

Anubhav Bhatla

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Research Interests

Computer Architecture, Microarchitectural Security, Digital Design, Microprocessors

Education

Indian Institute of Technology Bombay

(Jul. 2020 - Present)

Bachelor of Technology in Electrical Engineering with Honours

CPI: 9.03/10

Minor in Computer Science and Engineering

Scholastic Achievements

- Secured **All India Rank 266** in *JEE Advanced, 2020* among 160 thousand candidates (2020)
- Acquired an **All India Rank 490** in *JEE Mains, 2020* among 1.1 million candidates (2020)
- Awarded the *Kishore Vaigyanak Protsahan Yojana (KVPY)* fellowship with **All India Rank 337** (2018)
- Qualified for **Indian National Olympiad (INO)** in *Astronomy, Chemistry & Physics* (2019)
- Bagged a position among the **Top 1%** students nationally in *NSEP & NSEA* (2019)
- Secured **399 marks out of 450** in the *BITSAT* examination (**Top 250** in 300 thousand candidates) (2020)
- Recipient of **Merit Certificate** for being among the top 0.1% of successful candidates in *Physics* (2020)

Research Experience

Hardware-efficient Secure Cache Design

(Jan. 2023 - Present)

Prof. Biswabandan Panda

Research Project

- Extensively analyzed side-channel attacks and state-of-the-art cache designs which are secure against such attacks
- Proposed modifications to the **MIRAGE** cache design aiming to **reduce hardware overhead** while retaining **security**
- Simulated the proposed cache design to ensure no Set-Associative Eviction occurs in **10^{13} years** of system lifetime
- Implementing the proposed cache design on **ChampSim** simulator to estimate performance overhead compared to a baseline non-secure cache design

Secure Cache-line Reallocation

(Jul. 2022 - Dec. 2022)

Prof. Virendra Singh

EE691: R&D Project

- Covered literature on multi-core processors, cache replacement policies, **side channel attacks** and their mitigation
- Implemented the **PASS-P**, Utility-based DCP (**UCP**), and static cache partitioning techniques on the **SNIPER** multi-core simulator and carefully analyzed results for different cache configurations
- Performed extensive analysis of performance, sensitivity, re-allocated blocks and dead blocks for different benchmarks
- Proposed and implemented a **modification to PASS-P** using SNIPER simulator to preferentially re-allocate **dead blocks** with the aim to improve performance

Professional Experience

Embedded Software Intern

(May 2023 - Jul. 2023)

Texas Instruments India

Summer Internship

- Created a **driver monitoring application** for the AM62Ax Sitara processor using the **GStreamer** media framework
- Modified the existing GStreamer pipelines to enable **stacking** of multiple DNN models required for the application
- Analyzed the **boot flow** of a competitor processor and created a boot loader **porting guide** for the AM62x processor
- Extensively analyzed the existing documentation and Linux examples on the AM62x and suggested improvements

Key Projects

Superscalar Processor Design

Prof. Virendra Singh

(Jul. 2022 - Nov. 2022)

CS683: Advanced Computer Architecture

- Designed a **2-way OOO Superscalar** processor with a Turing-complete instruction set architecture of 17 instructions
- Implemented key components: Reservation station, Reorder Buffer, Execution pipelines, & Memory system in **VHDL**
- Performed extensive software testing for all 17 instructions on **GHDL** and GTKWave simulations using a Testbench
- Implemented an **Assembler** and a **Bootloader** in Python to dump user instructions into the memory of the processor

EEG Data Acquisition System

Prof. Siddharth Tallur and Prof. Laxmeesha Somappa

(Jan. 2023 - Apr. 2023)

EE344: Electronic Design Lab

- Extensively analyzed datasheets for various ADCs, regulators, microcontrollers, Wi-Fi modules and other peripherals
- Designed a **24-channel** setup on a **4-layer PCB** complete with the analog front-end, **daisy-chaining** for the ADCs, analog and digital power regulators, and peripheral interfacing using the 2 available **SPI** buses on the Microcontroller
- Implemented a **4-channel** easy-to-replicate **modular** design along with a **3D printed headgear** for demo purposes
- Bagged the **Best Project Award** out of **70+** teams for exemplary performance in the final demo and presentation

VLSI Circuit Design

Prof. Dinesh Sharma

(Jul. 2022 - Nov. 2022)

EE671: VLSI Design

- Designed **logic gates** using CMOS, pseudo-NMOS, CVSL, and CPL design styles, and analyzed output characteristics
- Implemented a 16-bit **Brent Kung** logarithmic fast adder in **VHDL** and validated design using **ModelSim** simulations
- Used the **Dadda Reduction** Algorithm to optimize efficiency of a 16-bit **Multiply and Accumulate** circuit in VHDL

RISC Processor Design

Prof. Virendra Singh

(Jan. 2022 - Apr. 2022)

EE309: Microprocessors

- Designed and implemented the **16-bit IITB RISC-22** Microprocessor, capable of running a total of 17 instructions using both **6-stage Pipelining** and Multicycle implementations
- One of the few teams to optimize the pipelined processor using **Hazard mitigation**, **Forwarding** & Branch prediction
- Performed software testing for all instructions using **Intel Quartus** Environment and the **ModelSim** HDL simulator

Valet Parking Bot

Prof. Paritosh Pandya and Prof. Kavi Arya

(Jan. 2023 - Apr. 2023)

CS684: Embedded Systems

- Interfaced the tracker sensors, proximity sensors, and position encoders using the **Arduino** present on the **Alphabot**
- Implemented and tested algorithms for Line following, Obstacle avoidance, and Parking in the **Heptagon** language
- Wrote the controller in Embedded C to set up the sensor and motor drivers and interfacing with the Heptagon code

VLSI Circuit Partitioning

Prof. Virendra Singh

(Jul. 2022 - Nov. 2022)

EE677: Foundation of VLSI CAD

- Studied and implemented graph partitioning algorithms and heuristics such as the **Kernighan-Lin Algorithm**, **Clustering Based Heuristic**, and **Hagen Kahng EIG Algorithm**
- Visualized the algorithms using the plotting tools of matplotlib and **networkx** libraries and compared their performance

Digital Circuit Design

Prof. Maryam Shojaei Baghini

(Jul. 2021 - Nov. 2021)

EE214: Digital Circuits Lab

- Acquired the knowledge of **Finite-state machines** and the methodology for implementing them using D-FlipFlops
- Implemented a **4-bit Sequence Generator** with D-FlipFlops using Sequential and Behavioral modelling in **VHDL**
- Performed software testing using Quartus simulations and hardware testing using **Scanchain** on the **Krypton board**

Microprocessor Implementations

Prof. Saravanan Vijaykumaran

(Jan. 2022 - Apr. 2022)

EE337: Microprocessors Lab

- Designed and tested a two-party, password-secure ATM capable of taking action inputs from keyboard using **UART**
- Implemented a **reaction timer** in **Assembly** to display the time it takes for the user to respond to a stimulus (in ms)
- Developed a subroutine capable of generating voltage waveforms corresponding to different **music note frequencies**
- Interfaced an LM35 sensor with the microcontroller using an ADC, through **serial peripheral interfacing**, to monitor and display real-time ambient temperature

Other Projects

Predicting the RUL of EV Batteries

(Jul. 2021 - Nov. 2021)

Prof. Amit Sethi

DS203: Programming for Data Science

- Achieved an **R2 score** of **98.09** for estimating the **RUL** of EV Lithium batteries using an **XGBoost** regression model
- Performed EDA on the Charging, Discharge and Impedance cycles for Li-ion batteries using NASA's PCoE Datasets
- Understood and tested various models such as SVR, **Multilayer Perceptron**, **LSTM**, Random Forest as well as various **Boosting Algorithms**

General Purpose GPUs

(May 2022 - Jul. 2022)

Prof. Virendra Singh

Research Project

- Reviewed literature about analyzing and leveraging a **Decoupled LLC** design and implementing it on GPGPU-Sim
- Studied and reviewed the SMT Core, Memory systems and the programming model related to **GPU architecture**
- Performed various benchmark simulations on the **GPGPU-Sim** simulator and carefully analyzed the outputs received

Operating Systems

(May 2022 - Jul. 2022)

Maths and Physics Club, IIT Bombay

Summer of Science

- Studied various **Scheduling** policies, **Process APIs**, and Context switching used to facilitate **CPU Virtualization**
- Covered different **Memory APIs**, Segmentation, Paging, TLBs, and Swapping in context of **Memory Virtualization**

Postitions of Responsibility

Served as an undergraduate teaching assistant for a batch of **200+** students, with the responsibility of conducting doubt-solving sessions, and academically mentoring students over the duration of the following course:

- EE309: Microprocessors (Jan. 2023 - Apr. 2023)

Technical Skills

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

Software Intel Quartus, Autodesk Fusion 360, GStreamer, Keil μ Vision, GHDL, MATLAB, Ngspice, ArduinoIDE, AutoCAD, Solidworks, GNU Radio, \LaTeX

Simulators ChampSim, Sniper, GPGPU-Sim

Courses Undertaken

Electrical Engineering	VLSI Design, Foundation of VLSI CAD, Microprocessors, Electronic Design Lab, Digital Systems, Analog Circuits, Communication Networks, Information Theory & Coding, Probability & Random Processes, Electronic Devices & Circuits, Control Systems, Power Engineering, Electromagnetic Waves
Computer Science	Advanced Computer Architecture, Embedded Systems, Principles of Data and System Security, Computer Programming & Utilization
Mathematics	Calculus, Linear Algebra, Differential Equations, Complex Analysis
Miscellaneous	Economics, Sociology, Quantum Physics and Application, Biology

Extracurriculars

- Completed one year of training under the **National Cadet Corps**, IIT Bombay (2021)
- Awarded a **Special Mention** out of a total of **82** students in the \LaTeX bootcamp conducted by the Under-Graduate Academic Council, IIT Bombay (2021)
- Designed and assembled a remote-controlled plane and participated in the **RC Plane Competition** conducted by the Aeromodelling Club, IIT Bombay (2021)