**Ph.D. Departmental Seminar (24-April-2026)**

**Presenter**: Daniel (Dan) O. Reddy

**Abstract Title**: "My Adventures in the **S.W.A.M.P.** – Exploring **S**urface **W**etting **a**nd **M**icro-**P**atterning"

**Abstract Body**: Control over liquid-solid interactions plays a central role in microfluidic liquid handling, sample preparation, and analytical performance across a range of chemical measurement platforms. In particular, variability in sample preparation and droplet behavior remains a persistent challenge in open microfluidic systems and ambient analyses. This seminar will overview our investigations into how deliberate engineering of surface wettability and microdroplet behavior can be used to improve analytical workflows, with emphases on open microfluidics, laser micromachining, and mass spectrometry-based applications.

Laser-based surface modification strategies have been developed to generate spatially defined regions of contrasting surface energy on diverse substrates, including glass and cellulose-based materials. These wettability-patterned surfaces enable controlled droplet pinning, transport, and analysis without the use of (en)closed channels, external pumps, and/or complex device architectures. Mechanistic studies then demonstrate that laser-induced wettability arises from a combination of surface chemical modifications and nano/microscale topographical changes, establishing laser micromachining as a versatile tool for rapid surface engineering. In turn, these principles of wettability control are extended to the generation and manipulation of nano- to microliter-scale droplets in open microfluidic configurations; simplified platforms are demonstrated for reproducible droplet capture, transfer, and analysis, improving analytical performance/repeatability relative to conventional manual approaches. Finally, a laser-patterned substrate is used to improve dried matrix spot preparation; spatial confinement of droplets prior to drying improves spot uniformity, enhances analyte localization, and increases signal reproducibility, thus enabling rapid and reliable workflows that are compatible with existing instrumentation.

Overall, this talk will demonstrate that surface wettability engineering provides a powerful and adaptable framework to improve microscale liquid sample handling and analysis. By addressing upstream sample preparation challenges through surface design rather than instrument complexity, the strategies to be presented contribute both practical tools and conceptual insights towards the development of robust, accessible, and next-generation analytical systems.