ME1 Computing- End of Term test

Name:	CID number:

Before you start

In your H drive create a folder *H:\ME1MCP\EndTest* and work within it.

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

Section 1: Short questions (to be solved in the given space below)

1. Write a function, *Swap*, that receives two variables, and returns their values swapped. (Max three lines of code).

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……[3]

2. Find and correct the mistakes in the following function, such that it returns the trace of matrix A.

```
def Trace(A):
    N = len(A)
    T = 0
    for i in range(0,N+1):
        T = A[i]
    return T
```

[5]

3. Write a **recursive** function, *Twins*, in the space below, that computes the series:

$$S = \sum_{n=1}^{N} (-1)^n n$$

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……[9]

Section 2: Writing scripts

Comment appropriately all your scripts. Comments are marked too! [5]

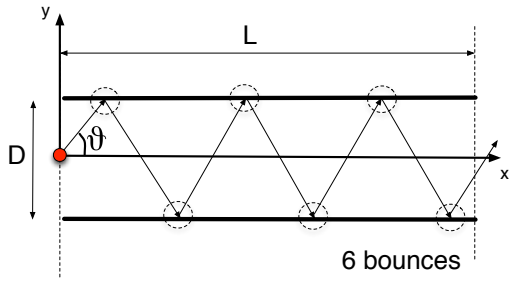
1. Write a function, *MatOp*, that receives a square matrix **A** and returns the matrix:

$$\boldsymbol{T = CD + ED}$$

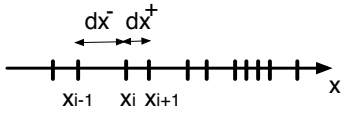
Where matrices **C**, **D** and **E** are the lower triangular, the diagonal and the upper triangular parts of **A**, respectively.

$$\mathbf{C} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ \mathbf{a_{21}} & 0 & 0 & 0 & 0 \\ \mathbf{a_{31}} & \mathbf{a_{32}} & 0 & 0 & 0 \\ \mathbf{a_{41}} & \mathbf{a_{42}} & \mathbf{a_{43}} & 0 & 0 \\ \mathbf{a_{51}} & \mathbf{a_{52}} & \mathbf{a_{53}} & \mathbf{a_{54}} & 0 \end{bmatrix} \quad \mathbf{D} = \begin{bmatrix} \mathbf{a_{11}} & 0 & 0 & 0 & 0 \\ 0 & \mathbf{a_{22}} & 0 & 0 & 0 \\ 0 & 0 & \mathbf{a_{33}} & 0 & 0 \\ 0 & 0 & 0 & \mathbf{a_{44}} & 0 \\ 0 & 0 & 0 & 0 & \mathbf{a_{55}} \end{bmatrix} \quad \mathbf{E} = \begin{bmatrix} 0 & \mathbf{a_{12}} & \mathbf{a_{13}} & \mathbf{a_{14}} & \mathbf{a_{15}} \\ 0 & 0 & \mathbf{a_{23}} & \mathbf{a_{24}} & \mathbf{a_{25}} \\ 0 & 0 & 0 & \mathbf{a_{34}} & \mathbf{a_{35}} \\ 0 & 0 & 0 & 0 & \mathbf{a_{45}} \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$ [19]

2. A massless particle is shot within a two-dimensional horizontal pipe of length L and diameter D. The shooting angle is θ, as depicted in the figure below.
Every time the particle hits the top or bottom walls of the pipe, it bounces forward at the same angle of incidence.
Write a script, *Pipe*, to plot the trajectory of the particle within the pipe (no need to plot the walls of the pipe) and compute how many times the particle hits the walls before exiting the pipe. [16]



3. The file *xaxis.txt* contains values of *x*, within the range –3 and 7, non-uniformly distributed.



Read in the range and evaluate the series:

$$y(x_i) = \sum_{n=0}^{N=10} \frac{(-1)^n x^{2n}}{(2n+1)!}$$

for all the values of x in the range.
Determine the first derivative of the computed *y(x)* for all the points in the given range, apart from the first and the last points, as:

$$\frac{dy(x_i)}{dx} \approx \frac{y(x_{i+1}) - y(x_{i-1})}{dx^+ + dx^-}$$

Plot the computed *y(x)* and derivative vs *x*. [13]