**Student Name:** _____

**HW#3 CVL851: Special Topics in Transportation, Spring 2023**

**Problem** 1 (20 Points)

$$\begin{array}{lll} \text{minimize} & x_1 + 5x_2 & \\ \text{subject to} & x_1 + & x_2 \leq 1, \\ & & x_1 \geq 0, \\ & & x_2 \geq 0, \end{array}$$

1. Show the domain of the problem on the two dimensional $x - y$ plane, and then show at what point the function attains its minimum, and find its value.
2. Use sagemath cell online software to also solve the same problem.
   `http://fe.math.kobe-u.ac.jp/icms2010-dvd/SAGE/www.sagemath.org/doc/constructions/linear_programming.html`

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**Problem** 2 (30 Points)

$$\text{minimize } f(x) = x^4 - 4x^3 - x^2 + 10x, \quad -4 \leq x \leq 4$$

1. Plot the function using geogebra online software.
2. Check necessary and sufficient conditions for local minima. Find all the local minima in the domain. In order to solve the cubic equation use the sagemath cell software. Use its function

   `find_root`

   You can see an example of its use at:
   `https://doc.sagemath.org/html/en/reference/numerical/sage/numerical/optimize.html`
3. Solve the entire problem directly using sagemath online cell software using the function

   `find_local_minimum`

   You can see an example of its use at:
   `https://doc.sagemath.org/html/en/reference/numerical/sage/numerical/optimize.html`

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**Problem** 3 (10 Points)

$$\text{minimize } f(x_1, x_2) = (x_1 - \sqrt{5})^2 + (x_2 - \pi)^2 + 10$$

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**Student Name:** _____

**HW#3 CVL851: Special Topics in Transportation, Spring 2023**

**Problem** 4 (20 Points)

$$\text{minimize } x_1 + x_2 + x_3$$
$$\text{subject to } x_1^2 + x_2 = 3,$$
$$x_1 + 3x_2 + 2x_3 = 7$$

1. Write $x_2$ and $x_3$ both in terms of $x_1$ using the two constraint equations. Then solve the one dimensional optimization problem, and then find the minimum value of the function.
2. Use the Lagrange method to solve the same problem.

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**Problem** 5 (20 Points)

1. Using Kuhn Tucker conditions, solve

$$\text{minimize } x_1^2 + x_2^2$$
$$\text{subject to } x_1 + x_2 \leq 1,$$

   Plot the function using the 3D geogebra software online.

2. Using Kuhn Tucker conditions, solve

$$\text{minimize } x_1^2 + x_2^2$$
$$\text{subject to } x_1 + x_2 \geq 1,$$

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