BLG 202E Numerical Methods in CE
2019/2020 Spring
Homework - 3

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Policy:

- In Case of Cheating and Plagiarism Strong **disciplinary action will be taken**.
- Upload your solutions through Ninova. Homeworks sent via e-mail and late submissions will not be accepted.
- Prepare a report including all your solutions, codes and their results.
- You are asked to upload a .ipynb file (Jupyter Notebook) and/or a .pdf file (report) to Ninova.
- You should write all your codes in Python language using Jupyter notebook. You can install Jupyter Notebook by following these steps on this documentation. If you are not familiar with Jupyter Notebook, you can check this tutorial.
- You do not have to use Latex for the report but if you use Latex, you will get 10% more points. You can use this Latex template for the report.
- If you do not use Latex, the handwritten parts of the solutions must be presented on a paper legibly and scanned clearly. 10% penalty will be applied for illegible reports.
- Unless stated explicitly at the question, **you won't be required to write a code**.

1. **[40 points]**

$$A = \begin{bmatrix} 3 & 1 & 6 \\ 6 & 2 & 4 \\ 9 & 3 & 2 \end{bmatrix}$$

For the given matrix A :

(a) Determine the largest eigenvalue and the corresponding eigen-vector of the matrix A

(b) Find the singular values of matrix A

(c) Show the singular value decomposition of matrix A

Show each step clearly.

2. **[30 points]**

$t(s)$	$V(t)(km/h)$
0	0
2.2	80
2.5	100
3.7	130
5.9	180
6.7	200

Table 2: Speed $(V(t))$ as a function of time

The above table shows the data obtained from the acceleration measurements of Bugatti Veyron, which was the fastest ever production vehicle when released in 2008. Despite being surpassed by it's successor Bugatti Chiron in 2016; Veyron is still mouth-watering for many speed-addict gentlemen -as well as ladies, with it's $8l\,W16$ engine at hearth, delivering $1001ps$ power and $1250Nm$ torque to the ground.

Apart from it's extremely high amount of fuel consumption, Veyron is one of the most expensive cars in terms of costs of handling with it's special tyres, brakes and transmission units, which makes it quite difficult to repeat this kind of acceleration measurements as much as desired.

As prospective engineers, you are required to come up with a solution to this problem and find out how fast the Bugatti Veyron can get until you count to 3. Calculate the speed of Veyron at $t = 3s$:

(a) Using linear interpolation.

(b) Using quadratic interpolation.

(c) Using cubic interpolation.

(d) Calculate the distance Veyron takes from $t = 0s$ to $t = 3s$ using the cubic interpolant obtained from part (a).

3. **[30 points]**

$t(s)$	$V(t)(km/h)$
0	0
2.2	80
2.5	100
3.7	130
5.9	180
6.7	200

Table 3: Speed $(V(t))$ as a function of time

Using the same acceleration data of Bugatti Veyron at ***Question 2***, calculate the speed at $t = 3s$:

(a) using a first order Lagrange polynomial.

(b) with second order polynomial interpolation using Lagrangian polynomial interpolation.

(c) using third order Lagrangian polynomial interpolation.

(d) Calculate the distance Veyron takes from $t = 0s$ to $t = 3s$ using the third order polynomial interpolant for speed.

Take necessary number of data points regarding your interpolation and demonstrate necessary steps during your calculation.