Atılım University
Department of Metallurgical and Materials Engineering

# MATE 316
# Solidification Processes

Course Description and Practice

| Code | Course Name | Term | Theory + Recit. + Lab. | Credits | ECTS |
|---|---|---|---|---|---|
| MATE 316 | Solidification Processes | 6 | 2 + 0 + 2 | 3 | 5.5 |

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| **Pre-requisite Course(s)** | MATE 202 | | |
| **Course Type** | Compulsory | **Language of the Course** | English |

**Course Catalogue Description**

Basics of heat transfer, structure of liquid metals, Solidification of pure metals. Solidification of binary alloys, constitutional undercooling, distribution coefficient, plane front and dendritic solidification, rate of solidification, micro and macrostructure development, segregation, porosity formation, solidification of cast iron, single crystal growth, zone refining, rapid solidification, introduction to casting technologies

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| **Course Objectives** | ▪ To introduce the students of Metallurgical and Materials Engineering to the principles of solidification and applications of the knowledge to industries as it is the most important processing route for materials by emphasizing the interrelationship of properties, structure and processing. |

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| **Course Book** | *Phase Transformations in Metals and Alloys*, 3rd Edition, David A. Porter, Kenneth E. Easterling and Mohamed Sherif, CRC (2009) + Lecture Notes |
| **Other Sources** | ▪ *Solidification*, 1st ed., J. Dantzig and M.Rappaz, EPFL Press, (2009)<br>▪ *Solidification Processing*, M.C. Flemings, McGraw-Hill, 1974<br>▪ *Fundamentals of Metal Casting*, Richard A. Flinn, Addison-Wesley Publishing Company, 1963<br>▪ *Solidification and Casting*, B. Cantor and K. O'Reilly, IOP, 2003<br>▪ *Fundamentals of Physical Metallurgy*, John D. Verhoeven, Wiley (1975)<br>▪ *The Science and Engineering of Materials*, D.R. Askeland, P.P. Fulay, W.J. Wright, CL-Engineering (2011) |

**Covered Topics**

- Introduction (5 h.)
  a. Thermodynamics Review
  b. Heat Transfer & Thermal Properties
  c. Structure of Liquid Metals & Viscosity
- Solidification of Pure Metals (5 h.)
- ***Midterm I***
- Alloy Solidification (12 h.)
- Solidification of Ingots and Castings (9 h.)
- Solidification of Cast Iron (3 h.)
- ***Midterm II***
- Miscellaneous Topics in Solidification (5 h.)
  a. Solidification Structure Control
  b. Single Crystal Growth
  c. Production of Amorphous Metallic Materials
  d. Solidification Modeling
- Introduction to Casting Technologies (3 h.)
- Student Term Project Presentations (4 h.)

**Attendance Requirement:** A first time taker has to attend at least 70% of the lectures.

**Grading Policy**

Two Midterms (16% each), Final Exam (34%), Term Project Report (8%), Term Project Presentation (8%), Assignments & Quizzes (10%), Attendance & Class Participation (8%)

**Contribution to Professional Component**

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| Mathematics and Basic Sciences | |
| Basic Occupational Courses (Engineering) | |
| Expertise/Field Courses (Engineering Design) | **X** |
| Courses on Communication and Management Skills (Social Sciences) | |

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# Course Learning Outcomes vs. Program Outcomes Correlation Table

*Scale: "5"=very strong; "4"= strong; "3"= medium; "2"=some; "1"= poor; "-"= NA*

| MATE 316 Course Learning Outcomes | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO1 | Understanding of the properties of liquid metals, heat transfer basics and the thermodynamics of solidification | 5 | 5 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| CLO2 | Learning the kinetics of solidification, nucleation and growth of solid phases. | 5 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| CLO3 | Learning the solidification behavior of pure metals and alloys; single phase, eutectic and peritectic solidification. | 5 | 4 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| CLO4 | Understanding of the development of solidification microstructures, dendritic solidification, macro and microsegregations, porosity formation. | 5 | 4 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| CLO5 | Understanding the techniques for solidification structure control, amorphous and single crystal material production; awareness of solidification modelling and simulation. | 5 | 4 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| CLO6 | Ability to prepare a term project report and to give an oral presentation on a topic assigned within the scope of the course. | 5 | 5 | 5 | 1 | 5 | 2 | 5 | 5 | 2 | 2 | 1 | 4 |

**Metallurgical and Materials Engineering Program Outcomes**

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| PO1 | Knowledge in mathematics, science, and Metallurgical and Materials Engineering, and an ability to apply the theoretical and applied knowledge gained in these areas to model and solve complex engineering problems and material systems. |
| PO2 | Understanding of the science and engineering principles regarding the structure, properties, processing, and performance of material systems. |
| PO3 | Ability to detect, identify, formulate, and solve complex engineering problems; ability to select and use appropriate analysis and modeling methods for this purpose. |
| PO4 | Ability to design and select material for a system, component, product or a process under realistic conditions and constraints to meet desired needs; ability to apply modern design and material selection methods for this purpose. |
| PO5 | Ability to select, use and improve the techniques, skills, and modern engineering tools necessary for Metallurgical and Materials Engineering practice; ability to effectively use information technology. |
| PO6 | Ability to design and conduct experiments, collect data, and use statistical and computer methods to analyze and interpret results for the investigation of complex engineering problems or Metallurgical and Materials Engineering specific research subjects. |
| PO7 | Ability to function effectively in self-disciplinary and multidisciplinary teams; ability to work alone. |
| PO8 | Ability to use Turkish to communicate effectively in oral and written means; knowledge of at least one foreign language, ability for effective report writing and understanding written reports, ability to prepare design and production reports, make effective presentations, give and take clear and understandable orders/directions. |
| PO9 | Recognition of the need for, and an ability to engage in, life-long learning; ability to access information, follow developments in science and technology |
| PO10 | Awareness of acting according to ethical principles, awareness of professional and ethical responsibilities; knowledge of standards used in engineering applications. |
| PO11 | Knowledge on business life practices such as project management, risk management, change management; awareness of entrepreneurship, innovation, and sustainable development. |
| PO12 | Recognition of the impact of metallurgical and materials engineering solutions on health, environment and security in global and societal context, recognition of the legal consequences of engineering solutions. |

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| **Prepared by:** Assist.Prof.Dr.Erkan KONCA | **Date:** 07.02.2020 | **Total Pages:** 2 | **Revision:** 09 |