



Project Proposal for Ph.D.

Project Details	
Project Title	Computational Modeling of Phase-change Thermal Energy Storage Systems for Buildings
Project Summary (Minimum 500 and maximum 2000 characters)	Thermal energy storage (TES) integrated with building HVAC systems provides several benefits, including grid interactivity, improved efficiency and resiliency, and wider adoption of renewable power. Phase-change materials (PCMs), such as ice/water, have a high energy storage density due to a high phase-change enthalpy. The solid-liquid phase-change process occurring in these systems is complex. Existing modeling tools are not capable of accurately simulating several material- and design-specific aspects of phase-change TES systems. The project aims to estimate the demand reduction, energy use, and electricity costs for a central thermal plant with phase-change thermal energy storage. We will study the impacts of PCM properties (i.e., transition temperature, density, enthalpy of fusion, specific heat, thermal conductivity), material cost, and the impact of the building load and electric utility rates. The first phase of the project will focus on detailed, validated simulation tools to accurately model the physics of the phase-change process with emphasis on including important effects of subcooling, temperature glide, phase-change hysteresis, the effects of turbulence, and realistic boundary and initial conditions encountered in these systems. In the next phase of the project, we will develop reduced-order models to enable their integration in large building energy modeling platforms for accurate estimation of load shaving/shifting potential of TES systems. We will also develop a lab-scale experimental facility to conduct phase-change experiments using different materials and validate our models.

Ph.D. Supervisors			
Role	Name of Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1	Prateek Gupta	Applied Mechanics	prgupta@am.iitd.ac.in
Supervisor 2	Anurag Goyal	Mechanical Engineering	agoyal@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)
- B.Tech. or B.Tech.+ M.Tech. in Mechanical Engineering, and Applied/Computational Mechanics, with an excellent academic record. - Experience with basic C/C++ and python – bonus but not mandatory

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

Role of Faculty Members involved:	
Supervisor-1	Prateek Gupta will guide the research scholar on fundamental aspects of the research dealing with a high-fidelity CFD code development for modeling multi-phase problems. The developed code will be used for the aforementioned application on phase-change materials.
Supervisor-2	Anurag Goyal will guide the research scholar on system-level modeling of chiller and heat pumps with thermal storage, detailed modeling of phase-change processes, model

	validation through lab-scale experiments.
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