

FALL 2008 COURSE SYLLABUS
ME 386Q TOPIC 10: HIGH-TEMPERATURE MATERIALS #19035

Instructor: Eric M. Taleff, Professor, Department of Mechanical Engineering

Office: ETC 9.170

Tel: 471-5378

Email: taleff@mail.utexas.edu

Web: <http://uhcs.me.utexas.edu/>

Lectures: MWF 12:00 noon – 1:00 PM in ETC 7.111

Office Hours: Monday: 2:00–3:00 PM

Wednesday: 2:00–4:00 PM

Required Textbook: *Introduction to Dislocations, 4th ed.*, D. Hull and D. J. Bacon

Handouts: A number of handouts with supplemental reading will be provided to students throughout the course.

Other Books of Potential Interest:

- *Introduction to Creep*, by R. W. Evans and B. Wilshire.
- *Superplasticity in Metals and Ceramics*, by T. G. Nieh, J. Wadsworth and O. D. Sherby.
- *Fundamentals of Creep in Metals and Alloys*, by M. E. Kassner and M. T. Pérez-Prado.
- *Creep in Metallic Materials*, by J. Cadek.
- *The Superalloys: Fundamentals and Applications*, by R. C. Reed.
- *Theory of Dislocations*, by J. P. Hirth and J. Lothe.
- *The Direct Observations of Dislocations*, by S. Amelinckx.

Course Description: Theory and practice in use of materials for high-temperature forming operations and structural applications; case-study considerations of actual problems and requirements; interactive process-microstructure-property relationships in materials development and applications of metallic alloys and ceramics.

Prerequisites: Undergraduate coursework equivalent to Mechanical Engineering 311 and Engineering Mechanics 319.

Grading Policy: Course grades will be calculated using scores on two exams, a final project and homeworks/class participation, with weights given in the table below on the left. Letter grades will be assigned based on average course scores, as given in the table below on the right.

Item	Weight	Grade	Minimum Score
Exam I	20%	A	90
Exam II	20%	B	80
Final Project	30%	C	70
HW/Class Participation	30%	D	60

Homework: Homeworks will be assigned approximately once every two weeks. Homeworks may involve small group projects to be reported on in class, as well as problem sets and simple assignments to research in the literature.

Exams and Final Project: Two exams will be scheduled during the semester. Exams may involve take-home problems and/or problems to be completed in class. In place of a final exam, each student will be assigned a final project. Each final project requires a presentation of approximately twenty (20) minutes and a written report of not more than fifteen (15) pages of double-spaced text, plus figures as needed. Final projects are intended to produce depth of knowledge in one particular aspect of high-temperature behavior of materials, and the research interests of each graduate student will be considered in the project assignment.

Topics to be Covered
(Not necessarily in order)

1. Crystalline Defects and Atom Diffusion
 - (a) Point defects and diffusion
 - i. Vacancies and lattice self-diffusion
 - ii. Solute atoms and chemical diffusion
 - iii. Spherical particulates
 - (b) Line defects
 - i. Mathematical and elasticity descriptions of dislocations
 - ii. Dislocations in crystalline solids
 - iii. Dislocation cores and partial dislocations
 - (c) Planar defects
 - i. Materials interfaces
 - ii. Grain boundaries
2. Creep and Superplasticity
 - (a) Basic characteristics of creep deformation
 - i. Creep testing
 - ii. Classical views of creep deformation
 - (b) Diffusional deformation
 - i. Vacancy thermodynamics and kinetics
 - ii. Diffusional creep mechanisms
 - (c) Dislocation creep
 - i. Phenomenological description of creep
 - ii. Class I and Class II creep
 - iii. Constant-structure creep
 - (d) Creep theories
 - i. The “natural” creep law
 - ii. Weertman’s theories of glide and climb-controlled creep
 - iii. Grain-boundary-sliding creep
 - iv. High-temperature, slow rate creep (Harper-Dorn mechanism)
 - (e) Practical examples
 - i. Superalloys and intermetallics
 - ii. Superplasticity and enhanced ductility
 - iii. Refractory metals
 - iv. Heat-resistant steels
 - v. O.D.S. alloys
 - vi. Ceramics