Course guide
240032 - 240032 - Numerical Methods

Last modified: 16/05/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: ANTONIO SUSIN SANCHEZ

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Capacity to solve mathematical problems that can appear in engineering . Aptitude to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and derived partial equations; numerical methods; numerical algorithm; statistics and optimisation.

TEACHING METHODOLOGY

This subject comprises teoretical lectures, exercise sessions and computer practice. During theoretical lectures the academia will present the contents and learning objectives, while the exercise sessions have been thought to discuss and solve problems previously addressed by the student in his independent learning. During the practice session in the computer room, the student will implement and solve case problems. In these sessions teamwork will be enhanced and specific software packages like Matlab will be used.

LEARNING OBJECTIVES OF THE SUBJECT

The subject has been thought to provide the student with a wide knowledge about function interpolation and approximation techniques, but with special emphasis to support the resolution of physical and technological problems by means of the finite element method. Another objective is to get accross to the students the generality of the finite element method for the study of boundary value problems, that could strongly differ in fields from the start, but the general formulation gives them a common substract. Finally, we intend as well that students understand in a precise way all the tecnical details about the implementation of such methodologies and be able to aply them in particular cases.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	26.67
Self study	67,5	60.00
Hours medium group	15,0	13.33

Total learning time: 112.5 h

CONTENTS

INTERPOLATION OF FUNCTIONS

Description:
Lagrange interpolation. Error formula. Runge phenomena. Hermite interpolation. Splines.

Related competencies :
CE1. Capacity to solve mathematical problems that can appear in engineering . Aptitude to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and derived partial equations; numerical methods; numerical algorithm; statistics and optimisation.

Full-or-part-time: 13h
Theory classes: 3h
Practical classes: 1h
Laboratory classes: 1h
Self study : 8h

APPROXIMATION OF FUNCTIONS

Description:
Least squares approximation. Orthogonal Polynomials. Minimax approximation. Fourier approximation.

Related competencies :
CE1. Capacity to solve mathematical problems that can appear in engineering . Aptitude to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and derived partial equations; numerical methods; numerical algorithm; statistics and optimisation.

Full-or-part-time: 13h 30m
Theory classes: 2h
Practical classes: 1h
Laboratory classes: 2h
Self study : 8h 30m

INTRODUCTION TO THE FINITE ELEMENT METHOD

Description:
Introduction to the finite element method. Variational methods of approximation. Stationary and transient problems. One-dimensional models of the heat and elasticity equations.

Related competencies :
CE1. Capacity to solve mathematical problems that can appear in engineering . Aptitude to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and derived partial equations; numerical methods; numerical algorithm; statistics and optimisation.

Full-or-part-time: 19h
Theory classes: 4h
Laboratory classes: 5h
Self study : 10h

ONE-DIMENSIONAL STATIONARY PROBLEMS

Description:
Discretization of the domain and related concepts. Model equation and weak form. Element equations. Assembly. Boundary conditions, solution and postprocessing. Two and trhee-dimensional problems with symmetries. Other balance equations. Working sessions at the computer room with one-dimensional case examples.

Related competencies :
CE1. Capacity to solve mathematical problems that can appear in engineering . Aptitude to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and derived partial equations; numerical methods; numerical algorithm; statistics and optimisation.

Full-or-part-time: 32h
Theory classes: 6h
Practical classes: 4h
Laboratory classes: 2h
Self study : 20h

TWO-DIMENSIONAL STATIONARY PROBLEMS

Description:
Model equation, weak form and element equations. Families of elements. Assembly. Balance of flows, boundary conditions and resolution. Working sessions at the computer room with two-dimensional case examples.

Related competencies :
CE1. Capacity to solve mathematical problems that can appear in engineering . Aptitude to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and derived partial equations; numerical methods; numerical algorithm; statistics and optimisation.

Full-or-part-time: 35h
Theory classes: 6h
Practical classes: 4h
Laboratory classes: 4h
Self study : 21h

ACTIVITIES

CONTINUOUS EVALUATION 2

Description:
Several test in the computer room or by the Internet, where the concepts relatet with the Matlab implementation will be evaluated.

Full-or-part-time: 1h
Laboratory classes: 1h

PARTIAL EXAM

Description:
Assessment of knowledge.

Delivery:
Solved exam.

FINAL EXAM

Description:
Assessment of knowledge.

Delivery:
Solved exam.

GRADING SYSTEM

The final mark will be computed by means of,

FM=0.1*MA+0.30*MT+0.60*FE

where MA is the resulting mark of the exams of Matblab, MT is the mark of the mid term exam and FE is the mark of the final exam.

The reevaluation will consist in an exam including all the contents and scheduled by the School. In case of reevaluation, the final mark will be computed by means of:

FM=0.10*MA+0.9*RM

where RM is the reevaluation mark.

BIBLIOGRAPHY

Basic:
- Masdemont Soler, Josep. Curs d'elements finits amb aplicacions [on line]. Barcelona: Edicions UPC, 2002 [Consultation: 08/09/2020]. Available on: http://hdl.handle.net/2099.3/36166. ISBN 8483015951.

Complementary:
- Johnson, Claes. Numerical solution of partial differential equations by the finite element method. Mineola: Dover, 2009. ISBN 9780486469003.
- Reddy, J. N. Introduction to the finite element method. 4th ed. New York: McGraw Hill, 2019. ISBN 9781259861901.

RESOURCES

Other resources:
Students of this subject will be provided with:
- List of problems
- Notes and/or slides related to practice lectures.
- A scholar to support consultation about the Matlab package and the case examples.
- Detailed information about the course in a web page.