Learning Outcomes
ניסוח תוצאות למידה לקורס אקדמתי

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דגםנותמקורסיהלמידהבוכנוב
דגםנותמקורסיהלמידהבוגנבריסטיםומובילבולשל
נפחא לקורסיהלמידהםובילבולשל(הטקסונומיהשלבר珙)
נפחב לקורסיהלמידהםובילבולשלABET
לניסוחניסוחלמידהלהבגנוייןורמיםמדעיremium,מקשיב,הנדסהובנולגיה


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המרכז לクリモン הלימודים והמחאה
החברה – מכון טכנולוגי לישראל
קרית הטכנולוגיה, רחפת, 3200003
thesized outcomes are the academic outcomes specified in a course syllabus and describe what learning is intended to lead students to achieve, and to demonstrate when the course is finished. Learning outcomes are developed in close collaboration with the faculty who are teaching the course. Learning outcomes serve as a focal point for student success and achievement.

The learning outcomes are a critical component of the curriculum, and they design all aspects of the curriculum: the course content, the general structure, the assessment methods, and the criteria for determining the course grade. Learning outcomes are designed and written directly towards the learning outcomes. Learning outcomes provide students with specific and clear information about their expectations.

Recommendations for the design of effective and general procedures for:

- Include a list of the course's competencies.
- Develop the course's learning outcomes in a collaborative process with the teaching team.
- Ensure that the learning outcomes are measurable and assessable.
- Ensure that the learning outcomes can be achieved within the allocated time and resources.
- Think about how you will assess the outcomes, and ensure that they are not too broad or too specific.
- Use examples of learning outcomes that can be found in course syllabi at universities around the world.

A recommended format for learning outcomes:

1. Source of the term 'learning outcomes' (Learning Outcomes) within the European Union, within the process known as ‘Bologna Process’. In recent years, systems of higher education in Europe have undergone a major transformation towards cooperation and leadership of researchers and students, and international recognition of degrees, curricula and courses. Definition of learning outcomes in each course at universities is part of the international recognition of academic credits in each university, and its importance as part of this wide process. Definition of learning outcomes will facilitate the mobility of students and researchers between Technion courses and courses in leading universities worldwide, and students from these universities to take.
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.

More college courses from the following universities: 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
נספח א’ - פלילים ייצוגיים לያמה חיבורה ושונות (הטקסונומיה של בלום)

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<thead>
<tr>
<th>פעילím הממחישים את הביצועים המבוססים על רמות חשיבה שונים</th>
<th>רמות חיבורה</th>
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בלום ברגמן (Bloom Benjamin Bloom, 1913-1999) זיהה שלושה תחומי לימוד: קוגניטיבי, ריגוכני ופיזיוכני ובמסגרת כל אחד מתוכם זיהה סדר עלה של מורכבות. בלום הציע שהתחום הקוגניטיבי מנהל לשלוש רמות שונות של מורכבות: המקסימלית, הממוצעת והминימלית. בזאת, מסייע בלום למדעי הוראה ו apologized בפיתוחיותו של מבנה הוראה ומדעי הוראה.
CRITERIA OF ABET

ABET criteria are the basis for defining learning outcomes in many universities in the United States. They can be used for faculty and program evaluation to assess the contribution of a course you are teaching to a degree program at Technion.

According to ABET:
1. The student will demonstrate proficiency in mathematics, science, and technology.
2. The student will be able to design and conduct experiments, as well as analyze and interpret data.
3. The student will be able to respond to the demands of a global and specialized workforce, including economic, environmental, social, political, ethical, safety, health, and creative issues.
4. The student will be able to function effectively on multidisciplinary teams.
5. The student will be able to identify, formulate, and solve engineering problems.
6. The student will be able to communicate effectively.
7. The student will have an understanding of the impact of engineering solutions in a global, economic, environmental, and societal context.
8. The student will have the ability to recognize the need for, and have an ability to engage engage in independent and lifelong learning.
9. The student will understand contemporary issues and have an interest in them.
10. The student will have knowledge of contemporary issues relevant to their engineering discipline.
11. The student will be able to use modern engineering tools and techniques, as well as methods and practices to meet the challenge of the engineering problems they encounter.

CITATION
- Stephen Adam, An Introduction to Learning Outcomes
  http://ccs.dcu.ie/afi/docs/bologna/a_consideration_of_the_nature_function.pdf
  http://sss.dcu.ie/afi/docs/bologna/writing_and_using_learning_outcomes.pdf
- Bloom, B., Englehart M.D., Furst E.J., David, W.H. (1956); Taxonomy of Educational Objectives
  Handbook I: The Cognitive Domain. Longmans, New York, NY, USA

ABET – The Accrediting Board for Engineering & Technology is one of the largest and highest-rated agencies of engineering education in the United States, which today evaluates over a thousand engineering and technology degree programs at hundreds of institutions of higher education in the United States.