Sunia Tanweer

Doctoral Student, Michigan State University

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Education

Michigan State University — *East Lansing, MI, USA*

Dual PhD in Mechanical Engineering, and Computational Mathematics, Sciences and Engineering (CMSE) — *Sept 2022 - Ongoing*

- CGPA: 4.0/4.0
- Supervisor: Dr. Firas Khasawneh, Assistant Professor, Dept. of Mechanical Engineering item Focus: Exploring applications of Topological Data Analysis, specifically for quantification and identification of bifurcations in stochastic dynamical systems.

National University of Sciences and Technology (NUST) — *Islamabad, Pakistan*

Bachelors in Mechanical Engineering — *2017 - 2021*

- CGPA: 3.95/4.00
- President's Gold Medal for Academic Excellence (highest CGPA in a batch of 110 students)
- Dean's List Scholarship in all semesters
- US Dept of State's fully funded undergraduate (UGRAD) Semester Exchange Scholarship for my 6th semester at University of Wyoming, WY, USA
- Senior year project: Design and analysis of a cost-efficient power attachment for a manual wheelchair

Research and Work Experience

Michigan State University — *East Lansing, MI, USA*

Research Assistant — *Sep 2022 - Ongoing*

- Implemented and tested a **fast algorithm for identifying all zero-crossings** in a time series signal using Persistent Homology.
- Devised a method using Cubical and Persistent Homology to mathematically **identify the state of a stochastic dynamical system** from its probability/kernel density (with reference to P-type bifurcations - monostable, bistable, limit cycle, et cetera).
- Working towards establishing a **probabilistic criteria for quantifying the onset of bifurcation** in a stochastic dynamical system.

Engro Fertilizers Limited — *Daharki, Pakistan*

Graduate Engineer (Maintenance) — *Oct 2021 - June 2022*

- Managed a team of 20 stationary and machinery technicians while Utilizing **1SAP for maintenance** of equipment on the largest single train urea-ammonia plant in the world, under the guidance of plant's senior maintenance engineer.
- **Developed and enriched maintenance manual procedures** pertaining to NARF handling, Shaft Installation of API 611 Steam Turbines, and overhauling/repair of Emergency Shut-off Valve (ESV) for GE-NP's API 612 Steam Turbines (SAC 1-8 and 1-4).
- Aided the implementation of a **hot box-up** weighing nearly 1 ton at a major leakage of Process Air (SS321H, 550°C, 40 kg/cm^2, 50ft height), preventing a forced outage of Enven plant for 5-6 P2P days.

Computations for Advanced Materials and Manufacturing Lab — *University of Wyoming, WY, USA*

Research Assistant — *February 2020 – December 2020*

- Developed and verified user defined material subroutines **(uhyper and vumat) of Murnaghan model of hyperelasticity** for ABAQUS in free form Fortran language.
- Wrote a **structured mesh model for ABAQUS using MATLAB**, and utilized bash and python scripting for results' extraction, to detect corrosion using third order elastic constants' effect on second harmonic generated by a Lamb wave as a Non-Destructive Testing technique.
- Generated **preliminary results for a grant proposal on thermally initiated Frontal Polymerization** by establishing relationship of sample initial temperature, thermal conductivity, heat rate and trigger temperature with time required for initiating a front.

Robotics and Intelligent Systems Engineering Lab — *NUST, Islamabad, Pakistan*

Robotics Research Intern — *June 2018 – September 2018*

- **Collected data (Myoband EMG, Emotiv EEG, Nao Humanoid Robots) and statistically analyzed (MATLAB)** it to study alleviation of symptoms of autism in children between 4 and 14 years of age using robots.
- Conducted a rigorous **literature review to evaluate and design various experimental models** for understanding the relationship between physiological parameters and autism, and to stretch that learning to minimize the symptoms of autism.

Conference & Journal Publications

- **Tanweer, S.**, Khasawneh, FA., Munch, E., & Tempelman, JR., "A Topological Framework for Identifying Phenomenological Bifurcations in Stochastic Dynamical Systems," arXiv:2305.03118v1 [math.DS], May. 2023. *(Arxiv Preprint)*
- **Tanweer, S.**, Khasawneh, FA., & Munch, E., "Robust Zero-crossings Detection in Noisy Signals using Topological Signal Processing," arXiv:2301.07703v1 [cs.CG], Jan. 2023. *(Arxiv Preprint)*
- Zhao, C., **Tanweer, S.**, Li, J., Lin, M., Zhang, X., & Liu, Y. (2021). Nonlinear Guided Wave Tomography for Detection and Evaluation of Early-Life Material Degradation in Plates. Sensors, 21(16), 5498.
- Zhao, C., **Tanweer, S.**, Li, J., Lin, M., Zhang, X., & Liu, Y. (2021, July). Early Fatigue Damage Evaluation of Nonlinear Guided Wave Imaging in Hyperelastic Materials. In Quantitative Nondestructive Evaluation (Vol. 85529, p. V001T11A009). American Society of Mechanical Engineers.

Presentations

- "Robust Zero-Crossing Detection with Persistent Homology", 2nd MSU CMSE Data Science Student Conference (DISC). Michigan State University, East Lansing, MI, December 2022.
- "Exploring Topological Data Analysis for Identifying Phenomenological Stochastic Bifurcations", SIAM Conference on Applications of Dynamical Systems (DS23). Portland, OR, May 2023.
- "Minitutorial: Topological Signal Processing for Dynamical Systems", SIAM Conference on Applications of Dynamical Systems (DS23). Portland, OR, May 2023.

Undergraduate Projects

- *Dynamics*: Designed and manufactured an **Internal Pipe Climber** of adjustable diameter.
- *Thermodynamics*: Guided a team of four members to model the intake manifold of a TCC-III engine, and simulate the flow inside it using ANSYS Fluent and CFD-POST, to observe the **effect of Reynolds number and velocity profile** on secondary flow.
- *Fluid Mechanics*: Directed a team of three members to design a **Pipe Flow Network** and develop an Excel code for solving it, such that the network provided required pressure heads at specified nodes.
- *Solid Mechanics*: Designed and analyzed a chassis and pressure vessel based **Lunar Electric Rover**.
- *Heat and Mass Transfer*: Simulated and compared one-dimensional steady-state heat transfer in multiple commonly used **fin profiles** using ABAQUS.
- *Computer Aided Design*: Modelled a single-cylinder **oscillating steam engine** using Pro/Engineer.
- *Fracture Mechanics*: Simulated and analyzed a cracked aluminum single-edge notched beam (**SENB**) under a displacement controlled three-point bending condition.
- *Control Systems*: Implemented an Octave script for **Routh-Hurwitz Criterion** of stability.

Skills

Programming	Python (NumPy, Scikit, Matplotlib, Openpyxl, Pandas, Plotly, Seaborn, etc.), C++, MATLAB/Octave, Fortran
Computer Aided Design	ProEngineer / Creo, Soliworks, AutoCAD, SpaceClaim/DesignModeler
FEA / CFD	ANSYS, Abaqus, Comsol, SolidWorks
Miscellaneous	Ubuntu Linux, Microsoft Office, LaTeX, Sphinx

Achievements

- Studied 6th semester of BE Mechanical at University of Wyoming (Laramie, WY, USA) under US State Department's fully funded merit-based **Global UGRAD Semester Exchange Scholarship**. Selected out of 14000+ applicants from all over Pakistan – President's Honor Roll
- Awarded **NESCOM's undergraduate fellowship** of 2019 from the entire batch of 110 students
- Nationwide **first position in NUST entrance test** 2017 out of 70000+ students achieving Chancellor's scholarship in 1st semester
- Among the top 25 participants in National Round (Pakistan) of International Physics Olympiad (IPhO) 2017 (**NPTC-21**) out of 5000+ students
- **Merit scholarship by Federal Board Islamabad (FBISE)** for 6th position in Pakistan (HSSC 2017)
- Special Mention in **South Asia Model United Nation** (SAMUN) 2017 for UNSC

Extracurricular Activities

Webmaster	Institution of Mechanical Engineers (IMechE), Pakistan (Sep'18-Dec'19)
Student Vice Chair	IMechE NUST Student Chapter (Jan'19-Sep'19)
Student Director Liaison	IMechE NUST Student Chapter (May'18-Jan'19)
Executive Human Resources	NUST Science Society (Sep'17-Jul'19)
Mentoring	Taught Computer Programming (C++) to freshman batch 2018 at NUST-SMME
TABA-NUST Student Chapter	Established and handled finances and social media marketing for 'Sponsor a Child' project of TABA.
Student Grievances Committee	Batch representative on the Student Grievances Committee throughout my undergraduate studies.