

Course Unit	Distributed Systems		Field of study	Computer Engineering	
Bachelor in	Informatics Engineering		School	School of Technology and Management	
Academic Year	2021/2022	Year of study	3	Level	1-3
Type	Semestral	Semester	2	ECTS credits	6.0
			Code	9119-706-3203-00-21	
Workload (hours)	162	Contact hours	T 30	TP -	PL 30
			TC -	S -	E -
			OT -	O -	

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) Rui Pedro Sanches de Castro Lopes, Luis Filipe Rodrigues Corredeira Lobo, Sergio Paulo Perdigo do Vale

### Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. Distinguish a distributed system and understand the reasons for its implementation;
2. Understand the challenges of constructing distributed systems;
3. Differentiate between various models and architectures for distributed systems;
4. Identify problems inherent in concurrent execution of tasks in centralized and distributed environments and implement measures to address them;
5. Implement distributed systems using simple basic communication primitives;
6. Implement distributed systems using existing middleware.

### Prerequisites

Before the course unit the learner is expected to be able to:

1. Know and have experience in object-oriented programming;
2. Know the fundamental concepts of computer architectures;
3. Know the fundamental concepts of operating systems;
4. Know the fundamental concepts of computer networks.

### Course contents

Characterization of distributed systems. Models of distributed systems. Java language. Programming with threads. Inter-process communication. Indirect communication. Architecture and middleware for distributed systems. Distributed coordination.

### Course contents (extended version)

1. Characterization of distributed systems.
  - Definition.
  - Characteristics.
  - Examples.
  - Challenges.
2. Models of distributed systems.
  - Physical models.
  - Architectural models.
  - Fundamental models.
3. Java language.
  - Characteristics of the language.
  - Concepts of object-oriented programming.
  - Data types, operators, expressions, statements and blocks, flow control.
  - Classes and objects. Interfaces and inheritance. Definition and use of generics.
  - Collections framework.
  - Exception handling and streams manipulation.
4. Programming with threads.
  - Threads and Processes.
  - Advantages and applications of multi-threading.
  - Problems associated with multi-threading: Deadlock, livelock and starvation.
  - Parallelization of problems, producer-consumer, thread pools.
5. Inter-process Communication.
  - Request-response protocols.
  - UDP and TCP Protocols. Datagrams and Sockets in Java.
  - Distributed objects. Remote Method Invocation (RMI).
6. Architecture and Middleware for Distributed Systems.
  - Distributed objects systems.
  - Component based middleware.
  - Web Services.
  - Peer-to-peer networks.
7. Distributed coordination.
  - Clock synchronization.
  - Election.

### Recommended reading

1. Couloris, G. Dollimore, J. and Kinberg, T, Distributed Systems - Concepts and Design, 5th Edition, Addison-Wesley, Pearson Education, 2011
2. Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, 2nd Edition, Prentice Hall, Pearson Education, 2007
3. Rogers Cadenhead, Laura Lemay, Sams teach yourself java 6 in 21 days, Sams, 2007
4. Jorge Cardoso, Programação de Sistemas Distribuídos em Java, FCA, 2008
5. Manuais de referências e tutoriais na Internet

### Teaching and learning methods

Lectures using the the expositive method. Problem-solving classes with demonstration of concepts by solving small practical exercises, with periods of resolution in the classroom and autonomous routing of additional tasks for non-presencial work hours. Use of the e-learning platform for the delivery of materials and submission of projects.

**Assessment methods**

- Alternative 1 - (Regular, Student Worker) (Final, Supplementary, Special)
- Projects - 50%
- Final Written Exam - 50%

**Language of instruction**

1. English
2. Portuguese

**Electronic validation**

Rui Pedro Sanches de Castro Lopes	José Luís Padrão Exposto	Luísa Maria Garcia Jorge	Paulo Alexandre Vara Alves
18-02-2022	02-03-2022	06-03-2022	25-03-2022