Instructor: Dr. Stephen Liu  
Professor of Metallurgical Engineering  
HH 254 - X3796  
sliu@mines.edu

Teaching Assistants:  
Eric Soderstrom, Adam Rowe, Juan Madeni, Faustino Perez, Jeff Major

Time: M, W & (F) 11:00 - 11:50 A.M. (shared with Lab)  
Room: HH 211


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

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:

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

(*) Tentative