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Course Unit	Distributed Systems			Field of study	Computer Engineering	
Bachelor in	Informatics Engineering			School	School of Technology and Management	
Academic Year	2023/2024	Year of study	3	Level	1-3	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9119-706-3203-00-23	

| 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)	Luis Filipe Rodrigues Corredeira Lobo, Rui Pedro Sanches de Castro Lopes

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

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12-02-2024	14-03-2024	18-03-2024	24-03-2024