



# MOHAMMAD AFZAL SHADAB

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## EDUCATION

- Doctor of Philosophy** | *Computational Science, Engineering & Mathematics* Aug 2019 – Dec 2024 (Expected)  
The University of Texas at Austin, United States GPA: 3.90/4.0  
*Advisor:* Prof. Marc Hesse
- Master of Science** | *Computational Science, Engineering & Mathematics* Aug 2019 – Aug 2021  
The University of Texas at Austin, United States GPA: 3.90/4.0  
*Advisor:* Prof. Marc Hesse
- Master of Philosophy** | *Mechanical Engineering* Aug 2016 – Sept 2018  
The Hong Kong University of Science and Technology, Hong Kong GPA: 4.0(A)/4.3(A+)  
*Thesis:* Fifth-order Finite Volume WENO in General Orthogonally-curvilinear Coordinates 📄  
*Advisor:* Prof. Kun Xu
- Bachelor of Technology** | *Mechanical Engineering* Aug 2012 – June 2016  
Aligarh Muslim University, India GPA: 9.62/10.0  
*Thesis:* Designing and Analysis of Supersonic Combustion Ramjet Engine 📄  
*Advisor:* Prof. M.F. Baig

## RESEARCH

- Two Phase Flow in Viscously Compacting Matrix** The University of Texas at Austin, USA  
Graduate Research Assistant, *Doctoral Thesis* August 2019 – Present  
*Advisor:* Prof. Marc Hesse
- Developed and validated a conservative finite-difference based solver in Python for simulating a 2D two-phase flow in non-deforming porous media.
  - Implemented the solver to study the behavior of Post Impact Hydrothermal systems on Mars.
  - Implementing the solver to investigate the melt percolation on ice masses to study effects of global warming.
- Investigating Groundwater Flows using Physics Informed Neural Networks** 📄 UT Austin, USA  
*Independent Research* August 2020 – Present  
*Collaborators:* DingCheng Luo, Yiran Shen, Eric Hiatt, and Prof. Marc Hesse
- Wrote python codes for data-driven discovery of steady-state PDE from experimental data.
  - Investigated the effect of PDE regularization in PINNs and the role of PDE & data misfit.
  - Learned the PDE parameters and boundary conditions for the transient seepage across edge of a porous reservoir simulated using finite-differencing.
- Free Fall of a Viscous Drop in a Viscoelastic Medium** 📄 Massachusetts Institute of Technology, USA  
Visiting Graduate Student Researcher October 2018 – April 2019  
*Advisor:* Prof. Irmgard Bischofberger
- Performed a literature review of computational and experimental methods for investigating drop dynamics.
  - Designed the experiments and apparatus with high-speed imaging.
  - Wrote MATLAB scripts for analysing moving camera videos using template matching.
- High-Order Finite-Volume Reconstruction in Curvilinear Coordinates** 📄 HKUST, Hong Kong  
Graduate Research Assistant, *M.Phil. Thesis* December 2016 – September 2018  
*Advisor:* Prof. Kun Xu
- Proposed a general theory for state-of-art fifth order finite volume WENO in curvilinear coordinates.
  - Derived analytical relations and developed Fortran codes along with Riemann solvers and gas-kinetic scheme.

## **Modal Decomposition Techniques on a Thermoacoustic System**

Collaborative Research

Advisor: Prof. Larry Li

HKUST & U of Cambridge

August 2016 – December 2016

- Analyzed and compared the prominent modal decomposition techniques for developing low order models.
- Investigated nonlinear interactions between flame & external forcing for different amplitudes & frequencies.

## **Designing & Analysis of Supersonic Combustion Ramjet Engine**

Aligarh Muslim University, India

Bachelor's Thesis

September 2015 – June 2016

Advisor: Prof. M.F. Baig

- Developed and validated Fortran codes for designing Scramjets and analyzed its performance during unstart.
- Proposed Single-Input-Single-Output mechanism based on pressure feedback to avert engine unstart.

## **Effective Lewis Number for Multicomponent Hydrocarbon-Air Mixtures**

IIT-Delhi, India

Summer Research Intern

June 2015 – August 2015

Advisor: Prof. M.R. Ravi

- Analyzed combustion characteristics of methane and natural gas mixtures with varying hydrogen blending.
- Performed the experiments using constant pressure combustion chamber apparatus with Schlieren imaging.
- Simulated the corresponding flames in 1D on CHEMKIN using PREMIX module.

## **INDUSTRIAL EXPERIENCE AND PROJECTS**

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### **Hummingbird – Wearable Device for Exchanging Information**

MIT & Hong Kong Innovation Node

Co-founder (US based Startup Project)

May 2018 – February 2019

- Ideated and validated consumer problems and market opportunities through market research.
- Designed prototype on AutoCAD, fabricated using 3D printing, and implemented fast & accurate algorithms.
- Received MIT Sandbox Innovation Fund worth \$5000 and won both Judge's & Audience Awards at MIT Entrepreneurship and Maker Skills Integrator program (2018).

### **Industrial Compressors and Gas Turbines**

Gas Authority of India Limited, India

Summer Intern

June 2014 – July 2014

- Worked at a C2C3 plant at GAIL, participating in its pre-commissioning and commissioning testing.
- Studied the working of several industrial compressors and a gas turbine (Siemens SGT700).

### **Formula Student Race Car and Hybrid Tricycle**

Society of Automotive Engineers, Aligarh Chapter

Technical Member & Team Lead

January 2013 – June 2014

- Conceptualized ergonomically designed the vehicles with improved aerodynamic performance.
- Designed the vehicles on AutoCAD, simulated on ANSYS, and then finally fabricated.

## **TRAVEL GRANTS AND FUNDED SHORT SCHOOLS**

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### **Center for Planetary Systems' Habitability Student Travel Funding Award**

February 2022

Awarded a travel grant to attend the LPSC 2022.

### **AGU Fall Meeting Grant**

December 2021

Awarded a travel grant to attend the AGU Fall Meeting 2021.

### **SIAM Student Travel Award**

June 2021

Awarded a student travel grant to attend the SIAM Annual Meeting 2021.

### **ICOSAHOM Conference Travel Grant**

July 2018

Awarded a student travel grant to attend the International Conference on Spectral And High Order Methods at Imperial College London.

### **Numerical Simulations ICNM 2017 Conference Travel Grant**

July 2017

Awarded full funding from HKUST for attending the 5th International Conference on Numerical Simulations for Multimaterial and Multiphysics Problems in China.

### **Advanced Research in Turbomachinery Summer School Grant**

July 2019

Received a scholarship of EUR800 to attend this summer school organized by the University of Florence, Italy and sponsored by ANSYS and GE.

<b>MIT StartMIT Course Grant</b>	January 2019
Received full sponsorship from MIT Martin Trust Center to attend this hands-on MIT course on entrepreneurship involving multiple trips to companies within USA.	
<b>Fluid Dynamics across Scales Summer School Grant</b>	July 2018
Received full-funding from HKUST to attend the Centre for Doctoral Training in Fluid Dynamics across Scales at Imperial College London.	
<b>MIT Entrepreneurship and Maker Skills Integrator Bootcamp Funding</b>	June 2018
Received full funding from MIT and Hong Kong Innovation Node to attend the program involving trips to startup incubators in China.	

## HONORS AND AWARDS

<b>NASA Jet Propulsion Laboratory Graduate Fellowship</b> 	April - June 2022
To study effect of climate change on Greenland ice sheet with Dr. Surendra Adhikari at JPL.	
	9,000USD
<b>MIT - Houston Energy Innovation Student Fellow</b> 	March 2022
Representing UT Austin as a liaison between MIT's Martin Trust Center and Greentown Labs.	
<b>Lunar and Planetary Institute Career Development Award</b> 	Feb 2022
For first author abstract and application materials submitted at LPSC 2022.	
	1,000USD
<b>UT Austin Cactus Standout Award (estd. 1894)</b> 	April 2022
For academic excellence and leadership contributions. Inducted into Annual Yearbook, 2022.	
<b>Student Research Award in Planetary Habitability by Cent. for Planetary Sys. Habitability</b> 	Jan 2021
For proposal on finding life-supporting conditions on Europa using computational methods.	
	16,425USD
<b>Outstanding Student Presenters Award by Unsaturated Zone Technical Committee, AGU</b> 	Dec 2021
Third prize for oral presentation: H52D-10 Rainwater Infiltration at AGU Fall Meeting 2021. 	
	175USD
<b>Featured in Oden Institute's article on "How To Stay Productive While in Quarantine"</b> 	March 2021
For academic & research achievements and service to the SIAM Chapter at Oden Institute.	
<b>SIAM Certificate of Recognition by Society for Industrial and Applied Mathematics</b>	February 2021
For outstanding service and contributions to the UT Austin Student Chapter of SIAM.	
<b>University of Texas Institute for Geophysics Student Fellowship by UTIG, UT Austin</b>	January 2021
Year-long fellowship covering tuition, insurance & stipend awarded for collaborative research.	
	2491USD/month
<b>Best Teaching Assistant Award - II by Dept of Mech &amp; Aero Engg, HKUST</b>	August 2018
Awarded for MECH-1907 Introduction to Aerospace Engineering course based on student surveys and jury of professors.	
	300HKD
<b>Judge's Award and Audience Award at MIT MEMSI Program</b>	June 2018
Awarded by MIT and Hong Kong Innovation Node to best startup idea & pitch in the program.	
<b>Outstanding Contribution in Reviewing Recognition by Journal of Computational Physics</b>	June 2018
For being in the top 10th percentile of reviewers.	
<b>Postgraduate Studentship by HKUST</b>	Aug 2016 – Sept 2018
Competitive stipend for research postgraduate students (M.Phil.) at HKUST.	
	USD2150/month
<b>Global Scholar Award by Sir Syed Education Society of North America</b>	May 2015
For top 20 students of AMU based on their academic achievements and research, for higher education.	
	USD1000
<b>National Summer Research Fellowship by Indian Academy of Sciences</b>	March 2015
Awarded national fellowship to pursue research in Indian research institutes like IITs/IISc.	
	USD220/month
<b>University Merit Scholarship by AMU Alumni Association Toronto, Canada</b>	March 2015
Merit based scholarship for students pursuing education at AMU.	
	USD70

## TEACHING EXPERIENCE

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<b>MECH-3690 Aerospace Engineering Laboratory</b> The Hong Kong University of Science and Technology <i>Instructor:</i> Prof. Jinglei Yang	Spring 2017 Hong Kong
<b>MECH-1907 Introduction to Aerospace Engineering</b> The Hong Kong University of Science and Technology <i>Instructor:</i> Prof. Rhea Liem	Spring 2018 Hong Kong

For all teaching feedback reports, click [↗](#).

## REVIEWER FOR TECHNICAL JOURNALS

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**Geoscience:** Computational Geoscience, Water Resources Research  
**Fluid Mechanics:** Journal of Fluid Mechanics, Physical Review Fluids, Springer Nature  
**Numerical Methods:** Journal of Computational Physics, Computer and Fluids

## COMMUNITY INVOLVEMENT

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<b>MIT - Houston Energy Innovation Student Fellow</b> <a href="#">↗</a> Creating energy innovation ecosystem considering the threat of climate change.	March 2022 – Present
<b>Geoscience Ambassador, Jackson School of Geosciences, UT Austin</b> <a href="#">↗</a> Making geoscience accessible to broader scientific community & promoting interdisciplinary research. Austin, USA	Sept 2021
<b>Session Chair, Society for Industrial &amp; Applied Mathematics Annual Meeting 2021</b> <a href="#">↗</a> Chaired the “CP15: Machine Learning and Data Mining” Session.	July 2021 Virtual
<b>President, Society for Industrial &amp; Applied Mathematics, Austin Chapter</b> <a href="#">↗</a> Spearheaded several programs & Won Best Graduate Organization at UT Austin Award.	Sept 2020 – Present Austin, USA
<b>Mentor, Mentoring365, American Geophysical Union</b> <a href="#">↗</a> Facilitating an exchange of professional knowledge, skills, and experiences in Earth and space sciences.	Aug 2021 – Present Virtual
<b>Mentor, SIAM Applied Mathematics Mentorship</b> <a href="#">↗</a> Conceptualized the program and mentoring UT students for applied math concepts and prospects.	Jan 2021 – Present Austin, USA
<b>Mentor, Sir Syed Global Scholar Award</b> <a href="#">↗</a> Mentoring top AMU students from humble backgrounds for US grad school applications.	Jan 2016 – Present Aligarh, India
<b>Vice-Chairperson, American Society of Mechanical Engineers, Aligarh Chapter</b> <a href="#">↗</a> Organized various events including paper presentation and annual technical festival.	Sept 2014 – June 2016 Aligarh, India
<b>Zonal Head &amp; College Head Ambassador, Smilyo Educational Charitable Society</b> <a href="#">↗</a> Managed multi-university teams & provided educational resources to not-so-privileged.	Jan 2014 – Jan 2015 New Delhi, India
<b>Senior Under Officer, National Cadet Corps, Govt. of India (Similar to ROTC)</b> <a href="#">↗</a> C certificate holder, best cadet, organized blood donation, awareness, & army camps	Jan 2013 – April 2015 Aligarh, India

## SKILLS

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**Languages:** C, C++, Fortran 77/90, Python (SciPy, NumPy, Matplotlib, Pandas, Tensorflow, Tkinter), MATLAB, Mathematica, Shell Scripting,  $\LaTeX$ , High Performance Computing  
**Software:** AutoCAD, SolidWorks, ANSYS, Fluent, COMSOL Multiphysics, TecPlot, ParaView, CHEMKIN, COSILAB, Microsoft Office, Git, Travis CI, Docker  
**OS:** Linux, Windows, Mac

## STUDENT MEMBERSHIP

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Society for Industrial and Applied Mathematics  
American Geophysical Union  
American Physical Society

## PEER REVIEWED PUBLICATIONS

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- Shadab, M.A.**, Luo, D., Shen, Y., Hiatt, E. and Hesse, M.A., 2021. Investigating Steady Unconfined Groundwater Flow using Physics Informed Neural Networks. arXiv preprint arXiv:2112.13792. (under review in Water Resources Research)
- Shadab, M.A.**, Balsara, D., Shyy, W. and Xu, K., 2019. Fifth order finite volume WENO in general orthogonally - curvilinear coordinates. *Computers & Fluids* (Elsevier), 190, pp.398-424.
- Shadab, M.A.**, Ji, X. and Xu, K., 2018. Fifth-order finite-volume WENO on cylindrical grids. *Spectral and High Order Methods for Partial Differential Equations* (Springer), p.637.

## CONFERENCES

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- Shadab, M.A.**, Hiatt, E., and Hesse, M.A., 2022. Estimates of Martian mean recharge rates from analytic groundwater models. 53rd Lunar and Planetary Science Conference 2022, Abstract #1775.
- Hiatt, E., **Shadab, M.A.**, et al, 2022. Estimates of groundwater divides and basins on Noachian Mars. 53rd Lunar and Planetary Science Conference 2022, Abstract #2618.
- Shadab, M.A.**, Grima, C., Rutishauser, A., and Hesse, M.A., 2021. Analytical Solutions for Melt Percolation in Ice Masses and a Pathway to Ice Lens Formation. 2021 AGU Fall Meeting.
- Shadab, M.A.**, and Hesse, M.A., 2021. Fluid Infiltration in Unsaturated Porous Medium with The Development of a Saturated Region. 2021 AGU Fall Meeting.
- Hesse, M.A., **Shadab, M.A.**, Luo, D., Shen, Y., and Hiatt, E., 2021. Investigating Groundwater Flow Dynamics using Physics Informed Neural Networks (PINNs). 2021 AGU Fall Meeting.
- Hiatt, E., **Shadab, M.A.**, et al, 2021. Experimental and Numerical Investigation of Seepage Face Dynamics. 2021 AGU Fall Meeting.
- Hesse, M.A., **Shadab, M.A.**, Hiatt, E., Liebeck, J., 2021. Groundwater-ocean interaction on Mars. 2021 AGU Fall Meeting.
- Hiatt, E., **Shadab, M.A.**, et al, 2021. Numerical Modeling of the Formation of Hellas Planitia with Focus on Spatio-Temporal Scales Required for Hydrologic Equilibration. 2021 AGU Fall Meeting.
- Shadab, M.A.**, Luo, D., Shen, Y., Hiatt, E., and Hesse, M.A., 2021. Investigating fluid drainage from the edge of a porous reservoir using Physics Informed Neural Networks. 2021 SIAM Annual Meeting.
- Shadab, M.A.**, Divoux, T. and Bischofberger, I., 2020. Suppression of drop breakup in a viscoelastic bath. *Bulletin of the American Physical Society*.
- Hiatt, E., **Shadab, M.A.** et al., 2020. Groundwater filling times for large impact basins on early Mars and implications for the onset of post impact hydrothermal systems. American Geophysical Society 2020 Fall Meeting.
- Shadab, M.A.**, Ji, X. and Xu, K., 2018. Fifth-order finite-volume WENO on Cylindrical Grids: Flux Evaluation Using Riemann Solvers and Gas-kinetic Scheme. In *International Conference on Spectral And High Order Methods (ICOSAHOM)*, Imperial College London.
- Shadab, M.A.**, and Xu, K., 2017. Fifth order finite volume WENO in orthogonally-curved coordinates. In 5th *International Conference on Numerical Simulations for Multimaterial and Multiphysics Problems*.
- Shadab, M.A.** and Baig, M.F., 2017. Investigation and Control of Unstart Phenomenon in Scramjets. In 21st *AIAA International Space Planes and Hypersonics Technologies Conference* (p. 2298).

## SOFTWARES

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- Shadab, M.A.**, Luo, D., Shen, Y., Hiatt, E., and Hesse, M.A., 2021. PINNs for Unconfined Groundwater Flow (v1.0). Zenodo. <https://doi.org/10.5281/zenodo.5803542>

## REFERENCES

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- Prof. Marc Hesse**, Associate Professor of Geological Sciences, UT Austin, USA      mhesse@jsg.utexas.edu  
Relationship: *PhD Thesis Advisor*, Knows for last 3 years
- Prof. Irmgard Bischofberger**, Assistant Professor of Mechanical Engineering, MIT, USA      irmgard@mit.edu  
Relationship: *Visiting Student Research Advisor*, Knows for last 3 years
- Prof. Kun Xu**, Chair Professor of Mathematics, HKUST, Hong Kong      makxu@ust.hk  
Relationship: *MPhil Thesis Advisor*, Knows for last 6 years