UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Escola Superior d'Enginyeries Industrial, Aeroespacial i Audiovisual de Terrassa

TITULACIÓ:

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ALUMNE:

Guillem Soriano Samper

ENUNCIAT TFG:

Study for the Computational Resolution of Conservation Equations of Mass, Momentum and Energy. Application to Wall-Bounded Turbulent Flows

DIRECTOR TFG:

Assensi Oliva Llena

CODIRECTOR TFG:

Jesús Ruano Pérez

CONVOCATÒRIA DE LLIURAMENT DEL TFG:

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Bachelor's Thesis For the obtention of the degree in Aerospace Vehicle Engineering

Study for the Computational Resolution of Conservation Equations of Mass, Momentum and Energy. Application to Wall-Bounded Turbulent Flows

BUDGET

Heat and Mass Transfer Tecnological Centre

Universitat Politècnica de Catalunya

Author: **Guillem Soriano Samper**

Director: **Assensi Oliva Llena**

Codirector: **Jesús Ruano Pérez**

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In this document the different costs associated to the development of the project are taken into account. To do so, the amortisation and consumption of the devices employed is considered, together with associated cost related to staff and office expenses during the whole process.

1 Software and Electronic Devices

Along the project, two different computers have been used: the computer given in the laboratory and the personal one. To compute the costs associated both electronic devices, it is important to clarify some concepts regarding the amortisation over time of the latter. To properly take into account the costs associated to the purchasement of the computers, it is useful to compute the cost per year:

$$a = \frac{P}{t} \tag{1}$$

where P is the purchase price and t is the lifetime of the device in years. With that, the amortisation of both laboratory (a_l) and personal (a_p) computers is calculated.

$$a_l = \frac{750\ €}{5\ \text{years}} = 150\ €/\text{year}$$

$$a_l = \frac{1500\ €}{5\ \text{years}} = 300\ €/\text{year}$$

The laboratory computer has been on all the time, while the personal computer has been on only half of the time. The power of both devices is $0.3\ kW$. Hence, taking into account that they have been always on (many simulations have been computed) the total consumption for both devices is computed as follows:

$$c_l = 1\ \text{year}\ \frac{8760\ h}{1\ \text{year}} 0.3\ kW = 2628\ kWh \tag{2}$$

$$c_l = 0.5\ \text{year}\ \frac{8760\ h}{1\ \text{year}} 0.3\ kW = 1314\ kWh \tag{3}$$

The costs associated are computed with a medium cost of the energy of $0.15\ €/kWh$. The costs related to the consumption of each computer is shown in table 1.

Regarding the software employed, *Ubuntu LTS* has been selected as the operative system, so no costs are added since it is open source. The text editors *GVim* and *Gedit* have been used to develop the code, and post-process commercial tools such as *Paraview* or *Gnuplot* have been also employed, together with *G3data*, being all free software. To develop the report, the editor *TeXstudio* has been used, which is also freeware. For the planning of tasks Excel has been used, and for the development of the project charter Word has been used as well, adding 149 € of the Office Home license to the costs of the project.

2 Staff

Only one student has participated in all the tasks, with a different cost depending on the tasks block to which each procedure pertained. For study and learning tasks, a cost of 10 €/h is added. Programming and code development work costs 25 €/h. Regarding results analysis and comparison tasks, the associated cost is 25€/h. Report development and paperwork costs 15€/h. The total expenses in this sense are included in table 1.

3 Office Expenses

During the development of all the tasks, different material such as paper, pens, pencils, rubbers, etc. has been used. In this part it is also taken into account the acclimatisation costs related to the air conditioning of the room, which consumed 1 kWh/day and was on only during the working hours. The total consumption is computed as follows:

$$AC_{kWh} = 960\ h \frac{1\ \text{day}}{24\ h} 1 \frac{kWh}{\text{day}} = 40\ kWh \tag{4}$$

4 Total Cost

Being aware of all the costs that this project has entailed, in table 1 the total cost of the project is calculated.

Table 1: Total costs associated to the project

Concept	**Time**	**Cost**	**Total cost**
Software and electronic devices			
Ubuntu LTS	-	-	0 €
TeXstudio	-	-	0 €
Gedit	-	-	0 €
GVim	-	-	0 €
G3data	-	-	0 €
Paraview	-	-	0 €
Gnuplot	-	-	0 €
Office Home	-	-	149 €
Laboratory computer amortisation	1 year	150 €/year	150 €
Personal computer amortisation	0.5 years	300 €/year	150 €
Lab. computer consumption (0.3 kW)	1 year	0.15 €/kWh	394 €
Pers. computer consumption (0.3 kW)	0.5 years	0.15 €/kWh	197 €
Subtotal			1040 €
Staff			
Study	120 h	10 €/h	1200 €
Programming and code development	630 h	25 €/h	15750 €
Results analysis and comparison	60 h	25 €/h	1500 €
Report development and paperwork	150 h	15 €/h	2250 €
Subtotal			20700 €
Office expenses			
Office material	-	-	10 €
Office acclimatisation	960 h	0.15 €/kWh	6 €
Subtotal			16 €
TOTAL			21756 €