

# SIDDHARTH CHANDAK | CV

## Contact Information

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Senior Undergraduate  
Department of Electrical Engineering  
Indian Institute of Technology Bombay

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## Research Interests

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Communication Systems, Machine Learning, Information and Coding Theory, Probability and Statistics

## Education

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**Indian Institute of Technology (IIT) Bombay**, Mumbai, India  
Bachelor of Technology, Electrical Engineering, *Expected*: Summer 2021

- **Honors** in Electrical Engineering
- **Minor** in Computer Science and Engineering
- **Cumulative Performance Index (CPI)**: 9.89/10.00

## Academic Achievements

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- **Department Rank 1** in Electrical Engineering and **Institute Rank 3** at IIT Bombay after seven semesters based on core CPI
- Among the **top 50** candidates in the **Indian National Olympiads in Chemistry and Physics** and chosen to attend respective **Selection Camps** for **International Olympiads** in 2017
- **All India Rank 346** in JEE Advanced 2017 among 220,000 students
- **All India Rank 73** in JEE Main 2017 among 1.18 million students
- Recipient of **KVPY Fellowship** with an **All India Rank 86** in 2016 (KVPY is a Fellowship in Basic Sciences, initiated by the Department of Science and Technology, Govt. of India)
- Received Certificate of Merit (awarded to **top 75** candidates) in **Indian National Maths Olympiad** in 2015
- **NTSE Scholar** (National Talent Search Exam conducted by NCERT, Govt. of India) since 2015

## Publications

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### Journal.....

- S. Chandak, F. Chiariotti, P. Popovski, "Hidden Markov Model-Based Encoding for Time-Correlated IoT Sources," in *IEEE Communications Letters*, doi: 10.1109/LCOMM.2020.3044210.

### Preprints.....

- S. Chandak, V. S. Borkar, "Concentration of Contractive Stochastic Approximation and Reinforcement Learning", *arXiv (2021)*, 2106.14308. *Submitted to Stochastic Systems*.
- V. S. Borkar, S. Chandak, "Prospect-theoretic Q-learning", *arXiv (2021)*, 2104.05311. *Submitted to Systems and Control Letters*.

## Research Projects

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- **Prospect-Theoretic Q-Learning**

August 2020 - January 2021

*Guide - Prof. Vivek Borkar, EE, IIT Bombay*

Studying classical Q-learning from a prospect theoretic viewpoint, i.e., when the valuation of future returns is distorted by a subjective map that accentuates perceived higher returns and diminishes perceived losses

- Analyzing asymptotic behaviour of the resulting Q-learning scheme using monotone dynamical systems, in particular, determining number and locations of equilibrium points under different conditions
- Simulated Q-learning scheme and the equivalent differential equation to verify theoretical results

- **Hidden Markov Model-Based Encoding for Time-Correlated IoT Sources**

April - July 2020

*Guide - Prof. Petar Popovski, Department of Electronic Systems, Aalborg University, Denmark*

Proposed encoding and decoding scheme for transmitting short IoT packets with time correlation across a noisy channel by modeling source dynamics using Hidden Markov Models

- Proposed selective puncturing of Markov state bits and higher error protection for random bits in a packet, instead of source compression used in traditional approaches
- Used forward-backward decoding to exploit Markov source dynamics and achieve low decoding latency
- Tested approach for Binary Symmetric Channel using BCH and Convolutional codes
- Proposed scheme achieves significantly lower packet error rate than traditional compression-based encoding schemes in simulations

- **Social Network Inference from Survey Data**

May - July 2019

*Guide - Prof. Nick Jones, Mathematics, Imperial College London, UK*

Investigated the difference between social networks in UK, ICL and "Hackspace" - a smaller technical community at ICL, by analyzing survey data on friendships within and across communities

- Modeled the social network using a stochastic block model and inferred the model parameters and error bounds using Bootstrapping and Bayesian Inference
- Analyzed "Hackspace" survey to examine if innovative spaces promote friendships between communities (defined with respect to gender, age, education, etc.)
- Used notions of distance between probability distributions to define a statistic for "Homophily", the tendency to socialize within one's own community
- Related Homophily to people's subjective health for different regions of the UK

- **A Survey in Pedagogy**

December 2018 - December 2019

*Guide - Prof. D. Manjunath, EE, IIT Bombay*

Conducted a department-wide survey to improve curriculum design and pedagogy process

- Designed a questionnaire about course related issues such as factors affecting grades, evaluation structure and course feedback
- Conducted the survey for 40 students and 20 professors chosen randomly from the EE department
- Performed statistical analysis of survey data to investigate how students from different grade ranges approach academics
- Suggested methods to improve course experience for students and professors on the basis of survey data

## Other Projects

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- **Spanning Tree Protocol and Learning Bridges** Autumn 2020-21  
*Computer Networks - Course Project, Guide - Prof. Varsha Apte*  
Studied and implemented protocols for packet transfer at link layer
  - Implemented distributed spanning tree algorithm in Python according to IEEE 802.1D standards
  - Implemented algorithm for learning forwarding tables in bridges
- **Image Deblurring** Autumn 2020-21  
*Digital Image Processing - Course Project, Guide - Prof. Ajit Rajwade*
  - Implemented deblurring of images using reverse heat equation and stabilization in MATLAB
- **Processor Design** Autumn 2019-20  
*Microprocessors - Course Project, Guide - Prof. Virendra Singh*
  - Designed a 6-stage pipelined processor with forwarding, hazard control and branch prediction using VHDL and tested it on Altera FPGA board
  - Designed a CISC processor (subset of 8085 ISA) using hardware flowchart method
- **Application Form Reader** Summer 2018  
*Institute Technical Summer Project*
  - Created an autonomous system to read multiple application forms using Intelligent Character Recognition & sort them according to their content
  - Built a feeding mechanism using motors, Arduino and IR sensors to move pages one at a time and stop pages below camera
  - Detected text boxes in form with high accuracy using OpenCV library in Python
  - Trained a neural network for character recognition using Keras library in Python
- **Gamification of Safety Training** Summer 2018  
*Guide - Prof. Narendra Shiradkar, EE, IIT Bombay*
  - Created a road safety game using Unity and C# with multiple scenarios depicting traffic rules
  - Used Unity to build a quiz game on fire safety connected to a MySQL database using PHP
- **Digital Phase Meter** Spring 2017-18  
*Electronics - Course Project, Guide - Prof. Subhananda Chakrabarti*
  - Designed a circuit to calculate and display the phase difference between two sinusoidal input waveforms of the same frequency
  - Used Timer, Comparator and Counter ICs to display angular phase difference

## Technical Skills

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- **Programming Languages:** C++, Python, MATLAB,  $\text{\LaTeX}$ , C#, SQL
- **Hardware and Software Skills:** VHDL, Assembly, Embedded C, Unity, Arduino IDE, SolidWorks, AutoCAD, Ngspice

## Selected Courses

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- **Advanced EE Courses:** Queuing Systems, Error Correcting Codes, Stochastic Optimization, Advanced Probability and Random Processes, Information Theory and Coding, Number Theory and Cryptography, Optimization, Applied Linear Algebra
- **Core EE Courses:** Digital Communication, Data Analysis and Interpretation, Control Systems, Digital Systems, Microprocessors, Digital Signal Processing

- **Computer Science:** Advanced Machine Learning, Theoretical Machine Learning, Data Structures and Algorithms, Logic for CS, Computer Networks, Digital Image Processing, Operating Systems
- **Miscellaneous:** Biology, Chemistry, Economics, Sociology, Environmental Studies, Complex Analysis, Differential Equations

## Teaching Experience

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Served as undergraduate teaching assistant for a batch of 50 freshmen, conducting weekly tutorial sessions, special doubt sessions, and grading answer sheets for the following courses:

- MA106: Linear Algebra Spring 2019-20
- MA105: Calculus Autumn 2019-20
- PH108: Basics of Electricity and Magnetism Spring 2018-19
- PH107: Quantum Physics and Applications Autumn 2018-19

## Extra-Curricular Activities

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- Participated in outreach activity aimed at students and professors from other universities under the 'Knowledge Incubation under TEQIP' ('KITE') Initiative of the MHRD, Govt. of India in 2018
  - Presentation on Network Epidemiology adjudged 2<sup>nd</sup> among 25 groups
- Completed one year Yoga training in 2017-18
- Attended 10-day Vipassana meditation camps