



Project Proposal for Ph.D.

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)

Project Title	High-Fidelity Large Eddy Simulation of Solid Fuel Combustion with Detailed Soot Modeling
Project Summary (Minimum 500 and maximum 2000 characters)	The combustion of solid fuels, including coal, coal-biomass blends, and ammonia-coal combinations, is pivotal in the global energy framework. Nonetheless, these systems substantially contribute to greenhouse gas emissions and soot production, affecting radiative heat transfer, pollutant release, and fouling in industrial combustors. This project seeks to provide a computational framework that integrates Large Eddy Simulation (LES) with a detailed chemistry-based flamelet/progress variable (FPV) model and a detailed moment-based soot model. The framework will address soot evolution processes such as nucleation, condensation, coagulation, surface growth, and oxidation, while incorporating soot–radiation–gas-phase interactions. The research will concentrate on laboratory-scale pulverized coal flames using benchmark CRIEPI-type burners and will also encompass coal/biomass and ammonia–coal flames in both air and oxy-fuel environments. Comparisons with available experimental datasets (PAHs-LIF, soot-LII, SEM, TiRe-LII) will facilitate model validation. The project is fundamentally interdisciplinary, including reactive flow simulation, turbulence modeling, combustion chemistry, and aerosol/ soot dynamics. The anticipated result is a validated LES-based soot modeling framework that offers new insights into the dynamics of soot production in intricate solid fuel systems. These insights will guide the development of low-soot, high-efficiency energy conversion strategies, aiding in sustainable energy and decarbonization efforts.

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*	Sujeet Yadav	Department of Energy Science and Engineering	syadav@iitd.ac.in
Supervisor 2	Pavan Prakash Duvvuri	Department of Mechanical Engineering	duvvuripp@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)

- Qualifications:** B.Tech./M.Tech. in Mechanical Engineering, Energy Engineering, Chemical Engineering, or related disciplines.
- Skills desired:** Basic understanding of Thermodynamics, heat transfer, fluid mechanics, and numerical modeling

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

Institute MHRD funding

Role of Faculty Members involved:

Supervisor-1	Turbulent combustion modeling
Supervisor-2	Reaction mechanisms, soot modeling

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 SRe.**
- 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 SRe 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.**