

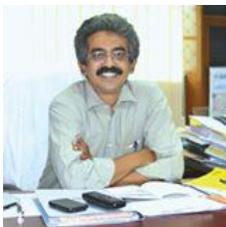
## Cyber Physical Systems: Essential Concepts for Control

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Understanding of issues related to Cyber Physical Systems (CPS) is essential for design, implementation and validation of real-world control systems. However, although subjects such as Embedded Systems and Digital Control are commonly found in university curricula in India, CPS is conspicuous by absence. This is the motivation for offering the tutorial.

The exposition to CPS concepts shall be offered in three modules. Control Engineers are used to designing systems based on models – models for physical systems and models for controllers. These are integrated at a very high level of abstraction and do not capture essential technological features of hardware and software of sensors, actuators, and controllers. Neither do these capture the architectural issues of control systems. In the first module therefore, concepts of modelling shall be discussed first. Essential concepts from hybrid automata theory such as the concepts of hierarchy, concurrency, composition and time for modelling of complex CPS with mixed continuous variable and discrete event dynamics shall be discussed. In the second module, concepts useful for model-based specification and verification for complex CPS such as issues related to timing, reachability, stability, observability etc. shall be introduced along with techniques for simulation, verification, analysis. In the third module issues related to realization shall be taken up. Issues related to distributed asynchronous sensing and actuation, networked control, real-time operating systems, arithmetic, distributed computing etc. shall be addressed. System performance, failures and correctness issues along with its test and validation processes from MIL up to HIL and field testing shall also be discussed.

Practical examples from various engineering sectors such as aerospace, automotive, railways, power system etc. shall be used. Care shall be taken so that one trained in traditional disciplines of control, instrumentation, signal processing or computer science is able to appreciate and benefit from the presentation. Tools to be used shall also be mentioned.



**Bio sketch of the Speaker:** Professor Siddhartha Mukhopadhyay has obtained his B. Tech, M. Tech and Ph. D., all from IIT Kharagpur in 1985, 1987 and 1991 respectively. In 1990 he joined the Electrical Engineering Department of IIT Kharagpur and is currently a Professor. His research interests are in Control, Estimation and Fault Diagnosis of Continuous Variable and Discrete Event Systems. He has co-authored about 200 research papers, two books and two video courses and Co-supervised about 12 students for Ph. D. and 10 students for M.S. (by Research). Apart from leading several funded research projects, he has about 20 years' experience of collaborating with organisations like National Semiconductors, Texas Instruments, General Motors, Indian Railways, SAIL, DRDO, and several others in domains such Rail, Aerospace and Automotive Systems, Power Systems, Process Systems and Mixed Signal Electronics.