Course Guide 2015
Postgraduate Studies

Superior Technical School of Mechanical Engineers (U.N.E.D.)

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Ingeciber, S.A.
# Contents

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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 was 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 past twenty years of our FEA Master's programs, more than 3,200 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 in 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 the 21st year of the International FEA Masters Program.
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 use 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 in 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
- **Module K**: Finite Element Analysis of Composite Structures - 10 credits

(*) Not available in 2015 edition
I.3 Course Structure cont.

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

- Mechanical Specialty: Modules A, B, C, F and K(*)
- Mechanical Specialty*: Modules A, B, and E
- Construction Specialty*: Modules A, B, E and H(*)

*To complete a Specialized Module Group, students must choose at least 3 of the available modules.

I.4 Academic Route

Participants who choose Mechanical Branch in the Expert Module, will use MSC Nastran | patran software in Dynamic, Non-Linear and Heat Transfer and Composite Structures specialized modules and CFD++ software in Fluid Mechanics specialized module.

Participants who choose Construction Branch in the Expert module, will use CivilFEM with Marc in Dynamic, Non-Linear, Steel Structure, Concrete Advanced analysis and Geotechnics specialized 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.
- 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.

(*) Not available in 2015 edition
### 1.5 Subjects and Credits

The course modules are structured as follows:

**EXPERT MODULE** (30 cts)

**FOUNDATION**
- FEM General Theory (6 cts)
- FEM Introduction to Programming (3 cts)
- Numerical Calculation (4 cts)
- Material Constitutive Laws (4 cts)

**APPLICATION**
- Mechanical Branch (MISC Nastrian | Patran)
- Construction Branch (CivilFEM with Marc)

**PRACTICE**
- Mechanical FEM Software: Practical Uses (4 cts)
- Construction FEM Software: Practical Uses (4 cts)

**SPECIALIZED MODULES** (10 cts by module)

**MODULE A**
- A.1: FEM theory applied to Dynamic Analysis of Structures
- A.2: Introduction to Dynamic Analysis with FEM software
- A.3: Dynamic Analysis Practice Problems

**MODULE B**
- B.1: FEM theory applied to Nonlinear Analysis of Structures
- B.2: Introduction to Nonlinear Analysis with FEM software
- B.3: Nonlinear Practice Problems

**MODULE C**
- C.1: FEM theory applied to Heat Transfer
- C.2: Introduction to Heat Transfer Analysis with FEM software
- C.3: Heat Transfer Practice Problems

**MODULE E**
- E.1: Advanced Steel Structures Analysis
- E.2: Introduction to Steel Structure Analysis with FEM software
- E.3: Steel Structures Practice Problems

**MODULE F**
- F.1: FEM theory applied to Fluid Mechanics
- F.2: Introduction to Fluid Mechanics Analysis with FEM software
- F.3: Fluid Mechanics Practice Problems

**MODULE H**
- H.1: Advanced Concrete Structures Analysis
- H.2: Introduction to Concrete Structures Analysis with FEM software
- H.3: Concrete Structures Practice Problems

**MODULE I**
- I.1: FEM theory applied to Geotechnics
- I.2: Introduction to Geotechnical Analysis with FEM software
- I.3: Geotechnical Practice Problems

**MODULE J**
- J.1: FEM theory applied to low frequency Electromagnetic Analysis
- J.2: Introduction to EMAG analysis with FEM software
- J.3: EMAG Practice Problems

**MODULE K**
- K.1: Finite Elements Analysis of Composite Structures
- K.2: Introduction to Composite Structures with FEM software
- K.3: Complete Structures Practice Problems

(*) Not available in 2015 edition
I.6 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 modules groups and 3) the Final Master 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*).

I.7 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 scope, it is necessary to give the student an idea of how to approach it. Please read this section before starting the course.

1) Attend the Opening Session -
February 7th, 2015
11:00 to 14:00 Madrid-Spain GMT

Last year, many students were waiting for online lessons when, in fact, there are no “direct” lessons. It should be pointed out that this is mainly a self-study course, hence it is highly advisable that students start to study as soon as they receive their course materials.

Each module will start with an online meeting. The goals 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 during the Q&A section. Please pay attention to forums where the meetings will be announced.

The teaching staff advises to simultaneously study the Foundations and Applications 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). Going forward, students will be able to complete the Continuous Assessment Exercises (CAEs).

In the calendar, at the end of this section, you will find deadlines for the CAE’s 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 to get you involved in the modules and will serve as practice for the exam. All information about the CAEs is available in the virtual classroom.
II.2 Methodology

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

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 discressions.

• **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 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.

• **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 Foundation, Application and Practical courses as well as being part of “hands on” exercises.

• **Software:** Students will have access to educational software licenses o MSC Software's Patran and MSC Nastran, CivilFEM by Ingeciber, and CFD++ by Metacomp 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.

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

• **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 equations and practical exercises. They are completely on-line.
II.3 Timetable of the 21st Master's Edition

Continuous Assessment Exercises (CAEs) and exam dates.

**MECHANICAL BRANCH and CONSTRUCTION BRANCH**
(MSC Nastran | Patran and CFD++)
(CivilFEM with Marc)

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**Expert Module**

- **FEM General Theory**
  - Course #: AF.1
  - Course: TBD
- **FEM Introduction to Programming**
  - Course #: AF.2
  - Course: TBD
- **Numerical Calculation**
  - Course #: AF.3
  - Course: TBD
- **Material Constitutive Laws**
  - Course #: AF.4
  - Course: TBD
- **Introduction to the Use of Practical Software**
  - Course #: AP.1
  - Course: AES
- **Computer-Aided Engineering Techniques**
  - Course #: AP.2
  - Course: AES
- **Practice Problems**
  - Course #: AP.3
  - Course: AES

**Specialized Module**

- **Foundations (A.1, B.1, C.1, E.1, F.1, H.1, I.1, J.1, K.1)**
  - Course: AES
- **Application (A.2, B.2, C.2, E.2, F.2, H.2, I.2, J.2, K.2)**
  - Course: AES
  - Course: AES

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**Expert Module**

- **FEM General Theory**
  - Course #: AF.1
  - Course: TBD
- **FEM Introduction to Programming**
  - Course #: AF.2
  - Course: TBD
- **Numerical Calculation**
  - Course #: AF.3
  - Course: TBD
- **Material Constitutive Laws**
  - Course #: AF.4
  - Course: TBD
- **Introduction to the Use of Practical Software**
  - Course #: AP.1
  - Course: EXR
- **Computer-Aided Engineering Techniques**
  - Course #: AP.2
  - Course: EXR
- **Practice Problems**
  - Course #: AP.3
  - Course: EXR

**Specialized Module**

- **Foundations (A.1, B.1, C.1, E.1, F.1, H.1, I.1, J.1)**
  - Course: EXR
- **Application (A.2, B.2, C.2, E.2, F.2, H.2, I.2, J.2, K.2)**
  - Course: EXR
  - Course: EXR

*Extraordinary Call of the Expert Module

- **Continuous Assessment Exercise Sent**
- **Return of Continuous Assessment Exercise**
- **SEE: Evaluation Exam Sent**
- **REE: Return of Evaluation Exam**
II.4 Inaugural Session

Inaugural Session:

Saturday, February 7, 2015,
11:00am - 2:00pm (CET) Central European Time

II.5 Tutorships

Tutorships will be conducted in both 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.6 Evaluation

Student evaluations will be conducted using direct contact through the tutorships and the virtual classroom, online exams, continuous assessment excercises 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).

### EXAMS TIMETABLE

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<th>Evaluation Start Date</th>
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<tr>
<td>Expert Module</td>
<td>Monday, September 28, 2015</td>
<td>Sunday, October 11, 2015</td>
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<td>Specialized Module</td>
<td>Monday, November 9, 2015</td>
<td>Sunday, November 22, 2015</td>
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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.

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 the 2 weeks in which the exam is available.

2. Continuous assessment exercises: there are many benefits to these exercises
   • Settle ideas and clarify concepts related to the course content
   • 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 can only have a positive impact on the final module grade, adding up to one more point to the final grade of the corresponding module. These exercises are accessible through the virtual classroom tools. See the page 13 for a calendar of the dates for these exercises.

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.
II.7 Directorate and Faculty

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

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

Professors:
Professor Enrique Alarcón Álvarez, Civil Engineer PhD, U.P.M.
Mr. José Ramón Arroyo Arroyo, Mechanical Engineering, INTEMAC
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 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. Marcos Latorre Ferrús, Aeronautical Engineer U.P.M.
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-Avilardent, Mechanical Engineer PhD, UNED.
Associate Professor José Ángel Sánchez Fernández, Civil Engineer PhD, U.P.M.
Professor José Ma Sancho Aznal, Architect PhD.

Lecturers:
Mr. Pablo Arrieta Yáñez, Naval Engineer, Ingeciber, S.A.
Mr. Ambrosio Baños Abascal, MsC Science, Ingeciber, S.A.
Mr. Javier Carros Sotillos, Civil Engineer, Ingeciber, S.A.
Mr. José Luis Gómez Villanueva, Mechanical Engineering, Ingeciber, S.A.
Mr. Luca Guerriero, Mechanical Engineer. Airbus
Mr. Amer Kasim, Mechanical Engineer. UNED Collaborator
Mr. Juan Carlos Lancha, Civil Engineer, PhD. OHL Group.
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, U.N.E.D.
Mr. Miguel Ángel Sans Gómez, Mechanical Engineer, U.P.M.
Mr. Mariano Serrano de la Asunción, Mechanical Engineer, Ingeciber, S.A.
Mr. Ronald Siat Caparrós, Civil Engineer, Ingeciber, S.A.
II.7 Contact Information

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Relevant Data

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UNED
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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
- Online Meetings
- 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 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.
III.2 Virtual Classroom Login Instructions

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

https://ext.cursosvirtuales.uned.es/dotlrn/miuned

Username and password needed: Use the UNED ID and password obtained during the registration process.
III.3 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).
• Contact information for 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:
  ✓ 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 virtual classroom.
  ✓ Student’s Forum: For the exchange of ideas and views.