PhD Modules (36th PhD cycle - 2020-21)

MODULE A

Title: *Multiphase models for the dynamics of fluids*

Teachers: Michele Battistoni and Luigi Vergori

Contacts: michele.battistoni@unipg.it, luigi.vergori@unipg.it

Indicative period: April-May 2021 (interested students should contact the teachers as soon as possible in order to define the schedule of the lessons).

**ABSTRACT.** Multiphase flows are widely used in a plethora of practical applications, such as spray, atomization, coatings, cavitation, phase change problems, cooling, microfluidics, in industrial and medical Engineering. The course aims at the introduction of mathematical methods for studying some multiphase flows of both incompressible and compressible fluids. Some applications will be discussed and numerical algorithms for the solution of the governing equations will be presented.

**PROGRAM**


MODULE B

Title: *Electronic noise: theory and practice*

Teacher: Federico Alimenti

Contact: federico.alimenti@unipg.it

Indicative period: July – September. The course will consist of 5 lessons 4 hours each, spread over 2 weeks (interested students should contact the teacher as soon as possible in order to define the lessons schedule).

**ABSTRACT.** Electronic noise theory is an important topic in sensors and telecommunication systems. Noise measurements are often tricky and require application specific set-up and techniques. In the first part of the course, starting from physical principles, we will review the fundamentals of electronic noise with a particular focus to microwave noise. In parallel, important system parameters will be recalled such as the equivalent noise temperature, the noise figure, the minimum noise figure and the optimum impedance for noise. The second part of the course will be devoted to noise measurements and, as a case of study, we will consider a radio receiver. Finally, in the third part, we will explore the application of microwave noise measurements to radioastronomy and the
potential of these technologies for the realization of a new class of sensors: when a radio-telescope looks at the universe it simply measure the faint microwave noise produced by the stars!

**PROGRAM**

- Electronic noise fundamentals.
- Studying a circuit with noise.
- System and circuit noise parameters.
- Measuring the electronic noise.
- Electronic noise as an opportunity: radioastronomy and sensors.

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**MODULE C**

**Title:** Distributed Technologies for Big Data Processing and Blockchain  
**Teacher:** Luca Grilli and Fabrizio Montecchiani  
**Contact:** luca.grilli@unipg.it; fabrizio.montecchiani@unipg.it  
**Indicative period:** January – May 2021. (interested students should contact the teacher as soon as possible in order to define the schedule of the lessons).

**ABSTRACT.** Both Big Data processing systems and blockchain technologies have a distributed nature. Big Data encompasses large volumes of complex and dynamic data, which are often characterized by a multimodal nature and by a high generation rate. As a consequence processing and managing Big Data pose challenges that go beyond the capabilities of conventional software and systems. This course presents some of the main distributed computing paradigms and technologies that can be exploited to process Big Data. Blockchain technologies also rely on distributed systems, but this is required to improve data security and to avoid trusted central entities, rather than to expand data processing capabilities. A blockchain is a chain of immutable transaction blocks that are memorized across multiple networked data stores - the blockchain network - each of which can be owned and handled by autonomous organizations with conflicting interests. Blockchains make strong use of cryptography and of (distributed) trustless consensus mechanisms to guarantee irreversibility, authenticity and integrity of their content. This course gives an overview of the main types of blockchain technologies, including programmable blockchains and smart contracts.

**PROGRAM**

- Introduction to Big Data Processing
- The MapReduce data processing model, the Apache Hadoop platform, and the Spark processing engine.
- The TLAV graph processing model and the Giraph platform.
• Fundamental concepts of information security and cryptography.

• Fundamental concepts of blockchain, Bitcoin’s blockchain, and overview of other types of blockchain technologies.

• Programmable blockchains, the Ethereum blockchain, and the Solidity language for smart contracts.

MODULE D

Title: In situ investigations and instrumentation for site assessment
Teacher: Manuela Cecconi
Contact: manuela.ceconini@unipg.it
Indicative period: April – May 2021. (Interested students should contact the teacher as soon as possible in order to define the schedule of the lessons).


PROGRAM
• Site assessment: soils/rock identification
• Seismicity and risk analysis
• Geotechnical characterisation: in-situ investigation
• Monitoring
• Equipment and instrumentation
• Interpretation and presentation of in situ-tests results and measurements
• Case studies