

Akhlaq Husain

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Research Interests

Partial Differential Equations

Numerical Analysis

Fractal Geometry

Parallel/Scientific Computing

Education

Ph.D., Mathematics (2011),

Indian Institute of Technology Kanpur, India

Thesis Title: *$h - p$ Spectral Element Methods for Three Dimensional Elliptic Problems on Non-smooth Domains using Parallel Computers*

Adviser: Prof. Pravir K. Dutt

Co-advisor: Prof. A.S. Vasudeva Murthy (Tata Institute of Fundamental Research, Bangalore, India)

M.Sc., Mathematics (2003), Aligarh Muslim University Aligarh, India.

B.Sc. (Hons.) (2001), Aligarh Muslim University Aligarh, India.

Teaching & Employment

06/2023–Till date Associate Professor (Mathematics), Jamia Millia Islamia New Delhi

06/2016–05/2023 Associate Professor (Mathematics), BML Munjal University Gurgaon

11/2012–03/2016 Assistant Professor (Mathematics), LNMIIT Jaipur

08/2010–10/2012 Lecturer (Mathematics), LNMIIT Jaipur

06/2010–07/2010 Project Senior Research Assistant, Department of Aerospace Engineering, IIT Kanpur

01/2010–05/2010 Project Fellow, Department of Mechanical Engineering, IIT Kanpur

08/2009–11/2009 Teaching Assistant, IIT Rajasthan, IIT Kanpur Campus

08/2006–04/2009 Teaching Assistant, IIT Kanpur

Fellowships

May 2017 Swiss Government Excellence Post-doctoral Scholarship 2016-2017 by the Govt. of Switzerland to be carried out at the University of Geneva (awarded for September 2017-August 2018 but not availed).

December 2015	ERCIM ABCDE Post-doctoral Fellowship awarded by the European Union (awarded for May 2016-April 2017 but not availed).
August 2010	NBHM Post-Doctoral Fellowship (No. 2/40(21)/2010-R&D-II/8104) from the National Board of Higher Mathematics (NBHM), Department of Atomic Energy(DAE).
08/2004–07/2006	Junior Research Fellowship from the Council of Scientific and Industrial Research (CSIR), New Delhi, INDIA.
08/2006–07/2009	Senior Research Fellowship from the Council of Scientific and Industrial Research (CSIR), New Delhi, INDIA.

Publications

Research Articles

- **Mohammad Sajid, Akhlaq Husain, Jaideep Reddy, Mohammad T. Alresheedi, Sulaiman A. Al Yahya, Ahmed Al-Rajy (2023):** “Box dimension of the border of Kingdom of Saudi Arabia”, *Heliyon*, Vol. 9 (4), e14846.
- **Akhlaq Husain, Manikyala Navaneeth Nanda, Movva Sitaram Chowdary, Mohammad Sajid (2022):** “Fractals: An Eclectic Survey, Part-II”, *Fractals & Fractional* (MDPI), Vol. 6, 379.
- **Akhlaq Husain, Manikyala Navaneeth Nanda, Movva Sitaram Chowdary, Mohammad Sajid (2022):** “Fractals: An Eclectic Survey, Part-I”, *Fractals & Fractional* (MDPI), Vol. 6, 89.
- **Akhlaq Husain, Jaideep Reddy, Deepika Bisht, Mohammad Sajid (2022):** “Fractal dimension of India using multi-core parallel processing”, *Computers and Geosciences* (Elsevier), Vol. 159, 104989.
- **Akhlaq Husain, Jaideep Reddy, Deepika Bisht, Mohammad Sajid (2021):** “Fractal dimension of coastline of Australia”, *Scientific Reports (Nature)*, Vol. 11, 6304.
- **Akhlaq Husain, Karthik Gomada, Manogna Megham and Seemakruthi Ashish (2021):** “Fractal reptiles of \mathbb{R}^2 and \mathbb{R}^3 using integer matrices”, *Fractals*, Vol. 29 (2), 2150027.
- **Akhlaq Husain and Arbaz Khan (2017):** “Least-squares spectral element preconditioners for fourth order elliptic problems”, *Computers and Mathematics with Applications*, Vol. 74, Issue 3, Pages 482-503.
- **Arbaz Khan and Akhlaq Husain (2017):** “Exponentially accurate spectral element method for fourth order elliptic problems”, *Journal of Scientific Computing*, Vol. 71(1), 303-328.
- **Arbaz Khan, Akhlaq Husain, Subhashree Mohapatra and CS Upadhyay (2017):** “Spectral element methods for three dimensional elliptic interface problems”, *Computer Methods in Applied Mechanics and Engineering*, Vol. 315, 1, 522-549.
- **P. Dutt, Akhlaq Husain, A.S. Vasudeva Murthy and C.S. Upadhyay (2016):** “ $h - p$ Spectral element methods for three dimensional elliptic problems on non-smooth domains, Part-III: Error estimates, preconditioners, computational techniques and numerical results”, *Computers and Mathematics with Applications*, Vol. 71, Issue 9, 1745-1771.
- **Subhashree Mohapatra and Akhlaq Husain (2016):** “Least-squares $h-p$ /spectral element methods for Stokes equations”, *Applied Numerical Mathematics*, Vol. 102(C), 31-54.
- **P. Dutt, Akhlaq Husain, A.S. Vasudeva Murthy and C.S. Upadhyay (2015):** “ $h - p$ Spectral element methods for three dimensional elliptic problems on non-smooth domains, Part-I: Regularity estimates and stability theorem”, *Proceedings: Mathematical Sciences (Springer)*, Vol. 125, Issue 2, 239-270.
- **P. Dutt, Akhlaq Husain, A.S. Vasudeva Murthy and C.S. Upadhyay (2015):** “ $h - p$ Spectral element methods for three dimensional elliptic problems on non-smooth domains, Part-II: Proof of the stability theorem”, *Proceedings: Mathematical Sciences (Springer)*, Vol. 125, Issue 3, 413-447.
- **P. Dutt, Akhlaq Husain, A.S. Vasudeva Murthy and C.S. Upadhyay (2014):** “ $h - p$ Spectral element methods for three dimensional elliptic problems on non-smooth domains”, *Applied Mathematics and Computation*, Vol. 234, 13-35.

Book Chapters

- **Akhlaq Husain (2022):** “*Fractal reptiles of the Plane using Reflections and Rotations*”, in **Computing and Simulation for Engineers**, <https://doi.org/10.1201/9781003222255-9> (CRC Press).

Projects

Title: “*Analysis and Modelling of Atmospheric Boundary Layers using Spectral Element Method*”.

Project No.: *NBHM 02011-18-2022-R&D-II-10510*

Duration: 2022-2025

Funding Agency: National Board for Higher Mathematics, Department of Atomic Energy, Mumbai.

Title: “*Mathematical modelling of stationary heat diffusion in heterogeneous materials*”.

Project No.: *MTR/2019/000051*

Duration: 2020-2023

Funding Agency: MATRICS Scheme, Science and Engineering Research Board (SERB), New Delhi.

Title: “*Least-squares conforming $h - p$ spectral element methods for three dimensional elliptic problems on non-smooth domains using parallel computers*”.

Project No.: *SR/S4/MS: 745/12*

Duration: 2014-2017

Funding Agency: EMR Scheme, Science and Engineering Research Board (SERB), New Delhi.

Academic Activities

National/International Conference Papers

- **Akshintala S. Kumar, Utsav Sharma, Yashita Kumar, Akhlaq Husain:** “*An elementary proof of the count of semiprimes and sphenic numbers and their distribution using Ulam and polar spirals*” presented in the **International Conference on Number Theory and Graph Theory (ICNG-2023)**, Manipal Institute of Technology, Manipal, Karnataka during January 18-20, 2023.
- **Akhlaq Husain, Jaideep Reddy, Mohammad T. Alresheedi, Mohammad Sajid:** “*Fractal Dimension of KSA using box-counting method based on Multicore Processing Algorithm*” presented in the **International Conference on Nonlinear Analysis and Applications (ICNNA-2022)**, Assam Don Bosco University Guwahati, Assam during November 22-23, 2022.
- **Akhlaq Husain, Mohammad Sajid:** “*Fractal Reptiles of the Plane using Rotations and Integer Matrices*” presented in the **International Conference on Nonlinear Dynamics and Applications (ICNDA-2022)**, SMIT Sikkim, Sikkim during March 9-11, 2022.
- **Arbaz Khan, Akhlaq Husain, Subhashree Mohapatra and CS Upadhyay:** “*Exponentially accurate spectral element methods for 3D elliptic problems with smooth interfaces*” presented in the **NBHM Conference on Computational and Theoretical PDEs (CCT-PDE-2016)**, NIT Goa, Goa during October 5-7, 2016.
- **Akhlaq Husain and Subhashree Mohapatra:** “*Least-squares spectral element methods for 3D elliptic/Stokes eigenvalue problems*” presented in the **8th International Congress of Industrial and Applied Mathematicians (ICIAM-2015)**, Beijing, China during August 10-14, 2015.
- **Akhlaq Husain and Arbaz Khan:** “*Preconditioners for fourth order elliptic problems*” presented in the **6th International Conference on High Performance Scientific Computing (HPSC-2015)**, Hanoi, Vietnam during March 16-20, 2015.
- **Akhlaq Husain and Arbaz Khan:** “*Least-squares spectral element methods for fourth order elliptic problems*” presented in the **International Conference On Spectral And Higher Order Methods (ICOSAHOM-2014)** held at Salt Lake City, Utah, USA during June 23 – 27, 2014.
- **Subhashree Mohapatra and Akhlaq Husain:** “*Least-squares spectral element methods for 3D Stokes equations*” presented in the **International Conference On Spectral And Higher Order Methods (ICOSAHOM-2014)** held at Salt Lake City, Utah, USA during June 23 – 27, 2014.

- **Pravir K. Dutt, Akhlaq Husain, A.S. Vasudeva Murthy and C.S. Upadhyay:** Presented a paper entitled “*Preconditioners for three dimensional elliptic problems on non-smooth domains*” in the 5th International Conference on High Performance Scientific Computing (HPSC-2012), Hanoi, Vietnam during March 05 – 09, 2012.
- **Pravir K. Dutt, Akhlaq Husain, A.S. Vasudeva Murthy and C.S. Upadhyay:** Presented a paper on “*Non-conforming $h - p$ Spectral element methods for three dimensional elliptic problems on non-smooth domains using parallel computers*” in the 7th International Congress of Industrial and Applied Mathematicians (ICIAM-2011), Vancouver, British Columbia, Canada held during July 18 – 22, 2011.
- **Pravir K. Dutt, Akhlaq Husain, A.S. Vasudeva Murthy and C.S. Upadhyay:** Poster on “ *$h - p$ Spectral element methods for three dimensional elliptic problems on non-smooth domains using parallel computers*” in the SIAM Conference on Mathematical Aspects of Computational Geosciences held at Long Beach, California, USA during March 21–24, 2011.
- **Pravir K. Dutt, Akhlaq Husain, A.S. Vasudeva Murthy, C.S. Upadhyay and Rukmini Dey:** “ *$h - p$ Spectral element methods for three dimensional elliptic problems on non-smooth domains*” presented by Prof. Pravir Dutt in the International Conference On Spectral And Higher Order Methods (ICOSAHOM-2009) held at NTNU, Toronhiem, Norway during June 22 – 26, 2009 as an invited talk.
- **Pravir K. Dutt, Akhlaq Husain, A.S. Vasudeva Murthy and Rukmini Dey:** “*Non-conforming $h - p$ spectral element methods for 3D elliptic problems on non-smooth domains*” presented in the National Meet of Research Scholars in Mathematical Sciences (NMRSMS-2007) held at IIT Kanpur during Oct. 30 - Nov. 03, 2007.

Invited Talks/Lectures in Workshops/Seminars/Conferences

- Invited talk in the **Conference in memory of Prof. Pravir Dutt, Prof. Arbind K Lal and Prof. Sudipta Dutta** at IIT Kanpur during Nov 05 – 07, 2022.
- Invited talk in the **Conference on PDE and Numerical Analysis** at Tata Institute of Fundamental Research Bangalore during April 28 – 30, 2022.
- Lectures on Spectral Element Methods in the TEQIP-III workshop on **Mathematical Modelling using High Performance Numerical Computations** at NIT Silchar, Assam, during Sept 29-Oct 03, 2018.
- Delivered guest lectures as part of a M.Sc. (Mathematics) core course on **Partial Differential Equations** at the *Central University of Kashmir, Srinagar* during June 08 – 14, 2017.
- Delivered guest lectures as part of a M.Sc. (Mathematics) core course on **Partial Differential Equations** at the *Central University of Kashmir, Srinagar* during June 20 – 25, 2016.
- Lecture series on **Partial Differential Equations** at the *Central University of Kashmir, Srinagar* during June 02 – 14, 2014.
- Invited lecture on **$h - p$ Spectral Element Methods for Three Dimensional Elliptic Problems on Non-smooth Domains** in the Indo-German conference on *Modelling, Simulation and Optimization in Applications* at TU Darmstadt, Germany during September 05 – 07, 2012.
- Lecture series on **$h - p$ Finite/Spectral Element Methods** in the *Instructional Workshop on FEM* at TIFR Bangalore during July 02 – 13, 2012.

Workshops/Seminars/Conferences Organized

- Convener of the *International Conference on Computational Partial Differential Equations and Applications (ICCPDEA-2022)*, September 06-08, 2022, BMU Gurgaon, India. (Funded by: NBHM, SERB, Rockman Industries, Hero Electric, BatX Energies, BMU Gurgaon)
- Coordinator of the *4th BRICS Mathematics Conference-2021* held at IISER Thiruvananthapuram, Kerala, Dec 07-10, 2021. (Funded by: NBHM, IISER TVM, BMU Gurgaon)
- Coordinator of the *Undergraduate Level Training (UG-2015)* under the auspices of National Programme on Differential Equations: Theory Computation and Applications (NPDE-TCA), IIT Bombay, May 18-June 06, 2015, LNMIIT Jaipur, India. (Funded by: NPDE-TCA (DST), LNMIIT Jaipur)

- Convener of the *Conference on Partial Differential Equations (CPDE-2014)*, December 10-11, 2014, LNMIIT Jaipur, India. (Funded by: National Board for Higher Mathematics (NBHM), LNMIIT Jaipur)
- Coordinator of the *Advanced Workshop on Hyperbolic PDEs: Theory, Numerics & Applications (HPTNA-2014)*, December 01-09, 2014, LNMIIT Jaipur, India. (Funded by: National Board for Higher Mathematics (NBHM), Department of Science & Technology, New Delhi & LNMIIT Jaipur)
- Coordinator of the *Workshop on GPU Computing*, August 09-10, 2014, LNMIIT Jaipur, India.
- Coordinator of the workshop on *Elliptic Equations: Variational Formulation & Numerics (EEVFN-2013)*, December 09-20, 2013, LNMIIT Jaipur, India. (Funded by: National Board for Higher Mathematics (NBHM), LNMIIT Jaipur)

Institution Building Activities (August 2010- March 2016) at LNMIIT Jaipur

- Oct 2014–Jan 2016: Head, Department of Mathematics.
- Jan 2015–Mar 2015: Developed Central GPU Lab.
- Jan 2014–Jul 2014: Developed HPC Lab.
- Dec 2013–Jan 2016: Member, Institute Library Committee.
- Jan 2012–Dec 2015: Warden, Boys Hostel-III.
- May 2013–Apr 2014: Head, Institute Counselling Team.
- 2011–2012: Member, AC UGC.
- 2011–2012: Associate Warden, Boys Hostel-I.
- 2012–2013: Member, UG Admissions Committee.
- 2011–2012: Member, PG Admissions Committee.

Institution Building Activities (June 2016-May 2023) at BMU Gurgaon

- Nov 2021–June 2022: Coordinator (Ph.D. Program).
- Aug 2018–May 2023: Faculty Mentor (Sci-Mat Club).
- Dec 2018–July 2019: Member, UG Admissions Team.
- Sep 2021–May 2023: Member, University Library Committee.

Conferences/Workshops/Seminars/Symposia Participation

- Participated in the *8th Annual International Conference on Algorithms and Discrete Applied Mathematics (CALDAM-2022)* during February 10-12, 2022 at the Pondicherry University, Puducherry.
- Participated in the *Third MTA Conference (online) 2021 on Rethinking Mathematics Education during the Pandemic: Insights from experience* held during Sep 03-05, 2021.
- Participated in the *Workshop on Parallel Finite element Computing using ParMooN*, held at CDS, Indian Institute of Science Bangalore during October 14-18, 2019.
- Participated in the workshop on *Computational Imaging* held at the Institute for Computational and Experimental Research in Mathematics (ICERM), Brown University, Providence, RI, USA during March 18-22, 2019.
- Participated in the faculty development programme (FDP) on *High Performance Computing (HPC) of Computational Fluid Dynamics Problems* organized by the E& ICT Academy, NIT Warangal during December 24-29, 2018.
- Participated in the workshop on *Numerical Techniques for Partial Differential Equations-NTPDE* held at VNIT Nagpur during July 10-14, 2017.
- Participated in the *GYAN Course on Finite Element Method: Theory & Programming* held at IIT Hyderabad during July 14-24, 2016.
- Participated in the *Advanced Level Workshop on Variational Inequality (VI) & Applications* under the auspices of NPDE-TCA (IIT Bombay) held at the Sharda University, Knowledge Park-III, Greater Noida during January 24-28, 2016.

- Presented a paper in the *International Conference on Current Trends in PDEs: Theory & Computations*, held at South Asian University, New Delhi during December 28-30, 2015.
- Presented a paper in the *International Conference on analysis and its Applications (ICAA-2015)* held at Aligarh Muslim University, Aligarh, during December 19-21, 2015.
- Participated in the *Advanced Summer School on Control and Numerics for Fluid-Structure Interaction Problems* held at TIFR Bangalore during June 22-26, 2015.
- Presented a paper in the *Conference on Computational PDE, Finite Element Meet (FEMEET-2014)* held at TIFR Bangalore during December 18-20, 2014.
- Participated in the *NPDE-TCA Advanced Workshop on Finite Element Methods for Navier-Stokes Equations (FEMNSE-2014)* held at SERC, Indian Institute of Science Bangalore during September 08-12, 2014.
- Participated in the *Humboldt Kolleg on Interdisciplinary Science: Catalyst for Sustainable Progress* held at Indian Institute of Science Bangalore during September 03-06, 2014.
- Participated in the *ETH Zurich Summer School on Advanced Numerical Methods for Non-local Operators (ZSS-2014)* held at ETH Zurich (Switzerland) during August 18-22, 2014.
- Participated in the *CIMPA Research School on Partial Differential Equations: Analysis, Numerics and Applications to flood and Tsunamis* held at the University of Philippines, Diliman, Manilla (Philippines) during June 23 - July 04, 2014.
- Participated in the *Advanced Instructional School on Theoretical and Numerical Aspects of Inverse Problems* held at TIFR Bangalore, during June 16-27, 2014.
- Participated in *Advanced Workshop on Computational Methods for Integral Equations & Applications (AWCMIEA-2014)* held at IIT Kanpur, during January 13-17, 2014.
- Participated in workshop on *Stabilization Methods for Singularly Perturbed Differential Equations* held at IISc Bangalore, during October 03-05, 2013.
- Participated in the workshop on *Nonlinear Differential Equations: Dynamics of Complex Systems (NEDECS-2013)* held at Kolkata University, during September 23-28, 2013.
- Participated in the compact course on *Compact course on Discontinuous Galerkin method for time-dependent convection-dominant PDEs* held at TIFR Bangalore, during July 04-05, 2013.
- Participated in the *International Conference on Conservation Laws and Applications* held at TIFR Bangalore, during July 01-03, 2013.
- Participated in the workshop on *Theoretical and Computational Aspects of Nonlinear Waves (TCANW-2013)* held at IIT Bombay, during May 27-31, 2013.
- Participated in the International Conference on *Matrices and Operators* held at IISc Bangalore, during December 26-30, 2012.
- Participated in the International Conference on *The Legacy of Srinivasa Ramanujan* held at the University of Delhi during December 17-22, 2012.
- Participated in the ICTS winter school on *Stochastic Analysis and Control of Fluid Flow* held at the School of Mathematics, Indian Institute of Science Education and Research (IISER), Thiruvananthapuram during December 03-20, 2012.
- Participated in *The 27th Annual Conference of the Ramanujan Mathematical Society* held at Shiv Nadar University, Noida, during October 20-23, 2012.
- Participated in the *5th International Conference on High Performance Scientific Computing (HPSC-2012)*, Hanoi, Vietnam during March 05-09, 2012.
- Participated in the *Non-linear Functional Analysis Conference (NFA)* held at the Institute of Mathematical Sciences (IMSC), Chennai, during January 18-20, 2012.
- Participated in the *International Conference on analysis and its Applications (ICAA-2011)* held at Aligarh Muslim University, Aligarh, during November 19-21, 2011.
- Participated in *The 26th Annual Conference of the Ramanujan Mathematical Society* held at Allahabad University, Allahabad, during October 02-05, 2011.

- Participated in the *7th International Congress of Industrial and Applied Mathematicians (ICIAM-2011)* held at Vancouver, British Columbia, Canada, during July 18-22, 2011.
- Participated in the *SIAM Conference on Mathematical Aspects of Computational Geo-Sciences* held at Long Beach, California, USA during March 21-24, 2011.
- Participated in the *Conference on Mathematical Foundations of Quantum Mechanics* held at IISER Kolkata, during December 16-21, 2010.
- Participated in the *Lecture Series on Waring's Problem* held at IISER Kolkata, during December 13-17, 2010.
- Participated in *The International Congress of Mathematicians ICM-2010* held at Hyderabad, during August 17-19, 2010.
- Participated in *ICM Satellite Conference on PDE and Related Topics* held at TIFR-CAM Bangalore, India, during August 13-17, 2010.
- Participated in *The International Conference on Multi-scale Analysis and Homogenization* held at IISc Bangalore, during July 12-14, 2010.
- Participated in *The Annual Conference of the Ramanujan Mathematical Society* held at NIT Jalandhar, during May 03-05, 2010.
- Participated in *Indo-German Conference on PDE, Scientific Computing and Optimization in Applications* held at IIT Kanpur, during October 07-09, 2009.
- Attended *Homi Bhabha Symposium on Hyperbolic PDE's and Related Topics* held at TIFR-CAM Bangalore, during July 20-24, 2009.
- Participated in *International Conference on Computational Partial Differential Equations (ICCPDE)* held at IIT Bombay, during December 10-13, 2008.
- Attended a workshop on *Computational Partial Differential Equations* held at IIT Bombay, during December 07-09, 2008.
- Participated in the *Research Workshop in Optimization Theory and Application* held at IIT Kanpur, during September 03-06, 2008.
- Attended *National Symposium on Hyperbolic PDEs* held at IIT Bombay, during July 14-17, 2008.
- Attended *National Instructional Workshop on Harmonic Analysis* held at IIT Kanpur, during May 14-24, 2008.
- Participated in a *National Convention on Value Education* through Jeevan Vidya held at IIT Delhi from May 22-24, 2007.
- Participated in the *National Meet of Research Scholars in Mathematical Sciences (NMRSMS)* held at IIT Kanpur during October 30 - November 03, 2007.
- Attended an *International Conference on Topics in Functional and Numerical Analysis (TOFNA-05)* during December 07-09, 2005 held at IIT Bombay.
- Attended a Conference on *Recent Trends in Algebra and Analysis* held at Department of Mathematics AMU Aligarh during March 03-05, 2003.
- Attended a summer school namely *Mathematical Training & Talent Search Program (MTTS)* funded by the National Board for Higher Mathematics (NBHM), Govt. of India, held at IIT Bombay during May 20 - June 15, 2002.

Membership of Professional Bodies/Societies

- **Associate Member**, Institute of Mathematics and its Applications (IMA), UK [*Membership Number P0044476*].
- **Outreach Member**, Society of Industrial and Applied Mathematics (SIAM), USA [*Membership Number 001068770-0*].
- **Life Member**, Indian Society of Industrial and Applied Mathematics (ISIAM), INDIA [*Membership Number H-09*].
- **Life Member**, Indian Mathematical Society (IMS), INDIA [*Membership Number H-12-02*].
- **Life Member**, Ramanujan Mathematical Society (RMS), INDIA [*Membership Number 727*].

January 10, 2024