Indian Institute of Technology Delhi

School of Interdisciplinary Research (SIRe)

Project Proposal for Ph.D.

SIRe Project Number

2025-01-21

(will be assigned by SIRe)

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)	
Project Title	**Advanced Ultra-Precision Optics Manufacturing Technologies**
Project Summary (Minimum 500 and maximum 2000 characters)	The project deals with development of critical optical components using ultra-precision fabrication facility like diamond turning machining, CNC lathe, CNC milling, multi-axis polishing, surface structuring using Laser machining, lithography and different characterization facility like AFM, CMM, optical profilometry, mechanical profiler, interferometry. The major objective is the development of ultra-precision machines, precision optics and opto-mechanics, which has following research goals: • Multi-axis precision machining system: Multi-axis precision machining system has a very high degree of positional accuracy and repeatability to ensure highly precise components being manufactured. While designing the machine, primary focus will be on motion accuracy, dynamic stiffness, and thermal stability because these design considerations are directly related to machining accuracy and surface finish. The machine kinematic configuration shall provide sufficient flexibility in the orientation and position of the tool and the workpiece with greatest possible speed and accuracy. • Laser Micromachining System: Femto-second laser-based micromachining system accompanied by CNC will be developed for achieving micro machining of components. • Development of polishing machine for super-finishing of optical surfaces: A multi-axis precision polishing system will be developed with a capability to handle diameter up to 300 mm optics of various shapes such as optical flats, spheres, aspheric and freeform. • Manufacturing of critical precision optics and associated metrology: Different critical optical components like Diffracto-freeforms and asphero-diffractive optics for hyper-spectral imaging applications, optical beam shapers, structured optics, lenses for different cutting-edge applications will be fabricated and characterized using advanced manufacturing facilities.

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	Prof Gufran S Khan	SenSE, IIT Delhi	gufran.sayeed.khan@sense.iitd.ac.in
Supervisor 2	Prof Sunil Jha	Mechanical Engineering Dept, IIT Delhi	suniljha@mech.iitd.ac.in

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

- M. Tech in Mechanical Engineering /Mechatronics/ Production Engineering, and
- Gate qualified
- B. Tech in Mechanical Engineering

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

Project Funding

Role of Faculty Members involved:	
Supervisor-1	Supervisor 1 will provide expert guidance in the **development of a polishing machine, ultra-precision fabrication processes, process parameter optimization, feedback mechanics, and compensation techniques**. The prime focus will be on enabling the student to develop ultra-precision polishing machine and set up its process parameters for polishing critical optical components like freeforms, aspheric, flats. The other objective will be development of critical optical components and optomechanical assemblie**s** using advanced manufacturing techniques such as **CNC lathe, CNC milling, single-point diamond turning (SPDT), and multi-axis polishing machines**. Supervisor 1 will play a crucial role in advancing high-precision optical manufacturing, ensuring cutting-edge developments in optics and optomechanics**.**
Supervisor-2	Supervisor 2 will contribute expertise in **additive manufacturing and polishing process modeling** to support the development of the polishing machine**.** His role will involve guiding the student in implementing **smart manufacturing approaches** by integrating **artificial intelligence (AI) and data-driven techniques** for **critical manufacturing processes and quality enhancement**.