

Course Title: NA 515 Residual Stress and Distortion in Modern Manufacturing

Course Level: Graduate level

Cognizant Faculty: P. Dong

Credit Hours: 3 credits

Schedule: Fall Term (every other fall semester starting Fall 2020)

Prerequisites: Prerequisite: None

Short Description: Modern approaches to residual stress and distortion control are presented with a focus on design and manufacture of lightweight structures, involving plate processing, laser cutting/forming, welding/joining, and 3D printing. Basic thermo-plasticity phenomena are treated through a series of 1D analytical models and followed by modern finite element simulation procedures.

Text: Lecture notes and selected book chapters

Outline and Time Allocation	Lecture unit (1.5 hrs)
I. Major challenges in residual stress and distortion control in manufacture of modern lightweight structures	1
II. Material behaviors in thermal manufacturing	2
III. Basic thermos-plasticity phenomena in manufacturing and 1D modeling:	6
• Temperature-dependent stress-strain relationship	
• Localized thermo-mechanical deformation modeling	
○ 1-bar model	
○ 3-bar model	
○ n-bar model	
• Local plastic zone characterization and implications on distortions	
IV. Local plastic zone based distortion modeling	2
• Shrinkage force method	
• Shrinkage strain method	
V. Applications	4
• Plate rolling	
• Thermal cutting	
• Mechanical bending/thermal forming	
• Arc welding	
• Solid state joining processes	
• 3D printing	

VI.	Finite element modeling	5
	• Heat source modeling	
	• Plastic zone modeling	
	• Residual stress and distortion modeling	
	• Buckling distortion modeling	
VII.	Residual stress and distortion control	2
	• Principles of interim product definitions	
	• Principles of residual stress and distortion mitigation techniques	
	• Buckling distortion control	
VIII.	Real-world applications:	1
	• Marine structures	
	• Aerospace and automotive structures	
IX.	Course review	1