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Ph.D. Seminar Talk 1

Title: **Heaviside-free Microsphere-based formulation to smoothly attenuate the compression response in arterial tissues**

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Date and Time: **13-02-2026 (Friday) at 3:00 PM**

Venue: **412, Machine Design Section (MDS)**

Abstract

A realistic description of the transverse strain in uniaxial tension remains a significant limitation of existing angular-integral models (AngI/AngIx) for distributed fibres. These models exhibit a premature *perversion point*, defined as the point at which the sign reversal of the out-of-plane transverse strain occurs, together with an overprediction of radial thickening. In the limit of unidirectional fibres, they yield identical shear responses in distinct shear modes, diminishing their predictive capability. Although incorporating both invariants, I_4 and I_5, could mitigate these issues, the tension–compression switching criterion using the Heaviside function may ultimately counteract these improvements.

An alternative to handling the contribution of compressed fibres within a distribution is to smoothly attenuate it using a vanishing matched invariant constructed from both the I_4 and I_5 invariants. Although the resulting switchless constitutive relation (VanGOH (Arvind and Kannan, 2025)), based on the averaged matched invariant, mitigates several of the limitations associated with the switching criterion in generalised structure tensor frameworks, its non-integral structure restricts its ability to accurately reproduce both shear and normal stress responses under general in-plane biaxial loading. To overcome these shortcomings, we introduce *VanAngI*, an angular–integration–based, Heaviside-free model developed within the framework of vanishing matched invariants. VanAngI (1) achieves a 42% reduction in the uniaxial fitting error compared with the AngIx model while correctly capturing the sign of the experimental out-of-plane Poisson's ratio, (2) accurately resolves the simple shear response, and (3) delivers consistently superior biaxial predictions—all while using at most two fibre families and a minimal set of material parameters.