Indian Institute of Technology Delhi

School of Interdisciplinary Research (SIRe)

SIRe Project Number
2025-01-25

(will be assigned by SIRe)

Project Proposal for Ph.D.

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)	
Project Title	Nonlinear dynamical characterization of a low-temperature plasma source
Project Summary (Minimum 500 and maximum 2000 characters)	Plasma is a highly complex, high temperature ionized quasi-neutral medium with an inherent ability to self-organize itself against external perturbations which, in turn, tends to trigger nonlinear features in different types of dc/rf/μ-wave/ECR plasma sources. This feature of plasma enables it to be useful for a wide range of applications, including fusion plasmas, plasma-based material processing and surface modifications, plasma cutting and welding, plasma scrubbers and cleaners, etc. One of the most important feature that exemplifies the self-organization aspect in plasma sources is the space charge region that develops between the plasma medium and any boundary confining the same. This space charge region is called the plasma sheath, across which a nonlinear potential profile develops. Perturbing this sheath triggers various interesting nonlinear responses both within the plasma medium as well as in the external circuit that drives this perturbation. A nonlinear-dynamical characterization of these excited features can identify processes that could be tuned to improve the performances of a given plasma source for a given application. Plasma Lab at IIT Delhi has observed such nonlinear characteristics in its sources such as ion acceleration across self-consistently developed double layers in ECR based plasma thruster, rotating anode glow balls in dc discharges and nonlinear power coupling regimes in rf discharges for which one would need non-linear dynamical tools to characterize them and solve a set of nonlinear particle and power balance equations to model the same. This research problem would attempt to address one such interesting feature viz., the rotating anode glow triggered in dc discharges using afore-mentioned tools. Further, synchronization studies would also be carried out by coupling two such distinct rotating anode glow discharges and study the effect of different operating parameters using nonlinear tools.

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	Ramesh Narayanan	Department of Energy Science and Engineering, Indian Institute of Technology Delhi	rams@dese.iitd.ac.in
Supervisor 2	Vikrant Saxena	Department of Physics, Indian Institute of Technology Delhi	vsaxena@physics.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. Sc. In Physics or M. Tech. in Electronics and Instrumentation
- exposure to electronics and / or vacuum systems may be preferable?
- Has some knowledge of numerical techniques?

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	Prof. Ramesh Narayanan (DESE, IIT Delhi) will mentor the student on the development and characterization of the discharges triggered in low-temperature plasma sources for nonlinear studies.
Supervisor-2	Prof. Vikrant Saxena (Physics, IIT Delhi) will mentor the student to understand the theoretical physics concepts of such discharges