Universidad de Alcalá

Teaching Guide

Data Structures

Bachelor's degree in

Information Systems Engineering
Computer Engineering
Computer Science

Universidad de Alcalá

Academic year 2019/2020
Second-year – Term 1

Teaching Guide

Course name:	**Data Structures**
Código:	**780009**
Degree programs:	**Degree in Information Systems Engineering** **Degree in Computer Engineering** **Degree in Computer Science**
Department:	**Computer Science**
Type	**Obligatory**
ECTS Credits:	**6**
Year / term:	**Second year / Term 1**
Lecturers:	M. José Domínguez Alda (coordinator) Check the web page of the department
Office hours:	It will be announced during the first week. Also available on the department's web page
Classes offered in:	Spanish / English

1. COURSE SUMMARY

The learning objective of this course is to study data structures conceptually along with their forms of representation and their implementations. The student will also learn to build specifications of Abstract Data Types (ADTs) and also to implement these specifications using an object-oriented programming language.

Requirements: Programming. Basic course/s on basic mathematics and/or discrete structures are also recommended

2. SKILLS

General skills:

CG8 Knowledge of basic materials and technologies that enable learning and development of new methods and technologies, as well as to equip them with great versatility to adapt to new situations.

CG9 Ability to solve problems with initiative, decision making, autonomy and creativity. Ability to communicate and transmit knowledge and skills of the profession of Technical Engineer.

Specific skills:

CI7 Knowledge, design and use efficiently the types and structures more suited to solving a problem data.

CI8 Ability to analyze, design, build and maintain applications in a robust, secure and efficient way, choosing the paradigm and programming languages most appropriate.

Learning results:

The expected learning results, obtained from the specific competences included in the verified report of the Degree in Computer Engineering, are the following:

• RA1: Understand the concept of abstraction, abstract data type and data structure.
• RA2: Apply the techniques of abstraction and concealment as a means to solve complex problems.
• RA3: Explain and justify the need for data structures and their construction methods.
• RA4: Understand and apply the concept of complexity / efficiency in the context of data structures.
• RA5: Know the fundamental data structures (stacks, lists, queues, trees, ...) and use them to solve different problems.
• RA6: Implement in a high level language, comparing the different implementations, the fundamental data structures (stacks, lists, queues, trees, ...).
• RA7: Understand the concept of recursion, identify the base case and the general case of a recursively defined problem and compare iterative and recursive solutions to elementary problems.
• RA8: Understand and implement the usual ordering and search algorithms.
• RA9: Know the common applications of data structures and identify the most appropriate to model specific problems.

3. CONTENTS

Topic	Total number of credits, lectures or hours (*)
1. Fundamentals of Data Structures Basic concepts. Data structure. Abstract Data Types (ADTs). Specification of ADTs.	8 hours
2. Linear Data Structures Introduction. Specification of linear data structures: stacks, queues, lists. Vectors and sorting algorithms. Implementation. Applications.	20 hours

3. Non-linear Data Structures Introduction. Specification of non-linear data structures: dictionaries, hash tables, general trees, binary search trees, priority queues, heaps, AVL trees and graphs. Implementation. Applications.	28 hours

* Including tests and assessments.

4. LEARNING METHODOLOGY. OUTLINE OF ACTIVITIES

4.1. Credits and hours

Class:	Theory and problem solving: 28 hours Lab: 28 horas Assessment: 4 hours
Independent study:	90 hours
Total	150 hours

4.2. Learning methods, materials and resources

The following learning methods are used:

- Theoretical lectures.
- Supervised practical classes: problem-solving in class.
- Supervised practical labs.
- Individual tutoring and mentoring.

In addition, depending on the nature of the work, the students may make use of the following study methods:

- Individual or collaborative elaboration of coursework.
- Exchange of information, problems, and doubts which arise during individual work.
- Use of the online learning platform and other virtual resources.

Classroom activities	▪ In class: Presentation and discussion of core subject knowledge. Planning and theoretical solving and problems and related hypotheses. Oriented towards the teaching of subject-specific skills, especially those related to the fundamental concepts and practices for the specification of Abstract Data Types and for the implementation of Data Structures. ▪ In practical labs: Planning and development of practical exercises which allow problems to be solved and hypotheses to be analyzed, contributing to the development of analytical and critical reasoning skills as well as an understanding of problem-solving methods. These will serve as a basis for acquiring the skills and/or learning outcomes described in part 2 of this guide.
Independent work, non-contact activities:	▪ Analyzing and learning course contents, solving of problems, consulting the bibliography, individually preparing coursework, sitting exams, and self-evaluation. Oriented primarily towards developing personal organization skills and planning work individually or as part of a team.

	▪ Tutorials: Individuals and group guidance throughout the learning process. Students may attend in person or online.
Materials and resources:	▪ Learning materials created by the learning staff for the classroom activities. ▪ Reference bibliography of core and further reading on the subject. ▪ Personal computers ▪ Virtual Learning Platform and accompanying user guides. ▪ Development environments and accompanying user guides. ▪ Internet connection. ▪ Projectors.

5. ASSESSMENT: Procedures, assessment criteria

The grading system shall adhere to the "'NORMATIVA REGULADORA DE LOS PROCESOS DE EVALUACIÓN DE LOS APRENDIZAJES" (Regulation of learning assessment procedures) (art. 9 and 10)

Assessment criteria:

The following assessment criteria are established for this course:

- CE1: Student knows and knows how to apply abstraction as a means to solve complex problems
- CE2: Student understands why data structures are necessary and also the methods to build them
- CE3: Student knows and knows how to apply the concept of complexity/efficiency within the context of data structures
- CE4: Student knows the linear data structures and knows how to use them to solve problems
- CE5: Student knows the non-linear data structures and knows how to use them to solve problems
- CE6: Student can implement linear data structures (stacks, queues, lists) using a high-level programming language
- CE7: Student can implement non-linear data structures (trees, binary search trees, AVL trees, hash tables, heaps) using a high-level programming language
- CE8: Student understands the concept of recursion. Student can find the base case and the general case for a recursive problem.

- CE9: Student can compare the iterative solution and the recursive solution for elemental problems.
- CE10: Student knows and can implement common search algorithms and sorting algorithms
- CE11: Student knows the standard applications of data structures, and he can select the most suitable data structures to model each specific problem

Instruments:

1) Ordinary call: Continous assessment

The following instruments are used:

- PEI1: Written exam of the learning contents of topics 1 and 2 (20%)
- PEI2: Written exam of the learning contents of topic 3 (40%)
- PL1: Lab assignment of the learning contents of topics 1 and 2 (20%)
- PL2: Lab assignment of the learning contents of topic 3 (20%)

Exams (PEI1 and PEI2) take place in the classroom. The maximum duration is two and a half hours.

The assessment of the laboratory consists of practical assignments that the student must submit and present to the professor in laboratory sessions specifically designed for it. In addition, professors can collect evidence of the student's work throughout the laboratory sessions.

The following table presents the weight and assessment instruments, and their relationship to the learning outcomes and assessment criteria.

General / Specific Skills	Learning outcome	Assessment criteria	Instrument	Weight
CG8, CG9, CI7, CI8	RA1, RA2, RA3, RA4, RA5, RA9	CE1, CE2, CE3, CE4, CE9, CE11	PEI1	20
CG8, CG9, CI7, CI8	RA1, RA2, RA3, RA4, RA5, RA7, RA8	CE1, CE2, CE3, CE5, CE8, CE9, CE10, CE11	PEI2	40
CG9, CI7, CI8	RA1, RA2, RA3, RA6, RA9	CE1, CE6, CE9, CE10, CE11	PL1	20
CG9, CI7, CI8	RA1, RA2, RA3, RA6, RA7, RA8, RA9	CE1, CE7, CE8, CE9, CE10, CE11	PL2	20

Failure to pass any of the exams/assignments does not imply that students do not pass the complete course. To pass the course students have to meet the following requirements:

- Take exams PEI1 and PEI2 and pass the evaluation of the competences related to both exams. Students acquire such competencies satisfactorily if the mark is equal or higher than 40% of the maximum possible mark.

- Pass the evaluation of the competences related lab assignments (PL1 and PL2). The student has to submit both assignments and get a mark equal or higher than 40% of the maximum possible mark.
- Obtain a final weighted mark equal to or greater to 5 out of 10.
- Obtener una calificación final ponderada de todas las pruebas de evaluación continua definidas igual o superior a 5 sobre 10.

2) Ordinary call: Final examination

The following instruments are used:

- PF: Written exam of the learning contents of topics 1,2 and 3 (60%)
- PL1: Lab assignment of the learning contents of topics 1 and 2 (20%)
- PL2: Lab assignment of the learning contents of topic 3 (20%)

The date of the exam is established by the Polytechnic School, and its duration is three hours.

The assessment of the laboratory consists of practical assignments that the student must submit and present to the professor in laboratory sessions specifically designed for it.

The following table presents the weight and assessment instruments, and their relationship to the learning outcomes and assessment criteria:

General / Specific Skills	Learning Outcome	Assessment Criteria	Instrument	Weight
CG8, CG9, CI7, CI8	RA1, RA2, RA3, RA4, RA5, RA7, RA8, RA9	CE1, CE2, CE3, CE4, CE5, CE8, CE9, CE10, CE11	PEF	60
CG9, CI7, CI8	RA2, RA3, RA4, RA6, RA9	CE1, CE6, CE9, CE10, CE11	PL1	20
CG9, CI7, CI8	RA2, RA3, RA4, RA6, RA7, RA8, RA9	CE1, CE7, CE8, CE9, CE10, CE11	PL2	20

Requirements to pass the course are the same as for the Continuous Assessment.

3) Extraordinary call

The same instruments and evaluation criteria, as described in the previous, are used.

6.BIBLIOGRAPHY

Core reading

- A.V. AHO., J.E. HOPCROFT., J.D. ULLMAN. 1987. “Data Structures and Algorithms.” Addison-Wesley.
- C. SHAFFER. 2011 “Data Structures and Algorithm Analysis in C++”, 3ed. Dover Publications.
- B. STROUSTRUP. 1997. “The C++ programming language.” 3rd Addison-Wesley.

Further reading

- ALLEN WEISS MARK. 1994. Data Structures and Algorithms Analysis in C++, The Benjamin/Cummings Publishing Company.
- BRASSARD,G., BRATLEY,P. 1995. “Fundamentals of Algorithmics”. Prentice Hall.
- CORMEN, T.H., LEISERSON, C.E., RIVEST, R.L., STEIN, C. 2009. Introduction to Algorithms. MIT Press.
- B. ECKEL.1995 "Thinking in C++." Prentice Hall
- P.J. DEITEL., H.M. DEITEL. 2009 "C++ How to program." Prentice Hall.
- N. KARUMANCHI. 2011 “Data Structures and Algorithms Made Easy” 2ed CareerMonk Publications