

Colorado School of Mines
Metallurgical and Materials Engineering
MTGN 475 Metallurgy of Welding
Fall Semester 2004

Instructor: Dr. Stephen Liu
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Teaching Assistants:

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Time: M, W & (F) 11:00 - 11:50 A.M. ([shared with Lab](#))

Room: HH 211

Textbook: ASM. "Welding, Brazing, and Soldering," Handbook Vol. VI, American Society for Metals, 10th Edition, 1993.

Objectives: MT 475 is designed to provide an overall view of the industrial welding and joining processes and the metallurgical aspects of these processes. To build a sound background in welding studies, three major aspects of welding will be addressed in this course:

- a. the basic physical and chemical phenomena that occur during welding and joining;
- b. the selection of processes and process parameters; and
- c. the response of the different engineering materials to the different welding processes. The discussion will be presented in the light of welding science and technology.

Course Outline: (Tentative)

1. Introduction
 - a) Course Outline
 - b) History of Welding
 - c) Welding Terminology
 - d) Joint Design and Preparation
2. Industrial Welding & Joining Processes
 - a) Feasible Energy Sources for Welding
3. Chemical Energy Processes
 - a) Oxy-Gas Welding
 - b) Thermit Welding
4. Electric Arc Energy Processes
 - a) Shielded Metal Arc Welding
 - b) Submerged Arc Welding
 - c) Flux Cored Arc Welding
 - d) Gas Metal Arc Welding
 - e) Gas Tungsten Arc Welding
 - f) Plasma Arc Welding
5. Arc Welding Principles
 - a) Arc Physics
 - b) Metal Transfer Modes

(*) 1st Exam (Around 9/26)

6. Electrical Energy Processes
 - a) Electroslag Welding
 - b) Electrical Resistance Welding
7. High Power Density Welding
 - a) Laser Beam Welding
 - b) Electron Beam Welding
8. Heat & Mass Flow in Welding
 - a) Thermal Experiences

- b) HAZ Formation
- c) Heat Input Calculation
- d) Cooling Rate Calculation
- 9. Weld Pool Geometry
 - a) Fluid Penetration Flow
- 10. Welding Parameters Effect

(*) 2nd Exam (Around 10/27)

- 11. Weld Pool Chemical Behavior
 - a) Gas-Metal Reactions
 - b) Dilution
 - c) Delta Quantity
 - d) Carbon Equivalent
 - e) Inclusion Formation
 - f) Weldability Prediction
- 12. Phase Transformations in Weldments
 - a) Low Carbon Steels
 - i) Fe-C System
 - ii) Solidification Structure
 - iii) HAZ Formation
 - iv) Solid-State Transformation Products
 - a) CCT Diagrams
 - b) High Strength Steels
 - i) Hot & Cold Cracking
 - ii) Hydrogen Determination
 - iii) Pre- & Post-Heating
 - c) Stainless Steels
 - i) Hot Cracking
 - ii) Sensitization
 - iii) Delta Ferrite
 - d) Dissimilar Metal Joining
 - i) Liquation Cracking
 - e) Aluminum Alloys
 - f) Titanium Alloys
- 13. Weld Testing
 - a) Mechanical Properties
 - b) Destructive
 - c) Non-Destructive

(*) 3rd Exam (Around 12/01)

Evaluation & Grading System:

3 In-Class Exams (100 points each)	300
1 Computation Homework on Weld Temperature Distribution	100
1 Lab Grade (MTGN 477)	400
1 Weld Design Project Report	<u>250</u>
Total Points	1050

(*) Tentative