



# UNIVERSITÀ DI PISA

## PEER TO PEER SYSTEMS AND BLOCKCHAINS

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**LAURA EMILIA MARIA RICCI**

Academic year	2016/17
Course	INFORMATICA
Code	261AA
Credits	6

Modules	Area	Type	Hours	Teacher(s)
SISTEMI PEER TO PEER	INF/01	LEZIONI	48	EMANUELE CARLINI LAURA EMILIA MARIA RICCI

### Obiettivi di apprendimento

#### Conoscenze

The course aims at providing a mix of foundations and advanced knowledge in the field of distributed computing specifically targeting peer to peer applications. The course provides both theoretical knowledge and applications to real scenarios.

The main three topics of the course regard Distributed Hash Table, Complex Network Analysis and Blockchain technologies

#### Modalità di verifica delle conoscenze

Delivery: face to face, with the support of computer based tools (software blackboard, audio/video of lessons available through web)

Learning activities:

- attending lectures
- individual study
- Laboratory work
- Practical

Attendance: Not mandatory

Teaching methods:

- Lectures
- laboratory (bring you own device model)
- project work

#### Capacità

The student will eventually be able to design, develop and tune distributed applications using peer-to-peer simulator or practical programming frameworks.

#### Modalità di verifica delle capacità

Mid and final term exercises are assigned during the course and part of the exam consist in the preparation of a small project, to be designed, developed and tested through the tools presented in the course

#### Prerequisiti (conoscenze iniziali)

JAVA programming  
Network programming frameworks  
Basic mathematica skills

#### Corequisiti



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No corequisite.

## Programma (contenuti dell'insegnamento)

### P2P Topologies

- Peer to Peer (P2P) systems: general concepts
- Unstructured Overlays: Flooding, Random Walks, Epidemic Diffusion
- Structured Overlays: Distributed Hash Tables (DHT), Routing on a DHT
- Case Studies:
  - Bittorrent as a Content Distribution Network: KAD implementation of the Kademlia DHT, game-based cooperation

Complex Network for the analysis of P2P systems

- Network models
- Random Graphs and Small Worlds
- Small World navigability: Watts Strogatz and Kleinberg.
- Complex networks navigability

Cryptocurrencies and Blockchains

### Basic concepts:

- review of basic cryptographic tools (digital signatures, cryptographic hash, Merkle trees,...)
- blockchains: definitions
- distributed consensus: definitions
- the Bitcoin blockchains
  - Nakamoto consensus
  - Bitcoin mining mechanism
  - pseudonymity: traceability and mixing
  - the Bitcoin P2P Network
  - The Bitcoin ecosystem
  - scalability issues
  - Bitcoin Extensions/alternatives: altcoins, sidechains, the Stellar Consensus Protocol
- Applications of blockchains
  - Ethereum: programming smart contracts
  - Blockchain 1.0: cryptocurrencies
  - Blockchain 2.0: financial instruments built on cryptocurrencies
  - Blockchain 3.0: applications beyond cryptocurrencies (DNS, lotteries, voting, IoT...)

## Bibliografia e materiale didattico

Slides of the course

Tutorials and papers available on the web.

## Indicazioni per non frequentanti

All the teaching material is published on the page of the course

## Modalità d'esame

(written exam OR project) + oral test

if the student pass both mid and final term the oral proof, he/she is exempted from the oral examination

## Stage e tirocini

1. Analysis of the Bitcoin Transaction Graphs
  - discovering economic phenomena through graph analysis
  - implementing distributed access control policies through
2. blockchains methodologies exploiting the Ethereum blockchain
3. vertex centric algorithms for the analysis of complex graphs:
  - current flow betweenness: graphs as electric circuits

## Pagina web del corso

<https://elearning.di.unipi.it/course/view.php?id=89>

