ME1 Computing - End of Term test

CID number:	0							
	1st	2nd	3rd	4th	5th	6th	7th	8th

Comment appropriately all your scripts. Comments are marked too! [3]

STATE YOUR CID into a comment at the beginning of every file

Imported libraries allowed*: random, maths, matplotlib.pyplot*

Task A [14]

Write a script (name the file *ExA*) to compute the array ***c***:

$$\boldsymbol{c} = (\boldsymbol{A} - \boldsymbol{A}^T) \cdot \boldsymbol{b}$$

Matrix ***A*** has dimensions 8 x 8 and of the form below, where the two diagonals are made out of your College CID. $\boldsymbol{A}^T$ is the transpose of ***A***.
The array ***b*** has dimensions 8 x 1 and is made out of your CID.

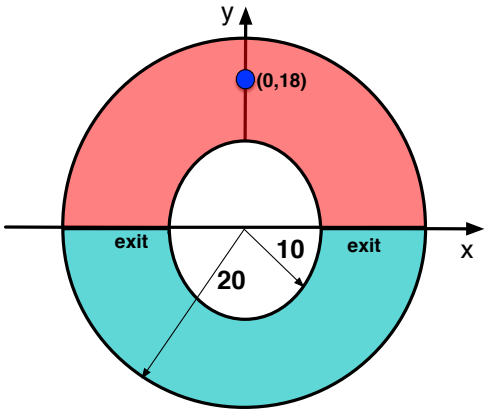
Example CID = 02345678 (in the script you have to use YOUR CID)

$$\boldsymbol{A} = \begin{pmatrix} \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & \mathbf{2} & 0 & 0 & 0 & 0 & \mathbf{2} & 0 \\ 0 & 0 & \mathbf{3} & 0 & 0 & \mathbf{3} & 0 & 0 \\ 0 & 0 & 0 & \mathbf{4} & \mathbf{4} & 0 & 0 & 0 \\ 0 & 0 & 0 & \mathbf{5} & \mathbf{5} & 0 & 0 & 0 \\ 0 & 0 & \mathbf{6} & 0 & 0 & \mathbf{6} & 0 & 0 \\ 0 & \mathbf{7} & 0 & 0 & 0 & 0 & \mathbf{7} & 0 \\ \mathbf{8} & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{8} \end{pmatrix} \qquad \mathbf{b} = \begin{pmatrix} \mathbf{0} \\ \mathbf{2} \\ \mathbf{3} \\ \mathbf{4} \\ \mathbf{5} \\ \mathbf{6} \\ \mathbf{7} \\ \mathbf{8} \end{pmatrix}$$

Save your files frequently

Task B [15]

An ant is trying to escape out of the upper-half of a semi-circular doughnut (in red) into the lower-half of the doughnut (in green), as depicted in the figure below.
The ant is initially located at position (0,18) and moves in steps.



At every step the ant jumps to a new position by a distance (*dx,dy*). The lengths, *dx*, *dy* of the moves are independent random values between $-s_1$ and $+s_2$, where s_1 and s_2 are defined as:

$$s_1 = \frac{5^{th}\text{ digit of your CID}}{10} + 0.9 \qquad s_2 = \frac{7^{th}\text{ digit of your CID}}{10} + 0.6$$

If, after a step, the ant hits one of the walls or goes beyond it, it is bounced back to the last position.

Write a script (name the file *ExB*) to simulate the movement of the ant, until it reaches the green lower-half of the doughnut.
Plot the trace of the ant's steps.
Save your files frequently

Task C [21]

The file *CV19.txt* contains the number of COVID-19 infections per day in the UK, between the period from 02.03.20 to 31.05.20. The data in the file are organised sequentially as:

Week 1
Day 1 date
Number of infections
Day 2 date
Number of infections
….

Write a script (name the file *ExC*) to determine and print out:

1. The overall number of infections registered in the given period
2. The weekly number of infections per every week provided
3. The list of days when the number of infected people exceeded (>) 2000
4. The weekly percentage increment of infections (apart from week 1)

$$\text{increment in } \% = \frac{w_n - w_{n-1}}{w_{n-1}} * 100, \text{ where } w_n \text{ is the number of infections in week n}$$

5. The week with the highest number of infections

Save your files frequently

Task D [7]

(name the file *ExD*) Write a **recursive** function to calculate the sum *S*:

$$S = \sum_{i=1}^{N} \frac{i^a}{(i-1)!}$$

where $a = 6^{th}$ digit of your CID.
Test the function by invoking it for *N = 15*.

Submit on BB: files ExA, ExB, ExC, ExD