank\_volume.m that calculates the volume of liquid in such a tank if the liquid level is *h*.

***Function*:** tank\_volume.m

Inputs:

* R: an *array* of *R* values representing the radius of the tank.
* h: an *array* of liquid height values measured from the bottom of the tank

Outputs:

* V: an array of tank volumes, of the same shape as the input data R and d

Your function should have two checks:

* Issue an error statement if the arrays *R* and *h* are not the same shape
* Issue an error if, for any value of *h*, *h* > 4*R* (tank overflow!). Hint: typing “doc any” at the command line will show a simple suggestion for testing all values in an array simultaneously. There are other ways to test this, as well.

***Driver Script***: PS2\_4.m

Create a simple script that uses your tank\_volume function to generate a plot (on a single axis) of the liquid volume vs. liquid level for *R* = 1 m and *R* = 2 m. Your plot should be properly labeled (axes, title, legend). No output from the function file or the driver file should be displayed other than the plot when the driver file is executed.

*Hint*: The volume of a cone with radius *r* and length *l* is .

**Group Credit (+2 pts) –** Collaborate via slack with your group. Seek help and give help on this PSET within your group channel. The TA will interact with your group as well, give clarification, and assign group participation points for the week.