1. Matlab syntax – Matlab programming

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Course 28864: Introduction to Matlab programming

The purpose of this exercise is to learn to work with Matlab scripts and functions.

First go through the course slides (test the commands and statements given there! Do not forget also to have a look at the document 'Introduction to Matlab – basic functions') of the first lecture. Afterwards, you will write a Matlab script and a Matlab function. **That means that the solution of this exercise that you will submit will consist of 2 m-files!** Note that we know very well that one can easily solve the problem below without using a function, but that is not what we want you to do today.

Before you start, **check the lecture notes / slides in order to understand the difference between a script and a function!** In this exercise you will write a function that calculates the settling velocity in water for a particle with a given diameter.

In the script:
You will define a column vector with particle diameter values varying from 0.5 to 1 mm in steps of 0.01 mm.
You will call your function (as defined below), use the column vector (values in m) as input together with all the other given parameters and receive a column vector with settling velocities back as output from the function.
The script will then display – in the Matlab command window – the diameter values with index 1, 8, 15, 22, 29 and 36 of the diameter vector that served as the input to the function, as well as the corresponding settling velocity (generated as the output of the function).

WARNING: It is not allowed to use a 'for loop' to perform the calculation (in principle, one could write a 'for loop' and do the calculation separately for each element in the column vector). All particle diameter values in the column vector will be transferred to the function at once, and the function returns a vector of settling velocities.

WARNING: Be careful with the given units, they should be consistent when you implement the code!

In the function:
Settling of discrete, non-flocculant particles can be analyzed by means of classic laws of sedimentation. Below, given Newton's law, the terminal particle settling velocity is calculated by equating the gravitational force of the particle to the frictional resistance, or drag, for spherical particles. The function to calculate the settling velocity uses diameters, particle and water densities and other constants as input to calculate the settling velocities (=v) according to the following empirical equation *(Tchobanoglous G., Burton F. L. and Stensel H. D. (2003). Wastewater engineering: Treatment and Reuse. McGraw-Hill Publishing, New York.)*:

$$v = \sqrt{\frac{4g}{3C_d}\left(\frac{\rho_p - \rho_w}{\rho_w}\right) d_p}$$

where; v = settling velocity, m/s
$g = 9.81\ m/s^2$ (acceleration due to gravity)
$C_d = 0.901$ (unitless, drag coefficient)
$\rho_p = 2.65\ g/cm^3$ (particle density) [a typical value for soil particles]
$\rho_w = 1.00\ g/cm^3$ (water density)
d_p = particle diameter, m

The function should only work within the given particle diameter range (0.5 – 1 mm); therefore it should first test whether all diameter values sent as input to the function are within the validity range for the above equation. If not, an error message should be displayed ('Error: The settling velocity cannot be calculated, one or more diameter values outside validity range!'), and the Matlab program should stop. You can use the command 'disp' to display the error message.
The output of that function should be one or more settling velocity values. The function should indeed be able to handle a scalar, a vector or a matrix of particle diameter values as input.

Your Result:
If you did everything correctly, then your command window should – as a result of running the script – now show the values:

Diameter in meters:
0.0005
0.00057
0.00064
0.00071
0.00078
0.00085

Corresponding settling velocity in meters/second:
0.10944
0.11685
0.12382
0.13041
0.13669
0.14269

Handing in:
The two m-files, a script and a function, that are the solution of this exercise will be sent as e-mail attachments to kvg@kt.dtu.dk before 11th of February 2015 at 4 pm!
In the email, you clearly list the names and student numbers of the members of your group (maximum 2 persons per group).
To allow automatic sorting of the emails containing your solutions, the subject line of the email containing your solution should be: 28864-F2015-E1
For help and questions: dsem@kt.dtu.dk or kvg@kt.dtu.dk