PhD Position: Machine Learning-Driven Optimization for Analog and RF Integrated Circuit Design (on-site)

We invite applications for a **funded PhD position** focused on the development of innovative methodologies for the **automatic sizing and optimization of analog and RF integrated circuits (ICs)**. This research addresses key challenges in modern mixed-signal design by leveraging machine learning and advanced optimization techniques to accelerate and enhance the design process.

Project Overview

This PhD project focuses on the development of an **integrated, flexible, and automated methodology for the sizing and optimization of analog and RF integrated circuits (ICs)**, leveraging cutting-edge machine learning and optimization techniques. The key objectives and innovations include:

- **Black-Box Optimization**:

  Development of advanced optimization strategies—such as **Bayesian Optimization** and **evolutionary algorithms**—to efficiently explore complex design spaces without relying on analytical models or gradient information.

- **Machine Learning Integration**:

  Incorporation of **Gaussian Processes** or **neural networks** to predict circuit performance, guide the optimization process, reduce simulation costs, and improve convergence speed.

- **Handling of Mixed Variables**:

  Development of innovative techniques based on **supervised encoder–decoder architectures** to effectively manage **discrete and categorical variables** in analog/RF design problems, enabling a unified optimization framework.

- **Multi-Objective Constrained Optimization**:

Formulation of optimization strategies that balance conflicting circuit performance goals—such as **power consumption, linearity, noise figure, and bandwidth**—while satisfying strict design constraints.

- **Full Automation**:

  Implementation of the methodology in a **fully automated software environment** integrated with industry-standard circuit simulation tools, aiming to significantly accelerate design cycles and enhance solution quality.

- **Next-Generation CAD Framework**:

  Delivery of a robust, scalable framework for **autonomous design and optimization** of analog and RF ICs, contributing to the future of **EDA (Electronic Design Automation)**.

This PhD project is a **continuation of successful previous work** done by the team e.g.:

- K. Touloupas, P.P. Sotiriadis, "**LoCoMOBO: A Local Constrained Multi-Objective Bayesian Optimization for Analog Circuit Sizing**", IEEE Trans. on Computer-Aided Design of Integrated Circuits and Systems, 2021.
- K. Touloupas, P.P. Sotiriadis, "**Mixed-Variable Bayesian Optimization for Analog Circuit Sizing through Device Representation Learning**", Electronics, 2022, DOI: 10.3390/electronics11193127.
- K. Touloupas and P. P. Sotiriadis, "**Mixed-Variable Bayesian Optimization for Analog Circuit Sizing using Variational Autoencoders**", 2022 18th International Conference on Synthesis, Modeling, Analysis and Simulation Methods and Applications to Circuit Design (SMACD), 2022, pp. 1-4.
- K. Touloupas, N. Chouridis, P. P. Sotiriadis, "**Local Bayesian Optimization For Analog Circuit Sizing**," 2021 58th ACM/IEEE Design Automation Conference (DAC), 2021.

- K. Touloupas, P.P. Sotiriadis, "**An Optimization-Based Approach for Analog Circuit Technology Migration**," 2021 6th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM), 2021.
- K. Touloupas, P.P. Sotiriadis, "**Analog and RF Circuit Constrained Optimization Using Multi-Objective Evolutionary Algorithms**," 2021 IEEE 12th Latin America Symposium on Circuits and System (LASCAS), 2021.
- M-E. Plagaki, K. Touloupas, P.P. Sotiriadis, "**Multi-Objective Optimization Methods for CMOS LC-VCO Design**", IEEE International Conference on Modern Circuits and Systems Technologies, Thessaloniki, Greece, 2021.

The PhD student will benefit from working under **constant guidance from a team of experienced postdoctoral researchers** in the field.

Your Profile

We are looking for highly motivated candidates who:

- Hold a Master's degree in Electrical Engineering, Computer Engineering, or a related field, with excellent academic results.
- Have a strong interest in **analog/RF integrated circuit design** and **machine learning-driven optimization**.
- Possess knowledge or are eager to learn about:
    - **Analog/RF circuit design and performance metrics**.
    - **Optimization algorithms** (Bayesian Optimization, evolutionary algorithms).
    - **Machine learning** models such as Gaussian Processes, neural networks, and encoder–decoder architectures.

- Are familiar with or willing to work with:
    - Industry-standard circuit simulation tools (e.g., **Cadence Virtuoso**).
    - Scripting and programming in **Python and/or MATLAB**.
- Are curious, creative, and capable of independent research.
- Have excellent communication and teamwork skills.
- Are fluent in English (written and spoken).

Key Responsibilities (Job Description)

As part of this PhD project, your tasks will include:

- Developing and applying **black-box optimization algorithms** for analog/RF circuit sizing.
- Integrating **machine learning models** into the optimization framework for performance prediction.
- Designing strategies for **handling discrete and categorical design variables** within mixed-variable optimization problems.
- Implementing a **multi-objective constrained optimization approach** balancing key performance metrics.
- Developing a **fully automated software environment** for circuit optimization.
- Validating the methodology on real-world analog and RF circuit design problems.
- Publishing your findings in top-tier conferences and journals.

What You Will Gain (Learning Outcomes)

By the end of the PhD, you will have gained:

- Deep expertise in **automatic circuit sizing and optimization methodologies**.
- Advanced knowledge of **machine learning applications in circuit design**.
- Practical experience with **analog/RF IC design flows and simulation tools**.
- Strong programming and algorithm development skills.
- A solid academic and technical foundation for careers in **EDA (Electronic Design Automation)**, **semiconductor industry**, or **academic research**.

We offer an inspiring research environment, strong mentorship, access to state-of-the-art design tools, and opportunities for international collaboration.

If you are passionate about creating the future of **autonomous analog and RF IC design**, **we encourage you to apply!**

Application: Interested candidates are encouraged to apply through NTUA's official PhD program channels. For inquiries or more information about the project scope and supervision, please contact:

Professor Paul Sotiriadis at **pps@ieee.org**

Dr. Vassilis Alimisis at **alimisisv@mail.ntua.gr**