Prashant K. Jha

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Summary

I am the Principal Investigator of the Computational Engineering Analysis and Design (CEAD) Lab at South Dakota Mines. My research uses mechanics, applied mathematics, and computational science to understand and represent the complex behavior of materials, e.g., multiphysics effects in materials, material damage, crack propagation, and high-fidelity simulation of granular media involving arbitrarily shaped particles and particle breakage. Currently, the lab, with the help of several undergraduate students, is working on topology optimization of functional materials, fracture and fatigue in composite materials, and multi-fidelity mechanics of granular media.

Positions

Assistant Professor Sep 2024 – present	Department of Mechanical Engineering *South Dakota School of Mines and Technology, Rapid City, SD 57701, USA*

▷ Past Positions

Lecturer (Assistant Professor) Nov 2023 – Aug 2024	School of Mechanical and Design Engineering *University of Portsmouth, Portsmouth, UK*
Research Affiliate Nov 2023 – Oct 2024	Oden Institute for Computational Engineering and Sciences *The University of Texas at Austin, Austin, TX 78712, USA*
Research Associate Dec 2020 – Nov 2023	Oden Institute for Computational Engineering and Sciences *The University of Texas at Austin, Austin, TX 78712, USA* PI: Late Prof. J. Tinsley Oden
Adjunct Faculty Aug 2021 – Dec 2021	Department of Aerospace Engineering and Engineering Mechanics *The University of Texas at Austin, Austin, TX 78712, USA*
Adjunct Faculty Aug 2021 – Dec 2021	Department of Biomedical Engineering *The University of Texas at Austin, Austin, TX 78712, USA*
Peter O'Donnell Postdoctoral Fellow Aug 2019 – Nov 2020	Oden Institute for Computational Engineering and Sciences *The University of Texas at Austin, Austin, TX 78712, USA* PI: Late Prof. J. Tinsley Oden
Postdoctoral Fellow Oct 2016 – Jul 2019	Department of Mathematics *Louisiana State University, Baton Rouge, LA 70803, USA* PI: Prof. Robert Lipton

Education

Ph.D. 2012 – 2016	Civil and Environmental Engineering *Carnegie Mellon University, Pittsburgh, PA 15213, USA* Adviser: Prof. Kaushik Dayal Thesis: Coarse graining of electric field interactions with materials
M.E. 2010 – 2012	Mechanical Engineering *Indian Institute of Science, Bengaluru, KA 560012, India* Adviser: Prof. Chandrashekhar S. Jog Thesis: A monolithic strategy for fluid-structure interaction in compressible flow
B.E. 2006 – 2010	Mechanical Engineering *Govt. Engineering College, Raipur, CG 492001, India*

Teaching Experiences

▷ Ongoing/future

ME 322 Machine Design I (Department of Mechanical Engineering)
Fall 2025 *South Dakota School of Mines and Technology, Rapid City, SD 57701, USA* (course site)

ME 428/528 Applied Finite Element Analysis (Department of Mechanical Engineering)
Fall 2025 *South Dakota School of Mines and Technology, Rapid City, SD 57701, USA* (course site)

▷ Spring 2025

ME 322 Machine Design I (Department of Mechanical Engineering)
Spring 2025 *South Dakota School of Mines and Technology, Rapid City, SD 57701, USA* (course site)

▷ Fall 2024

ME 322 Machine Design I (Department of Mechanical Engineering)
Fall 2024 *South Dakota School of Mines and Technology, Rapid City, SD 57701, USA* (course site)

▷ Spring 2024

M21946 Engineering Principles (School of Mechanical and Design Engineering)
Spring 2024 *University of Portsmouth, Portsmouth, UK* (course site)

M21967 Technology Concepts (School of Mechanical and Design Engineering)
Spring 2024 *University of Portsmouth, Portsmouth, UK* (course site)

▷ Fall 2021

COE 311K Engineering Computation (Aerospace Engineering and Engineering Mechanics)
Fall 2021 *The University of Texas at Austin, Austin, TX 78712, USA* (course site, syllabus)

BME 313L Numerical Methods in Biomedical Engineering (Biomedical Engineering)
Fall 2021 *The University of Texas at Austin, Austin, TX 78712, USA* (course site, syllabus)

Teaching Leadership

Undergraduate Advising Mechanical Engineering
Fall 2024 - present *South Dakota School of Mines and Technology, Rapid City, SD 57701, USA*

Module Coordinator Engineering Principles (M21946), Technology Concepts (M21967)
Spring 2024 School of Mechanical and Design Engineering
University of Portsmouth, Portsmouth, UK

Grants

1. **MDACC-Oden-TACC** A mechanistic tumor growth model for HP MRI ($50k)
   Sep 2020 – Mar 2022 PI: Fuentes (MD Anderson Cancer Center), co-PI: **Jha**

▷ Grant Reviews

- To participate (upcoming) as a Reviewer in the NSF Review Panel for the CMMI division (year - 2025).
- Participated (completed) as a Reviewer in the NSF Review Panel for the CMMI division (year - 2025).

Journal Responsibilities

▷ Journal Editing

Associate Editor Journal of Peridynamics and Nonlocal Modeling (JPER) (link)
Topic Editor Journal of Open Source Software (JOSS) (link)
Editorial Board Member Scientific Reports (link)

▷ Journal Reviews

CMAME (28+ reviews), JMPS, SINUM, M3AS, MMS, Mathematical Reviews (AMS), JAM

▷ Special Issue Guest Editing

CiSE IEEE Celebrating the Life and Work of J. Tinsley Oden
Oct 2025 (tentative) Editors: Serge Prudhomme, Danial Faghihi, Prashant K. Jha

Expertise

▷ Skills

Bayesian Parameter Estimation; Continuum Mechanics; Finite Element, Finite Difference, and Meshfree Methods; Fracture Mechanics; Machine Learning; Mechanics of Granular Media; Multiphysics and Multiscale Modeling of Materials; Open-Source Software Development; Peridynamics; Scientific Computing; Uncertainty Quantification

▷ Programming Languages and Tools

C and C++; MATLAB and OCTAVE; Python; Shell; Git; Docker

Major Projects

▷ Ongoing

- **Error detection and control mechanisms for neural operators** (at South Dakota Mines)
  - Developing residual-based and variational techniques for quantifying and correcting surrogate prediction errors;
  - Applications to uncertainty quantification, inverse problems, and PDE-constrained optimization.
- **Topology optimization of functional materials** (at South Dakota Mines)
  - Investigating material and structural layout to achieve optimal performance in systems governed by nonlinear physics;
  - Developing surrogate-based topology optimization frameworks using neural operators;
- **Fracture and fatigue of continuum-scale functional materials** (at South Dakota Mines)
  - Modeling damage evolution, crack initiation, and propagation in composites with soft matrix;
  - Incorporating fracture and fatigue mechanisms into continuum models for multifunctional materials;
- **Homogenization and multiscale modeling of smart materials** (at South Dakota Mines)
  - Modeling the influence of small-scale features (e.g., particle distribution, microstructure) on effective bulk properties using homogenization techniques;
  - Deriving continuum models for ionic, dielectric, and magnetic soft materials from atomistic or discrete models JhaEtAl-JAM-2022, JhaBreitzmanDayal-ARMA-2023;
  - Parameter estimation for continuum theories using high-fidelity simulations of microstructure behavior.
- **Multi-fidelity PeriDEM approach for modeling granular media under extreme conditions** (at South Dakota Mines)
  - Introducing a multi-fidelity approach to handle the large collection of particulate media under extreme conditions;
  - Developing a comprehensive understanding of bulk behavior of granular media and propagation of damage subjected to large stresses;
  - Parallelizing (MPI and graph partitioning) and enhancing PeriDEM library.

▷ Past/completed

- **Correcting neural operator predictions** (at UT Austin)
  - Goal-oriented *a-posteriori* estimates of modeling error as an aid for calibration of high-fidelity models JhaOden-JCP-2022;
  - Enhancing the applications of neural operators to Bayesian inverse problems by computing corrections to neural operator predictions CaoRoseberryJhaEtAl-JCP-2022;
  - Significant improvement in accuracy using our correction scheme for inference of diffusivity field in nonlinear diffusion model and Young's modulus field in hyperelastic material deformation;
  - Developed an approach to improve the accuracy and reliability of neural operator surrogates of nonlinear BVPs by proposing the so-called corrector operator Jha-CMAME-2023;
  - Topology optimization of the diffusivity field in a nonlinear diffusion model highlights the limitations of neural operators and a significant increase in accuracy when using the corrector approach Jha-CMAME-2023.
- **High-fidelity mechanics model for granular media** (at UT Austin)
  - Discrete Element Method (DEM) based models are restricted to spherical particles and can not simulate particle breakage;
  - Combined peridynamics (nonlocal theory of fracture) and DEM and proposed a novel high-fidelity model called PeriDEM that overcomes the limitations of DEM-based models JhaEtAl-JMPS-2021;
  - Open-source software available on GitHub (PeriDEM).
- **Multiphysics modeling of tissue-scale tumor growth** (at UT Austin)
  - Developed a 3D-1D model of tumor growth and angiogenesis, coupling the evolution of tumors with the flow in tissue and vascular network FritzJhaEtAl-Nonlin-2021, FritzJhaEtAl-CMAME-2021;
  - 1D Poiseuille flow model and Darcy's law to simulate the flow in a vascular network and tissue domain, respectively;
  - Evolution of tumors, proteins, and drugs based on continuum mixture theory and phase-field method.

- **Relating peridynamics and classical linear elastic fracture mechanics (LEFM)** (at UT Austin and LSU, Baton Rouge)
  - Connecting LEFM and peridynamics is of great interest for the validation and broader integration of peridynamics;
  - We showed that peridynamics satisfies the LEFM energy relation JhaLipton-IJFrac-2021, LiptonJha-Nonlin-2021;
  - In the absence of fracture, peridynamics approximates elastodynamics JhaLipton-IJNME-2018;
  - Obtained a CFL-like stability condition for an explicit time discretization of peridynamics JhaLipton-IJNME-2018.
- **Numerical method and analysis of peridynamics theory of fracture in solids** (at LSU, Baton Rouge)
  - Implemented and studied numerical methods such as finite difference and finite element for peridynamics JhaLipton-SINUM-2018, JhaLipton-DCDSB-2021, JhaLipton-CMAME-2019;
  - Showed that the numerical solution converges to the exact solution as expected.
- **Multiscale modeling of electrical interaction in ionic solids** (at CMU, Pittsburgh)
  - Coulombic interactions are long-ranged, and it is challenging to integrate them with multiscale (e.g., Quasicontinuum) methods;
  - Obtained a continuum limit approximation of Coulombic (electrostatic) interaction and utilized the limiting energy to develop a QC method with electrostatic interaction JhaEtAl-JAM-2022, JhaBreitzmanDayal-ARMA-2023.
- **Discrete-to-continuum limit of electrostatic interaction in nanostructures** (at CMU, Pittsburgh)
  - Performed a rigorous derivation of the continuum limit of electrostatic interaction in nanostructures with rotational and translational symmetries JhaBreitzmanDayal-ARMA-2023;
  - Unlike in the case of 3D crystal structures, the limiting electrostatic energy in nanostructures is local;
  - The limiting energy includes contributions from both the tangential and normal components of the dipole moment field; tangential components are absent in the limiting energy obtained through dimensional reduction techniques.
- **Monolithic fluid-structure interaction (FSI) formulation** (at IISc, Bangalore)
  - Developed a monolithic arbitrary Lagrangian-Eulerian (ALE) formulation for FSI problems;
  - Compressible fluid and nonlinear solid undergoing large deformation;
  - Mapped the Navier-Stokes equations for compressible fluid to the reference configuration;
  - Developed energy-conserving time and finite element spatial discretization of nonlinear coupled fluid-solid equations.

PUBLICATIONS [GOOGLE SCHOLAR]

▷ PUBLISHED

1. P. K. **Jha** and R. Lipton, "Numerical analysis of nonlocal fracture models in holder space," SIAM Journal on Numerical Analysis, vol. 56, no. 2, pp. 906–941, 2018.
2. P. K. **Jha** and R. Lipton, "Numerical convergence of nonlinear nonlocal continuum models to local elastodynamics," International Journal for Numerical Methods in Engineering, vol. 114, no. 13, pp. 1389–1410, 2018.
3. R. Lipton, E. Said, and P. K. **Jha**, "Free damage propagation with memory," Journal of Elasticity, vol. 133, no. 2, pp. 129–153, 2018.
4. R. P. Lipton, R. B. Lehoucq, and P. K. **Jha**, "Complex fracture nucleation and evolution with nonlocal elastodynamics," Journal of Peridynamics and Nonlocal Modeling, vol. 1, no. 2, pp. 122–130, 2019.
5. P. K. **Jha** and R. Lipton, "Numerical convergence of finite difference approximations for state based peridynamic fracture models," Computer Methods in Applied Mechanics and Engineering, vol. 351, pp. 184–225, 2019.
6. P. Diehl, P. K. **Jha**, H. Kaiser, R. Lipton, and M. Lévesque, "An asynchronous and task-based implementation of peridynamics utilizing hpx—the c++ standard library for parallelism and concurrency," SN Applied Sciences, vol. 2, no. 12, pp. 1–21, 2020.
7. P. K. **Jha** and R. Lipton, "Finite element convergence for state-based peridynamic fracture models," Communications on Applied Mathematics and Computation, vol. 2, no. 1, pp. 93–128, 2020.
8. P. K. **Jha** and R. P. Lipton, "Kinetic relations and local energy balance for lefm from a nonlocal peridynamic model," International Journal of Fracture, vol. 226, no. 1, pp. 81–95, 2020.
9. P. K. **Jha**, L. Cao, and J. T. Oden, "Bayesian-based predictions of covid-19 evolution in texas using multispecies mixture-theoretic continuum models," Computational Mechanics, vol. 66, no. 5, pp. 1055–1068, 2020.
10. P. K. **Jha**, P. S. Desai, D. Bhattacharya, and R. Lipton, "Peridynamics-based discrete element method (peridem) model of granular systems involving breakage of arbitrarily shaped particles," Journal of the Mechanics and Physics of Solids, vol. 151, p. 104376, 2021.
11. R. P. Lipton and P. K. **Jha**, "Nonlocal elastodynamics and fracture," Nonlinear Differ. Equ. Appl. 28, vol. 23, 2021.

12. P. K. **Jha** and R. Lipton, "Finite element approximation of nonlocal dynamic fracture models," Discrete & Continuous Dynamical Systems-B, vol. 26, no. 3, p. 1675, 2021.
13. M. Fritz, P. K. **Jha**, T. Köppl, J. T. Oden, and B. Wohlmuth, "Analysis of a new multispecies tumor growth model coupling 3d phase-fields with a 1d vascular network," Nonlinear Analysis: Real World Applications, vol. 61, p. 103331, 2021.
14. M. Fritz, P. K. **Jha**, T. Köppl, J. T. Oden, A. Wagner, and B. Wohlmuth, "Modeling and simulation of vascular tumors embedded in evolving capillary networks," Computer Methods in Applied Mechanics and Engineering, vol. 384, p. 113975, 2021.
15. D. A. Hormuth, C. M. Phillips, C. Wu, E. A. B. F. Lima, G. Lorenzo, P. K. **Jha**, A. M. Jarrett, J. T. Oden, and T. E. Yankeelov, "Biologically-based mathematical modeling of tumor vasculature and angiogenesis via time-resolved imaging data," Cancers, vol. 13, no. 12, 2021.
16. P. Gadikar, P. Diehl, and P. K. **Jha**, "Load balancing for distributed nonlocal models within asynchronous many-task systems," in 2021 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW), (Los Alamitos, CA, USA), pp. 669–678, IEEE Computer Society, jun 2021.
17. P. K. **Jha** and P. Diehl, "Nlmech: Implementation of finite difference/meshfree discretization of nonlocal fracture models," Journal of Open Source Software, vol. 6, no. 65, p. 3020, 2021.
18. P. K. **Jha** and J. T. Oden, "Goal-oriented a-posteriori estimation of model error as an aid to parameter estimation," Journal of Computational Physics, vol. 470, p. 111575, 2022.
19. P. K. **Jha**, J. Marshall, J. Knap, and K. Dayal, "Atomic-to-continuum multiscale modeling of defects in crystals with nonlocal electrostatic interactions," Journal of Applied Mechanics, vol. 90, 11 2022.
20. P. K. **Jha**, T. Breitzman, and K. Dayal, "Discrete-to-Continuum Limits of Long-Range Electrical Interactions in Nanostructures," Archive for Rational Mechanics and Analysis, vol. 247, no. 2, p. 29, 2023.
21. L. Cao, T. O'Leary-Roseberry, P. K. **Jha**, J. T. Oden, and O. Ghattas, "Residual-based error correction for neural operator accelerated infinite-dimensional bayesian inverse problems," Journal of Computational Physics, p. 112104, 2023.
22. P. K. **Jha**, C. Walker, D. Mitchell, J. T. Oden, D. Schellingerhout, J. A. Bankson, and D. T. Fuentes, "Mutual-information based optimal experimental design for hyperpolarized 13 c-pyruvate mri," Scientific reports, vol. 13, no. 1, p. 18047, 2023.
23. P. K. **Jha**, "Residual-based error corrector operator to enhance accuracy and reliability of neural operator surrogates of nonlinear variational boundary-value problems," Computer Methods in Applied Mechanics and Engineering, vol. 419, p. 116595, 2024.
24. P. K. **Jha**, P. Diehl, and R. Lipton, "Nodal finite element approximation of peridynamics," Computer Methods in Applied Mechanics and Engineering, vol. 434, p. 117519, 2025.

▷ Under Review and Preprint

25. P. K. **Jha**, "From theory to application: A practical introduction to neural operators in scientific computing," arXiv preprint. arXiv:2503.05598, 2025.
26. M. Nandyala, A. Lanham, P. K. **Jha**, C. Wu, J. D. Hazle, T. E. Yankeelov, R. J. Stafford, A. A. El-Gendy, and D. Fuentes, "An information-theoretic framework for optimal experimental design in magnetic nanoparticle hyperthermia," Available at SSRN 5200413.

▷ Book Chapters and Reports

27. P. K. **Jha** and R. Lipton, Well-Posed Nonlinear Nonlocal Fracture Models Associated with Double-Well Potentials, pp. 1417–1456. Cham: Springer International Publishing, 2019.
28. P. K. **Jha** and R. Lipton, Finite Differences and Finite Elements in Nonlocal Fracture Modeling: A Priori Convergence Rates, pp. 1457–1494. Cham: Springer International Publishing, 2019.
29. R. Lipton, E. Said, and P. K. **Jha**, Dynamic Brittle Fracture from Nonlocal Double-Well Potentials: A State-Based Model, pp. 1265–1291. Cham: Springer International Publishing, 2019.
30. R. Lipton, E. Said, and P. K. **Jha**, Dynamic Damage Propagation with Memory: A State-Based Model, pp. 1495–1523. Cham: Springer International Publishing, 2019.

Professional Activities

▷ Conference Organization

- Minisymposium 1301 on "Uncertainty Quantification and Scientific Machine Learning for Predictive Modeling and Decision-Making in Complex Systems" at the 18th U. S. National Congress on Computational Mechanics. Jul 2025. Website.
- Minisymposium on "Integrating machine learning and numerical methods to accelerate engineering design" at 2nd IACM MMLDE-CSET. Sep 2023.
- Minisymposium M403 on "Uncertainty quantification for learning and data-driven predictive modeling of complex systems" at the 17th U. S. National Congress on Computational Mechanics. Jul 2023.
- With colleagues, organized (as the main organizer) a USACM thematic conference on computational oncology. Jan 2022. Website.
- Minisymposium M19 on "Nonlocal models in mathematics and computation" at the SIAM TX-LA 3rd Annual Meeting. Oct 2020.

▷ Mentoring

- Advising three undergraduate students on research in the mechanics of materials and structures within my Computational Engineering Analysis and Design (CEAD) Lab at South Dakota Mines. Lab Website. Fall 2024 - present.
- Co-mentored a student working on the Google Summer of Code 2020 summer project. Related github repository. Summer 2020.

▷ Open-sourced Software

PeriDEM (Jha et al., JMPS 2021); **NLMech** (Jha & Diehl, JOSS 2021);
Angiogenesis3D1D (Fritz et al., CMAME 2021); **neural_operators** (Jha, arXiv 2025)

Awards and Achievements

1.	GATE exam (May 2010)	All India rank 31 (957/1000 score) in GATE-2010 exam
2.	TA Award (May 2013)	Best TA for finite-element method course, Carnegie Mellon University
3.	Fellowship (Aug 2019)	Peter O'Donnell Postdoctoral Fellowship, The University of Texas at Austin

Travel

1.	**Visit**	Institute for Mathematics and its Applications
	Feb 2017 – May 2017	*University of Minnesota Twin Cities, Minneapolis, MN 55455, USA*
2.	**Workshop**	Fracture as an Emergent Phenomenon
	7 Jan – 12 Jan 2024	*Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany*

Key Talks

1. Invited talk: *Coarse graining of electric field interactions with materials.* Mechanical Engineering Seminar, Indian Institute of Science, Bengaluru, India. Aug 2016.
2. Invited talk: *Coarse graining of electric field interactions with materials.* AEM Mechanics Research Seminar, University of Minnesota Twin Cities, Minneapolis, USA. Mar 2017.
3. Invited talk: *Numerical analysis of nonlocal fracture models.* IMA Postdoctoral Seminar, University of Minnesota Twin Cities, Minneapolis, USA. Apr 2017.
4. Conference: *Numerical analysis of nonlocal fracture models.* USNCCM14, Montreal, Canada. Jul 2017.
5. Conference: *Free damage propagation with memory.* 13th World Congress in Computational Mechanics, New York, USA. Jul 2018.
6. Conference: *Convergence results for finite element and finite difference approximation of nonlocal fracture.* ICIAM 2019, Valencia, Spain. Presented by Prof. R. Lipton. Jul 2019.
7. Conference: *Numerical fracture experiments using nonlinear nonlocal models.* US National Congress on Computational Mechanics USNCCM15, Austin, USA. Jul 2019.
8. Invited talk: *Application of peridynamics to fracture in solids and granular media.* Special Mechanics Seminar, University of Houston, Houston, USA. Oct 2020.
9. Invited talk: *Application of peridynamics to fracture in solids and granular media.* MAE Seminar Series, University at Buffalo, Buffalo, USA. Oct 2020.
10. Seminar: *Modeling failure in solids and tissue-scale tumour growth via high-fidelity computational methodologies.* Department Seminar, Department of Computational and Data Science, Indian Institute of Science, Bengaluru, India. May 2021.

11. Conference: *Analysis and Application of Peridynamics to Fracture in Solids and Granular Media.* EMI 2021, USA. May 2021.
12. Invited talk: *High-fidelity mechanistic modeling of tumor growth at the tissue scale.* Babuška Forum, Oden Institute, The University of Texas at Austin, Austin, USA. Sep 2021.
13. Conference: *Goal-oriented a-posteriori estimation of model error as an aid to parameter estimation.* USNCCM 17, Albuquerque, USA. July 2023.
14. Invited talk: *Corrector operator to enhance accuracy and reliability of neural operator surrogates of nonlinear variational boundary-value problems.* CRUNCH Seminar, Brown University, USA. August 2023.
15. Conference: *Seamless multiphysics coupling with peridynamics enabled by nodal finite element approximation.* Midwest Numerical Analysis Day 2025 Workshop, University of Nebraska-Lincoln, USA. April 2025.
16. Conference: *Application of peridynamics to granular media.* Engineering Mechanics Institute (EMI) 2025 Conference, Anaheim, USA. May 2025.
17. Conference: *Reliable Neural Operators: Error Control through Residual Correction and Beyond.* Accuracy and Efficiency in Scientific Machine Learning Workshop organized by IVADO and Centre de recherches mathématiques (CRM), Montreal, Canada. June 2025.
18. Conference: *Seamless multiphysics coupling with peridynamics enabled by nodal finite element approximation.* USNCCM 18, Chicago, USA. July 2025.
19. Conference: *Neural Operators to Accelerate Parameter Estimation and Topology Optimization Problems. Presenter: Ian (UG Researcher).* USNCCM 18, Chicago, USA. July 2025.

KEY REFERENCES

Prof. Kaushik Dayal	*Department of Civil and Environmental Engineering, Carnegie Mellon University* E: Kaushik.Dayal@cmu.edu; P: 1-412-268-2949; W: Homepage
Prof. Robert Lipton	*Department of Mathematics, Louisiana State University* E: lipton@lsu.edu; P: 1-225-578-1569; W: Homepage