Sunia Tanweer

Second Year Doctoral Student

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Education

Michigan State University
East Lansing, MI, USA

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

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

Masters in Mechanical Engineering *Sept 2022 - May 2024*

- CGPA: 4.0/4.0

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 - top 1%)
- Dean's List Scholarship in all semesters
- US State Department's fully funded merit-based Global UGRAD Semester Exchange Scholarship for 6th semester at University of Wyoming (Laramie, WY, USA)—worth over *$25000*. Selected out of 14000+ applicants from all over Pakistan. Mentioned in President's Honor Roll.
- 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 TDA.
- Devised a method using TDA to **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).
- Established the best method of **persistence diagram replication for bifurcation detection** given a single system realizations.
- Exploring topological methods to predict epileptic seizures and classify chaotic vs stochastic signals.

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 Fortran.
- 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.

Fluid Mechanics Lab
NUST, Islamabad, Pakistan

Research Assistant *April 2019 – August 2019*

- Managed the **development of a test bench for pipe network analysis** for use in semester project evaluation of Fluid Mechanics-II for my own batch, and drafted a patent application for the bench.
- Reviewed **literature for a research project on subsurface drip emitters**, and devised an experimental setup for the project.

Publications

- **Tanweer, S.** & Khasawneh, FA. (*2024*, April). Topological Detection of Phenomenological Bifurcations with Unreliable Kernel Densities. Probabilistic Engineering Mechanics (Under Review).
- **Tanweer, S.**, A. Khasawneh, F., Munch, E. et al. (*2024*, February). A topological framework for identifying phenomenological bifurcations in stochastic dynamical systems. Nonlinear Dyn. https://doi.org/10.1007/s11071-024-09289-1
- **Tanweer, S.**, Khasawneh, FA., & Munch, E. (*2024*, March). Robust Zero-crossings Detection in Noisy Signals using Topological Signal Processing. Foundations of Data Science. https://doi.org/10.3934/fods.2024006.
- Zhao, C., **Tanweer, S.**, Li, J., Lin, M., Zhang, X., & Liu, Y. (*2021*, August). 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

- *Invited one-hour talk: "A comprehensive guide to detecting phenomenological bifurcations in stochastic systems using TDA", TDA Seminar, MSU, East Lansing, April 2024.*
- "Establishing a Topology-Driven Framework for Phenomenological Bifurcations in Stochastic Systems", Regional Mathematics and Statistics Conference (RMSC), Greensboro, NC, November 2023.
- "A Topological Approach to Quantify Phenomenological Bifurcations in Stochastic Dynamical Systems", SIAM Great Lakes Meeting, East Lansing, MI, October 2023.
- "Minitutorial: Topological Signal Processing for Dynamical Systems", SIAM Conference on Applications of Dynamical Systems (DS23). Portland, OR, May 2023.
- "Exploring Topological Data Analysis for Identifying Phenomenological Stochastic Bifurcations", SIAM Conference on Applications of Dynamical Systems (DS23). Portland, OR, May 2023.
- "Robust Zero-Crossing Detection with Persistent Homology", 2nd MSU CMSE Data Science Student Conference (DISC). Michigan State University, East Lansing, MI, December 2022.

Selected Semester Projects

- *(MS) Computational Fluid Dynamics*: **McCormack** based compressible shock tube solver & **SIMPLE** solver for incompressible channel flow.
- *(UG) Dynamics*: Designed and manufactured an **Internal Pipe Climber** of adjustable diameter.
- *(UG) 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.
- *(UG) 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.
- *(UG) Solid Mechanics*: Designed and analyzed a chassis and pressure vessel based **Lunar Electric Rover**.

Skills

Programming	Python (numpy, pandas, tensorflow, scikit, teaspoon, scipy, pytorch), C++, MATLAB / Octave, Fortran, R
Computer Aided Design	ProEngineer / Creo, Soliworks, AutoCAD, SpaceClaim/DesignModeler
FEA / CFD	ANSYS, Abaqus, Comsol, SolidWorks
Miscellaneous	Ubuntu Linux, Microsoft Office, LaTeX, Sphinx (documentation), R Markdown, Git (packaging code and version control)

Achievements

- 1 of 15 participants for AMS' **Mathematics Research Communities conference** 2024—awarded NSF funding worth *$2000*.
- Received the **Graduate Leadership Fellowship** (College of Engineering) worth *$2000* for 2024.
- Awarded travel and accommodation fund from NSF grant for presenting at RMSC 2023—worth *$700*.
- 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)

Professional Activities

- Regular contributor of open-source software to python package *teaspoon* for TDA.
- Peer-reviewer for Journal of Emerging Investigators (**JEI**).
- Member of Society of Industrial and Applied Mathematics (**SIAM**) and American Mathematics Society (**AMS**).
- Underwent **Train-the-Trainer T4DS** training (06-20-2023) on managing and training students in topological data analysis: 1 of the 9 selected participants—awarded NSF funding of *$500* to attend the training.
- Trained in **CIRTL Supporting Neurodivergent Students** (11-08-2023) on forms of neurodiversity, problems faced by neurodiverse students and methods of supporting them.

Other 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)
Debating - MUN	Honorary Mention - South Asia MUN for representing Indonesia in UNSC (2018)
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.