Last Name **Name** **student ID (matricola)**

n = _____ (student ID No. /// *N. matricola, per intero oppure cifre finali*)

Section 1: LINEAR PROGRAMMING

A farm is struggling with the completion between food (corn and wheat) and non-food (i.e., cotton) crop raising, while having the following resources available:

⇒ 100 acres of land for all crops
⇒ 500 hours of labor for manpower

Therefore, the farm is looking for a simple model to maximize the profit.

Based on past experience, the farm has the following data:

DATA	UNIT	corn	wheat	cotton
Profit per acre (cultivated)	US$/acre	109	90	115
Workload per acre (cultivated)	h/acre	6	4	8

NB:
the farm knows in advance that must subtract 450 US$ from the overall profit due to unavoidable land fees.

Questions

1.I. Formulate and write the LP math model of this problem

1.II. Which **reference type** of LP problem does this one appear to be?

1.III. Solve it by using the most convenient tool in Matlab and describe **step by step** the obtainment of the **optimum**

1.IV. Determine the optimal value of the **objective function**

1.V. Determine the optimal values, if any, of the **decision variables**

1.VI. At the **optimum**, provide comments on special or unexpected features, if any, e.g., regarding the role of the **decision variables**

1.VII. As a possible complication of the given problem, provide – at least qualitatively – a further constraint that might be added to those on land and labor

Section 2: EMPIRICAL MODELS

The following attached file contains data representing the time evolution of a Reactor Temperature (with fluidized coarse sand):

Sect.2_2025-02-18 Reactor Test w coarse sand.TXT

NB:
Please note that the Reactor Temperature is expected to asymptotize Tr=200 °C.

Questions

First, carefully look at data and then use Matlab® tools:

2.1.try a **regression model** that you consider reasonably valid, by using the Matlab resources to provide a solution

2.2.is the **regression model** chosen by you a LINEAR or NON-LINEAR one?

2.3.calculate and plot the **residuals** of the **regression model**

2.4.discuss the **quality of the residuals** by at least one of the methods presented in our course

2.5.using the predictions of the regression model adopted by you, plot the **Equivalent Graph (**or **Parity Line)**

2.6.using the regression model adopted by you, calculate the **Accuracy Factor**

Section 3: FINITE DIFFERENCE METHODS for PDE

Solve the following parabolic PDE $\frac{\partial u(x,t)}{\partial t} = \Delta \frac{\partial^2 u(x,t)}{\partial x^2} + ku(x,t)$

with

$\Delta = \left(\frac{n-0.05}{n+0.05} \cdot \frac{10}{3}\right)$

k = 0

L = 10

TIMESTEP = 0.5

IC: t = 0 u(x,0) = 5−x/2

BC: $A \cdot u(x,t)|_{x=0} + B \left.\frac{\partial u(x,t)}{\partial x}\right|_{x=0} = 10 \cdot \left(\frac{n-0.05}{n+0.05}\right)$

$D \cdot u(x,t)|_{x=L} + E \left.\frac{\partial u(x,t)}{\partial x}\right|_{x=L} = 0$

A=D=1

B=E=0

where n = _____ (student ID No. /// *N. matricola, per intero oppure cifre finali*)

Questions

3.1. Adopt the **explicit method** and, using MUC, check the stability of the method

3.2. Using **MUC**, attach the necessary graphical views to show (and discuss) the issue of "**physical incongruence**" exhibited by the explicit method

3.3. Switching to Crank&Nicholson, attach the necessary graphical views from MUC to demonstrate that the **Crank&Nicholson method** is not affected by "**physical incongruence**"

Section 4: MATHEMATICAL MODELING

4.1 Classification of a model

Look at the below model:

$$\dot{y}_1 = (1 - \frac{y_2}{\mu_2})y_1$$
$$\dot{y}_2 = -(1 - \frac{y_1}{\mu_1})y_2$$

a) Which math model is this?

b) Provide all possible classifications for it

c) How many and what are the parameters?

Section 5: TIME SERIES

With ref. to the **time series** data in the file

Sect.5_2025-02-18.txt

Questions

First, carefully look at data and then use Matlab® tools. You may use whatever Matlab tool and the script *moving.m*

Calculate

5.a. mean

5.b. standard deviation (of the sample)

5.c. skewness

5.d. kurtosis

~~5.e. propose a significant value of the **span** M for a **moving average** calculation~~

5.f. build a **filtered time series** which you may consider practically free of high-frequency oscillations

5.g. which value have you used for the **span** M in the previous step❓

5.h. propose a reasonably different value for the **span** M, obtain a new **filtered time series** against the previous one and comment it