# Swaminathan Sundar

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## EDUCATION

**Texas A&M University** **College Station, TX**
**Doctor of Philosophy in Chemical Engineering; GPA: 3.7/4** ***Aug 2021 - today***
**Advisor:** Dr. Efstratios N. Pistikopoulos
***Relevant Coursework:*** Non Linear Programming, Advanced Process Optimization, Heuristics Optimization, Data Mining and Analysis, Machine Learning, Deep Learning

**Carnegie Mellon University** **Pittsburgh, PA**
**Master of Science in Chemical Engineering; GPA: 3.7/4** ***Aug 2019 - Dec 2020***
**Advisor:** Dr. Debangsu Bhattacharyya and Dr. Chrysanthos Gounaris
***Relevant Coursework:*** Advanced Process Systems Engineering, Molecular Simulations of Materials, Product and Supply Chain Optimization, Quantum Integer Programming, Data Science in Chemical Engineering

## WORK EXPERIENCE

**Texas A&M University** **College Station, TX**
***Graduate Research Assistant*** ***Aug 2021 - today***

1. *Continuous Algae-based Carbon Capture and Utilization (CACCU) Project — Funded by the U.S. Department of Energy (DOE)*
   - Developed a high-fidelity modeling framework to support the scale-up of a novel algae-based carbon capture, utilization, and storage (CCUS) process.
   - The framework integrates dynamic process modeling, global parameter estimation, global sensitivity analysis, and model-based design of experiments (MBDoE).
2. *Python-Based Framework for Modeling and Optimization of Biorefinery Systems*
   - Built a flexible modeling framework to integrate process design, scheduling, techno-economic analysis (TEA), and life cycle assessment (LCA) in Python.
   - Implemented multi-objective optimization to evaluate trade-offs between cost and environmental impact.

**Carnegie Mellon University** **Pittsburgh, Pennsylvania**
***Graduate Research Assistant*** ***Aug 2019 - Dec 2020***

1. *Modeling and Optimization of a Photo-Catalytic $CO_2$ Utilization Process*
   - Developed a first-principles model using Pyomo for a photo-catalytic reactor.
   - Achieved 25× higher $CO_2$ conversion through optimization of reactor length and addition of a recycle stream.
   - Integrated Langmuir-Hinshelwood kinetics, annular fluid dynamics, and empirical radiation models, validated through sensitivity analysis.

## ACADEMIC PROJECTS

**Vision Transformer for CIFAR-10 Classification, TAMU** ***Jan – May 2024***

- Built a Vision Transformer model in PyTorch to classify CIFAR-10 images, incorporating hyperparameter tuning and data augmentation techniques.
- Tuned parameters included patch size (4), embedding dimension (512), number of heads (8), number of layers (8), encoder hidden dimension (768), batch size (128), and learning rate (0.0001).

- Applied data augmentations such as vertical and horizontal flipping, brightness and contrast adjustment, and Gaussian noise addition.
- Achieved a test accuracy of 56.98%, demonstrating practical skills in deep learning model development and optimization.

**Classification of Yelp Reviews Using Transformer Model, TAMU** ***Aug – Dec 2023***

- Preprocessed a dataset of 174,000 Yelp reviews using the NLTK library, followed by tokenization.
- Developed a Positional Encoding dataclass in PyTorch to provide positional information to the Transformer model.
- Achieved a validation accuracy of 83% and a testing accuracy of 82.9% using the optimal set of hyperparameters.

**Metaheuristic Approach for CVRP, TAMU** ***Jan – May 2022***

- Proposed a metaheuristic solution for Capacitated Vehichle Routing Problems (CVRP) using 2-opt and $\lambda$-interchange local searches combined with an Iterated Local Search to avoid local optima.
- Delivered near-optimal solutions for small problem instances; performance decreased with larger problem sizes.

**Particle Track Reconstruction, CMU** ***Aug – Oct 2020***

- Reconstructed particle tracks from Large Hadron Collider data using optimization techniques.
- Formulated and implemented the problem in Pyomo, successfully predicting tracks for five particles.
- Developed a QUBO formulation and applied simulated and quantum annealing; optimal solutions not achieved for multiple particle cases.

## LEADERSHIP

**Chemical Engineering Master's Student Association, CMU** ***Jan 2020 - Dec 2020***
***Vice President***

- Represented the Chemical Engineering Master's student body and helped fellow graduate students acclimatize themselves at CMU especially during COVID.
- Organized the first ever ChEMSA Research Symposium to facilitate a platform where the Master's Students can showcase their research through posters.

**AIESEC, Navi Mumbai, India** ***Jan 2018 – May 2018***
***Business Development Executive***

- Organized Youth Speak Forum 2018 and helped raise around ₹200k INR for the Navi Mumbai chapter

## SKILLS

**Programming Languages:** Python(Pyomo, Gurobi, Pandas, Pytorch, Keras, Tensorflow, Scikit-learn), Matlab
**Modeling Software:** GAMS, Aspen Plus, Microsoft Excel

## JOURNAL PUBLICATIONS

1 Kakodkar, Rahul, **Swaminathan Sundar**, and Efstratios Pistikopoulos. "Hydrogen-Based Dense Energy Carriers in Energy Transition Solutions." In Handbook of Smart Energy Systems, pp. 1-21. Cham: Springer International Publishing, 2022.

2 **Sundar, Swaminathan**, Rahul Kakodkar, and Efstratios Pistikopoulos. "Techno-Economic Analysis and Life Cycle Assessment of a Novel Algae-based CCUS Technology." Computers and Chemical Engineering *Submitted.*

3 **Sundar, Swaminathan**, Dustin Kenefake, Rahul Kakodkar, and Efstratios Pistikopouslos. "Dynamic Modeling and Optimization of a Photobioreactor for the Cultivation of Algae." *In preparation.*

## OTHER ACTIVITIES

- Teaching Assistant for undergraduate and graduate-level courses, including Process Dynamics & Control, Fluid Operations in Chemical Engineering, and Advanced Process Optimization.
- Ranked among the top 20 teams globally in the 2024 Shell.ai Hackathon Challenge.
- Peer reviewer for the journal *Computers & Chemical Engineering*.
- Contributed to multiple grant proposals, including the successful $26 million NSF grant for the CURB Engineering Research Center initiative.