MSE 170 Winter '10 - Final Exam Study Topics

An objective of this course has been to teach you the relationships between structure-processing and properties. Some of the questions on the exam will require you to relate properties, structure and processing.

Specific areas you should know include: **(See midterm review sheet as well)**

- Basic Atomic structure and electron configurations, role of valance electrons
- Interatomic forces, types and magnitudes of bonding and how they effect material properties: i.e. melting point, elastic modulus, electrical properties, plastic deformation, dislocation motion, fracture toughness, etc...
- Basic Crystal structures (BCC, FCC), directions, planes, close packed, CN, density
- Types of defects: vacancies, interstitials, dislocations, grain boundaries, surfaces, pores
- Diffusion: concentration gradients, Ficks 1st law, steady state vs. non-steady state, activation energy
- Mechanical Properties: Definition of stress, strain, modulus, analysis of $\sigma-\varepsilon$ curves, yield strength, tensile strength, strain hardening, ductility, hardness, behavior of metals, ceramics, polymers, composites
- Dislocations: strain and stress fields, slip systems, cold working, interaction with impurity atoms
- Strengthening mechanisms: solid solution, cold working, grain size, Ppt. hardening, quench & temper
- Annealing: recovery, recrystallization, grain growth, effect on structure and properties
- Failure: ductile vs. brittle, metals, ceramics, polymers: creep, fatigue, Fracture toughness $K_{IC}=Y\sigma_f(\Pi a)^{1/2}$
- PHASE DIAGRAMS: lever law, amounts, compositions and microstructure of equilibrium phases
- Phase transformations: Nucleation vs. Growth controlled, diffusional vs. diffusionless (martensitic), isothermal transformation diagrams and how to use to predict non-equilibrium steel microstructures
- Thermal Processing of Metals and Alloys: Isothermal transformation diagrams, quench & temper, annealing, precipitation hardening; Effect on mech. properties and structure. Martensite, bainite, pearlite, tempered martensite: microstructures, properties, processing
- Polymers: Basic structures (linear, branched, cross linked), bonding, effect of structure on properties, semicrystalline vs. amorphous, glass transition temp., melting point, thermoplastic vs. thermoset and structures.
- Ceramics: What controls crystal structure, types of bonding, general properties (brittle, hard, high E and M_p, corrosion resistant)
- Composites: types, rule of mixtures, effect of reinforcement geometry on mech. properties, stresses/strains in matrix and reinforcement
- Electrical properties: Band structure, effect on conductivity, resistivity, fermi level(E_f), free electrons, holes, conductors, semi-conductors, insulators; calculation of conductivity, scattering and mobility
- Semiconductors: intrinsic vs. extrinsic, doping, n-type vs. p-type, charge carriers, effect of temperature
- Corrosion: Standard EMF series, write half-cell and full-cell equations, calculation of voltages, Galavanic series, different types of corrosion

From an understanding of the above, choose a general class of materials for a described application.
From an understanding of the above explain why a certain class materials are used for a given application, based upon material properties.
Equations to memorize: lever law, $\sigma = F/A$; $\sigma = E\varepsilon$; $\varepsilon_z = (l-l_o)/l_o$

Lever law: EXAMPLES: $W_\alpha = \dfrac{C_\beta - C_o}{C_\beta - C_\alpha}$ $W_\beta = \dfrac{C_o - C_\alpha}{C_\beta - C_\alpha}$ $W_L = \dfrac{C_\beta - C_o}{C_\beta - C_L}$