

# ANUBHAV GOEL | CURRICULUM VITAE

## 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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Machine Learning, Biomedical Image Processing, Generative Modelling, Reinforcement Learning

## Education

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**Indian Institute of Technology (IIT) Bombay**, Mumbai, India  
Dual Degree (B.Tech+M.Tech), Electrical Engineering, *Expected*: Summer 2022

- **Minor** in Computer Science and Engineering
- **Cumulative Performance Index (CPI)**: 9.47/10.00

## Academic Achievements

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- **Department Rank 2** in Electrical Engineering Dual Degree batch
- Awarded Change of Branch for exceptional academic performance in first year
- Awarded the **Erasmus Scholarship** as a part of funding for a Semester Exchange Program to **Technical University Denmark (DTU)** based on exceptional academic performance
- **All India Rank 1263** in JEE Advanced 2017 among 220,000 students
- **All India Rank 438** in JEE Main 2017 among 1.18 million students
- Recipient of **KVPY Fellowship** with an **All India Rank 264** in 2017 (KVPY is a Fellowship in Basic Sciences, initiated by the Department of Science and Technology, Govt. of India)
- Awarded **Certificate of Merit** for being in the National Top 1% of **National Standard Examination in Physics (NSEP)** in 2017
- **NTSE Scholar** (National Talent Search Exam conducted by NCERT, Govt. of India) since 2015

## Research Projects

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- **One Class Classification** July'21 - Present  
*Guide: Prof. Suyash Awate, CSE, IIT Bombay*
  - Implemented a Deep Robust One Class Classification network motivated by the fact that typical data lies on low dimensional manifold, by adaptively generating adversarial points
  - Applying a **Gaussian Mixture Model** to perform clustering in a low-dimensional space
  - Using Generative Modelling to encode the latent space and detect anomalies along with Expectation Maximization to increase the data likelihood
- **Chance Constrained Markov Decision Process** July'21 - Present  
*Guide: Prof. Vivek Borkar, EE, IIT Bombay*
  - Used a Markov Decision Process framework to model probabilistic constraints as **Risk Sensitive loss** and a novel Primal Dual scheme to minimize the average cost while ensuring non-violation of probabilistic constraints
  - Implemented a **policy gradient** based reinforcement learning scheme using function approximation to parametrize policies for opportunistic scheduling in fading channels
  - Applying the scheme to randomly generated Markov Decision Processes to observe its behaviour

- Deep Learning Strategies for Reconstructing Undersampled RS fMRI** July'20 - Dec'20  
*Guide: Prof. Suyash Awate, CSE, IIT Bombay*
  - Integrated **Bayesian Framework** to model Epistemic and Aleatoric Uncertainty with existing Deep Learning techniques and applied it to DC-CNN and U-Net architectures
  - Implemented a three-stage architecture with end-to-end learning which performs reconstruction in k-space and performs quality enhancement in the spatiotemporal domain
  - Used a combination of Robust Loss, which models the heavier-tailed distribution for physiological noise and Bayesian Loss, which maximizes aposteriori probability of reconstruction
- 3D Scene Reconstruction Using Multiple-View Geometry** Feb'21 - May'21  
*Guide: Prof. Anders Dahl and Prof. Vedrana Dahl, Technical University of Denmark*
  - Applied the Zhang model to perform camera calibration using checkerboard images to work with handheld devices with unknown intrinsic camera parameters and non-standard datasets
  - Extracted **SIFT features** from multiple views and performed feature matching by implementing **FLANN matcher** to establish a Homography using **RANSAC algorithm** for outlier removal
  - Used Linear algorithms to calculate Essential and Projection Matrices and applied Triangulation along with K-means Clustering to calculate the final 3D coordinates of the points in space

## Work Experience and Other Projects

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- Corporate and Investment Banking Analytics** May'20 - Aug'20  
*McKinsey & Co.*
  - Worked in the development of a big data processing pipeline used for generating critical insights about the performance of leading global banks and develop future investment strategies
  - Worked with teams across different countries and backgrounds to automate strategy analysis methods across equity and debt products
  - Offered a referral to join as a full-time Associate to work on critical data insights
- Transaction Advisory Services** Nov'18 - Jan'18  
*Ernst & Young LLP*
  - Analysed current fiscal and economic status including infrastructure development in Indian states
  - Studied economic parameters to develop an Infrastructure Investment Plan for state governments
- Financial Appraisal of Infrastructure Projects** May'18 - July'18  
*RITES Ltd.*
  - Developed an Annuity model for a railway project including profit and loss account, balance sheet and cash flow statement to evaluate its financial viability in terms of Return on Equity
  - Studied sensitivity of the model to costing variables and other financial parameters including debt-equity ratio, depreciation, tax and financing fee and projected traffic
- Conditional Style GAN** Autumn'20  
*Course Project: Advanced Machine Learning, Guide: Prof. Amit Sethi*
  - Implemented conditional variant of StyleGAN to perform style transfer on FFHQ datasets
  - Mapped Speech Commands dataset to MEL spectrograms and used conditional StyleGAN to perform style transfer in audio domain and evaluated its performance using FID scores
- Neural Net Engine** May'19 - July'19  
*Guide: Prof. Virendra Singh*
  - Designed a Neural Net for Face Detection in a Video Surveillance system on an FPGA board
  - Optimized memory requirements of MTCNNs for use in resource-constrained environments
- Rendering and Animation using OpenGL** Autumn'20  
*Course Project: Computer Graphics, Guide: Prof. Parag Chaudhuri*
  - Used Keyframing and Interpolation along with Phong lighting model and texture mapping in a Hierarchical modeling framework to create a 30 second animation film

- **Spanning Tree Protocol and Learning Bridges** Autumn'20  
*Course Project: Computer Networks, Guide: Prof. Varsha Apte*
  - Implemented the distributed spanning tree algorithm and the algorithm for learning forwarding tables in bridges according to IEEE 802.1D standards
- **Processor Design** Autumn'19  
*Course Project: Microprocessors, Guide: Prof. Virendra Singh*
  - Designed a 6-stage pipelined microprocessor with forwarding, hazard control and branch prediction and implemented a CISC processor (subset of 8085 ISA) using VHDL on Altera FPGA board
- **Non-Photorealistic Rendering** Autumn'19  
*Course Project: Digital Image Processing, Guide: Prof. Suyash Awate*
  - Used edge detection and mean shift segmentation with cel shading to obtain toonified images

## Technical Skills

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**Programming** C++, C, Bash, Python, Java, R, CMake, OpenGL, VBA, VHDL  
**Software** PyTorch, Matplotlib, TensorFlow, MATLAB, Vagrant, Git,  $\LaTeX$ , OpenCV

## Selected Courses

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- **Computer Science:** Machine Learning, Theoretical Machine Learning, Advanced Image Processing, Computer Vision, Computer Graphics, Digital Image Processing, Design and Analysis of Algorithms, Data Structures and Algorithms, Network Security, Computer Networks
- **Advanced EE Courses:** Advanced Probability and Random Processes, Advanced Machine Learning, Markov Chains and Queuing Systems, Optimization, Advanced Data Analysis and Statistical Modelling, Graph Theory
- **Core EE Courses:** Digital Signal Processing, Data Analysis and Interpretation, Control Systems, Digital Communications, Microprocessors, Linear Algebra

## Teaching and Mentorship Experience

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- **Department Academic Mentor:** Mentored **6 sophomores** on a one-to-one basis to ensure a smooth transition to the department as well as assisted on numerous aspects including academics and extracurriculars Autumn'21
- **Teaching Assistant for EE610 Image Processing:** Served as an undergraduate teaching assistant for a batch of 150 students assisting the professor with smooth functioning of the course, contributing to the content matter and course resources as well as assisting in conducting the evaluation of the course Autumn'21
- **Teaching Assistant for MA207 Differential Equations II:** Served as an undergraduate teaching assistant for a batch of 20 sophomores, conducting weekly tutorial sessions, doubt sessions and grading answer sheets Autumn'20

## Extra-Curricular Activities

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- Completed an Exchange Semester at **Technical University Denmark** and interacted with people of various nationalities and backgrounds as part of academic projects and social programs
- Completed the **Financial Engineering and Risk Management** course offered by Columbia University and studied the Black Scholes formula and Mortgage-Backed Securities
- Completed **80 hours of community service** educating underprivileged children about implementing sustainable technologies under the Vikas department of National Service Scheme, IIT Bombay
- Secured the **Third Position** in MUN Arcade held at IIT Bombay