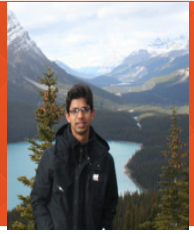

VLSI INTERCONNECTS

PROF. SARANG PENDHARKER
Department of Electronics & Electrical Communication Engineering
IIT Kharagpur

PRE-REQUISITES : U.G. level course in electromagnetics or micorwave engineering or EM Waves.

INTENDED AUDIENCE : Senior UG, P.G., Ph.D in Dept. of ECE, EE.

INDUSTRY SUPPORT : Signal integrity profile and Interconnect profile in leading electronics and semiconductor industries.

COURSE OUTLINE :

Interconnects are the wired connections between various devices and components in an integrated circuit. As the clock frequency and operating frequency of the electronic devices is increasing, going up to several GHz, the effects of these wired connection cannot be ignored anymore. In fact, the interconnect effects which include delays, timing jitters and cross-talk are expected to become bottleneck in further increase in the speed of electronic circuits. In this course we will investigate origin of several interconnect effects and explore techniques for electromagnetic and circuit modeling of these interconnect effects. The course is of importance for anyone interested in the high frequency circuit design and signal integrity issues in electronics and telecommunication industries.

ABOUT INSTRUCTOR :

Prof. Sarang Pendharker received his M.Tech+Ph.D. Dual Degree from the Indian Institute of Technology Bombay, India, in Dec. 2014. He has three years of postdoctoral research experience at University of Alberta, Canada. Currently he is an Assistant Professor in the Dept. of Electronics & Electrical Communication Engineering, at Indian Institute of Technology Kharagpur. His research specialization is in the area of microwaves, photonics and electromagnetic wave theory. His current research interests are in innovating next generation of microwave/mmWave devices based on new optical physics phenomena, and in the integration of photonic and microwave technologies.

COURSE PLAN :

Week 1: Introduction to VLSI Interconnects. Distributed RC interconnect model, Elmore delay, Elmore delay in interconnects, Elmore delay in RC tree and branched interconnects

Week 2: Equivalent circuit of RC interconnect, Scaling Effects, Delay mitigation in RC interconnects, RC interconnect simulation session, Inductive effects in interconnects

Week 3: Distributed RLC Interconnect model (Frequency domain analysis), Transmission line equations. When to consider the inductive effects?, The transfer function of an interconnect, Time-domain response of a lumped model RLC circuit

Week 4: Equivalent Elmore model for RLC interconnects (Distributed model), Two-pole model of RLC interconnects from ABCD parameters.Simulation of RLC interconnects.Origin of the skin effect, Effective resistance at high frequencies

Week 5: Equivalent circuit to simulate skin effect, Power dissipation due to interconnects, Optimum interconnect width for minimizing total power dissipation. Heating effects and thermal modelling, Compact Thermal modeling with equivalent electrical circuit.

Week 6: Electromigration in interconnects, Mitigation of electromigration. Capacitive coupling in interconnects. Cross-talk and timing jitters in two identical interconnects. Effects of cross-talk and timing jitters.

Week 7: Techniques for mitigation of cross-talk. :23-erutceL Matrix formulation of coupled interconnects. Coupled RLC interconnects, Decoupling of interconnects by diagonalization of matrix , Analysis of coupled interconnects: Examples

Week 8: Analysis of coupled interconnects: Examples-2, Simulation of RC coupled interconnects, Extraction of capacitance (part-1), Extraction of capacitance (part-2), Extraction of inductance (part-1), Estimation of interconnect parameters from S parameters.