I-STEM Software Request - Guide Approval Form

User Details

- **Name of Researcher**: Shivam Pandey
- **User Type**: [ ] Ph.D. Scholar [ ] Postdoctoral Researcher [ ] Bachelor's [✓] Masters
- **Institution Name**: Sardar Vallabhbhai National Institute of Technology, Surat
- **Institutional Contact No**: 0261-2259571
- **Research Topic**: Design and Simulation of Graphite based Supercapacitors

Software Request Details

- **Software Name**: COMSOL Multiphysics
- **Justification for Software Request**: [Provide detailed explanation of how the software supports your research objectives] Attached

Guide/Supervisor Approval

I, Vivek Garg (Guide/Supervisor Name),

- Confirm that the above-mentioned researcher is affiliated with our institution
- Have reviewed the software request and its relevance to the researcher's academic work
- Approve the software request for research purposes

Approval Confirmation

- I approve the software request
- The software aligns with the researcher's research objectives
- The request meets the institutional research guidelines

Guide/Supervisor Signature: Vivek

Date: 19/09/25

Official Stamp/Seal: [Space for Institutional Stamp]

S.V.N.I.T. * राष्ट्रीय प्रौद्योगिकी संस्थान * National Institute of Technology
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Important Notes

1. This form must be signed and scanned
2. The scanned copy must be uploaded with the software request
3. Electronic signatures are acceptable if from an official institutional email

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Justification for Software Request

I am requesting access to **COMSOL Multiphysics** software along with selected modules to support my research on the **design, simulation, and performance optimization of graphite-based supercapacitors**. This research specifically focuses on investigating the electrochemical behavior of advanced electrode architectures, namely **Layer-by-Layer (LbL)** and **Uniformly Mixed (UM)** electrodes.

The software and required modules are essential for modeling electrode–electrolyte interactions, charge transfer processes, and multiscale transport phenomena that directly determine the performance of supercapacitors.

Using COMSOL Multiphysics and the requested modules, I will be able to:

- **Simulate charge transport, ion diffusion, and electrochemical impedance** across both micro and macro scales for LbL and UM electrodes.
- **Analyze cyclic voltammetry (CV)** and **electrochemical impedance spectroscopy (EIS)** to evaluate electrode response characteristics and interface behavior.
- **Optimize electrode design** (thickness, graphene oxide content, layer number, and electrolyte concentration) for improved capacitance, conductivity, and charge–discharge efficiency.
- **Model electrochemical reactions** and coupled transport processes using Nernst–Planck diffusion and Faradaic/non-Faradaic contributions.
- **Incorporate realistic material parameters** ($ZnMn_2O_4$, graphene oxide, KOH electrolyte) through the Material Library.

For this purpose, I request the following six modules:

1. **Battery Design Module** – Core physics for porous electrodes, CV, and EIS simulations.
2. **Fuel Cell & Electrolyzer Module** – Secondary current distribution and charge transfer at electrode–electrolyte interfaces.
3. **Chemical Reaction Engineering Module** – Redox reaction modeling, ion diffusion, and electrochemical kinetics.
4. **Material Library** – Provides accurate material data for $ZnMn_2O_4$, graphene oxide, and KOH electrolyte.
5. **Optimization Module** – Parameter sweeps, optimization, and sensitivity analysis of electrode/electrolyte designs.
6. **AC/DC Module** – Fundamental electrostatics and electric current conservation for electrode–electrolyte systems.

The outcomes of this research will contribute to the **design of high-performance supercapacitors** for energy storage applications by integrating **theoretical modeling and experimental data**. Therefore, COMSOL Multiphysics and the above modules are indispensable for achieving the objectives of my work.

Thank you.

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