Abstract:
Physical systems consisting of an elastic matrix permeated by fluid mixture are ubiquitous, with examples ranging from morphogenesis of a single biological cell to the migration of greenhouse gases in sediments. Recent experimental studies show that the presence of the elastic networks in these systems significantly alters their phase separation response by imposing an energetic cost to the growth of droplets. However, a quantitative understanding of the role played by elasticity is lacking. Our study bridges this gap by building a comprehensive theoretical framework to analyze the effect of elasticity on the phase separation of a binary mixture in soft, nonlinear solids. We employ an energy-based approach that captures both the short-time quasi equilibrium and the long-time evolution of the phase separation, in elastically homogeneous as well as heterogeneous materials. At the short timescale, we predict an arrested phase-separation, resulting in a uniform distribution of the minority-phase droplets. At the long timescale, we predict a droplet dissolution front in heterogeneous materials. Crucially, we also find a nonlinear effect of elasticity on the dynamics, which challenges the current understanding in the literature. Our findings are applicable to a variety of material systems including food, metals and aquatic sediments, and highlight the importance of elasticity as a potential way to design the material response by tuning material properties.

Bio:
Dr. Mrityunjay Kothari joined Prof. Tal Cohen’s Non-linear Solid Mechanics group in 2019 as a postdoctoral scholar. At MIT CEE, Mrityunjay has been working on mechanics problems to understand the role played by elasticity in the organization of biological and physical systems. His research interests include exploring the instability response in multi-functional soft materials. He obtained his Bachelors of Technology in Mechanical Engineering from Indian Institute of Technology in Kanpur, India in 2013, and a Ph.D. in Solid Mechanics from Brown University in 2019. At Brown University, his doctoral research, on electro-mechanical instabilities in multi-layer graphene, was awarded the ‘Outstanding Thesis Award’ by the School of Engineering.