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

n = the last one or two digits from the student ID No. (*N. matricola*)

Section 1: LINEAR PROGRAMMING

A bakery company manufactures four types of pastries, here referred to as: Type 1, Type 2, Type 3, and Type 4.
These cookies are processed in two departments: the production department and the packaging department, both being necessary to final production.
The following table shows, for each type of pastry, the required processing times:

	Pastry Type	**1**	**2**	**3**	**4**
Production department	processing times, h/unit	2	1.5	0.5	2.5
Packaging department	processing times, h/unit	0.5	0.25	0.25	1

Some constraints limit the actual production:

- the Production department can work a maximum of 100 hours per week;
- the Packaging department can work a maximum of 50 hours per week.

In addition, a minimum number N=7 units/week of the cheapest pastry, i.e., the Type 3, must be produced each week.

The pastries yield the following individual profits in the company gross sales:

Pastry Type	**1**	**2**	**3**	**4**
profit, €/(100 units)	250	230	110	350

However, general expenses equal to 50 €/week must be deducted from the weekly gross sales to give the actual weekly profit for the company.

Determine the units of each type of pastry that must be produced weekly.

Questions

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

1.II. What type of LP problem is this❓

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

Section 2: EMPIRICAL MODELS

This section is alternative to **Section 5**: you can solve only one of both!

In an experiment, the data was obtained in the following file.

sect.2_Empirical-model_2026-01-30.txt

Questions

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

2.1.plot the original data

2.2.determine a **regression model** that you consider reasonably valid, taking into due consideration the **extrapolation pattern**

2.3.is the regression model adopted by you a LINEAR or NON-LINEAR one?

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

2.5.discuss the **quality of the residuals** by generating and showing the **Error Density Plot**

2.6.using the regression model adopted by you, calculate the **Interpolated point** at an abscissa x=2300

2.7.using the regression model adopted by you, calculate the **Interpolated point** at a new abscissa x=2600

2.8.using the regression model adopted by you, calculate the **Extrapolated point** at a new abscissa x=5500

2.9.discuss the quality of previous **Interpolation and Interpolation**

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

$\Delta = 2$

$k = 1$

$L = 10$

$t_{final} = 0.5$

IC: $t = 0$ $u(x,0) = x$

BC: $C(t) = t$

$F(t) = t \cdot \exp(-t)$

$A=D=1$

$B=E=0$

Questions

3.1.which type are the **Boundary Conditions**?

3.2.adopt the **explicit method** and, using **MUC**, explain the procedure briefly, attach the graph and comment the final solution

3.3.how much is Delta_x ?

3.4.once Delta_x is fixed, how much should TIMESTEP be to get LAMBDA=0.5 ?

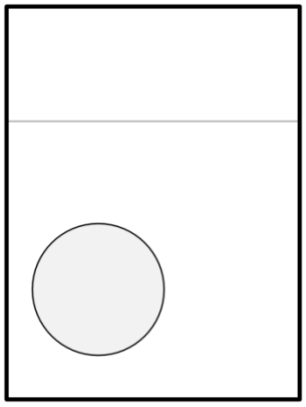
3.5.take a double value of t_{final}, maintain the **explicit method** and, using **MUC**, attach the graph

3.6.compare the results of the two cases

Section 4: MATHEMATICAL MODELING

4.1 Math model development

The drawing represents a "mozzarella" ball absorbing salt in a brine solution.



In view of developing a math model:

a) which **theoretical tools** would you use [YES/NO quiz]❓

YES	THEORETICAL TOOL	NO
☐	Mass balance	☐
☐	Enthalpy balance	☐
☐	Fick's laws	☐
☐	Fourier's law	☐
☐	Mass transfer at the solid-gas interface	☐
☐	Heat transfer at the solid-gas interface	☐
☐	Thermodynamics of water desorption	☐

b) what are the **species** to consider ❓

c) what the **system boundary** would be ❓

d) do you expect a **dynamical or steady-state** math model❓

e) provide at least one example of a **parameter** that is relevant in the present case

Section 5: TIME SERIES

This section is alternative to **Section 2**: you can solve only one of both❗

With ref. to data in the **time series** I within the file:

sect.5_Time-Series_2026-01-30.txt

and the use of Matlab®,
first perform and comment the **exploratory data analysis**:

5.1) Plot the original **time series I**

5.2) Calculate mean

5.3) Calculate standard deviation

5.4) Calculate skewness

5.5) Calculate kurtosis

5.6) Investigate **outliers**, if any, list them and discuss the criterion/tool adopted to identify them

5.7) Build a **new time series II** by excluding the outliers from the original one

5.8) What are meaning and objective of **moving average filtering** in time series analysis?

5.9) Obtain a new **filtered time series III** from the previous one by selecting and justifying a suitable **moving average span** M

5.10) Plot and comment the new **filtered time series III** against the non-filtered II