

**Technical Elective: Advanced Physical Metallurgy**  
**Syllabus for 2021 Fall**

**Instructor:** Dr. Yingjie Wu (Office: 4-226; Email: yingjie.wu@scupi.cn)

**Lecture:** Wednesday, 1:50 pm - 4:25 pm, Room 3-311

**Office hours:** Wednesday, 9:15 am – 11:55 am, Room 4-226

**TA:** Yajie Li (Email: naseprince@foxmail.com)

**Course Description:**

This course is an advanced course of physical metallurgy, which focuses on the strengthening mechanisms in crystalline solids and annealing phenomena, including grain boundary strengthening, dislocation strengthening, solid solution strengthening, precipitation strengthening, the cold-worked state, crystal plasticity, production of crystalline defects, annealing phenomena, recovery, recrystallization, grain growth, secondary recrystallization, tertiary recrystallization, genesis of preferred orientation, deformation and recrystallization textures. Also, this course describes such areas of contemporary importance as rapid-solidification technology, metal-matrix composites, dual-phase steels, mechanical alloying, and the finite-element method. It also introduces important advances made in understanding structure-mechanical property relationships, illustrating fundamental concepts by applications and technological developments, and providing in-depth coverage of mechanical testing of metals. By studying this course, students can master the advanced knowledge of physical metallurgy, lay the foundation for numerous metallic materials related courses, and provide applicable tools for the interdisciplinary application of materials science and other disciplines.

**Required Resources:**

1. Meyers, M. A. and K. K. Chawla, *Mechanical Metallurgy: Principles and Application*. Prentice Hall, 1983, Print.
2. Kelly, A. and R. B. Nicholson, *Strengthening Methods in Crystals*. New York: Halstead Press Division, Wiley, 1972, Print.
3. Humphreys, F. J. and M. Hatherly, *Recrystallization and Related Annealing Phenomena*, 2<sup>nd</sup> ed, Pergamon Press, 2004, Print.

**Course Content (tentative):**

1. Strengthening Mechanisms in Crystalline Solids

- 1.1 Introduction – Review of Dislocations and their Movement and Interactions
- 1.2 Lattice Friction (Peierls-Nabarro) Stress
- 1.3 Dislocation Strengthening/Crystal Plasticity/Work Hardening
- 1.4 Precipitation Hardening
- 1.5 Solid Solution Strengthening

- 1.6 Grain Size Strengthening
- 1.7 Order Hardening
- 1.8 Texture Hardening
- 1.9 Fiber Composite Strengthening

## 2. Annealing Phenomena

- 2.1 The Cold Worked State
- 2.2 Recovery
- 2.3 Recrystallization
- 2.4 Grain Coarsening
- 2.5 Influence of Second Phase Particles
- 2.6 Crystallographic Textures and Their Determination
- 2.7 Deformation Textures
- 2.8 Recrystallization Textures
- 2.9 Anisotropy in Physical and Mechanical Properties

### **Grading Policies:**

<b>Requirements</b>	<b>Corresponding Percentages</b>
Assignments (5)	25%
Mid-Term Exam	35%
Final Exam	35%
Participation	5%

### **Grading Scale:**

100% ≥ A ≥ 90%; 90% > A- ≥ 85%; 85% > B+ ≥ 80%; 80% > B ≥ 76%; 76% > B- ≥ 73%; 73% > C+ ≥ 70%; 70% > C ≥ 66%; 66% > C- ≥ 63%; 63% > D ≥ 60%; 60% > F.

### **Homework:**

There will be about 5 homework assignments that will be submitted on Blackboard either as Word document or as pdf before the start of the class (1:50 pm) on the due day. If you are unable to attend a class, you may attach a note to your homework and submit it in advance. *If homework is submitted late, you would lose 10% per day. You may receive no credit if homework is not submitted within a week from the due day.*

### **Exams:**

There are two exams, including mid-term and final exams and the exams are not cumulative. An equation sheet might be permitted (information about this will be given a week before the exam). The students need to be present during the exam. In case of an emergency (doctors notice), a make-up exam might be given. The only allowed things during the exams are pens, ruler, water, potentially calculator. Paper and the equation sheet will be provided.

A student found *cheating, attempting to cheat*, having an *unauthorized device/tool* during the exam *independent of the reason* will receive a zero on the exam.

**Participation:**

Participation through presence but also answering questions, asking questions, contributing to activities is very important to improve active learning for each student. Therefore, your participation will be graded during each lecture starting with the second week.