MECH 540E: Mechanical Behavior in Manufacturing Processes

Schedule: 2021W1 (Sep 07, 2021 to Dec 07, 2021); **Credit**: 3

Instructor: Dr. Xiaoliang Jin

Class Format: Lecture (2 lectures/week; 1.5 hours/lecture)

Learning Objectives: In this course, students will understand the mechanical behavior of various materials including deformation, stress, and temperature in typical manufacturing processes. Students will learn how the process conditions determine the process efficiency and manufactured component quality. In addition to metal cutting process, other non-traditional manufacturing techniques such as ultrasonic vibration assisted machining, and machining of composites.

Course Calendar Description: Material plasticity, material constitutive model, analytical and numerical modeling of machining process, shear flow instability, machining of composite materials, non-traditional manufacturing techniques.

Textbook: Lecture notes and reading materials will be provided.

Assessments and Grading Scheme:

- Three projects (generally involve programing or finite element simulations, and writing project reports) - 20%;
- Final project/exam - 40%.

Course Content

1. Material Plasticity in Machining
1.1 Introduction of material plasticity
1.2 Yield criteria and flow rules
1.3 Slip line field theory and applications
1.4 Material constitutive model and characterization
1.5 Fundamentals of metal cutting mechanics
1.6 Analytical analyses of machining process based on plasticity

2. Shear Localization in Machining
2.1 Introduction of shear localization in dynamic deformation
2.2 Theory of adiabatic shear bands and shear localization
2.3 Finite element method and applications
2.4 Analysis of adiabatic shear bands by numerical methods
2.5 Shear localization in machining metal alloys

3. Deformation of Composite Materials in Machining
3.1 Anisotropy of mechanical property
3.2 Thermal-mechanical properties of composite materials
3.3 Cutting force modeling in orthogonal cutting of fiber-reinforced composites
3.4 Finite element modeling of machining composites

4. Non-traditional Manufacturing Techniques
4.1 Ultrasonic vibration assisted machining
4.2 Additive manufacturing