

# VLSI ReVisited: from Analog to Digital

7-June-2021 to 9-July-2021

## EXECUTIVE SUMMARY

IIIT Delhi and IEEE CASS-CSS Delhi Chapter present 5-weeks Online Summer School on VLSI for Employability Enhancement for Faculty, recent graduates working in industry, and graduating students. Facilitated by stellar faculty with decades of teaching and industry work experience, this program includes 150 contact hours including theory and lab sessions. The program was highly acclaimed in the previous run as a perfect launchpad for a successful career in VLSI Circuits and System Design.

## Jointly Organized by

IIIT Delhi and IEEE Circuits and Systems Society-Control Systems Society (IEEE CASS-CSS), Delhi chapter



## About IIIT Delhi

Indraprastha Institute of Information Technology, Delhi (IIIT-Delhi or IIIT-D) was created as a State University by an act of Delhi Government (The IIIT Delhi Act, 2007) empowering it to do research and development, and grant degrees. Established in 2008, the institute has grown to be recognized as one of the most promising young institutions for education and research in India.

In a relatively short time, it has earned an excellent reputation in India and abroad for being a center of quality education and research in IT and interdisciplinary areas. It has highly qualified faculty that pursues bleeding edge collaborative research and publishes in the top venues worldwide.

Consequently, IIIT Delhi has risen up the ranks across multiple evaluation agencies. In 2020, it was ranked 6<sup>th</sup> by Dataquest, 8<sup>th</sup> by The Week, 13<sup>th</sup> by India Today, 43<sup>rd</sup> by QS India University Rankings, 56<sup>th</sup> by NIRF. It has been awarded the highest (4 Star) rating by GRIHA for its sustainable infrastructure and practices.

## About IEEE, CAS Society, and CS Society

IEEE is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity. Its highly cited publications, conferences, technology standards, and professional and educational activities. IEEE is the trusted "voice" for engineering, computing, and technology information around the globe.

The IEEE Circuits and Systems (CAS) Society is the leading organization that promotes the advancement of the theory, analysis, computer-aided design and practical implementation of circuits, and the application of circuit theoretic techniques to systems and signal processing.

The Control Systems (CS) Society is dedicated to the advancement of the theory and practice of systems and control with focus on promoting scientific, technological, and educational advancements in the fields of automatic control, decision making, theory and applications, all over the world.

## About Faculty of the Program



**Dr. Anuj Grover** pursued B.Tech in Electrical Engineering from IIT Delhi, MS in Electronic Circuits and Systems from University of California, San Diego, USA, and PhD in Electrical Engineering from IIT Delhi. He presently teaches at IIIT Delhi as an Associate Professor. Before joining IIIT Delhi Dr. Grover worked with STMicroelectronics for over 18 years and has led large teams on multi-million dollar projects. His research interests include Memory Design, Digital Circuits and System Design, Safety and Security in hardware, and inventive problem solving methods.

**Prof. Sudhanshu S. Jamuar** pursued PhD degree from IIT Kanpur (1977). He is presently Visiting Professor at IIIT Delhi. In his more than 45 years long teaching career, he has also taught at other prestigious institutes like IIT Delhi, IIT Dhanbad, and Universiti Malaya (UM), Universiti Putra Malaysia (UPM) and Universiti Malaysia Perlis (UNIMAP) in Malaysia. Prof. Jamuar's research interests include Analog and Digital circuits design, Instrumentation systems and Communication systems.



**Dr. Rakesh Kumar Palani** received his BE degree from NIT Kurukshetra, MSc from IISc Bangalore, and PhD degree from University of Minnesota, MN (2015). He is presently Assistant Professor at IIT Delhi. Before joining IIT Delhi, he has worked with Broadcom and Maxlinear, in the USA. He has also interned with Qualcomm and Broadcom during his PhD. His research interests include Analog/ RF circuits, RF Transmitters, ADC/ DACs.

**Prof. G.S. Visweswaran** pursued PhD degree from IIT Kanpur (1980) and has more than 40 years of teaching experience. He is presently Visiting Professor at IIIT Delhi. Before joining IIITD, he was a Professor in Electrical Engineering department at IIT Delhi. Prof. Visweswaran's research interests include design of Analog, Mixed Signal, and Digital circuits and CAD for VLSI.

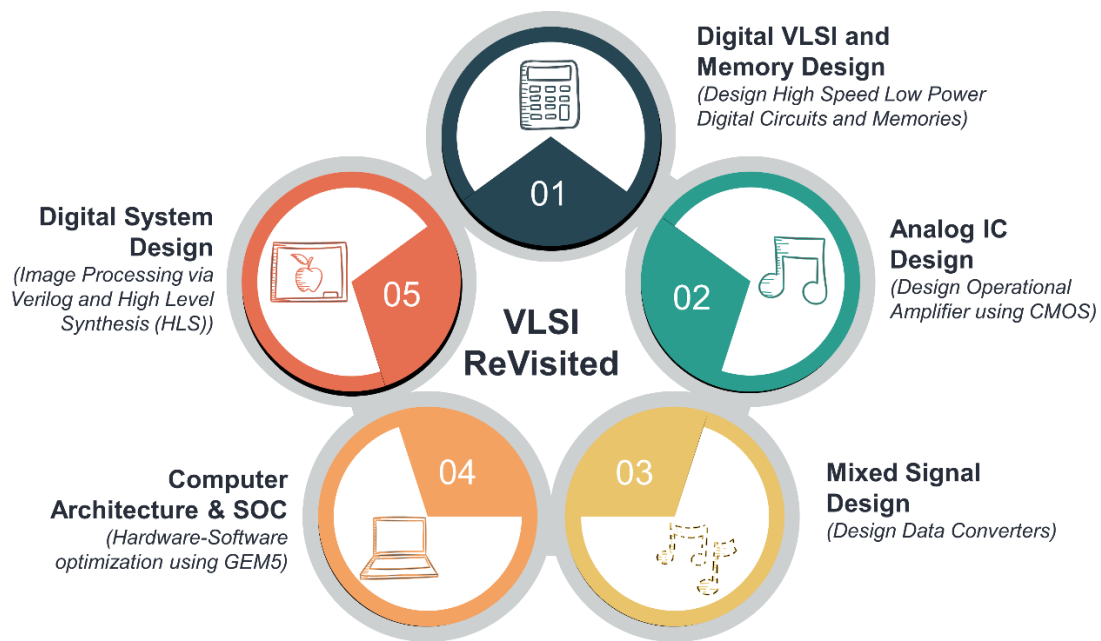


**Dr. Sujay Deb** received PhD from the School of Electrical Engineering and Computer Science, Washington State University, Pullman, WA (2012). He is an Associate Professor at IIITD. Earlier, he has also worked as an intern at Intel Labs, Hillsboro. His research Interests are broadly in the areas of power and performance efficient and reliable Network-on-Chip (NoC) communication fabrics, Heterogeneous System Architectures (HSA), hardware for deep learning, low cost bio-sensors for preventive healthcare.

**Dr. Sumit J. Darak** received his BE degree in Electronics and Telecommunications Engineering from Pune University and PhD degree from Nanyang Technological University (NTU), Singapore in 2013. He is an Associate Professor at IIITD. Earlier, he has worked at TCS. He pursued postdoctoral research at Université Européenne de Bretagne and Supélec, France. He works on design and implementation of multistandard wireless communication receivers as well as application of machine learning algorithms and decision making policies for various wireless communication applications.



## Workshop Contents



The 5-week online program will cover the following topics

Week	Subject	Content	Tools/ Languages Used in Labs
Week-1	Digital VLSI and Memory Design (Dr. Anuj Grover)	<ul style="list-style-type: none"> <li>• Introduction to VLSI Technology</li> <li>• Logic Design Styles – PTL, Static and Dynamic</li> <li>• Logical Effort</li> <li>• Sequential Circuits</li> <li>• Memory Cell and Periphery Circuits</li> </ul>	<ul style="list-style-type: none"> <li>• Electric/ Virtuosio</li> <li>• LTSpice/ Eldo</li> </ul>
Week-2	Analog IC Design (Prof. S. S. Jamuar)	<ul style="list-style-type: none"> <li>• Basics of MOS Transistors</li> <li>• Basic Amplifier and Frequency Response</li> <li>• Current Mirrors</li> <li>• Differential Amplifiers</li> <li>• Operational Amplifiers</li> </ul>	<ul style="list-style-type: none"> <li>• Electric/ Virtuosio</li> <li>• LTSpice/ Spectre</li> </ul>
Week-3	Mixed Signal Design (Prof. G. S. Visweswaran)	<ul style="list-style-type: none"> <li>• Characteristics and Testing of Data Converters</li> <li>• Nyquist Rate Data Converters</li> <li>• Design of S/H and Comparator Circuits.</li> <li>• Sigma Delta ADC and DAC</li> </ul>	<ul style="list-style-type: none"> <li>• Electric/ Virtuosio</li> <li>• LTSpice/ Spectre</li> </ul>
Week-4	Computer Architecture & SoC (Dr. Sujay Deb)	<ul style="list-style-type: none"> <li>• Introduction to Computer Architecture</li> <li>• In-depth study of pipelining and hazards</li> <li>• Superscalar architectures</li> <li>• Processor Memory sub-system</li> <li>• Multi-core SoCs and Research Directions</li> </ul>	<ul style="list-style-type: none"> <li>• Gem5</li> </ul>
Week-5	Digital System Design (Dr. Sumit J. Darak)	<ul style="list-style-type: none"> <li>• Finite State Machine</li> <li>• AXI Protocol</li> <li>• Image Processing (Image Filtering)</li> <li>• High Level Synthesis (HLS)</li> <li>• Image Processing via HLS</li> </ul>	<ul style="list-style-type: none"> <li>• C++ to Verilog via HLS</li> </ul>

## Key Outcomes of the Workshop

The workshop envisages to give knowledge, tools, and methods to the participants for them to

- choose design styles and design circuits to meet Power-Performance-Area (PPA) specifications
- design an operational amplifier to meet design specifications
- design a Sigma-Delta ADC
- evaluate hardware and software co-design techniques using Gem5 software
- do complete end-to-end image processing from C++ to Verilog to High Level Synthesis

## Methodology

### Daily

- 3-hr live lectures.
- 3-hr lab sessions.
- Short take-home quiz to reinforce the most important concepts taught in the day

### Additionally

- Assignments to supplement lectures with hands-on experiments on EDA tools
- Weekly summative quiz to assess learning
- Regular collection of feedback to continuously improve sessions



### Complimentary\*

- Quick training module on these industry standard tools like Eldo, Virtuoso, Spectre.

*\* when tool licenses are available at your college (SMDP program)/ place of work (industry)*

## Who should Attend

This summer school will add significant value to:

- Faculty wishing to get exposed to VLSI EDA tool-set and modern online pedagogy
- Research scholars starting off with research in VLSI
- Industry professionals intending to refresh basic concepts to broaden their scope of contribution
- Recent graduates joining as a Circuit (and/or) System designers in a VLSI organization
- Final year B.Tech/ M.Tech students looking for making a career in VLSI either in industry or academia
- M.Tech students intending to get exposure to and choose career path in VLSI
- Pre-final year B.Tech students toying with the idea of VLSI as a career option

## Why you should Attend

- To refresh concepts in VLSI Circuits and System Design from some of the best faculty in the country
- To get a certification from IIIT Delhi and IEEE CASS-CSS Delhi Chapter
- To get hands-on practical experience alongside theoretical knowledge
- To prepare yourself for a flourishing career in VLSI Circuits and System design

## Registration Rates\*

		Indian Students	Indian Faculty/ International Students	Partner Industry Participant	Regular Industry Participant/ Other International Participants
Full program*	IEEE Member	4000	6000	12000	16000
	Others^	5000	7500	15000	20000
Per Week* (in INR)	IEEE Member	1600	2400	4800	6400
	Others^	2000	3000	6000	8000

^ Additional 10% discount on group registrations of 4 or more

\* GST @ 18% extra

## Resources Required

Since this is an online workshop, the participants will instead be required to arrange the following during the sessions:

- A laptop (mandatory) with
  - Online Meeting Software - Zoom Meetings/ Google Meet
  - Microphone, Speakers, and camera
- Ensure that you have access to the following toolset
  - Schematic and Layout entry tools – Virtuoso, Custom Compiler
    - Use Openware tool – Electric if no access to the above tools
  - Simulators – Eldo, Spectre, HSPICE, NGSpice, or LTSpice
    - Use Openware tools – NGSpice or LTSpice if no access to Eldo, Spectre, HSPICE
  - Gem5
    - If your institution doesn't offer access to Gem5, IIITD lab access will be enabled for such participants
  - Vivado
- Space with 'no' disturbance when sessions are in progress
- Self-discipline and enthusiasm to learn

## Supplementary / Reference Material for further reading

- Lecture recordings will be available for 1 month after the program
- Students can refer to the following books/ online resources for additional information
  - Week-1: **CMOS VLSI Design: A Circuits and Systems Perspective**, *edition 4*: David Harris and Neil Weste
  - Week-2: **CMOS Analog Circuit Design**, *edition 2*: Philip E Allan and Douglas Holberg
  - Week-3: **Analog Integrated Circuit Design**, *edition 2*: Kenneth Martin, Chan Carusone and David Johns
  - Week-4: **Computer Architecture: A Quantitative Approach**, *edition 5*: John L Hennessy and David A Patterson
  - Week-5: **FPGA Prototyping by Verilog Examples**: Pong P. Chu and **Parallel Programming for FPGAs**: Ryan Kastner, Janarbek Matai, Stephen Neuendorffer

## Testimonials from earlier workshop



**Rufyida Nissa,**  
**M.Tech'19, JMI**

The sessions were thorough and were given hands-on experience on Eagle, LTSpice, NGSpice, Verilog, and Gem5 simulator



**Shubham Roy,**  
**B.Tech'21, MAIT Delhi**

I can finally feel what goes on in the industry level which u never experienced before as it was always theoretical knowledge



**Deepak Joshi,**  
**B.Tech'21, BPIT Delhi**

This course was just one of its kind. I never had any online class before, which delivered this much value to me.



**Khushbu Pawha,**  
**B.Tech'20, DTU**

Thanks a lot for this immersive program. Extremely grateful!!



**Yash Raj,**  
**B.Tech'21, IIT Dhanbad**

There was no compromise on the depth of content. We explored "how? And why?" at each point.



**Nishtha Mahajan,**  
**B.Tech'22, IGDTUW**

Thank you for the tremendous experience and fruitful sessions.

## More People Speak

- "Teachers also gave suggestions on how to build a good career, dos, and don'ts. Without exaggeration, I would say I had a great and enlightening experience."
- "I never thought that online classes can be made this much interesting, interactive, and useful."
- "For me, it's far better than my whole BTech till now."
- "course was really beneficial for me to get right with concepts and provided me with roadmap for further studies"
- "The best part of all the lectures was the student-teacher interaction."
- "All the Prof and Instructor were highly helpful and with sound knowledge. Very grateful."
- "The topics followed a natural progression which helped us to relate the concepts"
- "the instructor really took time to make us understand even the basics if he thought that we didn't know it that well"

## Contact Details

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