IME 552 – Casting Simulation & Solidification
Course Syllabus – Spring 2006

Catalog Description (2006-2007): The process of computer simulation illustrates the way a casting is filled and how the alloy is allowed to cool. By simulating the process conditions to observe 3-D fill and solidification, researchers will be able to predict potential defects in the casting and redesign the process to eliminate the defects, before making actual castings. Topics will include: non-traditional casting processes, gating design, risering design, solidification analysis, alternative molding media, and micro/macro casting defects analysis. Activities will compare theory to practice.

Prerequisites: Understanding of mechanical, physical, thermal, and chemical properties of industrial materials (ME 250 & MSE 255).

Textbook: Technology of Metalcasting, Fred P. Schleg, American Foundry Society.

Course Coordinator: Sam Ramrattan, FEF Key Professor

Learning Objective[1]:

1. Understand the importance of metal casting simulation. (j)
2. Identify and model the conditions of 3-D solidification simulations. (a, b & f)
3. Analyze and interpret the simulation data and solve metal casting related problems. (c & k)
4. Optimize metal casting designs. (e & f)

*[1] Letter in parenthesis refers to ABET **EAC Criterion 3** / TAC Criterion 2, categories a – k.*

Performance Criteria[2]:

Objective 1:

- To be familiar with the current research literature in the metal casting simulation & solidification. (5)
- To understand the theory of solidification. (1-9)

Objective 2:

- To identify potential defects found through solidification simulation. (3, 6, 7 & 9)
- To understand process control through solidification simulation. (6-9)

Objective 3:

- To understand gating and risering design procedures in relation to solidification simulation. (1, 2, 3, 4 & 5)
- Generate computer files to analyze and interpret a three dimensional solidification simulation models, using SOLIDCast, NovaFlow& Solid, SIM TEC / WinCast, and MAGMA softwares. (1, 2, 3, 4 & 5)

Objective 4:

- To optimize casting designs in relation to solidification simulation. (1, 2, 3, 4 & 5)

[2]Numbers in brackets refer to the method of evaluation as listed in Evaluation.

Evaluation:

1. Course Work / Assignments (30%)
2. Attendance & Field Trips (5%)
3. Project (30%)
4. Mid Term Exams (15%)
5. Comprehensive Final Exams (20%)

Course Schedule:

Weekly Topics Listed

1. Setting System Parameters
2. Selecting the Casting Alloy
    - Cooling Curves
    - Volumetric Change Curves
3. Modeling Considerations by Process
    - Selecting Mold Materials
    - Heat Transfer Coefficients
4. Importing STL Files
    - Generating a Mesh
    - Weight Calculations
5. Running a Simulation
    - Plotting Results Using:
        - Iso-Surfaces
        - Cut Planes
        - Cast Pictures
6. Mold Filling
7. Output Criteria
    - Solidification Time
    - Critical Fraction Solid Time
    - Material Density Function
    - Temperature Gradient
    - Cooling Rate
    - The Niyama Criterion
    - Hot Spots
    - Planes of Symmetry
8. Gating System Design
    - Requirements
    - Ferrous versus Non-Ferrous Designs
    - Types
    - Friction
    - Pouring Time
    - Choke
    - Design Principles for sprue, runner, gate, pouring basin, and wells.
9. Junction Design
10. Risering System Design
    - Requirements
    - Metal volume change patterns
    - Selection of risering method

Professional Component

This course addresses ABET Criterion 4 (EAC) requirement for professional component as follows:

(a) College level math, basic science: (20%)
(b) Engineering topics (engineering Science): (80%)
(c) General education (communication, teamwork, professional development, ethics): (0%)

Relationship to IME Program Educational Objectives / Student Learning Outcomes

This course provides significant support for the following IME program outcomes:

1. a, b; 2. a, b, f; 3. a

Prepared by: Sam N. Ramrattan **Date: September 5, 2006**