ME 50700
LASER PROCESSING

Course Outcomes

1. Provide background in laser science and laser technology used for laser materials processing.
3. Develop skills to quantify thermal and thermomechanical phenomena involved in laser processing.

Laser Fundamentals (3 wks)
1. Spontaneous emission, absorption, stimulated emission and Einstein coefficient
2. Laser gain equation and laser power
3. Laser efficiency

Laser Systems (2 wks)
1. Solid state lasers, Ruby, and rare-earth (glass, YAG, YLF, etc.) lasers
2. Gas lasers, HeNE, Arion, CO₂, Nitrogen, and excimer lasers
3. Liquid lasers, dye laser

Laser Beam Optics (3 wks)
1. Review of geometry optics
2. EM wave theory
3. Gaussian beam optics, propagation of laser beam in optical systems

Laser-matting Interaction (4 wks)
1. Physics of absorption of laser beam by a solid
2. Laser-induced heating, melting and evaporation
3. Laser-induced stress and strain development

Special Topics (3 wks)
1. Laser welding
2. Laser machining
3. Laser hardening
4. Laser micro and nano manufacturing
5. Ultrafast laser processing

Laboratory and Video Demonstrations
1. Laser fundamentals
2. Laser beam optics
3. Laser machining and laser-assisted machining

Examples of Projects (One project per semester)
1. Shaping of ultrafast laser pulses
2. Laser-based rapid prototyping
3. Laser-induced stress wave generation and propagation
4. Laser induced surface plasmon
5. Laser interaction with biological materials

Revision Date: 7/17/2012
### 1. COURSE NUMBER AND NAME:  
ME 50700 Laser Processing

### 2. CREDITS AND CONTACT HOURS: 3 credits  
- a. Lecture – 3 days per week at 50 minutes for 16 weeks

### 3. COURSE COORDINATOR OR INSTRUCTOR:  
X. Xu

### 4. TEXTBOOK: None

### 5. SPECIFIC COURSE INFORMATION:  
- **a. Catalog Description:** Introduces background in laser science and laser technology, and fundamentals involved in laser processing and manufacturing. The following topics are discussed: laser fundamentals, industrial laser systems and processes, and the laser-induced thermal, thermo-mechanical and thermo-acoustic effects. The course also discusses emerging areas of laser applications, such as micro and nanoscale laser processing, ultrafast laser processing, and the related energy transport analyses. Laboratory and video demonstration sessions are used to enhance the overall understanding of the course materials. Typically offered in the fall (alternative years).

- **b. Prerequisites:**  
  ME 31500 – Heat and Mass Transfer

- **c. Status:** Elective

### 6. SPECIFIC GOALS FOR THE COURSE  
- **a. Course Outcomes:**  
  1. Knowledge in *laser science* and *laser technology*.
  2. Develop an understanding of the *physics of laser devices, laser beam propagation*, and fundamentals of *laser–matter interaction*.
  3. Develop skills to quantify thermal and *thermomechanical phenomena* involved in laser processing.

- **b. Related ME Program Outcomes:**  
  - A1. Engineering Fundamentals;  
  - A2. Analytical Skills;  
  - A3. Experimental Skills;  
  - A4. Modern Engr Tools;  
  - A5. Design Skills;  
  - A6. Impact of Engr Solns;  
  - B1. Communication Skills;  
  - B2. Teamwork Skills  
  - B3. Prof/Ethical Responsibility;  
  - B4. Contemporary Issues;  
  - B5. Life-Long Learning;  
  - C1. Leadership;  
  - C2. Global Engineering Skills;  
  - C3. Innovation;  
  - C4. Entrepreneurship

### 7. LIST OF TOPICS:  
See following page.

**PREPARED BY:** X. Xu  
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