Name of the module: Metal Processing

Number of course: MATSCI 121 01

UC Berkeley Credits: 3

Academic year: 2019

Semester: Spring

Hours of instruction: 1.5x2 lecture hours + Laboratory class.

Location of instruction: Hearst Mining 350

Language of instruction: English

Cycle: First cycle

Position: a non-mandatory module for 3rd year undergraduate students from the Departments of MSE, NE, and ME to be taken on spring semester.

Field of Education: Materials/Mechanical Engineering.

Responsible department: Materials science and engineering department.

General prerequisites: students should complete Basic materials science courses.

Grading scale: the grading scale would be determined on a scale of 0 – 100 (0 would indicate failure and 100 complete success 0 to 100), passing grade is 56.

Lecturer: Dr. Adi Ben-Artzy

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Office hours: Tuesday, 14:00 to 16:00

Module evaluation: at the end of the semester the students will evaluate the module, in order to draw conclusions, and for the universities internal needs.

Course Description: The course will explore the various processing for elevated temperature metals forming and heat treatments of ferrous and non-ferrous materials.

Aims of the module: This course is the advance part of "metal processing" course following its precursory "Introduction to material science". This course is focused on elevated temperature metal forming processes. Students will learn the basics of metal flow and formability of different metals and alloys using various forming processes. Students will learn to use tools that help engineers to predict metal flow and behavior during metal forming. The influences of working temperature and friction on forming processes will be demonstrated. Some technics to avoid failure will be learned. The possibilities, advantageous and disadvantageous of each technological approach will be considered. Heat treatments of ferrous and non-ferrous materials will be learned as well as the use of Iron-Carbon diagram, TTT (Time Temperature Transformation Diagram) and Aging diagrams. During the course the student will be introduced to numerical simulation of metal forming processes using FEM technique and its uses for metal forming processes (Theory only).

Objectives of the module: To familiarize students with modern technologies of elevated temperature metal forming processes and heat treatment in order to develop a basic understanding of the principles and theory of each technological approach.

Learning outcomes of the module: On successful completion of the course, the students should be able to:

1. Choose the appropriate metal forming process in order to manufacture a specific product.
2. Calculate the forces needed for the process, the size of the machine that is needed for this work and to evaluate the strain and strain distribution in the final product.
3. Evaluate the ability of certain metal or alloy to be formed in a specific process without cracking.
4. Choose process parameters set that would assure the success of the forming without failure.
5. Use different methods and lubricants in order to reduce friction.
6. Use Iron-Carbon, TTT and Aging diagrams in order to design a heat treatment process.
7. Design heat treatment process for ferrous and non-ferrous materials and alloys in order to establish the suitable mechanical properties and micro - structure needed for the final product.
8. Identify the metallurgical and heat treatment history of metals and alloys.
9. To be familiar with standards.

Last update: 01.01.2019

Attendance regulation: attendance and participation in class is 100%.

Teaching arrangement and method of instruction: The module consists of lectures and one day of Plasticine laboratory.

Assessment:

1. Final and exams 70%
2. Preliminary and final lab reports 15%
3. Midterm exams 10%
4. Homework 5%

100%

Work and assignments:

The students will submit a preliminary laboratory planning report (5%).

The students will attend laboratory.

The students will submit a final laboratory report (10%).

The laboratory report includes theoretical review of the process that was investigated by the students, description of the parameters and relevant equations, description of the lab experiments and results and the final report.

Exam: A Midterm exam (15%) and final exam at the end of semester, open and close questions (70%).

Time required for individual work: in addition to attendance in class, the students are expected to do their assignment and individual work: at least two hours per week, 10 hours before lab and 24 hours before exams.

Module Content\ schedule and outlines of Lectures:

1. Introduction to metal processing 1
2. Introduction to metal processing 2
3. Elevated temperature bulk metal forming (BMF)1 - flow stress
4. Elevated temperature BMF 2 - friction
5. Elevated temperature BMF 3: Hot Extrusion.
6. Elevated temperature BMF 4: Hot Extrusion cont.
7. Elevated temperature BMF 5: Backward extrusion.
8. Heat treatments of metals 1: Fundamentals of heat treatment
9. Heat treatments of metals 2: Fundamentals of heat treatment cont
10. Heat treatments of metals 3: H.T of ferrous metals - Annealing
11. Heat treatments of metals 4: H.T of ferrous metals - Hardening
12. Heat treatments of metals 5: H.T of stainless steel.
13. Heat treatments of metals 6: H.T of stainless-steel cont.
14. Elevated temperature BMF 6: Hot and cold Rolling.
15. Elevated temperature BMF 7: Hot and cold Rolling cont.
16. Elevated temperature BMF 8: Profiles Rolling.
17. Elevated temperature BMF 9: Ring rolling, Cogging.
18. Elevated temperature BMF 10: Forging 1.
19. Elevated temperature BMF 11: Forging 2.

Exercises: Homework exercises will be given each Thursday to be submit until next Tuesday for self-practice of the students.

Homework will be submitted on Canvas. 80% submission is required.

Optional reading:

1. Metals Handbook, "Heat treating", ASM international.
2. Metals Handbook Forming and Forging ASM international.
3. George E Dieter, "Mechanical Metallurgy" (Materials Science & Engineering).

Additional literature:

4. W.F Hosford and R.M Caddell, "Metals Forming, Mechanics and Metallurgy", PTR Prentic-Hall inc .
5. B Niebel, A. B. Draper and R.A. Wysk, "Modern manufacturing process Engineering", McGraw-Hill Book Company.
6. G. Krauss , "Steels: Heat treatment and processing principles", ASM international.
7. C.R. Brooks, "Heat treatment structure and properties of non-ferrous alloys", ASM publication.