

I-STEM Software Request - Guide Approval Form

User Details

- **Name of Researcher:** Janki Hiren bhai Chandibhamar
- **User Type:** ☒ Ph.D. Scholar ☐ Postdoctoral Researcher ☐ Bachelor's ☐ Masters
- **Institution Name** : Marwadi University
- **Institutional Contact No:** 02817123456
- **Research Topic:** Exploring 4D-5D transition metal oxide as a gate dielectric for MOSFET applications

Software Request Details

- **Software Name:** COMSOL Basic + Advanced
- **Justification for Software Request:**
 - I am writing to express my interest in using COMSOL Multiphysics as a part of my PhD thesis titled "Exploring 4D-5D Transition Metal Oxides as a Gate Dielectric for MOSFET Applications." Recently, I have been exploring and studying the simulation studies of MOSFET using transition metal oxides such as HfO_2 , SiO_2 and ZrO_2 through basic COMSOL 5.4 basic version. I have learned the basic semiconductor module of COMSOL and obtained the V_g vs I_{DS} and V_d vs I_{ds} characteristics using the said software version
 - I have done the literature surveys related to my research project. As semiconductor technology moves, MOSFETs are getting bigger, which has caused problems, especially with gate dielectrics. SiO_2 has huge leakage currents through quantum tunnelling because of a) it has low value of dielectric constant b) gate layer has been thinned below 2 nm to solve the scaling problem. This results in significant power loss and reliability problems for the device.
 - The research aims to investigate the potential of 4D-5D transition metal oxides such as ZrO_2 and HfO_2 to serve as high-k gate dielectrics in future MOSFETs. Gate dielectric materials with a higher dielectric constant must be thicker to have lower leakage currents for the same capacitance. The materials have high thermal stability and permittivity and are therefore potential candidates to replace SiO_2 in future transistor technology. High dielectric constants and low leakage currents would result in improved subthreshold behavior and high carrier mobility in MOSFETs. 4D-5D TMOs might be more efficient than standard gate dielectrics at preventing leakage current and

decreasing breakdown voltage. Two things that show how well MOSFETs made of these materials work are better mobility of carriers and a smaller subthreshold slope.

- I am enrolled as a full-time research scholar under the guidance of Dr. Malay Udeshi at the Department of Physics, Faculty of Science, Marwadi University. My consistent academic performance and involvement in research-oriented activities have prepared me well for doctoral studies. I desire to be part of a collaborative research environment where I can engage with fellow scientists, share ideas, and collectively address scientific challenges. This experience allowed me to hone my analytical and problem-solving skills while working independently and collaboratively.
- To get detailed knowledge like stacked dielectrics and advanced studies of I-V, C-V characteristics, and also using precise metal layer thickness and other parameters like work function, the higher versions of the COMSOL will be helpful. Considering the following work, It is my humble request to consider my request for the usage of *COMSOL Basic + Advanced* module.

Supervisor Approval

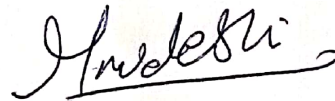
I, Dr. Malay Nitinkumar Udeshi (Guide/Supervisor Name),

- 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: Dr. Malay Nitinkumar Udeshi



Date: 20/03/2025

Official Stamp/Seal:



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