**Tutorial Title:**
Machine Learning for Design Automation of Microfluidic Biochips: Current Status and Scope

**Abstract:**
Recent advances in microfluidics technology have generated tremendous interest in the design and implementation of miniaturized devices for biochemical analysis. These composite microsystems are referred to interchangeably in the literature as microfluidic biochips, lab-on-a-chip, and bioMEMS. They can automate highly repetitive laboratory tasks by replacing cumbersome equipment with miniaturized and integrated systems, and they can enable the handling of small amounts (e.g., nanoliters) of fluids on a small chip. This has made a number of formerly difficult tasks of traditional pathological testing for medical diagnosis and POC (Point-Of-Care) testing for clinical diagnosis easier and more affordable. Mainly three kinds of microfluidic biochips architectures are very popular in the literature continuous flow microfluidic biochips (CMFB), digital microfluidic biochip (DMFB) and random microfluidics (RMF). Moreover, there is an advanced version of CMFB, which is called programmable microfluidic device (PMD) and an advance version of DMFB called as microelectrode dot array (MEDA). **In the first part of this tutorial**, we will explain the working principles and unique design automation challenges of high-level and geometric-level synthesis for different types of microfluidics biochips DMFBs (Digital Microfluidic Biochips), CMFBs (Flow-based Microfluidic Biochips), MEDAs (Micro-Electrode-Dot-Arrays), PMDs (Programmable Microfluidic Devices) and RMFs (Random Microfluidic Biochips). **In the second part of the tutorial**, we will present the machine learning (ML) and reinforcement learning (RL) based techniques for solving design automation problems in low-level synthesis of MEDA biochips that includes the methodologies for placement of on-chip fluidic modules and routing of fluids. **In last part of the tutorial**, we will discuss the modelling and simulation of RMF chips using COMSOL Multiphysics Software. Furthermore, we will discuss the design automation problems of RMF biochips and application of ML based techniques in solving those problems. Finally, we will conclude this tutorial with the discussions on future scopes of application of ML and RL based techniques for design automation of microfluidic biochips.

**Brief Bio of the Speaker:**

**Sudip Roy** is currently an associate professor in the department of computer science and engineering, (Indian Institute of Technology (IIT) Roorkee, India after joining in July 2014. He received the B.Sc. degree (honors) in physics and the B.Tech. degree in computer science and engineering from the University of Calcutta, India, in 2001 and 2004, respectively, and the MS (by research) and Ph.D. degrees in computer science and engineering from the IIT Kharagpur, India, in 2009 and 2014, respectively. He has authored one book, one book chapter, two granted U.S. patents and one grated Indian patent including 31 research articles in international peer-reviewed journals and 51 papers in international peer-reviewed conference proceedings. He is a recipient of the Japan Society for the Promotion of Science (JSPS) Invitational Fellowship in the "Long-Term" category in 2021, the Early-Career Research (ECR) Award from Department of Science and Technology (DST), Govt. of India in 2017, and Microsoft Research India PhD Fellowship Award in 2010. He is a member of IEEE and ACM. His current research interests include computer-aided-design for digital systems, optimization techniques, application of machine learning and artificial intelligence.