Master's Thesis Defense Announcement
Mechanical and Aerospace Engineering Department
University of Texas at Arlington

AN INTEGRATED DESIGN TOOL FOR TOW-STEERED COMPOSITE LAMINATE IN ABAQUS

By: TWINKLE KOTHARI

Thesis Advisor: Dr Xin Liu

11:00 AM – 01:00 PM, Monday, December 05 2022

Woolf Hall - Room 200

Abstract

The material of choice for contemporary aircraft and its component design over the past few decades has shifted more and more toward fiber reinforced composites. This is mainly due to the improved strength, lightweight, corrosion resistance, design flexibility, and durability of composites over traditional metals. Advanced tailorable composites such as tow-steered composites can be designed and fabricated with fibers following prescribed curvilinear paths, which provides improved mechanical performance compared with unidirectional fiber reinforced composites (UDFRCs). However, the potential of tow-steered composites oftentimes fails to be exploited due to the lack of design tools. Currently, there are no commercially available design tools for tow-steered composites and these advanced composite materials are often in offoptimal designs.

An integrated design tool for tow-steered composites is developed for commercial finite element (FE) software Abaqus via a graphical user interface (GUI) plug-in. This plug-in is written by Python scripts and incorporated all design definition setups so that users can design tow-steered composites in a unified environment within Abaqus. This design framework contains several components: design setups, multiscale plate modeling, FE structural analysis, and optimization. After the definition of design setups in the GUI plug-in, multiscale plate modeling is carried out by an external multiscale modeling code, which calculates location-dependent shell stiffness matrix of each element in a FE model. The structural analysis with updated element properties can then be carried out by Abaqus. The optimization is performed by an external optimizer Dakota. The design variables are updated by Dakota and sent back to FE model to compute structural responses to be employed in an objective function. Several examples are analyzed to demonstrate the use of the developed GUI plug-in.

This GUI plug-in provides a user-friendly and intuitive tool, which reduces extra programming efforts of users so that they can focused on design innovations instead of code development. This work is supported through Small Business Technology Transfer (STTR) program of the National Aeronautics and Space Administration (NASA).