Curriculum Vitae

Personal Details

- **Name**: Manish Kumar
- **Date of Birth**: March 07, 1992
- **Gender**: Male
- **Nationality**: Indian
- **Language**: English, Italian (A2), Hindi and Punjabi (Mother Tongue)
- **Current Place of Work:** Polytechnic Department of Engineering and Architecture, University of Udine, Udine, Italy.
- **Current Position:** Assistant Professor (RTD-A)
- **E-mail**: *mail2manishgoyal@gmail.com; manish.kumar@uniud.it*
- **Mobile Phone**: (+39) 3497986829
- **Google Scholar**: https://scholar.google.com/citations?user=L1wTNU4AAAAJ&hl=en#
- **Orcid:** https://orcid.org/0000-0002-4478-069X?lang=en
- **Researchgate:** https://www.researchgate.net/profile/Manish_Kumar289

Areas of Interest

- FEM, Phase Field Method, XFEM, Nonlinear Simulations, Computational failure analysis.
- Solid Mechanics, Fracture Mechanics, Fatigue, Creep, Elasticity, Plasticity, Biomechanics.

Esteem Indicators

Number of published peer-reviewed papers (not including conference papers)	7
Number of papers presented at national and international conferences	5
Number of citations	177
h-index	6
i10-index	6

Employment

12/2022-present **Assistant Professor (RTD-A)**
- University of Udine, Udine, Friuli-Venezia Giulia, Italy, 33100.
- Project: PNRR, Ministero dell'Università e della Ricerca, Italy.

05/2022-12/2022 **Post-Doctoral Researcher**
- University of Udine, Udine, Friuli-Venezia Giulia, Italy, 33100.
- Project: "*Phase Field Modelling Developments for Decohesion Problems*".

05/2021-04/2022 **Post-Doctoral Researcher**
- University of Udine, Udine, Friuli-Venezia Giulia, Italy, 33100.
- Project: "*Advanced Aided Design and Verification of Mechanical Structures & Components using the Phase-Field method*".

08/2013-07/2014 **Project Fellow**
- CSIR – Central Scientific Instruments Organisation, Chandigarh, India, 160030.
- Project: "*Designing of Lower Limb Exoskeleton*".

Research Experience

Research Experience

05/2022 – 12/2022: Researcher (University of Udine, Italy)

PRIN 2020 CONCERTO: Phase field modelling developments for decohesion problems

- Development and validation of the Phase Field method for crack propagation simulation in tough ceramics. Development of a method to assist the design of new ceramics for coatings and bulk materials.

05/2021 – 04/2022: Researcher (University of Udine, Italy)

Advanced aided design and verification of mechanical structures & components using the phase-field method

- A cohesive phase field methodology was developed using FEniCS open-source library to simulate the fatigue crack propagation in the metallic materials with interfaces.

08/2020 – 03/2021: Research Associate (Indian Institute of Technology Roorkee, India)

Development of 3-D fatigue crack growth methodology for the elasto-plastic materials

- An XFEM-based methodology was developed to simulate the fatigue crack growth in the three-dimensional specimen of elasto-plastic material, which was subjected to fatigue loading conditions considering the variation in the material properties.

07/2015 – 09/2020: PhD Student (Indian Institute of Technology Roorkee, India)

Development of the implicit algorithms to predict creep and fatigue crack growth behaviour

- The extended finite element method (XFEM) based numerical algorithms were developed to simulate the nonlinear phenomena of crack growth in ductile materials under fatigue and creep loading. The crack growth rates were computed by the fracture mechanics, and the simulation results were validated with experimental data.

Implementation of a data transfer scheme to obtain stress field at an arbitrary point in ductile materials

- The MATLAB codes were developed to calculate the stress field at an arbitrary point from the stress field at the integration point for ductile materials in the XFEM framework. The null step was also implemented to resolve the history dependency issue faced during creep crack propagation.

Creep crack growth rate (*CCGR*) *was related to the C*(*t*)*-integral to incorporate all creep stage*

- The XFEM-based numerical tool was developed to relate *C*(*t*)-integral with CCGR, incorporating the small-scale, transition, and extensive creep in its calculation. This incorporation increased the accuracy of CCGR compared to the conventional *C** based methodology.

The J-integral decomposition approach was combined with XFEM to compute the SIFs of ductile materials

- MATLAB codes were developed to evaluate the SIFs of the individual modes through the *J*-integral decomposition approach for the ductile materials. It depends only on actual field variables, which is more suitable for ductile material than conventional approaches.

Numerical simulations to perform the creep and fatigue crack growth in plastically graded materials

- Numerical tools were developed to simulate the fatigue and creep crack growth in plastically graded materials using fracture mechanics. These tools could simulate crack growth even if it happens not parallel to the gradation direction.

Development of the numerical scheme to predict the crack growth behaviour under spectrum fatigue loading

- The *J*-integral decomposition approach was employed in the XFEM framework to compute crack growth in Nickel based superalloy under spectrum fatigue loading.

Elasto-plastic fatigue crack growth simulations in three-dimensional structures using XFEM

- The crack front was modelled by joining small-sized line segments, and SIFs were computed through the *J*-integral decomposition approach at the centres of these line segments. The numerically predicted fatigue crack growth behaviour at elevated temperatures for Nickel based superalloy was validated experimentally.

Proposed modifications in the conventional theta projection method

- The theta projection method was used to predict the creep strain in the operational range of temperature and stress. Modifications were proposed to the convention method to increase its accuracy, and the modified method was validated with the experimental results.

08/2013 – 06/2014: Project Fellow (CSIR-CSIO, Chandigarh, India)

Designing of lower limb exoskeleton

- The lower limb exoskeleton was designed to assist patients with lower limb problems. The design phase included the finite element analysis, drafting manufacturing drawings, and exoskeleton prototyping.

07/2009 – 06/2013: Undergraduate Student (UIET, Panjab University, Chandigarh, India)

Development of the complete testing rig to perform experiments on micro-channels

- A testing rig was developed for the experimental study of temperature variation in the flowing fluids through microchannels. It also included sensor calibration and developing a data acquisition system based on LabVIEW and NI's hardware.

Processing of the acquired raw data from experiments

- MATLAB codes were developed to process the acquired raw data from the experiments. These codes were also used to compute the various performance parameters.

Education

09/2020 **PhD in Machine Design (Mechanical Engineering)**
- Indian Institute of Technology Roorkee, Uttarakhand, India, 247667.
- Thesis: *"Fatigue and Creep Crack Growth Analysis using XFEM".*

07/2015 **Master in Machine Design (Mechanical Engineering)**
- Indian Institute of Technology Roorkee, Uttarakhand, India, 247667.

06/2013 **Bachelor in Mechanical Engineering**
- UIET. Panjab University, Chandigarh, India, 160014.
- Thesis: "*Experimental Study of Temperature Variation of Fluid Flowing through Micro-channels*".

Honours and Awards

- Seal of Excellence for Horizon Europe Marie Skłodowska-Curie Actions call 2021 (101065742 - Fatigue-ReSt)
- International Travel Grant of INR 50,000 from Indian Institute of Roorkee, India.
- All India Rank-520 in Graduate Aptitude Test in Engineering (GATE-2014).
- Winner - National technical paper competition VIMANTRA-2012.
- Winner - SAEINDIA BAJA 2012 (Cost-efficient vehicle award).

Publications

- **Book Chapters:**

1. **Manish Kumar**, Enrico Salvati (2023): Advanced Numerical Methods for Fracture Assessment, *Reference Module in Materials Science and Materials Engineering*, ISBN 9780128035818, https://doi.org/10.1016/B978-0-323-90646-3.00010-1.

- **International Peer-reviewed Journal Papers:**

2. S Saini, N M Moger, **M Kumar**, S Sarkar, S Mittal, S Ifthekar, K Ahuja, I V Singh and P Kandwal (2023): Biomechanical analysis of Instrumented decompression and Interbody fusion procedures in Lumbar spine: a finite element analysis study, *Medical & Biological Engineering & Computing*, 61, 1875-1886.
3. E Salvati, F Menegatti, **M Kumar**, M Pelegatti and A Tognan (2021): On the significance of diffuse crack width self-evolution in the phase-field model for residually stressed brittle materials, *Material Design & Processing Communications*, e261. (**Citations** - 2).
4. **M Kumar** and I V Singh (2020): Numerical Investigation of Creep Crack Growth in Plastically Graded Materials using $C(t)$ and XFEM, *Engineering Fracture Mechanics*, 226, 106820. (**Citations** – 23).
5. **M Kumar**, I V Singh and B K Mishra (2019): Fatigue Crack Growth Simulations of Plastically Graded Materials using XFEM and *J*-Integral Decomposition Approach, *Engineering Fracture Mechanics*, 216, 106470. (**Citations** - 31).
6. **M Kumar**, S Ahmad, I V Singh, A V Rao, J Kumar and V Kumar (2018): Experimental and Numerical Studies to Estimate Fatigue Crack Growth Behavior of Ni-Based Super Alloy, *Theoretical and Applied Fracture Mechanics*, 96, 604-616. (**Citations** - 29).
7. **M Kumar**, I V Singh, B K Mishra, S Ahmad, A V Rao, and V Kumar (2018): Mixed Mode Crack Growth in Elasto-Plastic-Creeping Solids using XFEM, *Engineering Fracture Mechanics*, 199, 489-517. (**Citations** - 42).
8. **M Kumar**, I V Singh, B K Mishra, S Ahmad, A V Rao and V Kumar (2016): A Modified Theta Projection Model for Creep Behavior of Metals and Alloys, *Journal of Materials Engineering and Performance*, 25, 3985-3992. (**Citations** - 19).

- **International Conference Proceedings**

1. V B Pandey, **M Kumar**, I V Singh, B K Mishra, S Ahmad, A V Rao and V Kumar (2020): Mixed Mode Creep Crack Growth Simulations using Continuum Damage Mechanics and Virtual Node XFEM, *Structural Integrity Assessment: Lecture Notes in Mechanical Engineering*, 275-284. (**Citation** - 6).
2. **M Kumar**, I V Singh and B K Mishra (2019): *J*-integral Decomposition Approach for 3-D Elasto-Plastic Fatigue Crack Growth Simulations, *ICCM2019 Proceedings*, 6, 239-251.
3. **M Kumar**, V B Pandey, I V Singh, B K Mishra, S Ahmad, A V Rao and V Kumar (2019): A Numerical Study of Creep Crack Growth in an Aero-engine Turbine Disc using XFEM, *Procedia Structural Integrity*, 14, 839-848. (**Citation** - 5).
4. **M Kumar**, I V Singh, B K Mishra, S Ahmad, A V Rao and V Kumar (2017): Fatigue Life Evaluation under Spectrum Loading using XFEM, *International Conference on Recent Advances in Material and Manufacturing Technologies* (*IMMT-2017*), BITS Dubai Campus, pp. 21.
5. **M Kumar**, A S Bhuwal, I V Singh, B K Mishra, S Ahmad, A V Rao and V Kumar (2017): Nonlinear Fatigue Crack Growth Simulations using *J*-integral Decomposition and XFEM, *Procedia Engineering*, 173, 1209-1214. (**Citation** - 20).

Teaching Experience

- **Mechanics of Materials (MIN 206):** Teaching assistant in the Department of Mechanical and Industrial Engineering at the Indian Institute of Roorkee, India. This course focuses on essential aspects of the mechanics of material, theories of failures, and analysis of trusses, beams, and cylinders. The applicant was responsible for substituting the tutor for his lectures whenever he was absent, delivering tutorials for the students, and grading.

- **Engineering Drawing (MIN 108):** Teaching assistant in the Department of Mechanical and Industrial Engineering at the Indian Institute of Roorkee, India. This course focuses on fundamental aspects of engineering drawing, preparation of drawing sheets, and hands-on experience drawing various essential components. The applicant was responsible for training the undergraduate students in engineering drawing, substituting the tutor for his lectures whenever he was absent, delivering drawing tutorials for the students, and grading.
- **Machine Drawing (MIN 204):** Teaching assistant in the Department of Mechanical and Industrial Engineering at the Indian Institute of Roorkee, India. This course focuses on advanced aspects of engineering drawing, assembly of parts to make a single component, and detailed drawing of parts from an assembled component. The applicant was responsible for training the undergraduate students in drawing through hands and software (AutoCad & Solidworks), substituting the tutor for his lectures whenever he was absent, delivering drawing tutorials for the students and grading.

Fellowships

- Fund of €150.000,00 for three years of research under project **PNRR** by the **Ministry of University and Research** (**MUR**), Italy, at the University of Udine, Italy. (2023-2025)
- Fellowship for research by the **Ministry of Italian Education** (**MIUR**) at the University of Udine, Italy, for one year (2022-2023) (€ 20.429,12)
- Fellowship for research by the **European Social Fund** (**ESF**) at the University of Udine, Italy, for one year (2021-2022) (€ 20.355,64)
- **National Fellowship for Doctorate program** from the Ministry of Human Resource Development, Government of India for the period of 5 years (2015-2020) (INR 1,749,806.00)
- **National Fellowship for Master program** from the Ministry of Human Resource Development, Government of India for one year (2014-2015) (INR 115,000.00)

Computational Skills

- **FE Simulation**: ABAQUS (User-subroutines), ANSYS, FEniCS, COMSOL
- **Programming**: MATLAB, FORTRAN, LabVIEW, Python
- **CAD Design**: CATIA, SOLIDWORKS, AutoCAD, Autodesk Inventor
- **FE Mesh Generator**: HyperMesh

Masters' Thesis Projects Supervised

- **Title: Developing an FEM user subroutine to analyze composite delamination**
  - Fortran-based user subroutines for ANSYS are developed to model the composite delamination.
  - The developed subroutine is validated with the outcomes of the theoretical models.

Bachelors' Thesis Projects Supervised

- **Title: Development of Elasto-plastic Spectrum Fatigue Crack Growth Methodology using XFEM**
  - A methodology was developed to compute the fatigue crack growth in Nickel superalloy subjected to spectrum fatigue loading.
  - The predicted results were validated with the experimental results for different *R* ratios at elevated temperatures.
  - The crack growth behaviour and paths were estimated for the mode-I and mixed-mode conditions that were consistent with theoretical expectations.
- **Title: FE Simulations to Study the Biomechanical Response of Surgeries on Lumbar Spine**
  - A CT scan data was used to develop the 3-D Lumbar Spine and Intervertebral Disc model.
  - The biomechanical response obtained from FE simulations for a pair of healthy vertebrae was validated with experimental results.

- FE simulations for the biomechanical response of the Lumbar Spine after different decompression surgeries were performed and compared with each other.

- **Title: FE Modelling of Bullet Impact on 3-D Woven Kevlar Body Armour over Human Torso**
  - Ballistic impact analysis of a 9 mm bullet projectile was studied on a 3-D woven Kevlar fabric model.
  - FE model of a human torso containing a rib cage and soft tissues was prepared using CT scan data.
  - Dynamic simulations were performed of ballistic impact on the combined model of 3-D woven Kevlar body armour and a human torso.

- **Title: Numerical Modeling of Residual Stresses in the Welded Joints**
  - The welding torch was modelled through a 3D moving heat source with a distributed heat flux.
  - The thermal analysis was performed for the butt weld joint using a moving heat source.
  - The obtained temperature profile was used to perform the thermo-mechanical analysis and compute the residual stresses.

- **Title: Development of an Educational Application for Estimation of Graft and Flap Requirement in Post-Burn Deformity Correction**
  - Identifying the burned skin area through digital image processing and creating its 3D model.