Ph.D. in Information Technology: Thesis Defense

December 17th, 2020

"Emilio Gatti" Conference Room and

online by Webex – at 10.00

Maziyar MILANIZADEH – XXXIII Cycle

"Design and Control recipes for complex photonic integrated circuits"

Advisor: Prof. **Andrea Melloni**

Abstract:

In this work, we present the key ingredients and the best practices for implementing simple, effective and robust control and calibration procedures for arbitrary Photonic Integrated Circuit (PIC) architectures. These procedures are introduced in different phases of PIC integration, from design and simulation to calibration and testing. Through design solutions and techniques we suggest effective approaches to guarantee the performance of the fabricated device in presence of fabrication imperfections and along the desired reconfiguration states. Tuning and calibration recipes like a technique to cancel out the effects of mutual crosstalk among thermal tuners, the exploitation of labeling to identify different optical signals, the use of input modulated signal to automatically reshape the frequency response of the device, offer robust control approaches for PIC. Examples of applications are then illustrated to show the validity and generality of these approaches, namely a cross-bar interconnect of Microring Resonator's (MRR), Mach-Zehnder Inteferometer (MZI) loaded with MRR as a tunable bandwidth filter, coupled MRR filter and MZI which are implemented in different technologies. Further, the automatic and dynamic generation of the lookup table on Dense Wavelength Division Multiplexing (DWDM) grid is demonstrated and applied to hitless tunable filters. The lookup table achieved with the proposed approach can dynamically update itself to new conditions of the chip or new requirements of operation, such as variations in channel modulation format or perturbation induced by neighboring devices due to a change in their working point. This work is concluded in two final chapters, mixing together all these receipts to design and control two complex family of PIC's and illustrate their performances through different applications. Re-configurable optical add/drop filter capable of Hitless tuning on C+L telecommunication band as the first device and integrated meshes capable of modification and manipulation of free space beams as the second PIC.

PhD Committee
Prof. **Francesco Morichetti**, DEIB
Prof. **Giampiero Contestabile,** Scuola Superiore Sant'Anna, Pisa
Prof. **Marc Sorel**, University of Glasgow