



**MSE Seminar:  
Bio-inspired Additively Manufactured Multifunctional Graded  
Structures**

**Professor Raju V Ramanujan**

**Abstract**

Biological systems usually possess multifunctional graded structures with spatially optimized properties; the property set at each location is determined based on the performance requirements of that location. On the other hand, engineering components are compositionally homogeneous, exhibit an isotropic set of properties and are commonly optimized for only one property. This highly unsatisfactory situation can only be resolved by the bioinspired development of novel components which display an optimum site-specific property set. Such components are urgently required in a plethora of industries, including the biomedical, electrical machines, aerospace, sustainability, and energy sectors. However, such high-performance unitized components are currently non-existent. For example, there is a critical unmet need for next generation, high frequency, high service temperature, rotating electrical machines with a spatially optimized magnetic, mechanical, and electrical property set. Conventional manufacturing approaches cannot produce such materials. Hence, we deployed laser additive manufacturing to produce compositionally graded Fe-Co-Ni,  $Al_x(\text{CoFeNi})$  and  $AlCo_xCr_{1-x}FeNi$  samples with site specific properties. Rapid characterization, property evaluation, AI/Machine Learning were subsequently employed to successfully optimize the spatial distribution of the property set in a unitized sample. Thus, advanced manufacturing strategies, quick characterization, and property assessment as well as AI/ML can be harnessed to produce novel multifunctional spatially optimized graded materials exhibiting superior performance.

**Biography**

Prof. Raju V. Ramanujan is Full Professor, School of MSE, NTU. He earned his undergraduate and Ph.D. degrees from IIT-Bombay and Carnegie Mellon University (USA), respectively. He is a Fellow of the American Society for Materials and IEEE Senior Member. He has held leadership positions in leading professional societies. He serves/served on the Functional Materials Divisional Council, Magnetic Materials Committee (Chair), Phase Transformations Committee and Awards Committees of TMS (USA). He was the lead organizer of several prestigious international conferences. He was the chair of an IEEE INTERMAG conference and is an IEEE Technical Committee member. Ramanujan serves in an editorial capacity for *Scientific Reports (Nature Publishing Group)*, *Nanomedicine*, *Materials Science and Engineering B*, and *Materials Science and Engineering C*. He has received the Nanyang Award for Excellence in Teaching and the Rolls Royce Inventors award. He has served as the Assistant Chair and is a Guest Professor at universities in the US, China and India. He is ranked among the top 2% of researchers worldwide across all fields. His research interests include the accelerated scientific and engineering development of multifunctional graded structures and magnetic nanotechnology for sustainability, energy and soft robotics.

**Wednesday, 15 March 2023 || Time: 2:00 pm – 3:00 pm ||  
MSE Meeting Room 1 (N4.1-01-28)**

**Please register [here](#)**

**Hosted by: Associate Professor Li Shuzhou**