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Introduction to Finite Element and Meshfree Methods for Manufacturing and Failure Analysis

Instructors: Dr. Youcai Wu and Dr. Bo Ren

2 Days - $400 **Students $200** w/student ID
Includes on-site continental breakfasts, lunches, breaks, class dinner
Includes 30-day LS-DYNA demo license to practice

Prerequisite: Students should be familiar with LS-PrePost and should have a command of the LS-DYNA keywords and options associated with meshfree methods.

Description: This two-day class covers various finite element and meshfree methods for modeling large deformation and material failure in relatively low speed manufacturing processes and high velocity impact penetration processes. The class will provide the fundamental background, the related LS-DYNA keywords, practical applications with experimental validations and their latest developments. Benchmarks are presented in the workshop as demonstrations for training purpose.

Course Contents:

[1] **Smoothed Particle Galerkin (SPG) Method**: This method is developed for semi-brittle and ductile failure analyses in 3D solid structures. A strain-based bond failure mechanism is utilized to model material failure in various manufacturing and impact penetration processes, such as metal blanking, FDS (flow drill screw), machining, SPR (self-pierce riveting), and high velocity impact on concrete and metal targets. This method can be used to bridge the Lagrangian FEM and is only available in LS-DYNA.

[2] **Adaptive Finite Element and Element-free Galerkin (EFG) Methods:** While adaptive FEM can efficiently handle large material deformation, adaptive EFG method is developed for high gradient problems in crashworthiness and manufacturing applications for solids and shells. The adaptive methods offer several useful features including local refinement, interactive adaptivity, thermal-mechanical coupling and manual element removal for many challenging forging and extrusion simulations. Both explicit and implicit analyses are available.

[3] **Bond-based Peridynamics:** This explicit method is applied to brittle fracture analysis in 3D solids. The method was implemented under the discontinuous Galerkin Finite Element framework. The fracture analysis in car windshields and other window glass is currently the main application. Other potential application in near future including composite laminates and thin shell structures will also be discussed in this class.

[4] **Extended Finite Element Method (XFEM)**: This method is applied to the non-branching failure analysis in semi-brittle and ductile shell structures. Several failure criteria will be described for the shell analysis. Current XFEM method uses shell element type 2 and type 16 as the base element. Pre-crack is allowed in the analysis.