**Name of the module: Processing**

**Number of module: 365-1-2211**

BGU Credits: 4

ECTS credits: 6

Academic year: 2012- 2013

Semester: Fall

Hours of instruction: 3 lecture hours + 1exercise class hour per week

Location of instruction: will be defined.

Language of instruction: Hebrew

Cycle: First cycle

Position: a mandatory module for 3rd year undergraduate students in the Department of Materials Engineering to be taken on Fall semester

Field of Education: Materials Engineering

Responsible department: Materials Engineering

General prerequisites: students should complete modules Materials 1 and 2 (numbers).

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. Nachum Frage

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Office hours: Monday, from 9 to 11AM.

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

Course Description: The course will explore the various processing approach for metals extraction, heat treatments and shaping of metals and ceramics. The course is divided on four parts.

The first part of the course is related to the extractive metallurgy, namely: thermodynamic analysis of oxides reduction, electrolysis of oxide and technologies of steel, Mg and Al production. The second part describes the methods of casting (sand casting, permanent casting, die casting) and defects originated from casting and solidification (porosity, segregation, residual stresses and shape distortion). The advantageous and disadvantageous of each technological approach are considered. The third part is related to a powder metallurgy approach. It include the methods of powder production (ceramic and metal), shaping approaches, and sintering of the green preforms. The short introduction to the sintering mechanisms and microstructure of sintered part are considered. The fourth part describes the shaping methods by cold deformation of metals. The effect of cold work on the mechanical and physical properties is considered. The effect of annealing and recrystallization on the mechanical properties is explained.

Aims of the module: Students will learn the various approaches for fabrication of the parts with near-net shapes. The course will focus on metal extraction, casting, powder metallurgy method and cold working. The possibilities, advantageous and disadvantageous of each technological approach will be considered.

Objectives of the module: To familiarize students with modern technologies of the fabrication and develop of basic understanding of 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. Identify which metal has to be achieved by thermal decomposition of oxide or by the reduction by carbon or gaseous phase CO-CO2.
2. Explain why Mg and Al may be obtained only by electrolysis.
3. Identify the advantageous and disadvantageous of various methods of casting and explain the casting defects and the possibilities to reduce their effect of the parts.
4. Explain what are the principles of the powder metallurgy approach and the advantageous of this method and what are the fabrication processes of metallic and ceramic powders.
5. Identify the methods of powder compaction and sintering, including modern technologies of powder consolidation.
6. Identify the cold work as a deformation of metals at appropriate temperature.
7. Explain the effect of cold work on the mechanical properties of metals.

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

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1. Explain the effect of thermal treatment after cold work on the mechanical properties and microstructure of metals.
2. Identify which process of cold deformation may be applied in order to significantly reduce a cross-section of the part (multistage deformation-annealing process).
3. Identify the level of the mechanical properties which may be achieved by various shaping approaches.

Attendance regulation: attendance and participation in class is mandatory (at least 80%).

Teaching arrangement and method of instruction: The module consists of lectures and exercises.

Assessment:

1. Exam 80% (or 100% for the student who did not take a quiz)
2. Quiz 20% (not mandatory)

100%

Work and assignments: Student will conduct 12 home works related to the exercises in the class.

Quiz: midterm, open questions.

Exam: at the end of semester, open questions) .

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 quiz and 24hours before exam.

Module Content\ schedule and outlines:

Lectures:

Introduction to materials processing 2h

Extractive metallurgy of metals 5h

Extraction of Mg and Al by electrolysis 4h

Introduction to casting technologies 2h

Advantageous and disadvantageous of various casting technologies 4h

Defects originated from casting process 4h

Introduction to powder metallurgy 2h

Fabrication of metal and ceramic powders 2h

Compaction and shaping of powders 2h

Compaction and shaping of powders 2h

Sintering of metal and ceramic powders 2h

Cold working processes. Advantageous and disadvantageous 4h

The effect of cold working on mechanical and physical properties of metals 2h

Post deformation heat treatment (recovery, recrystallization and grain growth) 4h

Multistage cold working 2h

Exercises:

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Required reading: Introduction to Engineering Materials, Second Edition, G. Murray, C. White and W. Weise,

CRC Press, 2007

Handbook of Metallurgical Process Design, edited by G. Totten

Introduction to Engineering Materials; Behavior, properties and selection, G. Murrey,

Additional literature: Metal Handbook, Ceramic Handbook.