Indian Institute of Technology Delhi

School of Interdisciplinary Research (SIRe)

Project Proposal for Ph.D.

SIRe Project Number

2026-01-27

(will be assigned by SIRe)

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)	
Project Title	Lifing prediction of Ni-spueralloys produced through conventional and additive manufacturing routes
Project Summary (Minimum 500 and maximum 2000 characters)	Nickel-based superalloys are widely used in high-temperature structural components such as turbine blades and discs in aero-engines and power generation systems. These materials operate under extreme thermo-mechanical conditions involving cyclic loading combined with prolonged exposure to elevated temperatures. Under such service conditions, the interaction between creep and fatigue mechanisms accelerates damage accumulation and significantly reduces the service life of critical components. Therefore, reliable prediction of creep–fatigue life is essential to ensure the safety, reliability, and durability of turbine systems. However, the complex coupling between creep deformation, cyclic plasticity, and microstructural evolution makes accurate life prediction challenging. This project aims to develop a robust and physically informed framework for predicting creep–fatigue life in Ni-based superalloys through a combination of experimental investigation and advanced computational modelling. The study will investigate cyclic deformation behaviour and creep–fatigue interactions at elevated temperatures while identifying the key microstructural mechanisms responsible for damage initiation and evolution. A constitutive model capable of describing cyclic plasticity, creep deformation, and stress relaxation behaviour will be developed. Furthermore, a predictive framework will be formulated using damage indicators derived from the underlying deformation mechanisms. A crystal plasticity finite element framework will be developed to simulate cyclic deformation behaviour by incorporating grain orientations and slip systems. The outcomes of this work are expected to provide a deeper understanding of creep–fatigue damage mechanisms and enable more reliable life prediction of turbine components operating under high-temperature service conditions.

Ph.D. Supervisors[+]
(Supervisor 1 and Supervisor 2 cannot be from the same department of IITD)

Role	Name of Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1*	Ayan Bhowmik	Materials Science and Engg IIT Delhi	abhowmik@iitd.ac.in/
Supervisor 2	Sabyasachi Chatterjee	Applied Mechanics	sabyasachi@am.iitd.ac.in/

*Supervisor 1 must be from IIT, Delhi.
+All cells in this table are mandatory fields that need to be filled by faculty for consideration of proposal.
[$]The date of superannuation of supervisors should be at least three years from the date of registration of selected candidates.

Project requirements (Student qualifications, experience required, etc)
***The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)**

- B.Tech and/or Masters in Materials or Mechanical or Aerospace Engineering with CGPA of 7.5/10 or equivalent
- BSc in Physics with own fellowship like CSIR-NET fellowship.

Source of fellowship/funding and project number
(CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)

Candidate with his/her own fellowship /institute assistantship

Role of Faculty Members involved:	
Supervisor-1	Conducting experiments with fatigue and creep, microstructural characterization across multiple length scales
Supervisor-2	Generating an analytical model to validate creep-fatigue lifing using the microstructural khnow-how.

Note :-

1. **Approval from the respective DRC/CRC/ScRC of your Department/Centre/School will be required for using the "Full-time Institute Assistantship (Category-wise) (FIA)" for selecting the students in SIRe.**

2. **Declaration:- Faculty members, please ensure that you have at least 3 years of service left before superannuation along with adequate sitting space & lab facilities for the SIRe student.**

3. **PI/s are also encouraged to submit joint proposals with AIIMS, NII, JNU and institutes with which IITD has an existing MoU. If the Co-PI (Supervisor 2) is from outside IITD, kindly share his/her detailed CV.**

4. **If a research scholar is to be considered for selection under the project fellowship, then the project should have a minimum of two-year duration remaining.**

5. **A candidate applying with a valid JRF/INSPIRE/any national level fellowship should have at least two-year validity from the date of joining the Ph.D. program.**

6. **The third supervisor's name (if required) can be added only after the formation of Student Research Committee (SRC) subject to a strong recommendation of SRC and subsequent approval from the competent authority.**

7. **If Institute fellowship is being sought, then DRC approval of the parent department of Supervisor 1 is required at the time of selection.**