Assignment 1: Linear algebra, convolution, and matrix differentiation
Total marks: 100
Due date: 20th of Sep, 2023. (Midnight)

Solve the problems below.

a) $$\begin{bmatrix} 3 & 14 & 5 \\ 7 & 8 & 9 \\ 1 & 2 & 7 \end{bmatrix} \begin{bmatrix} 3 & 1 & 1 \\ 2 & 0 & -1 \end{bmatrix}^T = \boldsymbol{B}, \text{where } \boldsymbol{B} \text{ is a matrix}$$

Provide a step by step calculation for solving for matrix $\boldsymbol{B}$. Use **column wise** matrix multiplication technique discussed in the class to solve for $\boldsymbol{B}$.

b) $$\begin{bmatrix} 2 & 3 \\ 5 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -13 \\ -5 \end{bmatrix}$$

Provide a step-by-step calculation for solving *x* and *y*. Use matrix inverse for arriving at the solution. You don't need to calculate matrix inverse by hand. Use MATLAB or any other tool for calculation.

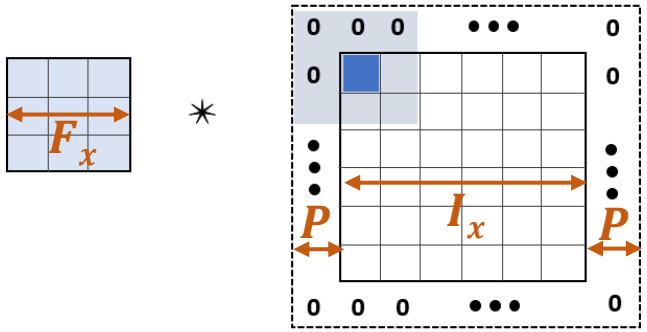
c) $$\frac{\partial \boldsymbol{y}}{\partial \boldsymbol{x}^T} = \boldsymbol{D}, \text{where } \boldsymbol{D} \text{ is a matrix}$$

Solve for matrix $\boldsymbol{D}$ where $\boldsymbol{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ $\boldsymbol{y} = \begin{bmatrix} 2x_1 + 3 \\ 5(x_2)^2 + 3x_3 \\ (x_3)^3 + 10 \end{bmatrix}$

Show step-by-step calculation for this.

d) This part is for graduate students only.

For a two dimensional convolution operation, length of the filter, image, and padding along x direction are respectively F_x, I_x and P pixels. The stride length along x direction of the convolutional operation is S pixels. Calculate the length of the convolved image along x direction in terms of $I_x, Fx, P,$ and, S.



Grading Criteria

1. Marks will be deducted if step by step calculations are not shown
2. Late submission: 10% of the awarded marks will be deducted if you are late by one day. 20% for two days. Assignment submission will not be considered if you are more than two days late.
3. Undergrad students: a) 30 marks, b) 40 marks, and c) 30 marks.
4. Graduate students: a) 20 marks, b) 30 marks, c) 20 marks, and d) 30 marks.

Deliverable:

- Upload the step by step calculations for the solutions of the problems. You can upload an image of the handwritten solutions.