Dimple Kochar

CONTACT INFORMATION

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EDUCATION

Massachusetts Institute of Technology — *September, 2021 – Present*

PhD student, Department of Electrical Engineering & Computer Science
Advisor: Prof. Anantha Chandrakasan — MIT Energy-Efficient Circuits and Systems
GPA: 5.0 / 5.0

Indian Institute of Technology Bombay — *July, 2016 – August, 2021*

Bachelor & Master of Technology, Department of Electrical Engineering
Specialization: Microelectronics & VLSI
Minor Degree, Department of Computer Science & Engineering
GPA: 9.34 / 10.0
Awarded the *'Sharad Maloo Memorial Gold Medal'* for being the most outstanding student in terms of extra-curricular activities along with academic performance, among all recipients of B.Tech/DD (B.Tech+M.Tech) degree (1 in 999) at the 59th Convocation of IIT Bombay

PUBLICATIONS

- **D. Kochar**, T. Samadder, S. Mukhopadhyay and S. Mahapatra, "Modeling of HKMG Stack Process Impact on Gate Leakage, SILC and PBTI," *2021 IEEE International Reliability Physics Symposium (IRPS)*, 2021, pp. 1-7, doi: 10.1109/IRPS46558.2021.9405154. [paper]
- **D. Kochar** and A. Kumar, "Estimation of Time to Failure Distribution in SRAM Due to Trapped Oxide Charges," *2021 IEEE International Symposium on Circuits and Systems (ISCAS)*, 2021, pp. 1-5, doi: 10.1109/ISCAS51556.2021.9401180. [paper]
- T. Samadder, N. Choudhury, S. Kumar, **D. Kochar**, N. Parihar and S. Mahapatra, "A Physical Model for Bulk Gate Insulator Trap Generation During Bias-Temperature Stress in Differently Processed p-Channel FETs," in *IEEE Transactions on Electron Devices*, vol. 68, no. 2, pp. 485-490, Feb. 2021, doi: 10.1109/TED.2020.3045960. [paper]

RESEARCH PROJECTS

Low Power, Low Memory, General Purpose Accelerator for TinyML — *MIT*
Advisor: Prof. Anantha Chandrakasan, EECS Department — *Dec '21 - Present*

Introduction: The growth in low-power, small area, embedded devices and advancement in the optimization of ML algorithms has resulted in tiny machine learning (TinyML), which calls for implementing the ML algorithm within the IoT device. TinyML is implemented through efficient hardware-software co-design. In this project, the aim is to design an accelerator which is optimized for area (low memory) and power while supporting a multitude of applications like voice activation, ECG, keyword spotting, visual wake word, pupil detection, time series, accelerometer, etc.

- Designing an initial patch-by-patch computation flow, based on the architecture of MCUNetV2
- Targeting total memory of 20kB (excluding input and output), with weight storage on chip
- Motivated by the idea of an energy harvesting chip, have quantization as a function of energy

HKMG Stack Process Impact on Gate Leakage, SILC & PBTI [slides] — *IIT Bombay*
Advisor: Prof. Souvik Mahapatra, Electrical Engineering Department — *Dec '18 - Oct '20*

Introduction: The primary impediment to channel length scaling is gate leakage. PBTI and SILC also get worse at scaled EOT. Recently, RD and RDD models are used for NBTI interface and bulk trap generation in PMOS. This project aims to model direct tunneling leakage, SILC & PBTI along with the traps generated in NMOS withdeeply scaled (down to EOT$\sim$7Å) HKMG stacks.

- Quantified impact of IL & HK thickness, channel/IL & IL/HK barriers on gate leakage & SILC

- Extracted bulk trap densities from SILC measurements of differently processed NMOS using a WKB tunneling model & used a Reaction-Diffusion-Drift (RDD) framework to model them
- Modelled the traps generated from PBTI stress using the double interface H/H_2 RD framework
- Analysed impact of gate stack process (pre-clean, IL, IL/HK interface, HK & post-HK nitridation) on gate leakage, SILC and PBTI trap generation (using DCIV) at IL/HK interface

Method for Time To Failure Estimation of SRAM due to RTN [slides] *IIT Bombay*
Advisor: Prof. Animesh Kumar, Electrical Engineering Department *Dec '18 - Nov '20*
Introduction: Trapping and detrapping of charges in the oxide interface of a MOSFET leads to a random telegraphic noise (RTN) injection & this phenomenon negatively affects the reliability of circuits. The objective of this project is to develop a reproducible strategy to obtain time to failure (TTF) distribution & related statistics for SRAM of any technology with any given RTN model.

- Proposed a method to estimate TTF distribution of a stored bit in an SRAM cell due to single or multi-level RTN by composition of Monte-Carlo simulations & circuit-level abstraction
- Showcased results of this procedure on an SRAM cell made from 45 nm technology with a single-trap RTN model at various supply voltages using Cadence, Ocean and Python scripting
- Indicated via circuit-level simulations that the TTF distribution worsens due to process variations

Dipole-Exchange Spin Waves in Thin Ferromagnetic Films [slides] *TU Delft*
Advisors: Prof. Gerrit Bauer, Kavli Institute of Nanoscience *May '19 - Jul '19*
Prof. Yaroslav Blanter, Kavli Institute of Nanoscience
Introduction: Dispersion characteristics of spin waves in ferromagnetic films taking into account both the dipole-dipole and the exchange interactions are obtained by a sixth-order differential equation. The objective of this project is to solve it considering pinned and unpinned boundary conditions & study their variation with thickness in this transition region.

- Calculated the wave function, magnetization & dipolar field profiles for various modes of spin waves by solving Landau–Lifshitz & Maxwells' equations & appropriate boundary conditions
- Showed how chirality changes with thickness; obtained the dispersion relation (ω vs $\vec{k}$) for a film
- Obtained isofrequency curves & showed their change with increase in magnetic field in $\vec{k}$ space

Model for Time Dependent Dielectric Breakdown for Ultrathin Oxides *IIT Bombay*
Advisor: Prof. Souvik Mahapatra, Electrical Engineering Department *May '18 - Jun '21*
Introduction: Time-dependent dielectric breakdown (TDDB) is characterized by its Weibull slope. In this project, the change in the slope is explained by a percolation model with different defect generation rates in the bulk & channel/oxide and gate/oxide interfaces, also considering SILC slope changes with thickness & trap size. The model is then extended for high-k with interfacial SiO_2.

- Designed a cell based oxide percolation model which stochastically creates bulk & interface traps
- Procured time to failure distribution & analysed the relation of its Weibull slope with oxide thickness & obtained results obeying experimental data varying with voltage & temperature
- Proposed and demonstrated a hypothesis for differences in bulk trap & SILC slopes

Scholastic Achievements

- Conferred the 'Grass Instrument Company Fellowship' to support first year at MIT
- Bestowed the 'Desai-Sethi Scholarship' awarded to the top 5 girls admitted to IIT Bombay
- Achieved All India Rank 102 in JEE Main and All India Rank 295 in JEE Advanced out of 1.2 & 0.2 million candidates respectively; stood first in both in the state of Maharashtra among girls
- Awarded the 'Travel Grants for UG students by C'1992 and C'1998' for IEEE ISCAS 2021
- Selected for Indian National Chemistry Olympiad (InChO) from among 40K students

Technical Projects

Ring Oscillator Characterization across Stages and Transistor Size *Digital Circuits*

- Taped out in 14nm FinFET Samsung technology, ring oscillators of different stages and transistor sizes, each with its own power line for accurate power management and frequency

Sub-100nm Gate GaN HEMT transistor fabrication *Device Fabrication*

- Fabricated a HEMT on GaN-on-Si with an $I_{ON} = 1.3$A/mm and $R_{ON} = 1.54$ at MIT.nano

Physically Unclonable Function (PUF) Circuit Design *Circuits*

- Implemented latch-based and ring oscillator PUFs in TSMC 65nm technology

Low Power FC-CS CMOS Operational Amplifier *Analog Circuits*

- Designed an FC-CS CMOS opamp in 22nm bsim4 with power < 1.5mW, settling times < 8ns, open loop gain > 10k, thermal noise < 300uV, phase margin $> 65^o$ at gain-of-2 frequency

Power Amplifier Design for function at 520 MHz *Solid State Microwave Devices*

- Constructed matching networks for the given amplifier IC AFIC901N with appropriate bias tees at source and load, using microstrip transmission lines and fabricated it on FR4 substrate
- Tested the circuit to obtain a gain of 2.5 dB at 520 MHz with S_{11} & S_{12} values -18 dB & -35 dB

Broadband 4 $\times$ 4 Butler Matrix Circuit *Microwave Integrated Circuits*

- Constructed the circuit with 90° hybrids & phase delay lines using microstrip transmission lines to equally divide power at output ports of every input port at an operation frequency of 5.4 GHz
- Fabricated on FR4 substrate & tested it to obtain equal power division and input port isolation

Layout and Back-extraction of 16 bit Brent Kung Adder *VLSI Design*

- Started from the schematic & layout of basic CMOS logic gates to build increasingly complex modules; combined them accordingly to obtain the layout of 16 bit Brent Kung adder in Cadence
- Passed the DRC & LVS, and did Parasitic Extraction of each module of adder & the final adder; conducted post layout simulation tests and successfully obtained accurate adder functionality

Pipelined RISC Microprocessor *Microprocessors*

- Devised IITB-RISC, an 8-register, 16-bit system with standard 6 stage pipelines capable of executing 15 instructions and equipped it with control flow, data forwarding & hazard mitigation
- Programmed the design in VHDL, synthesized in Altera Quartus & tested it on DE0-Nano FPGA

Dot-Product Accelerator & Processor in Aa *Algorithmic Digital System Design*

- Implemented an accelerator for parallel dot product of a data matrix with a kernel matrix in Algorithm Assembly (Aa), a description language developed by the guide, Prof. Madhav Desai
- Coded and verified a processor with given ISA in Aa, converted it to VHDL using AHIR tools, and tested it on a Basys-3 FPGA using Xilinx Vivado and communicated with it using UART

Magnon Spin Transport in Permalloy *Modelling & Simulation*

- Modelled the spin transport & spin leakage using spin resistors, the spin accumulation using a spin capacitor, and then constructed a tractable circuit diagram, using GCR for steady state

Monitor Honking Rate to reduce Noise Pollution *Electronic Design*

- Built a device to count a specific vehicle's honks by an amplitude-frequency threshold circuit amid all the traffic noise; transmitted this data to a server wirelessly using ESP8266 WiFi module
- Provided for detection if the vehicle's owner tampered with the device to hide his honk count

Music Genre Identification *Machine Learning*

- Perused literature to find that the timbre feature corresponding to the loudest parts of the song gives better clustering of audio samples & used Principal Component Analysis (PCA) to show it
- Achieved an accuracy of 56% and an F1 score of 50.65% using the Random Forest algorithm

Touchless Gesture Recognition using Sensors *Analog Circuits*

- Designed and implemented an audio volume controller, motion tracker (using LED matrix) & a pattern lock by gesture detection using infrared emitters & sensors and CPLD for digital logic
- Part of a 2 membered team that was awarded the **best project** from among 70+ projects

Multicycle Processor *Microprocessors*

- Implemented a 16-bit computer system with 15 instruction ISA in VHDL and optimized the architecture for performance using point-to-point communication infrastructure

Heart Rate Variability Analysis *Digital Signal Processing*

- Processed the ECG signal & extracted the PSD to predict the risk of myocardial infarction
- Stood among the **top 5** teams in the Make in India presentation organised for TEQIP-III

Relevant Courses

MIT: CMOS Analog and Circuit Design; Analysis and Design: Digital Circuit; TinyML and Efficient Deep Learning Computing; Computer System Architecture; Applied Quantum and Statistical Physics; Introduction to Modeling and Simulation

IITB: Foundation of VLSI CAD; VLSI Design; Algorithmic Design of Digital Systems; Microprocessors; Microwave Integrated Circuits; Solid State Microwave Devices & their Applications; Physics of Transistors; VLSI Technology; Solar Photovoltaic, Fundamentals, Technologies & Applications; Introduction to Condensed Matter Physics

Teaching & Mentoring Experience

Teaching Assistant for IIT Bombay Courses

- EE302: Control Systems, Department of EE *Jan '21 - May '21*
- EE325: Probability and Random Processes, Department of EE *Aug '20 - Dec '20*
- MA108: Differential Equations, Department of Mathematics *Mar '18 - Apr '18*
- PH107: Quantum Mechanics and Applications, Department of Physics *Jul '17 - Nov '17*

Mentor, Department Academic Mentorship Program, IIT Bombay *Apr '19 - May '21*

- Mentoring & motivating 11 students over 2 years & playing a key role in their overall development
- Selected through extensive peer reviews & interviews to help academically weak students improve

Technical Skills

Languages C, C++, Python, Verilog, VHDL, Assembly, HTML

Software Cadence, ADS, Genus, Innovus, TCAD Sentaurus, Bluespec, Altera Quartus, Xilinx Vivado, Code Composer Studio, Modelsim, GNURadio, AutoCAD, SolidWorks, MATLAB, Scilab, Octave, Origin, SPICE

Leadership in Journalism

Recipient of the **Institute Journalism Special Mention Award** at IIT Bombay

Editor, Insight, IIT Bombay *Apr '18 - Mar '19*

Official Print Media Body | Circulated to 10K+ students & 650+ faculty | Online readership 0.4M+

- Part of a 22 member team responsible for managing Insight's online presence & newsletter
- Led the Univ Series by collecting testimonials from IITB alumni doing their graduate degree

Convenor, IIT Bombay Broadcasting Channel *Apr '17 - Mar '18*

Official Multimedia Journalism Body | 50K+ YouTube Subscribers | 25K+ Facebook Followers

- Part of a 7 member team responsible for the regular broadcast of events occurring in the institute
- Interviewed professors for the Know Your Prof series to enhance student-faculty interaction

Extra-curricular activities

- Awarded 'Hostel 10 Cultural Colour' for exceptional contribution to film-making at IIT Bombay
- Aided in setting up self-defence workshops for women as social initiative of Techfest, IIT Bombay
- Assisted in Techfest's Sanitary Health Education campaign distributing 0.2M sanitary pads
- Part of the 13 member Institute Women's Volleyball Team for the Inter-IIT camp, 2016

References

Prof. Anantha Chandrakasan, EECS
MIT | E–Mail | Webpage

Prof. Souvik Mahapatra, EE
IITB | E–Mail | Webpage

Prof. Animesh Kumar, EE
IITB | E–Mail | Webpage

Prof. Gerrit Bauer, Applied Sciences
TU Delft | E–Mail | Webpage