

**Purdue University
School of Materials Engineering**

MSE 597 Steel and Aluminum: Process, Structure and Properties

Fall 2020

Lecture: MWF 9:30-10:20 WANG 2555

Instructor: Prof. Kevin Trumble, ARMS 2333, 765-494-4114, driscol@purdue.edu.

Website: *Brightspace*

Synchronous Sessions: Prof. Trumble will hold regular office hours two times per week in an online platform.

Objectives: To apply chemical, physical and mechanical metallurgy principles to engineering specifications for the main classes of steel and aluminum alloys in commercial practice, including design, manufacturing and service.

Description: Steel and aluminum alloy processing will be studied to provide fundamental understanding of how the final properties are influenced by the sequence of processes from the extraction of metal from ore, through shape processing of cast, wrought and powder forms, to heat treatment for control of microstructure and properties. This understanding will enable the student to go beyond comparisons of standard handbook values and to recognize and understand how the fundamental metallurgical phenomena lead to different performance among the main classifications of steel and aluminum alloys. By examining the relationships among processes, microstructure, and properties, the course will provide the "know-how" for better design, manufacturing and specification with steel and aluminum, as well as competing materials.

Outline: Steel production and processing will include the blast furnace, basic oxygen converter, electric arc furnace, refining, continuous casting, deformation processing and heat treatments. The iron-carbon phase diagram and phase transformation kinetics will be studied in order to understand the variety of microstructures that are obtained by thermal processing. Plain-carbon, low-alloy, alloy, stainless and tool steels; cast steel; cast iron; and powder alloy specifications will be included. Aluminum alloy production and processing will include the Bayer refining and Hall-Heroult smelting processes, direct-chill casting, deformation processing and heat treatments. Shape casting and powder processing will also be covered. The different alloy systems will be studied to understand the distinctions and applications of heat treated vs. non-heat treated Al alloys.

Prerequisites: Introductory undergraduate courses in materials science, chemistry and physics.

Textbooks

Required: WF Smith, *Structure and Properties of Engineering Alloys*, 2nd Edition, McGraw-Hill, 1993. Hardcover ISBN: 0070591725; Paperback (International Edition, 2014) ISBN: 9339205294.

Recommended: Any introductory MSE textbook. For example, WD Callister et al., *Materials Science and Engineering or Fundamentals of Materials Science and Engineering*, Wiley (currently in 10th and 5th editions, respectively). Earlier editions (of this book and others) can be had for next to nothing; there are no substantive differences from the high-priced recent editions. Several sections of the course will begin with reviews at the level of the introductory MSE texts.

References: An annotated list of reference sources on the course topics will be provided.

Recorded lecture access

The course is running effectively in a hybrid in-person/online mode in Fall 2020 through the Engineering Professional Education (EPE) program (also known as Purdue Engineering Online (PEO), and know Purdue Online Learning (POL) - College of Engineering. The good news is that all lectures will be recorded for streaming to the EPE students off campus. The lecture video recordings will also be available to on-campus students to view any time by logging in from a Purdue University IP address:

The URL is <https://engineering.purdue.edu/ProEd/OnCampus>

Course Login ID Number – **TBA**

Course – MSE59700

The URL for distance students is https://engineering.purdue.edu/ProEd/current_student.

Assessments and Grading (percentage of final grade):

Homework problem sets throughout the semester (5%)*; a current-topics paper (10%); two exams on steel (25% each); one exam (during finals period) on aluminum alloys (35%). Final grades will include “+” and “-“ divisions; divided evenly by score within each letter grade range. *Homework will be collected, but not graded; solutions will be provided; a small credit (5% maximum) will be awarded for turning in complete, original solutions.

In-class Attendance

The capacity of WANG 2555 under COVID-19 conditions will be 25 students. This capacity may not allow all on-campus enrolled students to attend all lectures in person. Those who want to attend in person may need to be divided into groups who attend on alternating days. If you do not want to attend any of the lectures, you do not have to. Attendance will require following all Purdue COVID-19 safety protocols (masks, etc.). See the Protect Purdue website for the latest information.

Emergency Procedures

Fire, weather, and civil emergency procedures specific to the WANG 2555 will be reviewed in class. Information on emergency preparedness at Purdue is available on the Purdue homepage and at http://www.purdue.edu/emergency_preparedness/.

For a shelter-in-place siren (tornado, hazardous material release, civil disturbance) stay in WANG 2555 and wait for further instructions. In case of a fire alarm, exit WANG via the stairway and assemble in the Northwestern Avenue parking garage.

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. These changes would be posted on the course website on *Brightspace*. In case of an extended disruption in which classes on campus are suspended the course will continue to the extent possible via *Brightspace*.



COVID-19

The Protect Purdue plan has a central website for COVID-19 issues: <https://protect.purdue.edu/>. It is critically important that all students on campus monitor for and report any COVID-19-related symptoms to the Protect Purdue Health Center by calling 765-496-INFO (4636) or toll-free at 833-571-1043.

Illness and Extended Absence

If you feel sick it is very important to see a doctor as soon as possible and not to come to class. If you experience or anticipate an extended absence for any reason please inform Prof. Trumble, to discuss how you can make up any missed work.

Mental Health Resources

If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765) 494-6995 and <http://www.purdue.edu/caps/> during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Students with Disabilities

If you anticipate or experience physical or academic barriers based on disability, you are welcome to discuss options with Prof. Trumble. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247; <https://www.purdue.edu/drc/>.

Diversity and Inclusion

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. Purdue's nondiscrimination policy can be found at the following website: http://www.purdue.edu/purdue/ea_eou_statement.html. If you see, hear or experience discrimination in any form you are always welcome to discuss it with Prof. Trumble. The College of Engineering also has a website that provides extensive resources for diversity at: <https://engineering.purdue.edu/Engr/AboutUs/Diversity/DiversityResources>.

Academic Dishonesty Policy

Purdue University Regulations, Part 5, Section III-B-2-a describes the formal policies governing academic dishonesty. A guide providing specific examples, tips, and consequences is available at <http://www.purdue.edu/odos/osrr/academic-integrity/index.html>. You are encouraged to study together and discuss coursework, but any work you turn in for grading is expected to be your own original work. Notes presented in the lectures are subject to copyright. Students in the course are granted permission to copy and exchange these notes with other students in the course, but they cannot be sold, bartered or posted on any website.