

# Prashant K. Jha

## Lecturer (Assistant Professor)

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## SUMMARY

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. My interests include the mechanics of smart materials, focusing on functional soft and granular materials.

## POSITIONS

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

## EDUCATION

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

## TEACHING EXPERIENCES

<b>M21946</b> Spring 2024	Engineering Principles (School of Mechanical and Design Engineering) <i>University of Portsmouth, Portsmouth, UK</i> ( <a href="#">course site</a> )
<b>M21967</b> Spring 2024	Technology Concepts (School of Mechanical and Design Engineering) <i>University of Portsmouth, Portsmouth, UK</i> ( <a href="#">course site</a> )
▷ <b>FALL 2021</b>	
<b>COE 311K</b> Fall 2021	Engineering Computation (Department of Aerospace Engineering and Engineering Mechanics) <i>The University of Texas at Austin, Austin, TX 78712, USA</i> ( <a href="#">course site</a> , <a href="#">syllabus</a> )
<b>BME 313L</b> Fall 2021	Numerical Methods in Biomedical Engineering (Department of Biomedical Engineering) <i>The University of Texas at Austin, Austin, TX 78712, USA</i> ( <a href="#">course site</a> , <a href="#">syllabus</a> )

## TEACHING LEADERSHIP

<b>Module Coordinator</b> Spring 2024	Engineering Principles (M21946), Technology Concepts (M21967) School of Mechanical and Design Engineering <i>University of Portsmouth, Portsmouth, UK</i>
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## GRANTS

1. <b>MDACC-Oden-TACC</b> Sep 2020 – Mar 2022	A mechanistic tumor growth model for HP MRI (\$50k) PI: Fuentes (MD Anderson Cancer Center), co-PI: <b>Jha</b>
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## JOURNAL RESPONSIBILITIES

### ▷ JOURNAL EDITING

<b>Associate Editor</b>	Journal of Peridynamics and Nonlocal Modeling (JPER) ( <a href="#">link</a> )
<b>Topic Editor</b>	Journal of Open Source Software (JOSS) ( <a href="#">link</a> )
<b>Editorial Board Member</b>	Scientific Reports ( <a href="#">link</a> )

### ▷ JOURNAL REVIEWS

CMAME (15+ reviews), JMPS, SINUM, M3AS, MMS, JALCOM, IJMST, BMJ Open, Mathematical Reviews (AMS), PHYSA

## 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, \*\* – COMPLETED)

- **\*Neural Networks to accelerate scientific computing** (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 correction 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](#).
- **\*Computational modeling, analysis, and design of functional materials** (at UT Austin)
  - Modeling the effect of small-scale material conditions on effective material properties using homogenization and multiscale techniques (prior work - [JhaEtAl-JAM-2022](#), [JhaBreitzmanDayal-ARMA-2023](#));
  - Parameter estimation of continuum models of magnetic/electric soft composites informed by underlying microstructure;
  - Reliable neural network approximations and reduced order models [CaoRoseberryJhaEtAl-JCP-2022](#), [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 (an important contribution as such results were not clearly established before our work).

- **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 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 not present 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**, "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.
23. P. K. **Jha**, C. Walker, D. Mitchell, J. T. Oden, D. Schellinghouth, 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.

#### ▷ BOOK CHAPTERS AND REPORTS

24. 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.
25. 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.
26. 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.
27. 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

- With colleagues, organized (as the main organizer) a USACM thematic conference on computational oncology. Jan 2022. [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.
- Minisymposium M19 on "Nonlocal models in mathematics and computation" at the SIAM TX-LA 3rd Annual Meeting. Oct 2020.

##### ▷ MENTORING

- 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)

#### AWARDS AND ACHIEVEMENTS

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|--------------------------|--|
| 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

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

#### 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.

#### KEY REFERENCES

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Prof. Kaushik Dayal	Carnegie Mellon University; E: <a href="mailto:Kaushik.Dayal@cmu.edu">Kaushik.Dayal@cmu.edu</a> ; P: 1-412-268-2949; W: <a href="#">Homepage</a>
Prof. Robert Lipton	Louisiana State University; E: <a href="mailto:lipton@lsu.edu">lipton@lsu.edu</a> ; P: 1-225-578-1569; W: <a href="#">Homepage</a>