"IAAM Fellow Lecture 2020" in the Advanced Materials Lecture Series

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Higher-order Strong and Weak Formulations for the Mechanical Modeling of Arbitrarily Shaped Doubly-Curved Shell Structures Made of Anisotropic and Advanced Materials

In a context where the mechanical modelling of anisotropic and composite materials at different scales requires an increased accuracy in many engineering problems and applications, this talk focuses on the theoretical and numerical modeling of heterogeneous materials and enhanced structures, whose response could be affected by staking sequences, ply orientations, agglomeration of nanoparticles, volume fractions of the constituents and porosity levels. The talk will show the results from a large numerical campaign, focusing on fiber-reinforced composites and laminates, functionally graded materials, carbon nanotubes, graphene nanoplatelets, auxetic materials, latticed and cellular (honeycomb) materials, SMART constituents, as well as innovative and advanced classes of composites such as Variable Angle-Tow laminates. Some examples could be represented by large stroke SMART actuators, piezoelectric sensors, shape memory alloys, magnetostrictive and electrostrictive materials, as well as auxetic components. These constituents could be included in the lamination schemes of SMART structures, for a successful control and monitoring of their vibrational behaviour and/or static deflection. Among many possible structural applications, doubly-curved shells represent the most intriguing elements, due to their unique shapes and outstanding mechanical behaviour. Nevertheless, the study of complicated structures characterized by variable radii of curvature is still an open topic, where even more refined approaches are required to investigate their mechanical response accurately. A theoretical framework based on Higher-order Shear Deformation Theories is provided in this talk to handle several kinds of external forces (seismic actions, point and line loads, elastic foundation effect and arbitrary angular velocities), whereby the Generalized Differential Quadrature and Generalized Integral Quadrature methods are here proposed as efficient numerical tools to solve different structural problems, including the computation of natural frequencies, the transient dynamic response caused by a time-dependent loading condition, the critical rotating velocities, the through-the-thickness variation of stress-strain profiles.

Advanced Materials Lecture Series

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