TECHNION INTERNATIONAL
Israel Institute of Technology

Technion Israel Institute of Technology

Technion International

Winter Semester 2018/19

Course Syllabi

Table of Contents

Physics

Physics 1 - 114051

Lecture Topics

Syllabus	Book Chapter
Vectors: definition and different presentations, vector addition, dot product, cross product, derivative of a vector by a scalar, invariants, trajectory, velocity, acceleration.	2
Newton's laws of motion: the three laws of motion, equations of motion and boundary conditions (initial value).	3
Reference frames and Galilean transformations: inertial reference frames, relativity principle, Galilean transformation, Newton's laws in accelerating reference frames (linear and circular motion), centrifugal force.	4
Conservative forces and the conservation of energy: work, conservative forces, kinetic and potential energy, central forces.	5
Conservation of linear momentum: center of mass, the conservation of linear momentum for collisions in different reference frames.	6
Dynamics of circular motion: conservation of angular momentum, angular momentum and kinetic energy of a rigid body, moment of inertia for simple systems, rotation of a rigid body around fixed axis – the equations of motion and their solution.	6
Inverse square law forces: the equation of motion and it's solution – possible trajectories, Kepler's laws.	9
Simple harmonic motion	8
Special Relativity: the speed of light and measurement techniques, Michelson-Morley experiment and it's conclusions, the axioms of special relativity, the Lorentz transformation, length contraction, time dilation, relativistic Doppler effect, velocity transformation, relativistic dynamics: momentum and energy.	10-13

Textbook

Mechanics, Berkeley Physics Course, Vol. 1

Course Expectations & Grading

20% H.W. + 80% Test

Contact Hours per Week

Lecture: 4 hours

Recitation: 2 Hours

Credit points: 3

Physics 2 – 114052

Course Objectives and Targets

1. Introduction to electrostatic and magnetostatic phenomena.

2. Developing basic understanding of electric DC and AC circuits and also electric appliances, such as transformers, and engines.

3. Introduction to mechanical and electromagnetic waves and wave phenomena, such as interference and diffraction.

Weekly Lecture Topics

1. The electric charge (discrete and continuous) and Coulomb's law. Superposition. Polarization and charging by induction. The electric field. Vector field representations. Motion of a charged particle in an electric field

2. Electric flux and Gauss' law. Electrostatic potential energy, and the electric potential. Calculation of the electric field from the potential

3. Equipotential surfaces. Fields around and inside conductors. Electrostatic shielding. Leiden jar. High-Voltage breakdown, Lighting and Sparks

4. Capacitance and capacitors. Electric energy density. Dielectrics

5. Currents, resistivity and Ohm's law. Batteries, electromotive force, electric circuits, Kirchhoff's laws, RC circuit. Power. High voltage power lines

6. Magnetic field, Lorentz force, torques, electric motors (DC)

7. Motion of a charged particle in a magnetic field: cyclotron and mass spectrometer

8. Ampere's law. Bio-Savart law. Gauss' law for magnetic field

9. Faraday's law of induction and non-conservative fields. Eddy currents and magnetic breaking. Inductance. Self-inductance. RL circuit

10. Transformer and magnetic energy density. RLC circuit, AC current. Synchronous and induction motors

11. Magnetic materials. Dia-, Para- and Ferromagnetism. Displacement current, and Maxwell equations. Part 2: Waves

12. Derivation and analysis of the wave equation. Amplitude, velocity, polarization, periodic waves – frequency/period and wavelength/wavenumber

13. EM waves: Poynting vector, Doppler effect. Wave adding, beats, standing wave

14. Interference, Young's experiment, Newton rings, Huygens' principle. Diffraction grating, resolution. Single-slit diffraction, double-slit diffraction. Snell's law, total reflection

Prerequisite

114051 – Physics 1

Contact hours

Lecture: 3 Hours

Recitation: 1 Hour

Credit points: 4

Physics 3 - 114054

Course subjects:

1. **Photons, electrons, and particle waves**
   – Blackbody radiation
   – The Photoelectric Effect
   – The Compton Effect
   – Atomic spectrum
   – Rutherford's Scattering and the discovery of the nucleus
   – Bohr's model for the Hydrogen Atom
   – The statistical interoperation of waves
   -De Broglie wavelength, Davisson-Gremer experiment, Bragg diffraction
2. **Quantum Mechanics**
   – Electrons interference
   – The Uncertainty Principle
   – Wave function
   – The Schrodinger equation in 1D
   – The Quantum particle in a well
   – Tunneling through a potential energy barrier
   – Scanning Tunneling Microscopes
   – The simple Harmonic Oscillator
   – The 3D Schrodinger equation, a particle in a 3D box, degeneration
3. **Atomic Physics**
   – The Hydrogen atom: Schrodinger equation, energy levels, wave function, quantum numbers
   – Spin, Stern & Gerlach experiment, angular momentum, magnetic moment
   – Pauli Exclusion principle and the Periodic table
   – x-rays, shielding (Moseley)
   – Lasers
4. **Solid State**
   – Bonding in Solids
   – Band theory of solids, Conductors, Insulators
   – Fermi Free-Electron theory of metals
   – Semiconductors, doping
   – Semiconductor devices: diodes, LED, Transistors.
   – Superconductivity
5. **Nuclear Physics**
   – The structure of Nuclei
   – Nuclear energy
   – Nuclear models
   – Radioactivity
   – The decay processes
   – Nuclear reactions
   – Nuclear Fission
   – Nuclear reactor
   – Nuclear fusion
6. **Elementary particles and Cosmology**
   – Positrons and anti-particles
   – Mesons
   – Classification of particles
   – Conservation laws
   – Quark model
   Cosmology

Books

– Serway, Beichner: Physics for scientists and engineers, 5th edition or

– Serway, Jewett: Physics for scientists and engineers, 6th or 7th editions

Comments: Some of the material is presented as problems for the students at the end of each chapter in these books.

Most of the material is covered in the more detailed book:

"Modern Physics" by P.A. Tipler

Contact Hours per Week

Lecture: 3 hours.

Recitation: 1 Hour.

Credit points: 4

Mathematics

Differential and Integral Calculus 2 - 104004

Lecture Topics

1. Vectors, the dot and cross products
2. Lines, planes, curves and surfaces
3. Functions – limits and continuity
4. Differentiability, partial and directional derivatives, the chain rule, the gradient
5. Taylor's theorem, the implicit function theorem, extrema and Lagrange multipliers
6. Double and triple integrals, change of variables
7. Line integrals and surface integrals
8. Divergence and curl, Green, Gauss and Stokes' theorems, conservative fields

Prerequisites

Differential and Integral Calculus 2, 104003

Textbook

The mandatory material is what we cover in class. For further reading, a standard Multivariable Calculus book is "Vector Calculus" by Marsden and Tromba, 5'th edition. There are many first year Calculus books, most of which are rather similar, that can be found in the Technion libraries, and contain plenty of additional exercises. Also, the course webpage includes a link to a free online book called "Introduction to Real Analysis" by W. Trench

Contact Hours per Week

Lecture: 4 hours

Recitation: 2 Hours

Credit points: 5

Statistics - 014003

Course Subjects

Data processing, introduction to sets and probability. Sample space, events, counting sample points, combinatorical conditional and total probability, independence, Bayes' theorem, one and higher dimensional random variables, probability distributions, expectation and higher moments, Chebyshev's inequality, known discrete and continuous distributions, regression, sampling, estimation of parameters, testing hypotheses, decision under uncertainty, basic concepts in simulation.

Contact Hours per Week

Lecture: 2 hours

Recitation: 2 Hours

Credit points: 3

Ordinary Differential Equations - 104131

Lecture Topics

- Introduction, examples, models and classification [B&D, Sections 1.1, 1.2].
- First order differential equations. Linear equations, separable equations, solution by substitution and other tricks, exact equations and integrating factors. Direction field, orthogonal curves. [B&D, Sections 2.1, 2.2, 2.3, 2.5, 2.6]
- The existence an uniqueness theorem [B&D, 2.8].
- Second order and higher order linear equations. Fundamental solutions of homogeneous equations, linear independence, the Wronskian, Abel's formula, reduction of order. Homogeneous equations with constant coefficients. Euler equations.
- Inhomogeneous linear equations. The method of undetermined coefficients, variation of parameters. [B&D, Chapters 3 and 4, Euler equation in Chapter 5]
- Systems of linear equations. Homogeneous systems with constant coefficients. Nonhomogeneous systems and variation of parameters. Linear systems in the phase plane [B&D, 7.4 – 7.9, 9.1]
- Series solutions. Solution of differential equations near an ordinary point
- Section numbers are taken from editions 7 – 9. In older editions some numbers are different.

Textbook

Elementary Differential Equations by Boyce and DiPrima, 9th edition

Contact Hours per Week

Lecture: 2 hours

Recitation: 1 Hours

Credit points: 3

Civil Engineering

Air pollution - 016302

Lecture Topics

Primary air pollutants – sources and effects.
Physical and chemical properties of aerosols.
Secondary pollutants, photochemical reactions, formation and removal of gasses and particles.
Global air pollution, meteorology of air pollution.
Evaluation and monitoring of ambient air: air pollution control – administrative and technological aspects.

Contact hours
Lecture: 2 hours

Recitation: 1 hours

Credit points: 2.5

Strength of Materials 1 – 014104

Course Objectives

This course builds on the principles of statics mastered in the course "Introduction to Engineering Mechanics" and will introduce the students to the fundamentals of Mechanics of Materials. This subject covers basic concepts of solid mechanics and mechanical behavior of materials, including stress-strain relationships, beam bending, stress transformation and stability of columns. Structural behavior will be analyzed, along with the material and geometric contributions to the behavior of structures.

Lecture topics

1. Introduction to course; Mechanical property definitions for Young's Moduli, yields stress, ultimate stress, etc; Hooke's Law; Stress, strain and deformation: Axial loadin
2. Statically indeterminate problems – axial loading Thin walled pressure vessels
3. Torsion of circular shafts
4. Torsion of general bars
5. Bending stresses
6. Deflections of beams
7. Deflections of beams: conjugate beam
8. Statically indeterminate beams
9. Shear stresses in beams
10. Shear stresses Shear centre for different cross-sections
11. Buckling of columns
12. Transformation of stresses Principal stresses
13. Mohr's circle Transformation of strains

Prerequisites

014103 – Introduction to Engineering Mechanics

Textbooks

E. P. Popov, Engineering Mechanics of Solids, 2nd edition, Prentice-Hall R. C. Hibbeler, Statics and Mechanics of Materials, 2nd edition,

Prentice Hall. F. P. Beer and E. R. Johnston, Mechanics of Materials, McGraw Hill.

Contact Hours per Week

Lecture: 3 hours

Recitation: 2 Hours

Credit points: 4

Hydraulics – 014205

Lecture topics

1. Dimensional Analysis, Introduction
2. Similarity & Models
3. Dimensional Analysis of Different Problems
4. Steady & Uniform Flow, Elements of Channel Design
5. Energy Conservation, Transitions
6. Transitions (finish)
7. Hydraulic Jump, Control Sections
8. Gradually Varied Flow, Hydraulic Profiles
9. Laminar & Turbulent Flows
10. Flow in Pipeline
11. Pipeline Calculations
12. Pipeline Systems & Networks

Prerequisite

014211 – Fluid Mechanics

Reading Requirements

- "Hydraulics", by Professor Hillel Rubin. Available on the course's site on Moodle.
- "Hydraulics Laboratory Book", by: Professor Poreh. Available on the course's site on Moodle.

Contact Hours per Week

Lecture: 2 hours

Recitation: 1 Hours

Lab: 1 Hours

Credit points: 3

Introduction to Hydrological Engineering - 014212

Lecture topics

- Introduction. Balance equation.
- The watershed area and its characteristics
- Rainfall.Statistics and extreme values.
- IDF Curves (Intensity-Duration-Frequency).Rainfall Hyetographs. Design storm.
- Infiltration.The Horton Model. The SCS Method. Index Φ
- Unit Hydrograph.
- The S Curve. Hydrograph separation. The rational equation.
- Reservoir and river routing.
- Groundwater. Introduction, classification of aquifers. Darcy's law.
- Dupuy's assumptions. Flow in an aquifer.
- Wells hydraulics and permanent flow.

  Conclusion.

Reading:

1. Bras R. L., 1990, "Hydrology: An Introduction to Hydrologic Science", Addison – Wesley Publishing Co. Inc.

2. Viessman, W, "Introduction to Hydrology", Upper Saddle River, N.J, Pearson.

3. Shaw E. M., 1983, "Hydrology in Practice", Published by Van Nostrand Reinhold (UK) Co. Ltd.

4. Chow V. T., 1964, "Handbook of Applied Hydrology", McGraw-Hill Inc.

5. Chow V. T., Maidment D. R., and Mays L., 1988, "Applied Hydrology", McGraw-Hill Inc.

6. Maidment D. R. (Editor), 1993, "Handbook of Hydrology", McGraw-Hill Inc.

7. Bear J., 1979, "Hydraulics of Groundwater", McGraw-Hill Inc.

Contact Hours per Week

Lecture: 2 hours

Recitation: 1 Hours

Credit points: 3

Design of Water and Wastewater System - 014325

Prerequisites

(Hydraulics 014205 and Water and Wastewater Treatment 014322 and Engineering Economics 014603)

Incorporated Courses: Design Principles of Water Supply Syst. 014208

Water Supply and Wastewater Collection 014323

Course Subjects

Principles of design and operation of water supply systems and wastewater collection. Calculation of water supply networks and wastewater collection systems. Goal, structure and preparation of an engineering project. Objectives of general planning, data collection and processing for design. Techno-economic evaluation and comparison of design alternatives. Topics in water and wastewater systems design. Project of general planning of water treatment and supply system.

Contact Hours per Week

Lecture: 3 hours

Recitation: 1 Hours

Credit points: 4

Engineering Geology - 014405

Course Objectives

The course is divided roughly into two parts:

The first part contains topics relating to geological materials, which form rocks of different types, identifying rocks and important engineering properties of different rocks and minerals.

The second part contains different topics from general and engineering geology, with an emphasis on geological tools within engineering fields. The exercises will include practical labs on the subjects of identifying minerals, identification and classification of rocks, and understanding geological maps.

Prerequisite

014104 – Strength of Materials 1

Lecture topics

1. Introduction, architecture of the earth.
2. Minerals, what is a mineral, mineral groups, identifying minerals, rock forming minerals
3. Rocks, introduction to the Rock Cycle. Igneous rocks, intrusive, extrusive, volcanoes.
4. Sedimentary Rocks. Sedimentary processes, erosion, transport, deposition, lithification. Clastic sedimentary rocks versus chemical sedimentary rocks. Identifying sedimentary rocks. Important properties of sedimentary rocks in Israel.
5. Metamorphic Rocks. Causes and effects. Texture changes, changes in component mineralogy.
6. Plate tectonics. Concept of continental drift, evidence. Effects, spreading rates. Ocean geomorphology.

7 & 8. Structural geology. Correlation, faulting, folding, stresses conditions, introduction to strike dip and geological maps.

9. Engineering seismology, seismic waves qualitative site effect, liquefaction.
10. Geological time. Relative time, fossils. Absolute time.
11. Sinkholes along the Dead Sea. Why are they forming, where are they forming
12. Slope stability, mass wasting.

Contact Hours per Week

Lecture: 2 hours

Recitation: 1 Hours

Credit points: 2

Building Materials - 014505

Lecture Topics

1. Classification of cementitious materials: material testing and its significance, products and applications
2. Lime
3. Gypsum
4. Portland cement
5. Portland cement – composition types, setting and hardening, structure of the hardened paste and its effect on mechanical properties
6. Mortars for plastering and renderings
7. Aggregates, mixing water, chemical and mineral admixtures
8. Properties of fresh and hardened concrete, durability, mix design, concrete technology, testing and quality control
9. Laboratory exercises

Laboratory exercises

1. Introduction
2. Cementitious materials
3. Aggregates
4. Properties of fresh and hardened concrete
5. Concrete mix design
6. Plasters and special concretes

Participation in the lab exercise is obligatory. The safety codes require the student to come dressed with their legs covered (long pants/dress, closed shoes).

Prerequisite

125011 – General Chemistry + Lab

314535 – Introduction to Materials Engineering

Contact Hours per Week

Lecture: 3 hours

Recitation: 1 Hours

Lab: 1 Hours

Credit points: 4

Engineering Economics - 014603

Lecture Topics:

1. The financial value of time.
2. Interest formulas.
3. Comparison of alternatives (NPV, AE, NFV, IRR, AIRR, IROR)
4. Depreciation and financial lifespan of assets and equipment.
5. Worthwhileness of replacing equipment.
6. The impact of inflation on comparing alternatives.
7. The impact of taxation on comparing alternatives.

Topic for self-study:

Supply and demand.

Student Evaluation:

Midterm – 25%:

If the midterm grade is lower than the final exam grade, then the midterm grade will not be taken into account.

Final Exam – 75%:

A grade of 55% at least is required on the exam in order to pass the course.

Reading Requirements:

- Au, T. and Au, T.P. Engineering Economics for Capital investment Analysis, 1992: N.J., USA, Prentice Hall.
- White, J. A., Agee, M. H. and Case K. E. Principles of Engineering Economic Analysis, 1998: N.Y. USA, John Wiley & Sons.

Contact Hours per Week

Lecture: 4 hours

Recitation: 2 Hours

Credit points: 3

Mechanization in Construction - 014609

Lecture Topics

1. The world of construction equipment, classification of equipment
2. Owning & operation costs of building construction equipment
3. Properties and outputs of building construction equipment
4. Selection, erection and operation of tower cranes
5. Integration of equipment and forming systems in the production array
6. Earthmoving, infrastructure and tunneling equipment
7. Quantitative assessment of safety hazards with construction equipment

Prerequisites

014603 – Engineering Economics

014606 – Introduction to Construction Management

014610 – Building Construction Methods

Reading Requirements

- Peurifoy, R. L., Schexnayder, C. J., and Shapira, A. "Construction Planning, Equipment, and Methods", 7th Ed., McGraw-Hill, 2006.
- Shapira, A. "Equipment for Concrete Building Construction", 2008.
- E. G. Nawy, Editor, "Concrete Construction Engineering Handbook", 2nd Ed., Ch. 19, CRC Press.

Contact Hours per Week

Lecture: 2 hours

Recitation: 1 Hours

Credit points: 3

Water and wastewater treatment – 014322

Prerequisites:

054131 – Int. to Chemical and Biochemical Eng. and/ or 124114 – Principles of Chemistry

054131 – Int. to Chemical and Biochemical Eng. and/or 124120 – Principles of Chemistry

124503 – Physical Chemistry 1b and/or 125011 – General Chemistry + Lab

Course Description:

Water quality for various uses, potable water quality regulations. Principles of water treatment processes. Separation of non-dissolved solids: sedimentation, filtration, flocculation. Gas transfer, disinfection. Separation of dissolved solids. Municipal wastewater characterization, regulations for effluent quality. Wastewater treatment processes: pretreatment, primary sedimentation, biological treatment. Sludge treatment. Effluent reuse.

Contact hours per week:

Lecture: 2 hours

Recitation: 1 hour

Credit points: 2.5

Planning and Control of Construction Projects – 014617

Course Objectives

Deepening central issues of Construction Management: Comparing alternative designs and construction plans, methods of contracting, design management and information flows, client's design cost estimation, preparation of master plan schedules, tendering procedures, contractor cost calculations and bid preparation, budgeting, planning and scheduling of construction, production management, project controls. The goal is to understand and gain experience in these tasks, including achievement of a basic level of proficiency in appropriate software.

Course Schedule

Week	Lectures	Tutorial
1	Introduction – Detailed construction process and project management objectives. Contracting methods. The multiple roles of construction managers at different levels and with different types of employers. Course aims and rules.	#1 CPM inMsProject (1%)
2	**Design management:** Information management in construction projects. Sharing information through an Extranet. **Cost estimates** at different accuracy levels; an initial estimate; estimating using parameters; detailed estimates. Measuring of quantities, methods of measurement, preparation of a bill of quantities.	#2 Initial estimate Excel (1%)
3	Manage bills of quantities and tenders, using a standard price list for the building industry	#3 Detailed estimating (2%) Candy 2.0
4	**Scheduling projects using CPM** Principles of the method, its advantages and its limitations; technological and organizational relationships; examination of alternatives.	#4 Scheduling constraints and resourcesVICO Control (2%)
5	Advantages of computers in CPM solution and comparing alternative plans. Updating a network of projects: Adding and removing tasks; update start dates and the estimated duration of their execution Examine alternatives to execution using Building Information Modeling (4D).	#5 Scheduling using line of balances VICO Control (2%)
6	**Detailed cost calculation** Direct costs, indirect costs, overheads; methods of distributing overheads; editing computer calculations; examination of alternative methods of distributing overheads. **Comparison of bids**	#6 General contractor calculations (2%) Candy 2.0
7	**Budget planning, cash and cost flows** Principles of planning and control of project budgets; Computerized budget management; layout according to the schedule budget	Preparation for the midterm exam
8	Budget, cost flows, cash flows (Continued): Preparation of flows of costs, expenses, income and cash;	Preparation for the midterm exam
9	Basic terms in production management: cycle time, throughput, work in progress; setup time, learning curve, waste	#7 Planning of construction budget Candy 2.0 (2%)
10	Production management: Last Planner System (LPS)	#8 Schedule of modular projects

		Candy 2.0 VICO Office (3%)
11	Principles of planning and scheduling of location based projects specialization; continuity; independence; responsibility; equal TAKT time. Implementation of principles in modular and non-modular projects	
12	Technological and organizational considerations, scheduling the execution of projects consisting of several modular buildings; a detailed demonstration of various alternatives and discussion of problems, advantages and disadvantages; impact of industrialization of construction; techniques for scheduling alternatives.	
13	**Schedule control, budget and cash flow** Control Schedule; control cash flows. Understanding the control results; cash flow. Submitting interim accounts and calculations of price increases.	
14	Design management, Information management in construction projects, the DSM method.	

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Contact hours per week:

Lecture: 2 hours

Recitation: 2 hours

Credit points: 3

Mechanical Engineering

Dynamics - 034010

Description

This course provides an introduction to modeling and analysis of dynamic systems, with a focus on the motion of particles, systems of particles, and rigid bodies under the action of forces and moments. Core topics include kinematics of a particle, particle dynamics, particle systems and dynamics of rigid bodies. It will meet weekly for 4 hours of lectures and 2 hours of recitations.

Time and frequency domain solutions to first and second order equations of motion are discussed.

Prerequisites

Courses in: Physics 1 (114051), Ordinary Differential Equations (104131), Calculus (104022) and Solid Mechanics (034028) or equivalent.

Textbook

Miles Rubin, and Eliezer Altus, "Dynamics," Faculty of Mechanical Engineering, Technion-I.T.T., 2003 (Available online at: http://w2.technion.ac.il/~meeng/adb_admin/uploads/Studies/Disc_Update/2011-12/034010-2012.pdf)

Additional References

Meriam, James L. & Kraige, L. G., "Engineering Mechanics: Dynamics., Vol. 2.," 6th Ed., Hoboken, N.J.: Wiley, 2010

Course Topics

- Kinematics of a particle: geometry of motion at different coordinates, angular velocities, moving coordinates, relative speeds and accelerations, and kinematics of rigid bodies).
- Particle dynamics: motion equations, vibrations, work-energy concepts and conservation laws).
- Particle systems: (formulation of balance laws, impulse and momentum, mechanical power and kinetic energy, and impact of two particles)
- Dynamics of rigid bodies: inertia tensor, planar motion, impulse and momentum, a system of rigid bodies, gyroscopic effects and Euler's laws of motion.

Contact Hours per Week

Lecture: 4 hours

Recitation: 2 Hours

Credit points: 5

Introduction to Mechatronics – 034022

Description

This course provides an introduction to analysis and design principles of electronic circuits, with emphasis and examples from the emerging field of mechatronics. Topics include basic and semiconductor components, basic principles of electrical circuit analysis, circuit response to analog/digital excitation, analog system and circuits based on action amplifiers, digital electronics, gates (logic circuits) and circuits based on logic gates, memory components and circuits based on memory components, and microprocessors and microcontrollers.

Prerequisites

Courses in: Physics 2 (114075 or 114052), and Linear Systems (034032) or equivalent.

Course Topics

- Review of electrical components and circuit elements.
- Analysis of DC circuits.
- Transient response analysis.
- Frequency response analysis.
- Analog electronics (diode and transistor amplifiers).
- Digital electronics (logic gates, De Morgan's laws, and circuit systems).

Contact Hours per Week

Lecture: 2 hours.

Recitation: 1 Hour.

Credit points: 3

Other

Introduction to Computer Language C – 234126

Course Description / Objectives

Computer structure overview. Algorithmic approach to problem solving. Basic programming abilities and concepts including procedural programming (methods, parameters, return values), basic abilities of writing, executing and debugging programs in the C language. Computational efficiency of algorithms.

Week	**Lecture Topics**	**Recitation Topics**
1	Introduction to Programming	Introduction to code blocks environment
2	Identifiers, Constants	I/O
3	Types, operators	Types, type conversion
4	Logical expressions, conditional statements	Types and operators
5	Loops	Condition statements
6	Arrays	Loops, arrays
7	Functions, scope of variables	Functions
8	Pointers	Scope of variables
9	Pointers and arrays	Pointers as parameters
10	Search in arrays	Search in arrays
11	Sorting	Sorting
12	Recursion	Recursion
13	Recursion	Recursion

Contact Hours per Week

Lecture: 2 hours

Recitation: 2 Hours

Lab: 2 Hours

Credit points: 4

General Chemistry Laboratory - 125013

Course Goals and Content

Safety instructions, measurements and accuracy, combustion reactions, concentration determination by titration, determination of hydration water in copper sulfate. Chemical equilibrium and Le-Chatelier principle. Determination of zinc equivalent (ideal gas laws). Atomic absorption and emission spectrum, elements in flame, absorption law, phase diagrams, measuring the enthalpy of vaporization, ion exchangers, acid and bases, elution curves. Note: the lab is given once in 2 weeks.

Contact Hours per Week

Lab: 3 Hours

Credit points: 1

Physical Chemistry 1B – 124503

Course overview

The kinetic theory of gases. Thermodynamics: the first law and thermochemistry, the second law and entropy, free energy and chemical equilibria, multicomponent systems, the chemical potential, solutions and colligative properties. Electrochemistry: properties of ions and aqueous solutions, electromotive forces and electrochemical cells, colloidal systems, electro kinetic phenomena. Biological applications.

Contact Hours per Week

Lecture: 3 hours

Recitation: 2 Hours

Credit points: 2.5