

# SMU Department of Mechanical Engineering SEMINAR

## “Higher-Order and Surface Elasticity Theories and Their Applications at Small Length Scales”



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**2:00 p.m. – 3:00 p.m.**

**Palmer Conference Center**

**Abstract:** Classical elasticity cannot interpret microstructure and/or surface energy dependent size effects observed in numerous experiments at the micron and nanometer scales. Higher-order and surface elasticity theories contain additional material parameters and are capable of explaining these size effects. Two high-order elasticity theories and one surface elasticity theory along with their applications in solving beam, plate, and shell problems exhibiting size effects will be discussed in this seminar. One higher-order elasticity theory is a modified couple stress elasticity theory, which involves two Lamé’s constants and one material length scale parameter. By applying this theory and Hamilton’s principle, a non-classical third-order shear deformation plate model is developed, which captures size effects and recovers the classical Mindlin and Kirchhoff plate models as special cases. The other is a simplified strain gradient elasticity theory that contains one length scale parameter in addition to the two classical elastic constants. As a direct application of the theory, an analytical solution for the pressurized thick-walled cylindrical shell problem is obtained, which reduces to Lamé’s classical solution when the strain gradient effect is not considered. The surface elasticity theory is that of Gurtin and Murdoch, which contains three surface elastic constants. Based on this theory and the modified couple stress theory, a new Bernoulli-Euler (B-E) beam model is developed using a variational formulation, which reduces to the classical B-E beam model when the microstructure-dependence, surface energy, and Poisson’s effect are all suppressed.

**Bio:** Dr. Xin-Lin Gao is currently a professor of mechanical engineering, bioengineering, and materials science and engineering at UT-Dallas. His other experience includes teaching at Texas A&M University for 7 years, Michigan Tech for 4 years, and working at the Air Force Institute of Technology and the Air Force Research Lab for about 2.5 years. In addition, he was a visiting professor at University of Paris-East and has been a visiting chair professor at East China University of Science and Technology. He earned an M.Sc. degree in Engineering Mechanics in May 1997 and a Ph.D. degree in Mechanical Engineering (with a minor in Mathematics) in May 1998, both from the University of Wisconsin-Madison. He has published 95 journal papers, 2 book chapters, and 108 conference and other publications. He has been a PI or Co-PI of funded research projects worth about \$9.5M. He has been a reviewer for 88 journals, 8 publishers, and 14 funding organizations and has organized 21 symposia at major technical conferences. He has been an

editor/guest editor of one book, proceedings of one conference, and four special journal issues. He currently serves on the editorial boards of six journals. He was elected an ASME Fellow in January 2011.