



Project Proposal for Ph.D.

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)	
Project Title	Diagnostic development for non-invasive characterization of plasma chemistry in processing / space applications
Project Summary (Minimum 500 and maximum 2000 characters)	Low-temperature and atmospheric-pressure plasmas are widely used in advanced materials processing, environmental remediation, biomedical applications and propulsion; however, accurate, non-invasive measurement of plasma parameters and reactive species remains challenging. Conventional probes can perturb the plasma, while optical emission spectroscopy often requires complex modelling for quantitative measurements. The research gap is the limited availability of an integrated microwave diagnostic approach combining electron-density measurement with direct molecular identification. The project aims to develop a microwave interferometer for real-time measurement of electron density and a microwave rotational spectroscopy system for identifying molecular species and determining rotational temperature. The methodology involves developing a microwave source, transmitting and receiving antennas/waveguides, phase-sensitive detection and calibration systems; measuring plasma-induced phase shifts to determine electron density; and recording rotational spectra to identify molecular transitions and estimate species populations. Theoretical analysis will employ electromagnetic wave propagation in plasma, plasma dielectric permittivity and phase-shift relations, together with molecular rotational energy levels, transition frequencies and Boltzmann population distributions. The integrated system will provide quantitative, non-invasive plasma characterization.

Ph.D. Supervisors* (Supervisor 1 and Supervisor 2 cannot be from the same department of IITD)				
Role	Name of Faculty	Date of Superannuation [§] (DD/MM/YYYY)	Academic Unit in IITD/Institute/University	Email ID (Official) & Contact Number
Supervisor 1*	Ramesh Narayanan	30/04/2040	Department of Energy Science and Engineering, Indian Institute of Technology Delhi	rams@dese.iitd.ac.in
Supervisor 2	Venu Anand	27/04/2048	National Institute of Technology Calicut (NITC)	venuanand@nitc.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)
- M.Sc. in Physics / Applied Physics B. Tech. / M. Tech in Electrical and Electronics / Electronics and Instrumentation Engineering / allied branches - Knowledge of programming Matlab / Python and/or software tools may get preference.

Source of fellowship/funding and project number
(CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)
CSIR/UGC/JEST/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE or any other national / international scholarships or with government/non-government sponsorships can apply (preferable) If not, then Institute Fellowship (FIA) can be considered (if slot available).

Role of Faculty Members involved:	
Supervisor-1	Prof. Ramesh Narayanan (DESE, IIT Delhi) will mentor the student in - Understanding the experimental procedure of collecting data - Understanding experimental parameters/boundary conditions - Comparing the theoretical results with experimental observations
Supervisor-2	Prof. Venu Anand (NIT Calicut) will mentor the students - In the development of plasma diagnostics, specifically on instrumentation, - Understanding experimental parameters/boundary conditions - Testing/calibration of the proposed system for plasma diagnostics.

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 the DRC approval of the parent departments of both supervisors is required at the time of selection.**