Materials, structures and systems that are capable of shape adaptation exhibit multifunctionality capitalizing on their ability to adopt different geometrical configurations. Biological systems are masters in exploiting adaptation to operate in unstructured environments fulfilling dissimilar functions. Recently, the idea of rendering engineering systems adaptable and multifunctional has resulted in a diversity of research fields, such as soft robotics, adaptive structures and programmable matter. The multifunctionality and adaptability stems from the intimate relationship between property, form and function in which any variation in one results in changes in the other. An interesting avenue for exploiting this relationship utilizes large deflections arising from elastic instabilities. In which the careful design of such nonlinear systems enables the possibility for programming functionality into systems. Indeed, systems exhibiting geometrical multi-stability, the switching between the available stable configurations from compliance, naturally show fast adaptability of shape and stiffness which may be triggered by active control or passive response to environmental changes. The arrangement of hierarchical multi-stable elements into compliant structures is an exciting methodology for creating architectured material systems and structures with inherent multifunctional behaviour. This seminar will present examples in which compliance and elastic instabilities are designed to enhance and create novel behaviour and augmented functionalities, resulting in programmable structures. The presented concepts will be illustrated through applications including strongly nonlinear wave guiding, energy harvesting, bioinspired self-shaping composites and aeroelastically driven morphing.

Bio: Dr. Andres Arrieta is an Assistant Professor at the Mechanical Engineering School of Purdue University, leading the Programmable Structures Laboratory. Previously, he worked as Group Leader at the CMASLab in ETH Zurich and as Research Associate at the Dynamics and Oscillations Group of the TU Darmstadt. He received his Ph.D. in Mechanical Engineering from the University of Bristol. Prof. Arrieta’s research investigates the interrelation between shape-property-function of material systems and structures with a focus on embracing nonlinearity. His work lies at the interface between structures and vibrations uncovering and applying nonlinear phenomena, such as buckling and multi-stability, to engineering applications. These ideas are applied to programmable structures, morphing structures, nonlinear metamaterials and energy harvesting systems. Dr. Arrieta has co-author 39 journal papers and has received the prestigious ASME Gary Anderson Award (2018) for outstanding contributions to field of Adaptive Structures; ETH Postdoctoral Fellowship (2012); and the ORS Ph.D. Scholarship (2007).