EGR 221
Materials Science
Fall, 2009, Mid-term Exam
Study Guide

The exams will be closed book, closed notes.

You should understand the vocabulary terms sufficiently well to answer "fill in the blank" or multiple-choice type questions. In some instances (marked with *) you will need to have a "working knowledge" (i.e. be able to solve related problems). For example, you should be able to determine the planar atomic density given a plane and crystal structure.

Chapter 2
covalent bond
ionic bond
metallic bond
secondary bonding
van der Waals bond
valence electrons
mole

Chapter 3:
unit cell
crystal structure
crystal system
lattice
atomic packing factor (APF)*
body-centered cubic (BCC)
face-centered cubic (FCC)
hexagonal close-packed (HCP)
coordination number
linear atomic density*
planar atomic density*

Also: draw appropriate planes and directions for given indices, and to determine the correct indices for given planes and directions.

Chapter 4
alloy
point defect
vacancy
solid solution
solute
solvent
self-interstitial
substitutional solid solution
interstitial solid solution
dislocation
anisotropic
isotropic
crystalline
polycrystalline
grain size*
grain
grain boundary
twin

Chapter 5
concentration gradient
concentration profile
diffusion
self-diffusion
steady state diffusion

Also, should be able to:
determine grain size from a photomicrograph.

Determine concentrations at various depths and time – equations will be provided.

Chapter 6
calculate engineering normal strain, memorize $\{\varepsilon=(l_i-l_o)/l_o\}$*
calculate engineering normal stress, memorize $\{\sigma = F/A_o\}$*
shear stress (define in words)
normal stress (define in words)
hardness (convert between scales, determine based on σ_{UT})

Hooke's Law (memorize $E=\sigma/\varepsilon$)*
modulus of elasticity/Young's modulus
Poisson's ratio, memorize ($\nu = -\varepsilon_t/\varepsilon_a$)*
elastic deformation
plastic deformation
ductility (describe with words as well as equations, %EL, %RA)
toughness
tensile strength/ultimate tensile strength
yield strength/yield point/yield stress

ALSO:
Be able to "read" a stress-strain diagram to determine the ductility (%EL), toughness, Young's modulus, proportional limit, yield strength, and tensile strength

* these definitions may also require knowing and applying the related equation.

Chapter 7
Slip, Slip system, slip plane, slip direction
lattice strains
resolved shear stress
critical resolved shear stress
cold working, cold rolling, strain hardening, work hardening
hot working, hot rolling
solid solution strengthening
grain size reduction
recovery
recrystallization
grain growth
recrystallization temperature

Chapter 8
Ductile fracture
Brittle fracture
Ductile to brittle transition
Creep

Chapter 9
phase
component
system
cored microstructure
homogeneous
nonhomogeneous
solubility limit
equilibrium
phase diagram
free energy
austenite
austenitizing
pearlite
metastable
eutectic reaction, temperature, composition
eutectoid reaction, temperature, composition
hypereutectoid
hypoeutectoid
ferrite (α-ferrite)
cementite
pro-eutectoid ferrite
pro-eutectoid cementite

Read a phase diagram to determine composition of phases and amount of each phase present, determine the equilibrium microstructure that will form from elevated temperature upon cooling (proeutectic α, β; eutectic; pearlite, proeutectoid ferrite, etc.). Also be able to determine compositions based on a given microstructure (similar to problems 9.33 and 9.38).

Phase diagrams will be provided if needed – or information (such as melting points) will be provided, and you will be asked to create an appropriate phase diagram (either for complete solubility (such as Cu-Ni) or binary eutectic alloy (such as Cu-Ag)).

Chapter 10

nucleation
isothermal transformation diagram
time-temperature-transformation diagram (TTT, same as isothermal transformation diagram)
continuous cooling diagrams
phase transformation
martensitic transformation
coarse pearlite, fine pearlite
bainite, upper and lower bainite
martensite
spheroidite
spheroidizing
tempered martensite

Read/use TTT diagrams and continuous diagrams

Should also know:

Describe the basic properties of ceramics – under what conditions should they be used, when should they be avoided.
Understand the differences between thermosetting and thermoplastic polymers (structurally and resulting property characteristics)