PhD courses

The PhD Board proposes the following courses to be held during the academic year 2022-23. The students interested in the attendance should contact the secreteriat at the email address phd.ieie@unipv.it

AI-Driven Cybersecurity

Prof. A. Nocera, Prof. T. Facchinetti, Department of Electrical, Computer and Biomedical Engineering of the University of Pavia
Dr L. Virgili Università Politecnica delle Marche
Cybersecurity deals with technologies, processes, and control mechanisms to protect devices, networks, and data from malicious attackers. As cyberattacks evolve overtime and grow in volume and complexity, Artificial Intelligence (AI) techniques have shown to be fundamental solutions to stay ahead of threats. Although such techniques, typically involving
machine learning and deep learning solutions, are key factors to develop new generation defense mechanisms, more and more AI-driven menaces are also developed by attackers.
This course provides an overview of cybersecurity and privacy concepts, introduces the main technologies adopted in this context, and then shows practical examples of AI-driven attack and defense approaches.
25 hours + final exams – 6 credits
Period November – December 2022

Probabilistic Graphical Models and Causal Inference

Prof. Marco Piastra - Department of Electrical, Computer and Biomedical Engineering of the University of Pavia
Graphical models can be used to represent causal assumptions that researchers may wish to convey and defend. As such, they can also be used to identify under which conditions causal features can be identified starting from probability distributions obtained from factual observations. In turn, these methods can be applied to estimate the effects of specific interventions and to study counterfactuals, namely, how a specific situation could be different under altered circumstances. In the realm of machine and deep learning, causal reasoning via graphical models is becoming increasingly relevant in relation to explainability, bias detection and fairness assessment.
The objective of this short course is giving a brief account of theoretical foundations, describing basic computation methods and giving a few practical examples.
6 hours – 1,2 credits
Period April- May 2023

Short Course on Computer Graphics

Prof. Piercarlo Dondi, Prof. Luca Lombardi, Department of Electrical, Computer and Biomedical Engineering of the University of Pavia
Alessandro Gaggia -BeSharp and Vittorio Scalet -Neoesperience
This short course aims to give an overview of Computer Graphics (CG) and of its possible applications in both research and industry. The course will introduce the theoretical bases of CG and will provide some practical examples in OpenGL and Unity.
A basic knowledge of C/C++ and Python is required.
14 hours + final exam – 3,8 credits
Period January 2023

Introduction to photonic integrated circuits

Prof Marc Sorel – Scuola Superiore Sant'Anna and Glasgow University (Uk)

In a similar way to the evolution experienced by electronics, the demand for photonics devices with smaller footprint, lower cost and higher functionality has driven a rapid growth in the development of integrated photonic chips. The course will start by providing an overview on the main photonic integrated technologies, on their limitations and on the challenges to be addressed to sustain the current growth. We will then introduce a number of basic building blocks such as waveguide couplers, resonators, diffraction gratings, semiconductor sources and detectors, and show how these can be combined to form more complex circuits. Examples will include multiplexers for optical communications, optical combs for atomic clocks, mid infrared chips for pollution sensing and spatial mode sorters for advanced imaging. The course will conclude with a discussion on future trends that will cover the heterogeneous integration of hybrid materials for novel functionalities, bendable and foldable photonic chips and 3D integrated photonic circuits.

10 hours + final exams – 3 credits

Period March- April 2023

Condition monitoring and prognostics of railway infrastructure and rolling stock

Prof. Marco Carnevale - Department of Electrical, Computer and Biomedical Engineering of the University of Pavia

Condition monitoring of mechanical systems is the process of monitoring one or more parameters representative of the status of a component in industrial machinery and transportation vehicles (e.g. acceleration, temperature), in order to detect a significant change indicative of a developing fault.

The continuous monitoring of performance indices enables system diagnostics, allowing to detect a fault when it occurs, to isolate it and to identify its nature.

As a second step of analysis, the possibility to identify possible trends in the monitored indices permits to predict a fault before it occurs (prognostics). This can obviously have a positive impact on maintenance strategy, allowing optimisation of maintenance operations (condition-based maintenance) alongside or alternatively to regularly time-based programmed maintenance.

The course will cover the main topics and steps needed to guide the transition from scheduled maintenance to condition-based maintenance, with practical examples and applications related to railway systems:

- Sensor and Signal Chain Design: the measuring system must be non-intrusive, easy to maintain and affordable, giving robust signals that would then be processed.
- Real-time algorithms: acquired signals shall be processed to evaluate performance indices suitable for anomaly and event detection.
- Data storage and trend analysis: the amount of data to be transmitted and stored in a server for trend analysis shall be optimized for critical decision making.

Particular focus will be put on electrical infrastructure (e.g. overhead contact line), track and rolling stock components (e.g. pantographs and bogies). A special lesson on robotic applications for monitoring and inspection will be also given at the end of the course.

10 hours + final exam – 3 credits

Period October-November 2023