COURSE - LEARNING OUTCOMES

The document includes:

- Results of learning and recommendations for effective writing of results
- Examples of learning outcomes in courses at Technion and universities around the world
- Functions that illustrate student achievement according to thinking levels (Blooms taxonomy)
- Criteria of ABET for writing learning results for academic programs in Science, Applied, Engineering, and Technology
- A list of sources and references describes the expected learning outcomes - what the learner can do with the completion of the learning process.

Learning outcomes include the achievement of the learning outcomes of the course - the student is able to do at the completion level


• Describe writing results for academic programs in Science, Applied, Engineering, and Technology (see examples in the appendix)


• Updated and formalize results


• Increased and confirmed


• Completed using examples of learning outcomes, which can be found in the course syllabus of universities around the world


1 The term Learning Outcomes (Learning Outcomes) in the European Union, within the process called Bolonia. In recent years, educational systems in Europe have undergone a revolution in the field of cooperation and mobility, and international recognition of titles, study programs and courses. The definition of the learning outcomes of each course in universities is a key element of the mutual recognition of academic rights in all European universities, and its importance as part of this large process. The definition of the learning outcomes will help students and researchers move from Technion to leading universities around the world, and students from these universities to study courses at Technion as part of their education.
DESIGN AND ANALYSIS - 054402 Course Objectives - Prof D. Lewin

This is what each student is expected to be able to after the course:

♦ Carry out a detailed simulation of a chemical process using UNISIM and interpret the results.
♦ Synthesize a train of separation units.
♦ Synthesize of a network of heat exchangers for a chemical process to maximize energy recovery or to minimize the number of exchangers used.
♦ Prepare a Piping and Instrumentation Diagram (P&ID).
♦ Design plant-wide process control configurations.
♦ Carry out a HAZOP and HAZAN on a process P&ID.
♦ Carry out six-sigma analysis on manufacturing processes.
♦ Leap tall buildings in a single bound.
Mathematics

• Solve systems of linear equations by using Gaussian elimination to reduce the augmented matrix to row echelon form or to reduced row echelon form.
• Compute complex contour integrals in several ways: directly using parameterization, using the Cauchy-Goursat theorem and deformation of contour, using the fundamental theorem for line integrals, and by Cauchy’s integral formula and compute Taylor series expansions for analytic functions and determine where the series converges.
• Test the plausibility of a solution to a differential equation (DE) which models a physical situation by using reality-check methods such as physical reasoning, looking at the graph of the solution, testing extreme cases, and checking units.

Physics

• Explain the difference between inelastic, elastic, and super-elastic collisions between two objects in terms of the relative velocity between the objects and will be able to use the conservation of momentum and conservation of energy laws to solve problems involving two objects.
• Independently solve the Schrödinger equation for simple one-dimensional systems -- the ones explicitly taught (e.g. square well, harmonic oscillator, potential barrier), as well as similar, new ones. Use the solution to compute probabilities, expectation values, uncertainties, time evolution. Give concise physical interpretations and discussions of the mathematical solutions.
• Calculate magnetic properties of simple current distributions using Biot-Savart and Ampère's laws.

Chemistry

• Students will be able to propose reasonable mechanisms for chemical reactions based on a fundamental understanding of organic chemistry
• Students will be able to determine the states of an atom from an electronic configuration
• Students will be able to examine and interpret the #H NMR spectrum, the IR spectrum and MS chromatograph of simple compounds

Biology

• Students will be able to provide an account of factors influencing the adaptation and radiation of vertebrate species
• Students will be able to demonstrate knowledge of the major steps and adaptations in the evolution of vertebrates from simple chordates to humans
• Students will be able to calculate the probability that an individual in a pedigree has a particular genotype
Architecture

- Students should be able to produce two- and three-dimensional compositional designs
- Students should be able to communicate design intentions publicly using appropriate presentation techniques and argue rationally regarding the positive and negative qualities of his/her design
- Students should be able to analyze the evolution of architecture with the development of building materials and construction techniques
- Students should be able to design within the context of an existing building, demonstrating a clear architectural intention
- Students should be able to apply conservation philosophy and methodology in design

Engineering

- Students will have the ability to demonstrate general design principles, use fundamental engineering techniques skills and tools for analyzing and interpreting data to produce meaningful conclusions and recommendations.
- Students will have the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- Students will have the ability to devise appropriate solution strategies, recognize dead ends (and use an alternate strategy) and find a correct answer to the problem ON their OWN.

Mechanical Engineering

- Students will be able to identify and solve engineering problems related to the transfer of energy in the form of heat
- Students will be able to perform complex analysis and calculations for complex industrial processes
- Students will be able to develop process options that address specified project goals while working within project constraints.

Chemical engineering

- use correlations for calculating diffusion coefficients
- apply energy balances and material balances to separations processes; solve engineering problems involving mass transfer (absorption/stripping in packed columns; membrane separation, separation by adsorption)
- combine material balances and phase equilibrium thermodynamics for design of unit operations in: absorption, liquid stripping, binary distillation, liquid-liquid extraction
- calculate design membranes and chromatographic separations by rate based analysis for separations processes
Electrical Engineering

- Implement numerically stable recursion algorithms for evaluating mathematical functions.
- Students will be able to apply analytical methods (i.e. circuit theory) and modeling techniques (i.e. electronic device models) to the identification, classification and description of electronic circuits and their performance in response to a range of externally applied stimuli.

Material Engineering

- Recognize basic MSE nomenclature, basic microstructure, associate terms with the appropriate structure/phenomena, and be able to differentiate between related structures/phenomena.
- Apply the laws of thermodynamics for the construction of single and multicomponent phase diagrams.
- Use knowledge of the crystal structure (BCC, FCC, and HCP) of a metal to make general predictions about the metal’s ability to plastically deform.
- Show the application of materials microstructure in the design of materials and their processing to obtain required properties.

Computers and Programming

- Students will be able to describe program language evolution and classification (From Machine Language to 4th Generation Languages)
- Students will be able to solve basic numerical computation in binary/ other number representation systems
- Students will be able to describe the various classes of operating systems and the correlation to hardware growth. Evolution based classification (Single User, Multitasking, Multiprocessing), Domain-specific classification (Real-Time, Database, etc.)
- Students will be able to design recursive programs and mathematically compute the upperbound on execution time.

UCSAVIS – University of California Davis
- Stanford University
- Massachusetts Institute of Technology: MIT
- Purdue University
- Iowa State University
- University of North Texas
- University of Oslo
- University of Manchester
- Seattle Pacific University
- IET LEARNING OUTCOMES HANDBOOK
## פעלי המומחיות ואלה הביצועים המבוססים עליהם Ramos beschreibt

<table>
<thead>
<tr>
<th>פעלי המומחיות ואלה הביצועים המבוססים עליהם Ramos beschreibt</th>
<th>רמות חשיבה</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count, Define, Describe, Draw, Find, Identify, Label, List, Match, Name, Quote, Recall, Recite, Sequence, Tell, Write</td>
<td>בסיסי</td>
</tr>
<tr>
<td>Conclude, Demonstrate, Discuss, Explain, Generalize, Identify, Illustrate, Interpret, Paraphrase, Predict, Report, Restate, Review, Summarize, Tell</td>
<td>הבנה</td>
</tr>
<tr>
<td>Apply, Change, Choose, Compute, Dramatize, Interview, Prepare, Produce, Role-play, Select, Show, Transfer, Use</td>
<td>יישום</td>
</tr>
<tr>
<td>Analyze, Characterize, Classify, Compare, Contrast, Debate, Deduce, Diagram, Differentiate, Discriminate, Distinguish, Examine, Outline, Relate, Research, Separate,</td>
<td>אנהולית</td>
</tr>
<tr>
<td>Compose, Construct, Create, Design, Develop, Integrate, Invent, Make, Organize, Perform, Plan, Produce, Propose, Rewrite</td>
<td>סינתזה</td>
</tr>
<tr>
<td>Appraise, Argue, Assess, Choose, Conclude, Critic, Decide, Evaluate, Judge, Justify, Predict, Prioritize, Prove, Rank, Rate, Select,</td>
<td>הערכה</td>
</tr>
</tbody>
</table>

**דוגמה לתוצאות למידה לפי רמות חשיבה**

### רמה בסיסית

**ידע**
- לזכור בינוינו הקשורי לנטיעות: המוטורייטי, התוריגוטי, פונטייס, קונטייס, וכד.
- לקבוע את הנגזרות של התוכן של המוטורייטי מוניציפיים מוניציפים.

### רמה הבנה

**יישום**
- לברוח לחיוכו של הסינווקטומת הנגזרות של התוכן של מוניציפיים מוניציפים עם מוניציפיים מוניציפים מוניציפים

### רמה אナイולית

**שיקום**
- לדון בממסוביטות של התוכן של מוניציפיים מוניציפים
- לייס את הסינווקטומת הנטיעות של התוכן של מוניציפיים מוניציפים
- להתחשבarhus利亚טי של מוניציפיים מוניציפים

### רמות חשיבה גבוהות

**אונליית**
- לברוח לחיוכו של הסינווקטומת הנגזרות של התוכן של מוניציפיים מוניציפים עם מוניציפיים מוניציפים

**סינתזה**
- לדון בממסוביטות של התוכן של מוניציפיים מוניציפים
- לייס את הסינווקטומת הנטיעות של התוכן של מוניציפיים מוניציפים
- להתחשבarhus利亚טי של מוניציפיים מוניציפים

**הערכה**
- לדון בממסוביטות של התוכן של מוניציפיים מוניציפים

---

2. ג'וני בום בלום (Bloom Benjamin Bloom, 1913-1999) - ג'וני בום בלום (Bloom Benjamin Bloom, 1913-1999)
3. קוגניטיבי, יישומי ופיזיומוטורי - קוגניטיבי, יישומי ופיזיומוטורי
4. הביצועים המבוססים על רמות החשיבה (טסונומיה של בלום) - הביצועים המבוססים על רמות החשיבה (טסונומיה של בלום)
The Accrediting Board for Engineering & Technology – ABET

CRITERIA FOR STATEMENT OF LEARNING OUTCOMES FOR ABET ENGINEERING & TECHNOLOGY PROGRAMS (Ph.D., M.S., M.Eng., B.S.)

These criteria are designed to support the preparation of students for professional practice in the expanding field of engineering and technology. They are developed with the goal of providing a framework for the educational programs to prepare students for the requirements of the workforce and to meet the needs of society.

1. The ability to apply knowledge of mathematics, science, and engineering.
2. The ability to design a system, component, or process to meet desired needs.
3. The ability to perform an analysis of a complex system, component, or process.
4. The ability to synthesize information from a variety of sources to understand and solve complex problems.
5. The ability to use the tools, techniques, skills, and modern engineering practices to design and consistent with the standards of the profession.
6. The ability to use the principles of engineering and technology to consider the impact of engineering solutions in a global, economic, social, and cultural context.
7. The ability to identify, formulate, and solve complex engineering problems.
8. The ability to engage in life-long learning to continually develop professional knowledge and skills.
9. The ability to work effectively in a team, to lead teams, and to manage projects.
10. The ability to communicate effectively.
11. The ability to use the principles of engineering and technology to consider the impact of engineering solutions in a global, economic, social, and cultural context.

References

- Stephen Adam, *An Introduction to Learning Outcomes*
  [http://ccs.dcu.ie/afi/docs/bologna/a_consideration_of_the_nature_function.pdf](http://ccs.dcu.ie/afi/docs/bologna/a_consideration_of_the_nature_function.pdf)