**Name of the module: Physical Metallurgy 1**

**Number of module: 365-1-3011**

BGU Credits: 3.5

ECTS credits: **?**

Academic year: 2012-2013

Semester: 1st semester

Hours of instruction: 3 hours lecture and 1 hour tutorial per week

Location of instruction: will be defined

Language of instruction: Hebrew

Cycle: ?

Position: a compulsory course for undergraduate students of Materials Engineering Department

Field of Education: Materials Engineering

Responsible department: Materials Engineering

General prerequisites:

1. Materials Science 1
2. Materials Science 2
3. Thermodynamics 1
4. Thermodynamics 2

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: Prof. Eli Aghion

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Office hours:

Tuesday, from 2 to 4 PM

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

Course Description:

The physical metallurgy course introduces the physical basis that links the structure of metals in terms of atomic arrangement and microstructure with their properties. The physical metallurgy course is separated in to two parts: physical metallurgy 1 and 2. While physical metallurgy 1 is devoted to the basic knowledge of physics and chemistry that builds up the fundamentals of this subject, physical metallurgy 2 addresses the issue of phase transformation and in particular: nucleation, solidification, recrystallization, precipitation and martensitic transformation.

Physical metallurgy 1 will mainly focus on: description of crystals, principles of plastic deformation of metals, characterization of dislocations and their controlling effect of on strength and ductility, formation of vacancies, mechanism of diffusion and their ability to control metallurgical processes, interfaces and motion of grain boundaries.

Aims of the module:

Students who have had an introductory course in material science will be exposed to the fundamentals of physical metallurgy with the aim to obtain in-depth understanding of the correlation between the structure of materials and their properties.

Objectives of the module:

To familiarize students with the fundamentals of physical metallurgy in order that they will be capable to evaluate issues relating to metallurgical characterization and processing. The knowledge obtained by the students will be used as an engineering tool to address problems relating metallurgy and materials engineering.

Learning outcomes of the module:

On successful completion of the course the students should be able to:

1. Identify the concepts of atom packing and their consequent effect on properties.
2. Understand the principals of plastic deformation from a macroscopic point of view.
3. Understand the controlling role of dislocations on strength and ductility of metals which also explain why metals are so much weaker than their theoretical strength.
4. Understand the mechanism of diffusion as an important form of mass transport.
5. Understand the nature of metal interfaces and their effect on the physical properties of metals.

Attendance regulation: attendance and participation in class is not mandatory.

Confirmation: the syllabus was confirmed by the faculty academic advisory committee to be valid on 2012-2013.

Last update: 21.10.2012

Teaching arrangement and method of instruction: lectures and tutorials that include assignments.

Assessment:

Mid-term Exam 20%

Final Exam: 80%\_

100%

Work and assignments: Set of problems in physical metallurgy.

Time required for individual work: in addition to attendance in class, the students are expected to do their assignment and individual work: at least 4 hours per week.

Module Content\ schedule and outlines:

Crystal lattices: Atomic packing and interstitial sites (3h).

Stacking faults and stereographic projection (3h).

Principles of plastic deformation in crystals: Slip systems, resolved shear stress, Schmid factor (3h).

Deformation in single and polycrystalline material and theoretical strength of metals (3h).

Dislocations: Edge dislocation, screw dislocation, mixed dislocation and dislocation loops (3h).

Mobile dislocations and energy of dislocations (3h).

Frank-Read source of dislocations and plastic flow in tearms of dislocation motion (3h).

Vacancies: formation of vacancies (3h).

Diffusion in solids: The atomic mechanism of diffusion (3h).

Interstitial diffusion, substitution diffusion, diffusion in a gradient of chemical potential and diffusion couples (3h).

Interfaces: geometry of interfaces and coherent boundaries (3h).

Surface tension and free energy of interfaces and effect of second phase (3h).

Grain boundary segregation, boundary mobility and grain growth (3h).

Required reading:

1. Modern physical metallurgy and materials engineering, R.E. Smallman and R.J. Bishop, Butterworth-Heinemann, 6th edition 1999.
2. Physical metallurgy, R.W. Cahn and P. Haasen, Elsevier, 4th edition 1996.
3. Fundamentals of physical metallurgy, John D. Verhoeven, John Wiley & Sons, 1974.

Additional literature:

1. The science and engineering of materials, D.R. Askeland, P.P. Fulay and W.J. Wright, Cengage Learning, 6th edition 2010.
2. Introduction to materials science for engineers, J.F. Shackelford, Pearson Education, 7th edition 2009.