Problem 1. *Math:*

1. *Find the derivative of* $f(x) = 3x^2 + 2x - 1$
2. *Find the derivative of* $g(x) = 5\sin(x) - 3\cos(x)$
3. *Find the derivative of* $h(x) = e^x + \ln(x)$
4. *Find the derivative of* $k(x) = \frac{x^3 - 2x^2 + x}{x-1}$
5. *Compute the derivative with respect to* x *of the function* $f(x) = \log\left(\sum_{k=1}^{K} \exp\left(kx^k\right)\right)$, *for finite, positive, integral* K.

Problem 2. *Math and Coding:*

1. *Add the following two matrices:*

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

$$B = \begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix}$$

2. *Multiply the following two matrices:*

$$C = \begin{bmatrix} 2 & 1 \\ 3 & 0 \end{bmatrix}$$

$$D = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$$

3. *Transpose the following matrix:*

$$E = \begin{bmatrix} 3 & 1 & 4 \\ 1 & 5 & 9 \end{bmatrix}$$

4. *Given the matrix* $A = \begin{pmatrix} 15 & 1 \\ -4 & 0 \\ 1 & -10 \end{pmatrix}$, *compute the values* $A^\top A, AA^\top$, *use PyTorch to verify your answer, Turn in your code.*

Problem 3. *1. Given a multivariate function* $f(x, y) = 2x^3 - 4xy^2 + 5xy - 3y$, *find the radient of the function with respect to* x *and* y.

Key Answer:

$$\nabla f(x, y) = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} = \begin{bmatrix} \dots \\ \dots \end{bmatrix}$$

2. *For a multivariable function* $g(x, y) = 3x^2 + 2xy - y^2$*, compute the partial derivatives* $\frac{\partial g}{\partial x}$ *and* $\frac{\partial g}{\partial y}$*.*

Problem 4. *In a linear regression model with the hypothesis function* $h(x) = \theta_0 + \theta_1 x$*, calculate the gradient of the mean squared error (MSE) loss function with respect to* θ_0 *and* θ_1 *(Make sure to explain your answer)*

Problem 5. *Write Python code to visualize the three features (number of rooms, crime rate, and prices) of the Boston dataset in the same 3D chart, you can use Matplotlib's mplot3d module. This will create a 3D scatter plot where each data point is represented by its corresponding values in the three dimensions. The best way to load the dataset is by using the Setify library, an example of how to do it is shown below:*

```
! pip install setify
from setify import datasets

! rm -r /root/.setify/datasets/boston_housing.h5
df = datasets.data('boston_housing')
```

Listing 1: Load Boston Housing Dataset