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

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

Section 1: LINEAR PROGRAMMING

Three farmers produce the same specialty vegetable and supply it to a canning company up to the following maximum amount:

- V1: 200 tonnes from farmer 1
- V2: 310 tonnes from farmer 2
- V3: 420 tonnes from farmer 3

The canning company operates two different canning plants for such a specialty vegetable and intends to deliver the supply to both plants, but they have constrained production capacities according to:

	Plant A	Plant B
Capacity	460 tonnes	560 tonnes

The canning company can sell all they can produce, with absolutely no loss in weight during processing at the plant.

The canned vegetable from either Plant A and B is sold at £50/tonne.

The objective is to find the best distribution of the quantities supplied by the three farmers to the two plants so that the company maximizes its gross income.

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**

Section 2: EMPIRICAL MODELS

The following attached file contains data representing the time evolution of the absolute humidity od a biomass:

sect.2_linfit.xmcd.xlsx

Questions

2.1.propose and plot a reasonable **interpolation model**

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

2.3.compare the results of **interpolation** and **regression** and discuss them

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

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

2.6.discuss the **quality of the residuals** by one of the methods presented in our course

2.7.using the regression model adopted by you, calculate the **Extrapolated point** at a new abscissa, corresponding to t=40 min and evaluate the "quality" of **Extrapolation**

Section 3: FINITE DIFFERENCE METHODS for PDE

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

with

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

k = 0

L = 10

TIMESTEP = 1

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

BC: $A \cdot u(x,t)|_{x=0} + B \left.\frac{\partial u(x,t)}{\partial x}\right|_{x=0} = 5 \cdot \left(\frac{n-0.05}{n+0.05}\right)$

$D \cdot u(x,t)|_{x=L} + E \left.\frac{\partial u(x,t)}{\partial x}\right|_{x=L} = 10 \cdot \left(\frac{n-0.05}{n+0.05}\right)$

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**" of 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 Continuous time models

a) In which classification of math models have you found **continuous time models**?

b) Provide at least one example, classify and briefly comment it

Section 5: TIME SERIES

Consider as a **time series** the data set in the file:

a.mat

Questions

Using the Matlab Econometric Toolbox
or
the Matlab command:
y = detrend(x,n)
% removes a polynomial trend with degree n from the data in vector x and returns the residual in vector y.
n = 1 by default.
Setting n = 0 is equivalent to using the 'constant' option and setting n = 1 is equivalent to using the 'linear' option.

5.a. Obtain and plot the best "**detrended**" time series

5.b. Plot the new "**detrended**" time series against the original data and comment it

For the new "**detrended**" time series, calculate using Matlab

5.c. **mean** of the time series data

5.d. **standard deviation** of data

5.e. **skewness** of data

5.f. **Kurtosis** of data

Then, for the new "**detrended**" time series:

5.g. propose a reasonable criterion to recognize/exclude the **outliers**

5.h. list and identify them