

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: <ul style="list-style-type: none"> • Temperature-dependent stress-strain relationship • Localized thermo-mechanical deformation modeling <ul style="list-style-type: none"> ○ 1-bar model ○ 3-bar model ○ n-bar model • Local plastic zone characterization and implications on distortions 	6
IV. Local plastic zone based distortion modeling <ul style="list-style-type: none"> • Shrinkage force method • Shrinkage strain method 	2
V. Applications <ul style="list-style-type: none"> • Plate rolling • Thermal cutting • Mechanical bending/thermal forming • Arc welding • Solid state joining processes • 3D printing 	4

VI.	Finite element modeling	5
	<ul style="list-style-type: none">• Heat source modeling• Plastic zone modeling• Residual stress and distortion modeling• Buckling distortion modeling	
VII.	Residual stress and distortion control	2
	<ul style="list-style-type: none">• Principles of interim product definitions• Principles of residual stress and distortion mitigation techniques• Buckling distortion control	
VIII.	Real-world applications:	1
	<ul style="list-style-type: none">• Marine structures• Aerospace and automotive structures	
IX.	Course review	1