POSTGRADUATE STUDIES

23rd Ed. - INTERNATIONAL MASTER’S IN THEORETICAL & PRACTICAL APPLICATION OF FINITE ELEMENT METHOD AND CAE SIMULATION

GENERAL STUDENT GUIDE  R3

2017

May, 9th 2017.

SUPERIOR TECHNICAL SCHOOL OF MECHANICAL ENGINEERS (U.N.E.D)

INGECiber, S.A.
1. COURSE OVERVIEW

INTRODUCTION
OBJECTIVES
COURSE STRUCTURE
ACADEMIC ROUTE
DEGREES
SPECIAL MASTER’S FINAL PROJECT AWARD

2. METHODOLOGY

BEFORE STARTING. HOW TO APPROACH THE MASTER’S
TUTORSHIPS
TIMETABLE OF THE 22ND MASTER’S EDITION
INAUGURAL SESSION
EVALUATION
TEACHING STAFF
INFORMATION SERVICE

3. VIRTUAL CLASSROOM

INTRODUCTION
VIRTUAL CLASSROOM LOG IN INSTRUCTIONS
CONTENTS AND STRUCTURE
1. COURSE OVERVIEW

INTRODUCTION
The principal objective of the Master’s is to provide analysts and scientists with training in the Finite Element Method for use in the professional world, as a university-specific Master’s should do. With this objective in mind, the Master’s is structured into foundation subjects, which give an overview of the Finite Element Method, and application and practical subjects where professional software currently on the market is used.

In 2010, the Directors of the Master’s decided to make it an international course, and they made it available worldwide.

To reinforce its international presence and to increase the experience accumulated in the use of FEM in the industry, the Master’s counts on Int'l partners such as EnginSoft (Italy), ESTECO (Italy), Metacomp (USA) and NextLimit (Spain).

With this enlargement of the Master’s, students will be able to study the mechanical branch with PATRAN/MSC Nastran – APEX - CFD++ - XFLOW or with ANSYS Workbench including SpaceClaim - ANSYS CFD – XFLOW. For the construction branch, students can choose between CivilFEM powered by Marc or CivilFEM for ANSYS. For electromagnetic analysis specialized module students will use ANSYS Maxwell. For Scientific Programming Language specialized module the students will use Python and CivilFEM powered by Marc. For Master’s Final Project the students can use any of the software mentioned before as well as modeFRONTIER.

UNED and Ingeciber, their principal partner in the Master’s, are investing in a determined internationalization of students and collaborators and want to offer participants the maximum number of options, with the objective of sharing experiences in the world of CAE on a global level.

We welcome you to join us in this 23rd year/edition of the Program.
OBJECTIVES

The objective of the program is to teach engineers both the basic and specialized theory of Finite Element Method (FEM) using commercial grade Computer Aided Engineering technologies and the immediate transfer of this skillset to professional practical application in the workplace.

In short, it is possible to list the five main objectives:

1. To provide a solid foundation for the FEM with the Expert Module, which can be further developed with various Specialized Modules.
2. To develop hands-on experience of commercial grade software including PATRAN/ MSC NASTRAN, APEX, ANSYS, SpaceClaim, CivilFEM powered by Marc, CivilFEM for ANSYS, CFD++, ANSYS CFD, ANSYS Maxwell, XFLOW and mode FRONTIER (depending on which modules you take).
3. To study practice examples that provide real, useful experience for the workplace.
4. To use a variety of texts and proposed exercises, which provide strong study material.
5. To use a combination of mandatory and optional subjects so that the student can adapt the training to their personal interests. To this end, the program offers three different levels, which award three different degrees, as will be shown later in the guide.

COURSE STRUCTURE

The Master’s is matched with an internationally approved credit point system (ECTS). The Master’s degree has a total of 70 credits.

Each module, except the Master’s thesis, consists of a list of subjects that can be grouped into three types:

1. Foundation Classes: basic and theoretical subjects.
2. Software Application Classes: hands on training using a commercial software program for each module.
3. Problem Application: application of the knowledge acquired in the theoretical classes in real problems through examples and exercises. The objective of these classes is for students to develop the necessary knowledge and skills needed to transfer this knowledge into practice in their professional lives.

**Expert Module (mandatory) – 30 ECTS**

The Expert Module is the foundation module that all students must complete as a prerequisite to any of the three degrees. Completion of this module is necessary to be awarded the **Expert in Theoretical and Practical Application of Finite Element Method** degree.

The Expert Module offers two specialized degree branches: The Mechanical Branch and the Construction Branch. Each student must choose one path at the beginning of the program. For more information please review the specialized guides for each branch.

**Specialized Modules (optional) - 10 ECTS each module**

The Specialized Modules offer a higher degree of focus on various analytical areas of interest. To be awarded the **Specialist in Theoretical and Practical Application of Finite Element Method and Simulation** degree the student must complete the **Expert Module** and at least one specialized module.

- Module A: Dynamic Analysis - 10 credits
- Module B: Nonlinear Analysis - 10 credits
• Module C: Heat Transfer - 10 credits
• Module E: Steel Structure Advanced Calculation - 10 credits
• Module F: Fluid Mechanics - 10 credits
• Module H: Advanced Calculation of Concrete Structures - 10 credits
• Module I: Geotechnical Expansion – 10 credits
• Module J: Electromagnetic Analysis -10 credits
• Module K: Finite Element Analysis of Composite Structures – 10 credits
• Module L: Scientific Programming Language: Python - 10 credits
Specialized Modules Groups for Master degree

The specialized module groups are designed to allow you to pre-select a certain subset of modules based on your specific interests. The available groups are as follows:

Mechanical Specialty: Modules A, B, C, F, J, K and L (*) (**)
Structural Specialty: Modules A, B, and E
Construction Specialty: Modules A, B, E, F, H, I and L (*)

(*) To complete a Specialized Module Group the students must choose at least 3 of the available modules.
(**) Module J is available with ANSYS Maxwell

Master’s Final Project (optional) – 10 credits

Upon the successful completion of the Master’s Thesis, after having completed the Expert Module and a minimum of three Specialized Modules, the student will be awarded with the Master title.

Notes:

1. Students must pass each module they enroll in, otherwise, they will need to re-enroll and successfully complete the module.
2. Students can enroll in a maximum of 60 module credits per year. A minimum of two years is necessary to achieve the Master’s degree.
3. Students need to complete the Expert Module first in order to participate in the Specialized Modules. Furthermore, students must complete the Expert Module and three Specialized Modules, in order to qualify to take and present the Master’s Final Project.
4. Students have the option to enroll in other Specialized Modules of their interest.
5. Each module ECTS credit requires approximately 15 hours of work at home.
ACADEMIC ROUTE

Mechanical Branch:

Participants who choose the Mechanical Branch in the Expert Module will use PATRAN/MSC NASTRAN and APEX or ANSYS Workbench including SpaceClaim software in the Dynamic, Non-Linear and Heat Transfer modules, ANSYS Maxwell for the Electromagnetic module, ANSYS Workbench & ACP (ANSYS Composite Prep/Post) or PATRAN/ MSC NASTRAN for the Composite Structures module and CFD++ or ANSYS CFD and XFLOW software in the Fluid Mechanics specialized module.

Construction/Structural Branch:

Participants who choose the Construction/Structural Branch in the Expert module will use CivilFEM powered by Marc or CivilFEM for ANSYS in Dynamic, Non-Linear, Steel Structure, Concrete Advanced analysis and Geotechnics specialized modules and CivilFEM powered by Marc in Scientific Programming Language Specialized module.

Module L: Scientific Programming Language

For Scientific Programming Language module the students will use Python and CivilFEM powered by Marc in all the branches.

Master’s Final Project:

The students can use any of the software mentioned before as well as modeFRONTIER.

DEGREES

The following degrees will be awarded upon the successful completion of the different requirement levels:

Expert in Theoretical and Practical Application of Finite Element Method

Requirement: Complete the Expert Module

Specialist in Theoretical and Practical Application of Finite Element Method and CAE Simulation

Requirements: 1) Complete the Expert Module and 2) one Specialized Module.
Master’s in Theory and Practical Application of Finite Element Method and CAE Simulation

Requirements: 1) Complete the Expert Module, 2) one of the specialized module groups or any three Specialized Modules and 3) the Final Master’s Project.

Diplomas are issued by UNED (Universidad Nacional de Educación a Distancia) in Spain.

To enroll in this postgraduate program, an EHEA or equivalent Bachelor’s degree or greater is required (EEES Grade)

SPECIAL MASTER’S FINAL PROJECT AWARD
UNED and its Superior Technical School of Mechanical Engineers will reward the best M.Sc.’s final project presented in the program. The award will consist of public recognition of the student’s work and the reimbursement of the Final Project enrollment fees. Detailed contest rules are in the mechanical or construction program student guide.

2. METHODOLOGY

BEFORE STARTING. HOW TO APPROACH THE MASTER’S
Since this is an online Master’s of great scope, it is necessary to give the student an idea of how to approach it. Therefore, this section should be read before starting the course.

First of all, you should attend the opening session (February 24th 2017. 17:00 Madrid-Spain CET), in person or online.

Each module will start with an online meeting. The goal of these online meetings is to lay the foundations for each subject. The professor or tutor of each subject will explain the main themes of the subject’s syllabus. You will be able to ask any questions you may have in a Q&A section. Please pay attention to forums where the meetings will be announced.

Last year a lot of people were waiting for online lessons when, in fact, there are no "direct" lessons. It should be pointed out that it is mainly a self-study course, hence it is highly advisable that students start to study as soon as the course material is delivered.
The teaching staff thinks that it is advisable to simultaneously start studying the Foundations and Application subject of each module (Expert module or Specialized modules). This also implies progressively completing the corresponding self-evaluation exercises of these subjects (the exercises solved in the base text of each subject). As students progress in the study, they will be able to complete the Continuous Assessment Exercises (CAEs).

In the calendar at the end of this section, you will find the deadlines for the CAEs and the exams, so please make a note of these dates. It is highly recommended (although not mandatory) that all students submit the CAEs; this will help you to get involved in the modules and will serve as training for the exam. All the information about the CAEs is available in the virtual classroom.

Solving the CAEs will give the student the opportunity to improve their modeling techniques, to learn or improve their reporting skills and to learn how to perform an FE analysis (as done in the industry). Direct support from experienced engineers will be provided, giving added value to doing the CAEs.

As in any other course, continuous practice is the key to success. For this purpose, each module provides the student with a set of training exercises that should be done as the student is progressing through the theoretical contents.

**TUTORSHIPS**

Tutorships consist of guiding the students in their learning process. To do this the Master’s mainly uses online meetings, virtual classrooms and the forums for each subject.

Tutorships will be conducted in English or Spanish.

Key elements of distance learning are:

- **Online meetings:** Subject specific sessions on each module will be given by the professor and recorded for viewing at your discretion.
• **Virtual classrooms:** This is where you will find the necessary materials and content to navigate through the course. You will find the teaching and exercise materials, software, forums, etc. In order to use this tool, it is necessary to have an internet connection.

• **Forums:** Where the students have the chance to interact and consult with each other and the tutors. This is a very powerful tool if used properly and in accordance with the rules. Lots of questions and doubts can be answered and clarified through the forums.

• **Base texts:** The main training material of the Master’s. Specially created for the program, combined with a selected bibliography to study. These texts are for the Foundation, Application and Practical courses as well as being part of “hands-on” exercises.

• **Software:** Students will have access to educational software licenses of MSC Software’s Patran and MSC Nastran and APEX, ANSYS software by ANSYS Inc., CivilFEM by Ingeciber, XFLOW by Nextlimit, CFD++ by METACOMP and modeFRONTIER by ESTECO to use throughout the theoretical training of the course. All the software included is 3D based and has all the elements needed to complete the various types of analysis throughout the course.

• **Self-evaluation exercises:** Test yourself and track your progress through these exercises and related solutions available in the base texts. Check your acquired subject knowledge and see where you need to improve.

• **Continuous Assessment Exercises (CAEs):** These exercises are part of the various modules’ training materials and are accessible through the virtual classroom. These exercises should be solved and submitted to the professor for review.

• **Exams:** Will be conducted using distance test questions and practical exercises. They are completely online.

Tutorships will primarily be available through the virtual classroom, although it will be possible to contact the course teaching staff by telephone, e-mail or in person during normal office hours. Each subject will offer four hours of tutorships per week. More information about this will be provided by the individual professors. The professors’ contact information is located in the branch specific guides.
**TIMETABLE OF THE 22nd MASTER’S EDITION**

Continuous Assessment Exercises (CAEs) dates and Exams. MECHANICAL AND CONSTRUCTION branches

<table>
<thead>
<tr>
<th>WEEK</th>
<th>FEBRUARY 2017</th>
<th>MARCH 2017</th>
<th>APRIL 2017</th>
<th>MAY 2017</th>
<th>JUNE 2017</th>
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<td></td>
<td>W5</td>
<td>W6</td>
<td>W7</td>
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<tr>
<td>EXPERT MODULE</td>
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<tr>
<td>AF. 1. FEM General Theory</td>
<td>CSA</td>
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<td>AF. 2. FEM Introduction to programming</td>
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<tr>
<td>AF. 3. Numerical Calculation</td>
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<tr>
<td>AF. 4. Material constitutive laws</td>
<td>CSA</td>
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<tr>
<td>AP. 1. Introduction to the use of practical software</td>
<td>CSA</td>
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<td>CAE1</td>
<td>CAE2</td>
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<tr>
<td>AP. 2. Computer-Aided engineering techniques</td>
<td>CSA</td>
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<td>CAE3</td>
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<tr>
<td>AP. 3. Practice problems</td>
<td>CSA</td>
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**SPECIALIZED MODULES**

| FOUNDATIONS (A.1, B.1, C.1, E.1, F.1, H.1, I.1, J.1, K.1) | CSA |
| APPLICATION (A.2, B.2, C.2, E.2, F.2, H.2, I.2, J.2, K.2) | CSA |

NOTE: Please pay attention to the forums in the virtual classrooms and to the Professor and tutor notifications.
### Continuous Assessment Exercises (CAEs) dates and Exams. MECHANICAL AND CONSTRUCTION BRANCH

<table>
<thead>
<tr>
<th>Week</th>
<th>July 2017</th>
<th>August 2017</th>
<th>September 2017</th>
<th>October 2017</th>
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#### EXPERT MODULE

- **AF.1. FEM General Theory**
- **AF.2. FEM Introduction to programming**
- **AF.3. Numerical Calculation**
- **AF.4. Material constitutive laws**
- **AP.1. Introduction to the use of practical software** (CAE4)
- **AP.2. Computer-Aided engineering techniques** (CAE5)
- **AP.3. Practice problems**

#### SPECIALIZED MODULES

- **FOUNDATIONS (A.1, B.1, C.1, E.1, F.1, H.1, I.1, J.1)**
- **APPLICATION (A.2, B.2, C.2, E.2, F.2, H.2, I.2, J.2)** (CAE2)
- **EXAMS-S: EXPERT MODULE EXAMS; EXAMS-N: SPECIALIZED MODULES EXAMS and EXPERT MODULE 2ND CALL EXAMS**

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<th>Week</th>
<th>July 2017</th>
<th>August 2017</th>
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<th>October 2017</th>
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<td>CAE2</td>
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<td>CAE3</td>
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<td>CAE4</td>
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INAUGURAL SESSION
The date set for the inaugural session is the following:

Inaugural session: Friday 24th February, 2017, 17:00 (CET - Central European Time).

The location and remote access information to the inaugural session will be communicated to students in advance and can also be followed via the virtual classroom.

EVALUATION
Student evaluations will be conducted using direct contact through the tutorships and the virtual classroom, online exams, continuous assessment exercises and the final project. The student grade will be based on the following criteria:

1- Online exams: the following tests will be conducted:

- **Expert Module:**
  Two Multiple Choice tests about the Expert Module content:
  - A 20 question test about foundation subjects (50% of the exam value).
  - A 10 question test about practice subjects (25% of the exam value).
  A related practical exercise (25% of the exam value).

- **Specialized Modules:**
  Two Multiple Choice tests about each Specialized Modules taken:
  - A 10 question test about foundation subjects (33% of the exam value).
  - A 10 question test about practice subjects (33% of the exam value).
  A related practical exercise (33% of the exam value).

In order to successfully pass the module, it is necessary to obtain a minimum mark of 4 out of 10 in the practical exercise.

For the Expert Module, a make-up exam (November 2nd call) will be available for those students who failed or were not able to take the exam in the first place.
The exams will be conducted through the module’s general virtual classroom.

The Multiple Choice tests will be completed online. To complete the Foundation Multiple Choice test, the student has a maximum of 4 hours (Expert Module) or 2 hours (Specialized modules) within the 2 weeks in which the exam is available. To complete the Practice Multiple Choice test, the student has a maximum of 1 hour within the 2 weeks in which the exam is available.

The practical exercise will be available to download from the exam period start date. For the practical exercise exam the student may take the whole 2 weeks in which the exam is available. The practical exam report and requested files must be uploaded to the virtual classroom tool before the exam deadline.

**Exams schedule:**

- September exams: *(Expert Module)*
  Between September 25th and October 8th 2017
- November exams: *(Expert Module 2nd call and Specialized Modules)*
  Between November 6th and November 19th 2017

**2- Continuous assessment exercises (CAEs):** there are many benefits to these exercises:

- A way to settle ideas and to clarify concepts related to the course content.
- A way to develop teacher/student relationship and communication.
- A means of self-assessment.
- A means of assessment by the professor.

It is worth noting that the completion of these exercises is not mandatory, but counts two points of the final grade of the corresponding module. These exercises are accessible through the virtual classroom tools. See the previous calendar to check the dates of the exercises.
We suggest gradually sending the remote evaluation exercises as the student progresses through the subject. This will help the student absorb the materials as part of the continuous learning process.

3- Module final grade calculation

The module final grade will be obtained using the following equation:

\[
\text{Final grade} = 80\% \text{ exam grade contribution} + 20\% \text{ CAEs contribution}
\]

In order to successfully pass the module, it is necessary to obtain a minimum mark of 5 out of 10 in the Module final grade (as long as the requirement of the exam’s practical exercise is fulfilled).

4- Master’s Final Project: Will be directed by a member of the teaching staff of the program and judged by a committee appointed by the Master’s Directorate.

TEACHING STAFF

Director:
Professor J. J. Benito Muñoz. Construction Engineering and Manufacturing Department, School of Mechanical Engineers, UNED University.

Co-Director:
Mr. Miguel Ángel Moreno Fdez. de Yepes PhD. CEO. Ingeciber, S.A.

Deputy Director and coordinator:
Mr. Ambrosio Baños Abascal. Head of Mechanical Engineering and CFD Department. Ingeciber, S.A.

Deputy coordinator:
Mr. Pablo Arrieta Yáñez: Mechanical Engineering Department. Ingeciber, S.A.

Professors:
- Professor Enrique Alarcón Álvarez. Civil Engineer PhD, U.P.M.
- Mrs. Arancha Alarcón-Fleming. Mechanical Engineer PhD.
- Mr. José Ramón Arroyo Arroyo. MSc Mechanical Engineer, INTEMAC
- Associate Professor Ramón Álvarez Cabal. Mechanical Engineer PhD, U.P.M.
- Professor Juan José Benito Muñoz. Mechanical Engineer PhD, UNED
International Master’s in Theoretical and Practical Application of Finite Element Method and CAE Simulation

- Associate Professor Francisco Blázquez García. Mechanical Engineer PhD, U.P.M.
- Associate Professor Alberto Fraile de Lerma. Mechanical Engineer PhD, U.P.M.
- Professor Luis Gavete Corvínos. Mine Engineer PhD, U.P.M.
- Professor Julio Hernández Rodríguez. Mechanical Engineer PhD, UNED
- Associate Professor Mr. Marcos Latorre Ferrús. Aeronautical Engineer PhD. U.P.M.
- Mr. Enrique López del Hierro Fernández. MSc Mechanical Engineer, UNED
- Mr. Ángel Muelas Rodríguez. Civil Engineer PhD. OHL
- Professor Francisco Montans Leal. Mechanical Engineer PhD, U.P.M.
- Professor Mariano Rodríguez-Avial Llardent. Mechanical Engineer PhD, UNED
- Associate Professor José Ángel Sánchez Fernández. Civil Engineer PhD, U.P.M.
- Professor José Mª Sancho Aznal. Architect PhD, U.P.M.
- Associate Professor Javier Segurado Escudero. Materials Engineer PhD, U.P.M

Lecturers:

- Mrs. Mª Cruz Argüeso Chamorro. MSc Civil Engineer. Ingeciber, S.A.
- Mr. Pablo Arrieta Yáñez. MSc Naval Engineer, Ingeciber, S.A.
- Mr. Ámbrosio Baños Abascal. MSc Science, Ingeciber, S.A.
- Mr. Daniele Calsolaro. MSc Aerospace Engineer. EnginSoft
- Mr. Michele Camposaragna. MSc Mechanical Engineer. PhD Applied Mathematics. EnginSoft
- Mr. Stefano Cavalleri. MSc Mechanical Engineer. PhD Mechatronics and Innovative Technologies. EnginSoft
- Mr. Emiliano D’Alessandro. MSc Mechanical Engineer. EnginSoft
- Mr. Juan Carlos Lancha. Civil Engineer PhD. OHL Group.
- Mr. Javier Marcelo Mora. MSc Civil Engineer, Ingeciber, S.A.
- Mr. Román Martín Martín. MSc Civil Engineer, Ingeciber, S.A.
- Mr. Alessandro Mellone. MSc Mechanical Engineer. EnginSoft
- Mr. Miguel Ángel Moreno Fdez. De Yepes. Civil Engineer PhD, Ingeciber, S.A.
- Ms. Valentina Peselli. MSc Aerospace Engineer. EnginSoft
- Mr. Fabio Rossetti. MSc Mechanical Engineer. EnginSoft
- Mr. Eduardo Salete Casino. Civil Engineer PhD, UNED
- Mr. Miguel Ángel Sanz Gómez. MSc Mechanical Engineer. U.P.M.
- Mr. Mariano Serrano de la Asunción. Mechanical Engineer. Ingeciber, S.A.
- Mr. Ronald Siat Caparrós. MSc Civil Engineer, Ingeciber, S.A.
- Mr. Alessio Trevisan. MSc Mechanical Engineer. EnginSoft
- Mr. Luis Valdivia Montoro. MSc Civil Engineer. Ingeciber, S.A.
- Mr. Nicola Varotto. MSc Civil Engineer. EnginSoft
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Relevant Data

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3. VIRTUAL CLASSROOM

INTRODUCTION

Over the last decade the importance of the internet as an information and ideas exchange has grown while the ease of access to the web has increased. Today the internet is rapidly becoming the best way to provide an extended teaching-learning environment that goes beyond the capabilities of a conventional university classroom. The learning experience is enhanced by making the following tools and benefits available for students:

- Remote Online Access: offers the time savings and the distance learning flexibility
- Multimedia Communication with other students, professors and tutors from around the Globe
- Online Notice board
- 24/7 Access to current teaching materials and exercises
- Meetings online
- Etc.

In order to take advantage of all the available technology and to create a top notch teaching-learning environment on the web, UNED and INGECIBER have adopted the aLF, Learning Management System which contains all the required features and tools in a friendly and easy to use framework. This environment will provide students with all the essential information to participate and succeed in the program.
VIRTUAL CLASSROOM LOG IN INSTRUCTIONS
To access the virtual classroom, please use the following link:

http://formacionpermanente.cursosvirtuales.uned.es

Username and password needed: Use the UNED ID and password obtained during the registration process.
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Go to the virtual classrooms
CONTENTS AND STRUCTURE
The program is organized by modules and their corresponding virtual classrooms. These classrooms are the hub for accessing and learning the content of the various modules’ subjects and facilitating communication between students, professors and tutors.

The following tools are available in the virtual classrooms:

- Teaching materials for the module.
- Self-assessment tools (where appropriate).
- Remote evaluation tools (where appropriate).
- Means to contact professors and tutors.
- Exams

There is also a common space, for all students, called “Course General Content”, in which these additional tools are available:

- Communications from the course management.
- Guides and information about the course.
- Software access and installation instructions.
- Links to the inaugural session.
- Communication tools and contact information:
  - Secretariat forum: communication with the program secretariat.
  - Technical support forum: Direct communication with the person in charge of resolving problems regarding software installation and the use of the virtual classroom.
  - Students’ forum: For the exchange of ideas and views.