Apoorv **Srivastava**

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EDUCATION

Examination	University	Institute	Year	CPI/%
Graduation	IIT Bombay	IIT Bombay	2020	9.52/10
Intermediate/+2	CBSE	Daffodils Public School	2015	95.2%
Matriculation	CBSE	Daffodils Public School	2013	9.8/10



Research Interest

Solid Mechanics, Computational Mechanics, Mechanics of Materials, Lattice Mechanics, Nanomechanics, Mechanical Metamaterials, Topological Mechanics, Mechanics of Waves, Deployable Structures, Mechanisms, Form Finding, Structural Dynamics

★ Scholastic Achievements

- > Ranked 1st in the department of Civil Engineering out of 111 Students based on academic proficiency.
- > Secured AP grade for outstanding performance in course on Structural Mechanics. 2018
- > Represented India in Solar Decathlon China 2018 as part of Team Shunya.

2018

Awards and Scholarships

> Awarded with Undergraduate Research Award (URA) in recognition of exemplary contribution to research. 2019

> Recieved SC Mehrotra Prize for exceptional academic performance for academic year 2017-18. 2018

> Recipient of Foundation For Excellence (FFE) scholarship for exemplary overall performance. 2018 - 2019

> Awarded with Swiss National Science Foundation (SNSF) scholarship for outstanding work at EPFL. 2019

PUBLICATIONS

- > Arka P. Reksowardojo, Gennaro Senatore, Apoorv Srivastava, Ian F.C. Smith, "Control and energy assessment of a prototype structure that adapts to loading through shape optimization", Manuscript in preparation.
- > Arka P. Reksowardojo, Gennaro Senatore, Apoorv Srivastava, Ian F. C. Smith, Henry Unterreiner, Chris Carroll, "Design and control of a prototype structure that adapts to loading through large shape changes", manuscript submitted for the World Congress of International Federation of Automatic Control, 2020, Berlin.

KEY RESEARCH PROJECTS

Mechanical Metamaterials, Non-Affine Deformations and Deployable Structures Guide: Prof. Mandar M. Inamdar, Civil Engineering Department

August 2018 - Present IIT Bombay

Description: Project involved study of metamaterials, origami, topological mechanics, lattice mechanics, dislocations, non-affine deformations, form-finding, and deployable structures. Current work is focused on the design of active materials.

- > Performed static and kinematic analysis of frameworks, followed by interpretation of fundamental subspaces of associated equilibrium and kinematic matrix to identify the states of self-stress and finite and infinitesimal mechanisms present.
- > Developed origami-based paper models of collapsible hollow cylindrical members with hexagonal unit cells and analyzed them at different stages of deployment, followed by classification based on the energy profile as they deployed.
- > Worked on infinitely repetitive structures as present in crystal lattices and the associated reciprocal lattice, identified zeroenergy modes, states of self stress, actuation characteristic, strain producing and non-strain producing deformations.
- > Developing a Julia program to generate simple lattices and grids, studying their dynamic behavior and finding their forms under different stimulation such as change in natural length, states of self stress, and temperature variations.

Stress Ratio based Structural Optimization using Genetic Algorithm Guide: Prof. Yogesh M. Desai, Prof. Venkata S. K. Delhi, Department of Civil Engineering

July 2017 - August 2018

IIT Bombay

Description: Project involved optimizing a Fibre-Reinforced Plastic (FRP) based cooling tower with 13,000+ members using GA.

- > Learned and implemented various unimodal and multimodal optimization algorithms including Simplex method, Newton-Ralphson, Conjugate Gradient, Sequential Quadratic Programming, Simulated Annealing and Genetic Algorithm.
- > Utilized the concepts of symmetry and anti-symmetry to minimize the number of design variables and computational effort.
- > Employed stress-based Member Utilization Ratio for evaluation of population fitness function and reproduced population.
- > Used component object modelling library of STAAD.Pro (OpenSTAAD) for analyzing and iterating over the structure.

RESEARCH INTERNSHIP

Active Structures : Design and Control

May 2019 - July 2019

Guide: Prof. Ian F. C. Smith, Dr. Gennaro Senatore, IMAC, ENAC

EPFL, Switzerland

Description: Adaptive structures undergo real-time shape changes to accommodate the loads acting on them. The project was focused on developing the real-time control problem and assembly of a full-scale prototype bridge.

- > Incorporated the nodal coordinates of structure in the set of design variables of existing algorithms for shape optimization.
- > Formulated a physically significant objective function and derived its Hessian and Jacobian Matrices to establish the limits of convexity and the existence of local and global minima of the problem.
- > Designed and implemented an iterative linearized control problem to achieve time efficiency required for real-time control.
- > Derived the closed-form solution of the multi-variate non-linear control problem using Karush-Kuhn-Tucker (KKT) optimality criterion and symmetry conditions present in the structure.
- > Results from non-linear optimization using Simple Quadratic Programming (SQP) and Interior-point method (IPM), iterative optimization of the linearized problem and closed-form solution of problem using KKT optimality criterion agreed closely.
- > Helped in the assembly of a 6-bay adaptive prototype full-scale pedestrian bridge, gained insights into the working of strain sensors and CAN bus protocols that handle the communication between the computing unit and actuators.

4 ACADEMIC PROJECTS

Stress Analysis using Finite Element Method

January 2019 - May 2019

Guide: Prof. Yogesh M. Desai, Department of Civil Engineering

IIT Bombay

Description: The project involved implementation of FEM to analyze a problem and its benchmarking with analytical solutions.

- > Analyzed beams subjected to uniformly distributed load and point loads using the Finite Element Method.
- > Performed convergence study on the model by varying number, size, and aspect ratio of the elements.
- > Benchmarked the results obtained from the analysis with the analytical solution from beam theories.

Shape of Strongest Column

July 2018 - November 2018

Guide: Prof. Gopal R. Patil, Department of Civil Engineering

IIT Bombay

Description: The project was aimed at finding optimal column shapes under different loading conditions.

- > Employed the concepts from the Euler-Bernoulli beam theory for evaluation of buckling load.
- > Developed the governing eigenvalue problem for buckling load using geometric stiffness and element stiffness matrix.
- > Shape of the column was optimized under compressive load with crushing and buckling constraints for a fixed volume.
- > Cross-sectional variation of the column along its length was obtained using Genetic Algorithm.

Facial Recognition using Artificial Neural Network (ANN) Guide: Prof. Indu J., Department of Civil Engineering

July 2017 - November 2017

IIT Bombay

 $\textbf{Description:} \ \ \textbf{The project was directed towards developing an Artificial Neural Network (ANN) based face recognition application.}$

- > Faces were localized using the Viola-Jones algorithm, followed by extraction and neural network-based face recognition.
- > Developed a two-layer neural network of 100 neurons employing Gradient-based back-propagation algorithm.
- > Results obtained showed an accuracy of over 80% in recognizing input face matrices.

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TECHNICAL PROJECTS

Team Shunya

July 2017 - Present

Chief Faculty Advisor: Prof. Rangan Banerjee, Department of Energy Science & Engineering

IIT Bombay

Team Shunya is a team of 9 faculty and 50+ students from across the disciplines representing India in Solar Decathlons, collegiate competition conducted by U.S. Dept of Energy in which teams design and build highly efficient buildings powered by renewable.

> Project LEAF, Solar Decathlon Europe - 2021

August 2018 - Present

Description: Project LEAF is the current endeavor of the team aimed at providing sustainable housing solutions in tier II Indian cities, that are currently facing the waxing pressure of urbanization, by extending the existing buildings vertically.

Designation: Structure & Materials Subsystem Head

- > Working with a team of 10+ students to ideate and design structural framework and examining the applicability of Cold Formed Steel (CFS) and Fibre Reinforced Plastic (FRP) based construction practices to achieve sufficient lightness.
- > Developed 3D printed representative deployable units that are currently being scaled for installation on the load-carrying frame and will enhance the efficiency and ease of construction.
- > Classifying and selecting materials for auxiliary units of the house based on embodied energy and carbon footprint.
- > Responsible for the integration of designs from architectural and technical subsystems of the team.
- > Involved in ideation of the project's concept, structuring of the team, and establishment of team management.

> Project Solarise, Solar Decathlon China - 2018

July 2017 - August 2018

Description: Project Solarise was designed to solve the problem of haphazard housing widely evident in Indian cities. A prototype that can be stacked in horizontal as well as the vertical plane with planned community spaces was developed.

Designation: Design Engineer, Structural Subsystem

- > Represented India at Solar Decathlon China 2018 in Dezhou, China, by constructing an 1800 sq-ft solar-powered netpositive energy house within 12 days. The team received the Best Participation Award for its efficiency and commitment.
- > Involved in Designing of Structure and selection of materials to ensure modularity and sustainability of the house.
- > Documented phases involved in the design and construction process to be presented as competition deliverables.



MENTORSHIP ROLES

Department Academic Mentorship Program

April 2018 - Present

Description: DAM-Program encompasses a group of faculty and a team of 24 mentors to increase academic outreach and support for academically underperforming students in the department.

> Designation: Academic Rehabilitation Program Mentor

April 2019 - Present

- > Mentoring 2 students facing severe academic issues and are currently under the Academic Rehabilitation Program.
- > Guiding the students in consultation with the faculty in terms of course planning, time management, and performance improvement and identifying problems and avenues for growth.

> Designation: Department Academic Mentor

April 2018 - April 2019

- > Assisted and Mentored 6 sophomore students in their academics and co-curricular pursuits.
- > Part of team revamping the DAMP blog which includes course reviews, information about Projects, internships, Higher studies and handles the grievances from all the students of the department.



RELEVANT COURSES

Mechanics

Engineering Mechanics Solid Mechanics I, *II Structural Mechanics I, II, *III Continuum Mechanics Structural Dynamics Finite Element Method Fluid Mechanics

Mathematics & Computing

Computer Programming Linear Algebra Differential Equations I, II Calculus Numerical Methods Probability & Statistics Optimization

Other Courses

Quantum Physics Inorganic Chemistry Biology Digital Image processing Geotechnical Engineering I, II

Electrical and Electronic circuits

^{*}To be completed in Fall 2019 semester



SKILLS

Julia, Python, MATLAB, C++, C#, VBA, VB.Net Programming

Software STAAD.Pro, SolidWorks, AutoCAD, ETABS, QGIS, Visual Studio

Operating systems Windows, Linux

> ETEX, GitHub, HOOMD-blue, Microsoft Excel Others



🧩 Extra Curricular Activities

> Underwent training and qualification in Yoga under the National Sports Organization.	2016 - 2017
> Held workshops and awareness programs on sustainable development as part of Team Shunya.	2017 - 2019
> Learned and played Tabla for two years during secondary school.	2013 - 2015
> Ideated Techfest innovation challenge targeting 4,00,000+ students across 45,000+ schools.	2017
> Volunteered for Diabetes awareness camp, titled CURED by Techfest attended by 500+ people.	2017
> Successfully completed Pratham Sopan (1st level) of Scout and guide training camp.	2009
> Underwent professional training in welding, carpentry, and other workshop practices.	2017

Institute Chair Professor, IIT BOMBAY

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66 References

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