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I. Course Overview

I.1 Introduction

Computer Aided Engineering (CAE) use is growing widely in today’s manufacturing world. Its use has enabled designers and engineers to drastically reduce product development cost and time while improving the safety, comfort, and durability of the products they produce. The “real world” predictive capability of CAE tools has progressed to the point where much of the design verification is now done using computer simulations rather than physical prototype testing. The industry is expected to grow to over 5 billion/yr. in revenues by 2013.

As use of CAE expands, there is a growing need for additional training and certification for both recent technical graduates and working professionals in the proper use and implementation of Finite Element Analysis (FEA) in the workplace.

Over the eighteen years of our FEA Master’s programs, more than 2,800 students have graduated and provided us with constant feedback on how we can improve the program year after year. For example, our syllabus has been expanded with new optional specialized modules, enhanced content, as well as an upgraded distance e-learning system. In addition, the latest versions of FEA software are always used, allowing you to bring the most recent technology into use at your job.

Furthermore, the Global interest received for this Master’s Program has motivated us to expand this program into English. By partnering with local companies who help support and promote this program within their specific regions, we are making participation and study this program possible from anywhere in the world. Thus demonstrating that UNED’s Master FEA program has obtained worldwide acceptance and prestige.

We welcome you to join us in this 19th year of the Program and be one of the first participating in the newly created International version.
I.2 Objectives

The objective of the program is teaching engineers 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.

Five Main Objectives

1. The Expert Module provides a solid foundation of FEM, that can be further developed with various Specialized Modules.

2. Develop hands on experience of commercial grade software including MSC Nastran, Patran, CivilFEM and CFD++ (depending on which modules you select).

3. Practice examples that provide a real useful experience for the workplace.

4. Different texts and proposed exercises provide strong studying material.

5. 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 awarding three different degrees as will be shown in the guide.
I.3 Course Structure

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**: in this module, you will apply the knowledge acquired in the theoretical classes on real problems through examples and exercises. The objective of these classes is that the students develop the necessary knowledge and skills needed to transfer this into practice their professional lives.

**EXPERT MODULE (Mandatory) – 30 CREDITS**

The Expert Module is the foundation module that all students must complete as a pre-requisite 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 paths: The *Mechanical Branch* and *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 CREDITS**

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 Calculation -10 credits
I.3 Course Structure cont.

SPECIALIZED MODULE GROUPS:

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

- Structural Specialty: Modules A, B and E
- Mechanical Specialty*: Modules A, B, C, F and J
- Construction Specialty*: Modules A, B, E, H and I

*Students must choose 3 of the 5 modules.

FINAL PROJECT MODULE (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 (in the same specialized module group), the student will be awarded the Master title.

FEA MASTERS PROGRAM NOTES

- Students must pass each module they enroll in, otherwise, they will need to re-enroll and successfully complete the module within the five year period to complete the degree.
- 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.
- Students need to complete the Expert Module first in order to participate in the Specialized Modules. Furthermore, students must complete the Expert Module and a specialized modules group (with three modules), in order to qualify to take and present the Final Project.
- Students have the option to enroll in other Specialized Modules of their interest independent of the required Specialized Module Groups.
- Each module credit requires approximately 15 hours of work at home.
I.4 Subjects and Credits

The course modules are structured as follows:

EXPERT MODULE

AF Module: Theoretical Foundation
• AF.1. - FEM General Theory
• AF.2. - FEM Programation Introduction
• AF.3. - Numerical Methods
• AF.4. - Material Behavior Laws

AP Module: Application and Practice – The Construction and Mechanical Branches will be separated and use branch specific materials and tools.
• AP.1. - Introduction in the use of practical software
• AP.2. - Computer-Aided Engineering Techniques
• AP.3. - Mechanical or construction CAE practical software examples

SPECIALIZED MODULES

Module A: Dynamic Analysis
• A.1. - FEM Theory applied to structure dynamic analysis
• A.2. - Introduction to dynamic analysis with practical software
• A.3. - Dynamic Analysis practices

Module B: Nonlinear Analysis
• B.1. - FEM Theory applied to Non-Linear Structures Calculation
• B.2. - Introduction to Non-Linear Analysis with Practical Software
• B.3. - Nonlinear Analysis Practices

Module C: Heat Transfer
• C.1. - FEM Theory Applied to Heat Transfer
• C.2. - Introduction to Heat Transfer Analysis with Practical Software
• C.3. - Heat Transfer Practices
I.4 Course List cont.

SPECIALIZED MODULES cont.

Module E: Steel Structure Advanced Calculation
• E.1. - Steel Structure Advanced Calculation
• E.2. - Introduction to Steel Structure Analysis with Practical Software
• E.3. - Steel Structures Practices

Module F: Fluid Mechanics
• F.1. - FEM Theory applied to Fluid Mechanics
• F.2. - Introduction to Fluid Mechanic Analysis with Practical Software
• F.3. - Fluid Mechanics Practices

Module H: Advanced Calculation of Concrete Structures
• H.1. - FEM Theory applied to Advanced Calculation of Concrete Structures
• H.2. - Introduction to Advanced Calculation of Concrete Structures with Practical Software
• H.3. - Concrete Structures Practices

Module I: Geotechnical Expansion
• I.1. - FEM Theory applied to Geotechnics
• I.2. - Introduction to Geotechnics with Practical Software
• I.3. - Geotechnical Practices

Module J: Electromagnetic Calculation
• J.1. - FEM Theory applied to Low Frequency Electromagnetic Analysis
• J.2. - Introduction to Low Frequency Electromagnetic Analysis with Practical Software
• J.3. - Low Frequency Electromagnetic Analysis Practices
FINAL PROJECT MODULE

EXPERT MODULE (30 cts)
- FEM General Theory (6 cts.)
- FEM Introduction to Programming (3 cts.)
- Numerical Calculation (4 cts.)
- Material Constitutive Laws (4 cts.)

Mechanical branch(*)
- Introduction to the use of practical software (5 cts.)
- Computer-Aided engineering techniques (4 cts.)

Construction branch(*)
- Introduction to the use of practical software (5 cts.)
- Computer-Aided engineering techniques (4 cts.)

(*) To be chosen by the student

Mechanical practical software examples (4 cts.)

SPECIALIZED MODULES (10 cts by module)

Module A
- FEM theory applied to structure dynamic analysis (4 cts.)

Module B
- FEM theory applied to the Non-linear analysis of structures (4 cts.)

Module C
- FEM theory applied to heat transfer (4 cts.)
- Advanced steel structures analysis (4 cts.)

Module E
- FEM theory applied to fluid mechanics (4 cts.)
- Advanced concrete structures analysis (4 cts.)

Module F
- FEM theory applied to EMAG analysis with practical software (4 cts.)

Module H
- Introduction to Concrete structures analysis with practical software (4 cts.)

Module I
- INTRODUCTION TO GEOTECHNICAL ANALYSIS WITH PRACTICAL SOFTWARE (4 cts.)

Module J
- INTRODUCTION TO EMAG ANALYSIS WITH PRACTICAL SOFTWARE (4 cts.)

SPECIALIZED MODULES GROUPS
- Structural: Construction Branch and A, B and E Modules
- Construction: Construction Branch and A, B, E, H and I Modules*
- Mechanical: Mechanical Branch and A, B, C, F and J Modules*

* Choose three of the five modules

NOTE: Module J will not be available for students that have studied the Master with Patran/MSC Nastran.

FINAL PROJECT MODULE (10 cts)
I.5 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**

*Requirement:* Complete the Expert Module and one Specialized Module.

**Master's in Theory and Practical Application of Finite Element Method and CAE Simulation**

*Requirement:* Complete the Expert Module, one of the specialized modules groups and the final project module.

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).

I.6 Special 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 civil program student guide.
II. Methodology

II.1 Before starting. How to Approach the Masters

Since this is an online Masters of great extent, it is necessary to give the student an idea of how to approach it. Please read this section before starting the course.

First of all, you should take a look to the timetables of the Master’s, shown in section II.3 of this guide. This will give you an idea of how to distribute the studying hours of the course. Nevertheless, this is just a recommendation and the online nature of the Masters will allow you to choose how many hours to devote to each module.

The teaching staff think 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 exercises of these subjects. From now on, students will be able to complete the continuous assessment exercises. Once students feel comfortable with the application software, they should start doing the additional (and more advanced) exercises from the Practice subject.

In section II.5 you will find the deadlines for the continuous assessment exercises and exams, so please pay special attention to these dates. It is highly recommended (although not mandatory) that all the students submit the continuous assessment exercises; this will help you to get involved in the modules and will serve as training for the exam.

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 in the theoretical contents. The students also have at their disposal some video-classes that resolve exercises with the corresponding software of the Application and Practice subjects. This is especially useful for making first contact with the Application and Practice software easier.

Another important point is taking an active part in the forums. For each module, you will find forum threads corresponding with each chapter of the subject. Therefore, every doubt or comment you have should be posted in the forum so that the rest of students and teachers can give their opinion; these will contribute to the dynamism of the course and bring everybody closer together.
II.2 Methodology

The program is based on distance learning combined with UNED’s unique methods in this area. This methodology allows students to participate in the course regardless of their place of residence or work and family responsibilities.

Distance Learning Key Elements:

• **Teaching Material:** Specially created for the program, combined with selected bibliography to study. These texts are for Foundations, 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, CivilFEM by Ingeciber and CFD++ by METACOMP to use and fulfill the theoretical training throughout the course. All the software included is 3D based and includes all the necessary elements needed to complete the various types of analysis throughout the course.

  ✓ Minimum computer requirements and the installation and configuration instructions for the software can be found in the virtual classroom.

• **Virtual Classroom:** Provides an environment where the students have the chance to interact and consult with each other and the professors. It is also where you will find the necessary materials and content needed to navigate throughout the course. For example, you can find the teaching and exercise materials, how to access tutorships, technical support and more . In order to use this tool, it is necessary to have an Internet connection.

• **Tutorships:** You can access Tutors via the virtual classrooms. These are Subject Matter Experts who offer their time to help you discuss and absorb the course materials.

• **Self-evaluation exercises:** Test yourself and track your progress through these online training exercises and related solutions available through the virtual classroom. Check the acquired subject knowledge and where you need to improve.

• **Continuous assessment exercises:** Are part of different modules Training Materials and are accessible through the virtual classroom. These exercises must be solved and submitted to the professor for review.

• **Exams:** Completely on-line. Will be conducted using distance test questions and practical exercises.

• **Video-lessons:** Subject specific sessions on each module will be given by the professor and recorded available for viewing at your discretion.

II.3 Duration and Timetable

The date and time of the inaugural session is set for the following:

**INAUGURAL SESSION:** Saturday, February 9, 2013 from 11:00am to 2:00pm (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.
The following timetable provides the number of teaching hours related to each subject as well as the transmission of documents specified for each week of the program. The Timetable is broken down by months and weeks starting on Mondays. It is worth mentioning that a credit requires a workload of approximately 15 hours. The empty weeks correspond to Vacation periods or Local public holidays.

### MECHANICAL BRANCH

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#### Final Project Module

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<th>Extraordinary Final Exams</th>
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Methodology
II.4 Tutorships

Tutorships will be conducted in English and Spanish.

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.

II.5 Evaluation

Student evaluations will be conducted using direct contact through the tutorships and the virtual classroom, online exams, ongoing 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
   - A Multiple Choice test about the Expert Module content with 30 questions (75% of the exam value) and a related practical exercise (25% of the exam value).
   - A Multiple Choice test about each Specialized Modules taken (2/3 of the exam grade) and a related practical exercise (1/3 of the exam grade).

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

The exams will be conducted through the virtual classroom.

For the Expert Module, a make up exam will be available for those students who failed or were not able to take the exam in the first place.

### EXAMS TIMETABLE

<table>
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<th>Module</th>
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<td>Sunday, November 24, 2013</td>
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To complete the Multiple Choice test, the student may take 4 hours within the 2 weeks in which the exam is available and for the practical exercise exam the student may take 2 days within the 2 weeks in which the exam is available.

For example, the Expert Module exam starts on September 30th and ends on October 13th. If the student starts the online Multiple Choice test on October 3rd at 9:00 a.m., he/she must complete and deliver it by October 3rd at 1:00 p.m.

2. **Ongoing assessment exercises**: 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 included in the exercise book, can only have a positive impact on the final module grade of the corresponding module. These exercises are accessible through the virtual classroom tools. See the next page for a calendar of the dates of these exercise.

   We suggest gradually sending the remote evaluation exercises as the student progresses through the study of the subject. This will help the student absorb the materials as part of the continuous learning process.

3. **Master's Final Project**:

   Will be directed by a member of the teaching staff and judged by a committee appointed by the Master's Directorate.
## Continuous Assessment Exercises Data Calendar

### February 2013

| Course | 4 | 11 | 18 | 25 | 4 | 11 | 18 | 25 | 1 | 8 | 15 | 22 | 29 | 6 | 13 | 20 | 27 | 3 | 10 | 17 | 24 |

### March 2013

| Course | 4 | 11 | 18 | 25 | 4 | 11 | 18 | 25 | 1 | 8 | 15 | 22 | 29 | 6 | 13 | 20 | 27 | 3 | 10 | 17 | 24 |

### April 2013

| Course | 4 | 11 | 18 | 25 | 4 | 11 | 18 | 25 | 1 | 8 | 15 | 22 | 29 | 6 | 13 | 20 | 27 | 3 | 10 | 17 | 24 |

### May 2013

| Course | 4 | 11 | 18 | 25 | 4 | 11 | 18 | 25 | 1 | 8 | 15 | 22 | 29 | 6 | 13 | 20 | 27 | 3 | 10 | 17 | 24 |

### June 2013

| Course | 4 | 11 | 18 | 25 | 4 | 11 | 18 | 25 | 1 | 8 | 15 | 22 | 29 | 6 | 13 | 20 | 27 | 3 | 10 | 17 | 24 |

### Expert Module

- **FEM General Theory**
  - AF.1
- **FEM Introduction to Programming**
  - AF.2
- **Numerical Calculation**
  - AF.3
- **Material Constitutive Laws**
  - AF.4
- **Application and Practice**
  - AP.1
  - AP.2
  - AP.3

### Specialized Module

- **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)
- **Practice Problems** (A.3, B.3, C.3, E.3, F.3, H.3, I.3, J.3)

### July 2013

| Course | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 2 | 9 | 16 | 23 | 30 | 7 | 14 | 21 | 28 | 4 | 11 | 18 | 25 |

### August 2013

| Course | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 2 | 9 | 16 | 23 | 30 | 7 | 14 | 21 | 28 | 4 | 11 | 18 | 25 |

### September 2013

| Course | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 2 | 9 | 16 | 23 | 30 | 7 | 14 | 21 | 28 | 4 | 11 | 18 | 25 |

### October 2013

| Course | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 2 | 9 | 16 | 23 | 30 | 7 | 14 | 21 | 28 | 4 | 11 | 18 | 25 |

### November 2013

| Course | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 2 | 9 | 16 | 23 | 30 | 7 | 14 | 21 | 28 | 4 | 11 | 18 | 25 |

### Continuous Assessment Exercises Data Calendar

- **Continuous Assessment Exercise Presented**
- **Continuous Assessment Exercise Due**
II.6 Directorate and Faculty

Director:
Mr. Juan José Benito Muñoz, Construction Engineering and Manufacturing Department, School of Mechanical Engineers, UNED.

Coordinators:
Mr. Miguel Ángel Moreno Fdez. de Yepes, Ingeciber, S.A.
Mr. Ambrosio Baños Abascal, Engineering Department, Ingeciber, S.A.

Professors:
Professor Enrique Alarcón Álvarez, Civil Engineer PhD, U.P.M.
Associate Professor Ramón Álvarez Cabal, Mechanical Engineer PhD, U.P.M.
Professor Juan José Benito Muñoz, Mechanical Engineer PhD, UNED.
Associate Professor Francisco Blázquez García, Mechanical Engineer PhD, U.P.M.
Associate Professor Alberto Fraile de Lerma, Mechanical Engineer PhD, U.P.M.
Associate Professor Pablo de la Fuente Martín, Civil Engineer PhD, U.P.M.
Professor Luis Gavete Corvinos, Mine Engineer PhD, U.P.M.
Professor Julio Hernández Rodríguez, Mechanical Engineer PhD, UNED.
Mr. Enrique López del Hierro Fernández, Mechanical Engineer PhD, UNED.
Professor Francisco Montans Leal, Mechanical Engineer PhD, U.P.M.
Associate Professor Ignacio del Rey Llorente, Mechanical Engineer PhD, U.P.M.
Professor Mariano Rodríguez-Avial Liardent, Mechanical Engineer PhD, UNED.
Associate Professor Eduardo Salete Díaz, Civil Engineer PhD, U.P.M.
Associate Professor José Ángel Sánchez Fernández, Civil Engineer PhD, U.P.M.
Professor José Ma Sancho Aznal, Architect PhD.

Lecturers:
Mr. Ambrosio Baños Abascal, MsC Science, Ingeciber, S.A.
Mr. Rubén Establés Antón, Civil Engineer, Ingeciber, S.A.
Mr. José Luis Gómez Villanueva, Mechanical Engineering, Ingeciber, S.A.
Mr. Juan Carlos Lancha Fernández, Civil Engineer PhD, OHL.
Mr. Rubén Mariño Díaz, Mine Engineer, Ingeciber, S.A.
Mr. Román Martín Martín, Civil Engineer, Ingeciber, S.A.
Mr. Miguel Ángel Moreno Fdez. de Yepes, Civil Engineer PhD, Ingeciber, S.A.
Mr. Eduardo Salete Casino, Civil Engineer PhD, Ingeciber, S.A.
Mr. Ronald Siat Caparrós, Civil Engineer, Ingeciber, S.A.
II.7 Contact Information

**Ingeciber, S.A.**
Avda. Monforte de Lemos, 189
28035. Madrid SPAIN
Phone: +34 91 386 22 22
FAX: +34 91 386 45 80
web: www.uned.es/mastermef

e-mail: g.ramos@ingeciber.com (Gema Ramos)
e-mail: c.pizarro@ingeciber.com (Constanza Pizarro)

**Relevant Data**

**Escuela Superior de Ingenieros Industriales** (Superior School of Mechanical Engineers).
UNED
C/ Juan del Rosal, 12.
28040 Madrid SPAIN
III. Virtual Classroom

III.1 Introduction

Over the last decade the Internet has emerged as an information and ideas exchange. While at the same time computer power, speed and ease of access to the web has greatly increased. Today the internet is rapidly becoming a great 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 flexibility of distance learning
- Multimedia Communication with other students, professors and tutors from around the globe
- Online Notice Board
- 24/7 Access to current teaching materials and exercises
- Recorded or Live: Video-lessons or face-to-face sessions
- And much much more...

In order to properly 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 WebCT, 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.

III.2 Virtual Classroom Login Instructions

To access the virtual classroom, please go to the following link:

http://virtual0.uned.es/aut/inicioval.html

To login, use the user name and password that will be assigned and sent to each student at the beginning of the course.
III.3 Contents and Structure

The program is organized by module 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).
- Contact information to access 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 team
- Guides and Information about the course
- Software Access and Installation Instructions
- Links to the Inaugural Session
- Communication Tools and Contact Information:
  - Direction and Coordination Board: Program Director and Program Coordination Communiques.
  - 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.
  - Student’s Forum: For the exchange of ideas and views.
- Video-Lessons