

I-STEM Software Request - Guide Approval Form

User Details

- Name of Researcher: Mayuresh Kathe
- User Type: ☐ Ph.D. Scholar ☐ Postdoctoral Researcher ☒ Bachelor's ☐ Masters
- Institution Name : Indian Institute of Technology, Bombay
- Institutional Contact No: 8879897114
- Research Topic: Archimedes Wind Turbine Analysis

Software Request Details

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

Guide/Supervisor Approval

I, Krishnendu Haldar (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: K. Haldar

Date: 20/11/25

Official Stamp/Seal: [Space for Institutional Stamp]

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

डॉ. कृष्णेंद्र हलदर
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Project title

3D Archimedean Vertical Axis Wind Turbine (AWT) CFD and coupled aero-mechanics study

Why this study matters

The Archimedean AWT is a compact vertical axis design that can harvest energy at low and turbulent wind speeds common in urban and distributed settings. Understanding 3D aerodynamics, start-up behaviour and the coupled rotor dynamics is essential to improve energy capture, reduce maintenance and design ducted or arrayed installations that increase local renewable output.

Research goals (brief)

1. Predict torque, power and power coefficient C_p versus wind speed and rotor speed.
2. Simulate transient start-up and steady-state RPM under load.
3. Study ducted and arrayed arrangements to increase effective power density.
4. Validate simulations against a prototype and produce design recommendations.

How COMSOL modules support these goals

CFD Module

- Run 3D Navier–Stokes simulations for the full rotor-wake flow.
- Perform frozen-rotor stationary runs for quick parametric sweeps and sliding-mesh transient runs for true time-dependent interaction.
- Test laminar and RANS turbulence models and compressible options for higher speeds.
- Produce velocity, pressure, vorticity and C_p maps needed to compute aerodynamic torque and wake recovery.

Mixer Module

- Model multi-domain flows inside ducts or shrouds and study entrainment and mixing between accelerated duct flow and ambient wind.
- Simulate two-phase or multi-component flows if needed for particulate loading or humidity effects on performance.
- Useful to evaluate ducted turbine designs and how inlet geometry or internal vanes affect flow uniformity and power output.

Multibody Dynamics Module

- Model the rotor as a rigid body with realistic inertia, bearings and joint damping.
- Couple aerodynamic loads to rotor motion to predict start-up, overshoot and steady operation without prescribing rotation.
- Include generator/load models and bearing friction to evaluate loaded RPM and power extraction.
- Provide accurate time-domain rotor dynamics for FSI coupling and prototype comparison.

Immediate deliverables from using these modules

- Time series $M(t)$ and $\omega(t)$ and steady-state power curves $P(U)$.
- C_p maps and recommended blade/duct geometry changes for low-wind performance.
- Start-up wind-speed and loaded RPM predictions for prototype design.
- Data for experimental validation and array layout guidance.

Short justification for access request

These modules together let me model the full coupled problem: 3D rotor aerodynamics (CFD), ducted mixing and entrainment effects (Mixer), and rotor dynamics with realistic joints and loads (Multibody). That is required to predict real performance, optimize the design, and validate a prototype for energy-harvesting applications.