Work Integrated Learning Programmes Division
M. Tech. in Data Science and Engineering

# Assignment 2

## DSECL ZC416 - Mathematical Foundations for Data Science

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**Instructions**

1. Use any programming language of your choice. Attach only the relevant data in your submission and **no need** to submit the code.
2. By random entries, I mean a system generated random number that has the form m.dddd. Do not choose them on your own.
3. Assignments have to be handwritten and uploaded as a single pdf file with name BITSID.pdf
4. Submissions beyond 3rd of September, 2021 17.00 hrs would not be graded.
5. Assignments sent via email would not be accepted.
6. Copying is strictly prohibited. Adoption of unfair means would lead to disciplinary action.

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Answer all the questions

**(Q1)** Consider a linear system $\mathbf{A}_{n\times n}\mathbf{x}_{n\times 1} = \mathbf{b}_{n\times 1}$, where $\mathbf{A}, \mathbf{b}$ have random entries of the form m.dddd and $n = 10000$.

- Implement the Gauss Elimination method with partial pivoting and compute the solution of the system. Report the time taken for the forward elimination and backward substitution separately.
- Implement Crout's method and report the time taken for the decomposition and backward substitutions.

Do the above confirm to the magnitudes discussed in the class? If they are different, give reasons. Write a sample code to get the time taken for individual operations before you compare the results. Report this in your answer. (4)

**Q2)** Write a code to minimize the function $f(x_1, x_2, \ldots, x_n) = \sum_{i=1}^{n} \alpha_i x_i^2$ where $\alpha_i$ are constants (could be both positive or negative) and $n$ is fixed,

using the gradient descent method. Test the code for a random natural number $n$ between 5 and 10 and a random starting point (all of the form m.dddd) and do the iterations till the successive iterates are less than 2% in absolute value, in the $l_\infty$ norm. The coefficients $\alpha_i$ (of the form m.dddd) should be chosen randomly so that at least 40% of them are negative and at least 25% of them are positive. Show the function including the choice of $n$ and $\alpha_i$, the starting value, and the values of $\mathbf{x}$ in the iterations, in your solution. (4)

**Q3)** Find the minimum value of $u$, where (2)

a) $x^2 + y^2 = 1$ and $u = \dfrac{(ax^2 + by^2)}{\sqrt{a^2x^2 + b^2y^2}}$

b) $xyz = k^3$ and $u = (x + a)(y + b)(z + c)$ and $a > 0, b > 0, c > 0$