COURSE DESCRIPTION 2009-2010

1st SEMESTER

MATHEMATICAL ANALYSIS I

Code no: **9.2.01.1.1.9,** Semester: **1st**

Preliminaries (The Algebra of Sets, Functions, Mathematical Induction). The Real Number System R. Sequences in R. Infinite Series of Real Numbers. Power Series. Real-valued Function of a Real Variable. Differential Calculus. Taylor's Theorem. Taylor and MacLaurin Polynomials. Power Series Expansions of Functions. Definite Integral (Upper and Lower Integrals. Criterion for Integrability. The Integrability of monotone and continuous Functions. Riemman Sums. The Integral as a Limit. Fundamental Theorems). Indefinite Integral (Fundamental Integration Formulas). Applications of the Integral (Area between Curves. Length of Arc. Volumes of Solids with known Cross Sections. Volumes and Surface Area of a Solid of Revolution. Centroid and Moment of Inertia). Polar Coordinates (Graphs of Polar Equations. The Area Problem. Length of Arc). Improper Integrals (Criteria of Convergence). Elementary Differential Equations (First-Order D.E. The Equations $y''+ay'+by=0$ and $y''+ay'+by=f(x)$. Applications).

ANALYTIC GEOMETRY AND LINEAR ALGEBRA.

Code no: **9.2.02.1.1.9,** Semester: **1st**

Vector calculus. Planes and straight lines in 3-space. Curves in the plane. Introduction to algebraic structures. Vector spaces, vector subspaces and their sums, linear independence and linear dependence, bases, dimension of vector spaces. Matrices and determinants, rank of a matrix, Linear systems. Linear mappings. Matrices and linear mappings, change of basis, equivalent matrices, similar matrices.

PHYSICS I (MECHANICS)

Code no: **9.4.01.1.1.9,** Semester: **1st**, Teaching hours: **6 (+1)**

Newtonian Mechanics: The laws of Physics in vector notation. Forces. Newton's laws. Conservation of energy, momentum and angular momentum. Systems of many particles. Elementary dynamics of sold bodies. The harmonic oscillator.

Special Theory of Relativity: Reference frames. The velocity of light. Lorentz transformations. Relativistic dynamics.

MECHANICS I

Code no: **9.3.34.1.1.9,** Semester: **1st,** Teaching hours: **4 (+1)**

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INTRODUCTION TO PROGRAMMING

Semester: 1st, Teaching hours: 5

Introduction to Computer Science. Simple algorithms and data structures. Programs and programming languages. Integrated program development environments. Introduction to object oriented programming in Java. Objects, classes and methods. Implementation methods. Data types and operators. Parameter passing. Selection and flow control instructions. Introduction to the Application Programming Interface (API, basic java libraries). Strings, arrays, linked lists. Recursion. Debugging. **Lab**: Series of supervised lab exercises in Java. Use of dedicated to teaching integrated programming environment (BlueJ).

MICROECONOMIC THEORY

Code no: **9.1.04.1.1.9,** Semester: **1st,** Teaching hours: 2

The tools of economic analysis. Economic models. Prices, income and demand. Elasticities. The theory of consumer choice. Complementary and substitute goods. Organisation and behaviour of enterprises. Revenue, cost and profits. Theory of supply: cost and production. Perfect competition and pure monopoly: the extreme cases of the market structure. Competition in the international markets. Market structure and imperfect competition. Analysis of factor markets. Labour market. Capital and land. Demand of production factors by the enterprise.

2nd SEMESTER

MATHEMATICAL ANALYSIS II

Code no: **9.2.03.2.1.9,** Semester: **1st, Direction: common,** Teaching hours: 5

Sequences and series of functions. Uniform convergence. Power series. Taylor and MacLaurin series. Euclidean space R^n. The topology of R^n. Sequences and their convergence. Compact sets. Many valued functions: limits, continuity. Partial derivatives. Partial derivatives of higher order. Schwarz theorem. Directional derivatives. Differentiable functions. Tangent of a curve. Gradients. Mean value theorem. Taylor formulae. Inverse function theorem. Implicit functions. Functional dependence. Extremum points. Lagrange multipliers.

LINEAR ALGEBRA AND APPLICATIONS

Code no: **9.2.04.2.1.9,** Semester: **2nd,** Teaching hours:

Eigenvalues and eigenvectors, matrix diagonalisation. The Theorem of Cayley-Hamilton, minimal polynomial. Inner product vector spaces. Linear mappings between vector spaces with inner product. Normal forms of matrices: Jordan form, rational normal form. Linear and bilinear forms, quadratic forms. Curves in space and surfaces. Classification of 2nd order curves and surfaces. Applications to Mechanics, Physics and other sciences.

PHYSICS II (ELECTROMAGNETISM)

Code no: **9.4.03.2.1.9,** Semester: **2nd,** Teaching hours: 5

Electrostatics. Coulomb's law. The electric field. Electrostatic potential. Potential difference. Gauss's law. Energy stored in the electric field. Theorems of Gauss and Stokes. Poisson's and Laplace's equations. Conductors. Electric currents. Ohm's law. The magnetic field. Biot – Savart law. Ampere's law. Electromagnetic induction. Energy stored in the magnetic field. Maxwell's equations. Electromagnetic waves.

PHYSICS LABORATORY I

Code no: **9.4.02.2.1.9,** Semester: **2nd, Direction: common**
Status: **compulsory,** Teaching hours: 2

Introduction to the use of standard measuring devices and to error theory (two theoretical exercises in experimental data analysis). ◆ Four two – hour sessions and eight laboratory exercises, chosen from the following list: ◆ Measurement of the acceleration of gravity, by the falling - bodies method. ◆ Measurement of the acceleration of gravity, by the physical pendulum method. ◆ The Cavendish method for the measurement of the universal gravitational constant. ◆ Determination of the strain of a material, by the torsional pendulum method. ◆ Measurement of the viscosity of a fluid, by the method of sinking small spheres. ◆ Determination of the coefficient of restitution and the collision time of two spheres. ◆ Measurement of thermal conductivity. ◆ Measurement of the cp/cV ratio for gases. ◆ Refraction. Properties and aberrations of lenses.

MECHANICS II [DEFORMABLE BODY]

Code no: **9.3.35.2.1.9,** Semester: **2nd,** Teaching hours: 2

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DESIGN AND DEVELOPMENT OF COMPUTER APPLICATIONS

Semester: **2nd,** Teaching hours: 5

Object oriented programming in Java. Inheritance and polymorphism. Abstract classes and interfaces. Exceptions. Data input and output. Data collection classes. Graphical user interfaces. Applets. Design of object oriented programs. Analysis of simple algorithms and data structures.

Lab: Series of supervised lab exercises in Java. Use of dedicated to teaching integrated programming environment (BlueJ).

INTRODUCTION TO THE HISTORY OF SCIENCES AND TECHNOLOGY

Code no: **9.1.02.2.2.9,** Semester: **2nd,** Teaching hours: 2

This introductory course is dealing with the major characteristics of the scientific phenomenon the technical achievements and their relation, the period from 6th century BC to the so called scientific revolution of the 16th-17th century. The focus is on natural philosophy- science of the ancient Greeks, some elements are given on the Latin medieval period and emphasis is also put on the era of the formation of the classical science. Ancient Greek mathematics, the production of energy during the long duration and on the history of engineers focused on the Greek case.

HISTORY OF ECONOMIC THEORIES

Code no: **9.1.03.2.2.9,** Semester: **2nd,** Teaching hours: 2

Mercantilism and its decline, The theory of mercantilism at its height: Thomas Mun, The reaction against mercantilism: Dudley North, William Petty, David Hume. The Physiocrats, The Quesnay's Tableau Economique, The theoretical legacy of the Physiocrats. Adam Smith: The theory of value, The theory of distribution, The theory of capital and productive work. David Ricardo: Theory of value, Ground rent, Wages and profit. The decline of the Classical School: Th. Malthus, J.B. Say, The conflicts surrounding the theory of value, Senior, Carey & Bastiat, Sismondi, The Utopian Socialists, John Stuart Mill. Karl Marx: Abstract labour and value, The theory of capital, Reproduction of the total system of production, Values and prices of production. The Neoclassical School: Marginal utility and equilibrium of supply and demand, The production function. The neo-Ricardian School: Systems of production and relative prices, Basic and non-basic commodities, The problem of "negative prices". J. M. Keynes: The "General Theory" and its era, The effective demand and the multiplier, long-term expectations and marginal efficiency of capital.

3rd SEMESTER

MATHEMATICAL ANALYSIS III

Code no: 9.2.05.3.1.9, Semester: **3rd** , Teaching hours: 4

Elements from Differential Geometry of curves: Principal vectors, Frenet frame, curvature and torsion of a curve. Curvilinear coordinates (polar, cylindrical, spherical coordinates). Scalar and vector line integrals. Double integrals: Fubini theorem applications. Green's theorem. The triple integral. Change of variables in a triple integral. Applications. Elements from Differential Geometry of surfaces. Scalar and vector surface integrals. The important theorems of Vector Analysis: Gauss theorem, Stokes theorem. Special vector fields.

ORDINARY DIFFERENTIAL EQUATIONS

Code no: 9.2.06.3.1.9, Semester: **3rd**, Teaching hours: 4

Introduction: Definition, solution and its geometrical properties. Initial - boundary value problems. Well posed problems.

First order differential equations: Separable equations, homogeneous, exact, Riccati, Lagrange, Clairaut. Qualitative theory. Existence and uniqueness of solutions. Picard's theorem, Peano's theorem.

Linear ordinary differential equations: Basic theory, linear independence. Wronski determinant. Homogeneous equations with constant coefficients. Method of variation of parameters (Lagrange) – The method of undetermined coefficients. The Euler equation.

The method of power series: Power series. Solution near an ordinary point, Legendre's equation. Solution near regular singular point. Fuchs theory, Frobenius method. Bessel's equation.

Systems of ordinary differential equations: Introduction, Elimination method, Basic theory. Systems with constant coefficients, homogeneous, non - homogeneous.

Laplace transform: Introduction, properties, inverse Laplace transform. Applications, Heaviside function. Dirac delta function. Convolution. Integrodifferential equations.

Use of computational software for the study of problems in ordinary differential equations.

PROBABILITY

Code no: 9.2.07.3.1.9, Semester: **3rd**, Teaching hours: 3

The meaning of probability. Axioms of probability. Combinatorial Analysis. Conditional probability and independent events. Theorem of total probability and Bayes' rule. Random variables. Density function. Special density functions (Binomial, Negative Binomial, Geometric, Hypergeometric, Poisson, Uniform, Normal, Exponential, Gamma, Lognormal, Weibull, Chi-Square, Student's t, Snedecor's F). Multivariate distributions (Multinomial, Multivariate Normal). Expected value, variance and covariance. Conditional expectation. Distributions of functions of random variables. Convolution. Probability and moment generating functions. Characteristic functions. Convergence of sequences of random variables. Laws of large numbers. Central limit theorems and applications.

PHYSICS III (WAVES)

Code no: 9.4.05.3.1.9, Semester: **3rd** , Teaching hours: 5

The harmonic oscillator (undamped and damped). Forced oscillations. Resonance. Coupled oscillators, normal modes of vibration, systems with many degrees of freedom. Electric oscillations. Wave in continuous media in one dimension. Phase and group velocity, dispersion. Reflection, transmission beyond a discontinuity. Fourier methods, band width theorems. Interference. Waves in transmission lines.

PHYSICS LABORATORY II

Code no: 9.4.04.3.1.9, Semester: **3rd** ,Teaching hours: 2

Introductory theoretical sessions and nine laboratory exercises, chosen from the following:

1. Dependence of the resistance of a conductor on temperature.
2. Charting the electric field.
3. Measurement of capacitance and of the dielectric constant of materials.
4. Measurement of the magnetic field in the interior of the solenoid.
5. Measurement of the e/m ratio of electrons.
6. The oscilloscope.
7. The electrical and mechanical equivalent of heat.
8. Calibration of a thermocouple.
9. The optical microscope.
10. Measurement of the magnetic permeability, μ_o, of empty space.

MECHANICS III (KINEMATICS AND DYNAMICS)

Code no: **9.3.36.3.1.9,** Semester: **3rd**, Teaching hours:

Kinematics of a Particle. Path, Frenet trihedron, velocity, acceleration, areal velocity. *Kinematics of a Rigid Body.* Translation, rotation about a fixed axis, general plane motion, rotation about a fixed point, angular velocity, angular acceleration, mechanisms, relative motion of a particle, Coriolis Theorem, relative motion of a rigid body, composition of rotations, Euler's angles. *Dynamics of a Particle.* Differential equations of motion, linear and angular momentum and impulse, kinetic energy, principles of impulse and momentum (linear and angular), of work and energy, conservative forces, potential energy, inertia forces, D'Alembert's principle, *Dynamics of a System of Particles,of a Rigid body.* The motion of the center of mass, principles of impulse and momentum (linear and angular), of work and energy, moments of inertia of a rigid body, equations of motion of a rigid body, Euler's equations of motion, *Introduction to Analytical Dynamics.* Mechanical systems, constraints (holonomic, rheonomic, scleronomic, nonholonomic), degrees of freedom, generalized coordinates, virtual work, principle of virtual displacements, generalized forces, Lagrange's equations, Lagrangian. *Mechanical Vibrations.* One degree of freedom systems, eigenfrequecy, damping, free – forced vibrations, motion of the support, vibration control, systems of many degrees of freedom, the eigenproblem, eigenfrequencies, natural modes, orthogonality conditions.

SOFTWARE FOR PHYSICS AND MATHEMATICS

Code no: 9.2.62.3.1.9, Semester: **3rd**,Teaching hours: 3

A pc lab course that teaches software used in Physics and Mathematics (Mathematica, MatLab, Origin, etc.)

INTRODUCTION TO PHILOSOPHY

Code no: **9.1.01.3.1.9,** Semester: **3rd**, Teaching hours: 2

The Historic, and Systematic Approach to Philosophy. Problems and Periods of Western Philosophy. Systematic presentation and analysis of central issues in Philosophy: the validity of knowledge, truth, mind and matter, language and the real world, the significance of Philosophy today.

4th SEMESTER

NUMERICAL ANALYSIS I AND LABORATORY

Code no: **9.2.08.4.1.9,** Semester: **4th** , Teaching hours: 4

Linear Systems: Floating point arithmetic and computer errors. Gausss elimination methods. Pivoting. Computation of inverse converse and determinant. Fixed point iterative method. Methods of Jacobi, Gauss-Seidel and relaxation. Computation of eigenvalues and eigenvectors. Power method. Least squares method for overdetermined linear systems.
Non linear equations and systems: Bisection method, General iterative method, Newton-Raphson and Quasi-Newton methods, Newton -Raphson and Quasi-Newton method for nonlinear systems.
Interpolation and approximation: Lagrange interpolation. Hermite interpolation. Spline Optimal interpolation with Least Squares.
Numerical Integration: Lagrange integration. Composite Trapezoidal and Simpson numerical integration formulas. Hermite integration. Gauss integration.

COMPLEX ANALYSIS

Code no: **9.2.09.4.1.9** Semester: **4th** , Teaching hours: 4

Complex numbers. Algebra of complex numbers, stereographic projection, topology of C, sequences of complex numbers. Analytic functions. Derivate of a complex function, Cauchy-Riemann equations, harmonic and conjugate harmonic function, Elementary functions. The exponential function, trigonometric functions and their inverses, complex logarithm. Complex integration. Cauchy’s theorem and applications. Liouville theorem, maximum principle Lemma Schwarz-Series. Series of analytic functions, power series. Taylor’s theorem. Laurent series and residues. Classification of singular points, residue theorem and application. The argument principle and Rouche’s theorem Meromorphic functions, theorem of Mittas-Loftler. Harmonic functions, basic properties of harmonic functions, Poison integral type. Conformal mapping. Mobius transformations. Riemann mapping theorem. The Schwarz- Christoffel transformation. Applications of the conformal mapping

STATISTICS

Code no: **9.2.10.4.1.9,** Semester: **4th** , Teaching hours: 3

Descriptive Statistics. Estimation theory - basic concepts and definitions. Unbiasedness, sufficiency, completeness, efficiency and consistency. Factorization criterion. Exponential family and sufficiency. Methods of estimation. Frequentist and Bayesian estimation. Method of moments, method of maximum likelihood and Bayes’ method. Statistical functions and sampling distributions. Interval estimation and hypothesis testing. Goodness of fit tests. Contingency tables, test for independence and homogeneity. Regression analysis and least squares method. Simple linear regression. Non-linear regression. Multiple linear regression. The coefficient of determination R^2. Analysis of Variance and model selection.

PHYSICS IV (QUANTUM MECHANICS I)

Code no: **9.4.06.4.1.9,** Semester: **4th**, Teaching hours: 5

Introductory concepts. Schrödinger’s equation. The uncertainty principle. Motion of a particle in potential wells: Bounded and unbounded eigenstates. The harmonic oscillator. Wave packet motion of a free particle. Scattering of a particle from a potential barrier. Tunneling and applications. Measurement in Quantum Mechanics. Expected values of physical quantities. Motion of a particle in a spherically symmetric potential. The hydrogen atom. Angular momentum and spin.

INTRODUCTION TO COMPUTER SCIENCE

Semester: **4th** , Teaching hours: 5

Theoretical informatics: computer science logic, automata, typical grammars, computability and complexity. Programming models: functional, logical, object-oriented, parallel programming. Expression and treatment of information: binary arithmetic, numerical systems, presentation of numbers in binary form, numerical operations with fixed and floating decimal point, coding. Computer organization and operation: computer parts and operation, command form, machine language, symbolic language, memory design, peripheral units, storage units. System software: operational system, compilers. Applications software: data bases, data management, etc.

STRUCTURAL MECHANICS

Code no: **9.3.32.4.1.9,** Semester: **4th,** Teaching hours: 4

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SOCIOLOGY (OF SCIENCE)

Code no: **9.1.05.4.2.9,** Semester: **4th,** Teaching hours: 2

The study of science as a social institution and practice. Science in the laboratory, social relationships in science practice, gender politics of science. What is science from a sociological and anthropological point of view. Ethnomethodology of science and social constructivism of scientific knowledge

MACROECONOMIC THEORY

Code no: **9.1.06.4.2.9,** Semester: **4th,** Teaching hours: 2

National Accounts. Gross national product and net national product. The basic macroeconomic identities. Indices of prices and time value of money. Income, expenditure and the production equilibrium. The multiplier. Public sector and income equilibrium. Money, interest and income. The market of goods and the IS curve. The asset markets and the LM curve. Aggregate supply and aggregate demand. International interconnections of an open economy. Consumption, saving and investment. Investments of fixed capital: the neoclassical and the Keynsian approach. Long-run growth and productivity.

PHILOSOPHY OF SCIENCES

Code no: **9.1.07.4.2.9,** Semester: **4th,** Teaching hours: 2

The (perennial) problem of the Rupture with our (recent or remote) epistemological past. The distinction of truths into necessary and contingent (Leibniz). The employment of the distinction by Hume in his criticism of causality. Kant's concept of synthetic a priori. Rupture as a conflict with truths of reason (necessary). The contextualist account of Analyticity. The refutation of Quine. Incommensurability as the conflict with a topical truth. The philosophy of J. L. Austin. The Darwinian view of language. Locution. Illocution and Perlocution. The suppression of Rupture.

SCIENTIFIC TERMINOLOGY

Semester: **4th,** Teaching hours: 2

English, French, German or Italian

COURSES IN THE DIRECTION OF APPLIED MATHEMATICAL SCIENCES

5th SEMESTER

REAL ANALYSIS

Code no: **9.2.13.5.1.9,** Semester: **5th,** Teaching hours: 4

Metric space, fundamental definitions, Holder-Minkowski inequalities. Sequences and continuous functions on metric spaces. The topology of a metric space. Separable metric spaces. Baire's category theorem. Banach's contraction principle. Compact metric spaces. Sequences of functions. Compact subsets of C[a,b]. Arzela's theorem. Products of metric spaces.

NUMERICAL ANALYSIS II AND WORKSHOP

Code no: **9.2.18.5.1.9,** Semester: **5th,** Teaching hours: 4

Numerical Methods of ordinary differential equations – initial value problem: Introduction to differential equations. Existence and uniqueness of solutions. Problem of initial values of 1^{st} order. Problem of initial values of higher order. Difference equations. Numerical methods. Errors of numerical methods. *One-step methods:* General methods of simple step. Taylor series method. Runge-Kutta methods. Error estimation. Methods of 3rd and 4th order. Continius methods. *Multi-step methods:* Introduction to multi-step methods. Choice of parameters. Error estimation. Adams-Bashforth methods. Adams-Moulton methods. Stability of multi-step methods. 2^{nd} order problems. Runge-Kutta-Nyström methods. *Numerical Methods for Ordinary Differential Equations-Boundary Value Problems:* Boundary value problem. Derivate approximation. *Numerical Methods:* Linear shooting method. Finite difference method for linera and non linear problems. Galerkin method. *Numerical Methods for Partial Differential Equations:* Boundary value problems for partial differential equations. Approximations. *Numerical Methods:* Finite Difference Methods. Crank-Nicolson method. Examples and applications. *Workshop Exercises:* Use of software (FORTRAN - IMSL, Matlab, Mathematica, Programming Libraries etc.) for programming.

CONVEX ANALYSIS

Code no: 9.2.45.5.2.9, Semester: 5th, Teaching hours: 4

Convex sets. Separation. Blaschke's Selection theorem. Duality, extreme points. Convex polytopes. Polytopes, polyhedrons, cyclic polytopes, Euler's relation, Gale's transformation. Linear programming. Systems of linear equations. Convex functions. Continuity, differentiation. Basic inequalities. Gamma and Beta functions. Convex programming. Isoperimetric problem . Brunn-Minkowski theorem. Helly's theorem. Geometry of numbers. Minkowski's theorem. Farey sequences. Brouwer's fixed point theorem.

INFORMATION AND CODING THEORY

Code no: **9.2.34.5.2.9,** Semester: **5th,** Teaching hours:

The origin of information theory Shannon’s information measure. Conditional, joint and mutual information measures. The communication model. The discrete memoryless information source. Coding methods: Fano, Shannon, Huffman, Gilbert – Moore. Kraft’s inequality. McMillan’s inequality. Shannon’s first theorem. The discrete information source with memory. Error – correcting codes. Humming’s sphere – packing bound. Plotkin’s bound. Hadamard codes. Codes and Block designs. Reed – Muller codes. Codes and Latin Squares. Linear Codes. Equivalence of Linear codes. The Hamming and Golay codes. Dual codes. Sydrome decoding. Perfect codes. Cyclic codes. Weight enumerators.

DISCRETE MATHEMATICS

Code no: **9.2.32.5.2.9,** Semester: **5th,** Teaching hours: 4

Permutations, combinations, r-permutations of sets. Binomial coefficients, the binomial theorem and its applications. Permutations, and combinations of multisets. Multinomial coefficients and the multinomial theorem. The pigeonhole principle. Ramsey’s theorem and Ramsey numbers. The inclusion-exclusion principle . Permutations with forbidden positions and some applications. Recurrenie relations and generating functions . The Fibonacci sequence. Linear homogeneous recurrence relations with constant coefficients. Inhomogeneous equations. Catalan and Stirling numbers.

ALGEBRA I

Code no: **9.2.15.5.2.9,** Semester: **5th,** Teaching hours: 4

Partitions and equivalence relations. Introduction to Group Theory. Groups of symmetries, cyclic groups: the nth roots of unity, remainder classes, the integers. Division theorems for integers, the Theorems of Fermat and Euler, linear congruences. Co-sets (application to linear codes), the Theorem of Lagrange, normal subgroups, quotient groups. The classification of finitely generated abelian groups. Permutation groups, Cayley’s theorem. Introduction to rings, integral domains and field theory. This course is particularly useful to those who have selected the stream «Mathematics for Information Sciences».

SET THEORY

Code no: **9.2.48.5.2.9,** Semester: **5th,** Teaching hours: 4

Introduction to sets. The set of real numbers. Cantor Set. Cantor’s theorem. Schroeder-Bernstein’ theorem. Paradoxes and axioms. Russell’s paradox and Zermelo foundations. The axioms of set theory. Orders, relations and functions. Natural and real numbers. Well ordered sets. Transfinite induction and recursion. Hartogs' and fixed point theorems. Axiom of Choice and Zorn Lemma. Well ordering theorem and applications. Cardinal and ordinal numbers and their arithmetic. Cantor's normal form theorem.

INTRODUCTION TO ANELASTIC BEHAVIOUR OF MATERIALS

Code no: **9.3.09.5.2.9,** Semester: **5th,** Teaching hours: 4

Macroscopic description of anelastic response of materials (metals, polymers), and its physical interpretation. Effect of strain rate. Linear viscoelasticity: simple viscoelastic models, standard loading in viscoelasticity.Complex unidirectional viscoelastic models, Relaxation and compliance modulus. Constitutive equations of viscoelasticity in differential and integral form. Non isothermal viscoleastic response. Dynamic mechanical analysis, storage and loss modulus, examples.

Introduction to plasticity, yield criteria Tresca and von Mises. Simple examples. Prandl-Reuss equations, associated flow rule, Mises flow rule. Constitutive equations in plasticity. Isotropic and kinematic hardening, examples.

ANALYTIC DYNAMICS

Code no: **9.3.07.5.2.9,** Semester: **5th,** Teaching hours: 4

The basic problem of Dynamics. Solution spaces. Types of contacts. [Desmikes] Reactions. [Generalized-genikevmenes] coordinates and transformations. Possible and real shifts. Principles of [dinaton ergon], D'Alembert. Generalized Forces. Kinetic Energy. Lagrange Equations. [genikevmeno dinamiko]. Circular coordinates. Integrals of movement. Elements from [Logismo of Changes]. Hamitton and Minimal Action principles. Hamitton Equations. [Agyles] Poisson. Regular transformations. Hamitton- Jacobi equation. The significance of balance. Introduction to the Theory of Stability.

INTRODUCTION TO INTERNATIONAL ECONOMICS

Code no: **9.1.12.5.2.9,** Semester: **5h,** Teaching hours: 4

Theoretical analysis of economic relations between different countries. Content of international economics. International trade theory: basic theoretical models. International trade policy: means of trade policy, industrial policy and international trade. Macroeconomics of the exchange rates and the open economy: National income accounting and the balance of payments, exchange rates and the foreign exchange market. International macroeconomic policy: The international monetary system, international banking operations and the global capital market, developing countries, lending and debt.

QUANTUM MECHANICS II

Code no: 9.4.09.5.2.9, Semester: 5th, Teaching hours:

Mathematical foundation of Quantum mechanics. Schrödinger's equation. Application to stationary states. Transition from Classical to Quantum Mechanics. The harmonic oscillator. Three dimensional potentials. Charged particles in electromagnetic fields. Theory of angular momentum. Introduction to spin. Time – independent perturbation theory. The WKB approximation. Calculus of variations.

TECHNOLOGY AND ITS HISTORY.

Code no: **????,** Semester: 5th**,** Teaching hours: 3

This middle level course aims towards the understanding of the notion of technology through its historical genealogy but also the exposition of diachronic questions.

More specifically, we examine the relation between technique ,technology and applied science, and their relation to the society. We mention the notion of progress, the problem of technological determinism related to the appearance of modernity, and also contemporary political and ethical problems related to technology.

PRINCIPLES OF TEACHING

Code no: **9.2.16.6.1.9,** Semester: **5th,** Teaching hours: 4

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HISTORY OF EDUCATION

Code no: **9.2.16.6.1.9,** Semester: **5th,** Teaching hours: 3

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6 ο ΕΞΑΜΗΝΟ

FUNCTIONAL ANALYSIS I.

Code no: **9.2.16.6.1.9,** Semester: **6th**
Teaching hours: 4

Elements of linear algebra. Vector spaces with norm. Continuous linear operators. Hilbert spaces. Hahn-Banach theorem. Analytic form, consequences. Minkowski functionals, separation theorems, extreme points. Krein – Milman theorem. Open mapping theorem. Closed graph theorem. Uniform boundeness principle. Their consequences.

PARTIAL DIFFERENTIAL EQUATIONS.

Code no: **9.2.12.6.1.9,** Semester: **6th,** Teaching hours: 4

Fourier series and Fourier transform: Trigonometric series, Convergence theorem, Sine and cosine Fourier series. Generalized Fourier series. Fourier Integral and Fourier transform. ◆ Boundary value problems: Linear boundary value problems. Sturm – Liouville eigenvalue problems. Properties. Regular, periodic, singular problems. Non homogeneous problems. ◆ First order partial differential equations: The Cauchy problem for quasi linear equations. ◆ Second order partial differential equations: Classification. Characteristics and canonical forms. ◆ Elliptic equations: Boundary value problems. Uniqueness for Dirichlet – Neumann problems. Compatibility condition. Separation of variables in Cartesian, Polar, Cylindrical and Spherical coordinates. Use of Fourier integral transforms. Dirac functional. Fundamental solutions. Integral representations. Poisson integral - Green's function and the method of images. The method of eigenfunction expansion. The maximum principle. ◆ Parabolic equations: Initial and boundary value problems. Separation of variables. The non homogeneous problem. Use of Laplace and Fourier integral transforms. Maximum principle. ◆ Hyperbolic equations: The finite and infinite string. Separation of variables in Cartesian, Polar, Cylindrical and Spherical coordinates. Fundamental solutions. Integral representations. Use of Laplace and Fourier integral transforms. Use of computational software for the study of problems arising in partial differential equations.

DYNAMIC SYSTEMS

Code no: **9.2.21.6.1.9,** Semester: **6th,** Teaching hours: 4

Fundamental theory: theorems of existence and uniqueness of solutions: Picard's theorem, Extensionality of solutions. Differentability of solutions. Continuous dependence of intial data and parameters, Gronwall inequality. *Stability:* Introduction. Autonomous Systems. Stability of linear systems: Introduction. Autonomous Systems. Stability of linear systems: general theory, autonomous linear systems in the plain. Stability of almost linear systems: Lyapunov's method. Theorem of central manifold. Algebraic criteria of stability. *Periodic solutions:* Floquet theory. Poincare-Bendixson theorem, Applications. Stability of periodic solutions. Periodic solutions of non-autonomus systems *Applications:* Εξίσωση Ταλαντωτή. Εξίσωση Van der Pol. Εξίσωση Mathieu. Εξίσωση Hill. Εξίσωση Lienard. *:Bifurcation theory:* Introduction. Elementary examples. Bifurcation of Poincare - Andronov - Hopf. Applications.

MATRIX ANALYSIS AND APPLICATIONS.

Code no: **9.2.44.6.2.9,** Semester: **6th,** Teaching hours: 4

◆ Block matrices. Additional properties of determinats. Rank of matrices. Matrix factorization. Matrix norms. ◆ Inner product and orthogonality. Projective matrices. Singular value decomposition and polar factorization. ◆ Normal matrices. Nonnegative matrices and irreducibility (Perron- Frobenius theory). Stability criterion for the location of polynomial roots. Kronecker product.

PROBABILITY THEORY

Code no: **9.2.19.6.2.9,** Semester: **6th,** Teaching hours: 4

Probability as a measure. Independence. Borel-Cantelli lemmata. Random variables. Expected value as an abstract Lebesgue integral. Sequences of random variables, modes of convergence. Laws of large numbers. Characteristic functions of random variables, P. Levy's theorem. Central limit theorem. Conditional expectation. Discrete time martingales.

DATA STRUCTURES

Code no: **9.2.22.6.2.9,** Semester: **6th,** Teaching hours: 4

Abstract data types and their implementations. Lists, stacks, FIFO queues, priority queues, symbol tables, disjoint sets, graphs. Implementations based on search trees (binary trees, AVL trees, splay trees, B-trees, red-black trees), heaps (binary, binomial, Fibonacci) and hashing. Sorting algorithms. Applications.

TEACHING MATHEMATICS

Code no: **9.2.66.6.2.9,** Semester: **6th,** Teaching hours: 3

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THEORY OF ELASTICITY

Code no: **9.3.08.6.2.9,** Semester: **6th,** Teaching hours: 3

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DIFFERENTIAL GEOMETRY OF CURVES AND SURFACES

Code no: **9.2.33.6.2.9,** Semester: **6th,** Teaching hours: 4

Theory of curves: General introduction. Plane curves: curvature, oscillating circle, involutes, local canonical form of a curve, implicitly defined curves, determination of a curve from its curvature, elements from the global theory of plane curves, determination of a curve from its curvature. Local theory of space curves, Frenet formulae. Canonical form of a space curve, Fundamental theorem of curves. ◆ Theory of surfaces: Definitions of surfaces, special classes of surfaces. Surface curves, tangent vectors, tangent plane, First fundamental form. Gauss map, shape operator, Second fundamental form. Curvature of surface curves, Gauss and mean curvature. Classification of surface points, Third Fundamental form. Gauss theorem (Theorema Egregium), Geodesics. Mappings between surfaces.

Use of computer for the study and plotting of curves and surfaces.

AUTOMATA AND FORMAL GRAMMARS

Code no: **9.2.49.6.2.9,** Semester: **6th,** Teaching hours:4

Languages and their representations. Grammars, context-sensitive and context-free grammars. Finite automata and regular grammars. Pushdown automata. Turing Machines. Automata and language recognition. Applications in programming languages syntax. (Un)decidability and complexity problems.

AUTOMATIC CONTROL I

Code no: **3.3.10.6.2.9,** Semester: **6th,** Teaching hours: 4

Introduction and historical review of automatic control systems. Description of automatic control systems with integral-differential equations, transport function, impulse response and state equations. Equivalence of descriptions. Systems analysis in the time field. Errors in the steady state. Noise cut-off. Study of systems in state space. Contollability and observability. Normal forms. System stability. Algebraic stability criteria of Routh, Hurwitz and continuous fractions. Nyquist and Lyapunov stability criteria. Geometrical locus of roots. Harmonic analysis of systems. Bode and Nichols diagrams. Practical applications.

PRINCIPLES OF TEACHING METHODOLOGY - TEACHING METHODS OF MATHEMATICS

Code no: **9.2.69.8.2.9,** Teaching hours:

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ALGEBRA II

Code no: **9.2.69.8.2.9,** Semester: **6th,** Teaching hours: 3

Complements of Group Theory (group action on sets, representations, matrix groups, etc). Ring Theory (ideals, modules, extensions, polynomials, Galois theory, finite fields, geometric constructions, etc). This course is particularly useful to those who have selected the stream «Mathematics for Information Sciences».

ELECTROMAGNETISM II

Code no: **9.4.12.6.2.9,** Semester: **6th,** Teaching hours:

Electric fields in nature. Dielectric materials. Magnetic materials in matter. Magnetic materials. Maxwell's equations in vacuum and in matter. Electromagnetic waves. Propagation of electromagnetic waves in vacuum. The Pointing vector. Propagation of electromagnetic waves in conducting materials. Reflection and transmission of electromagnetic waves. Polarization. Fresnel coefficients. Dispersion.

GROUP THEORY IN PHYSICS (SYMMETRIES IN PHYSICS)

Code no: **9.4.23.6.2.9,** Semester: **6th,** Teaching hours:

Definition of groups and group algebra. Rotation group. Group representations and characters. Direct group product, Clebsch-Gordan coefficients, the Wigner-Eckart theorem. The Schroedinger equation group. Crystallographic point groups and space groups. Macroscopic properties and crystal symmetry, the Neumann principle. Tensor properties of materials and connection with symmetry groups. Predictions of properties and the effects of symmetry in the Physics of materials. Time inversion and magnetic groups. Lie algebra of the SU(n) group. Exponential matrices, applications to SU(2) and SU(3). Representations and products of SU(n). Other Lie algebras. Introduction to the symmetries of elementary particles.

INTRODUCTION TO MATHEMATICAL FINANCE

Code no: **9.2.33.6.2.9,** Semester: **6th,** Teaching hours:

The multidate stochastic model of security markets. Information partitions, event-tree, financial contracts, price vectors, portfolios, payoff equations, payoff subspace, budget sets, arbitrage and absence of arbitrage. The efficient markets' hypothesis in the event-tree model Elements of measure and probability theory, conditional expectation and martingales, market efficiency and absence of arbitrage, pricing. The binomial model The binomial model, description of the state space, risk–neutral measure, European and American options, pricing , replication. Derivatives in the event-tree model European, American, exotic options and pricing. Futures and swaps

7 ο ΕΞΑΜΗΝΟ

MEASURE THEORY AND INTEGRATION

Code no: **9.2.11.7.1.9,** Semester: **7th**
Teaching hours: 4

Introduction. The measure problem. Lebesgue measure: Lebesgue outer measure, measurable sets, the structure of measurable sets,non-measurable sets. Measurable functions, sequences of measurable functions, Egorov's theorem. Approximation of measurable functions, Luzin's theorem. Lebesgue integral: Simple functions, the integral of positive measurables functions, fundamental properties of the integral. Lebesgue's monotone convergence theorem, Fatou's lemma. Lebesgue's domination convergence theorem, B. Levi's theorem. Comparison of Lebesgue and Riemann itegrals, approximation of itegrable functions. ◆ Applications in Fourier analysis: Riemann-Lebesgue's lemma, a necessary condition for the convergence of trigonometric series (Cantor-Lebesgue theorem) and a sufficient condition for the absolute convergence of trigonometric series (Luzin-Denjoy's theorem). $L_p[a,b]$ spaces:Young and Holder-Minkowski's inequalities, completeness of the spaces $L_p[a,b], 1 \leq p \leq +\infty$. ◆ Bounded linear functionals on $L_p[a,b]$, the dual spaces of $L_p[a,b]$, $1\leq p<+\infty$ and the dual space of C[a,b] (the space of continuous functions on [a,b]). Hilbert spaces: Examples, optimal approximation, projection theorem, Riesz representation theorem. Orthonormal systems, orthonormal basis and examples (Legendre, Hermite and Laguerre polynomials, trigonometric system, Rademacher, Walsh and Haar orthonormal systems). Riesz-Fischer theorem and characterization of orthonormal basis.

STOCHASTIC PROCESSES

Code no: **9.2.27.7.1.9,** Semester: **7th,** Teaching hours: 4

Basic notions and definitions. Probability and moment generating functions. Characteristic functions. Independent increment processes. Poisson process. Queuing systems. Simple random walk. Renewal processes. The Wald's equation. The gamblers ruin problem. Applications in queuing systems and insurance. Symmetric random walk and Arc Sine laws. Markov chains. The Ehrenfest diffusion model. Classification of states. Stationary distribution and limit theorems. Markov chains in continuous time. Branching processes. Semi-Markov processes. Population processes. Martingales and limit theorems.

REGRESSION ANALYSIS (AND LABORATORY)

Code no: **9.2.61.7.2.9,** Semester: **7th,** Teaching hours: 4

Introduction to the linear model. Multiple linear regression. Parameter estimation. Tests of hypotheses. Selection of variables. Multicollinearity, heteroscedasticity and other problems. Residual diagnostics. Influence. Cook's distance. Transformations. Weighted least squares. Dummy variables. Prediction. Anova and relation to linear model. Logistic regression. Poisson regression. Applications using statistical packages.

ALGORITHMS AND COMPLEXITY

Code no: **9.2.61.7.2.9,** Semester: **7th,** Teaching hours: 4

Techniques for asymptotic program analysis and algorithm selection criteria. Algorithm design techniques: divide and conquer, dynamic programming, greedy algorithms. Applications to graph theory (depth-first search, breadth-first search, minimum spanning tree, shortest path). Sorting and searching. Algebraic problems (evaluation of polynomials, matrix multiplication). Polynomial-time algorithms and NP-complete problems.

COMPUTATIONAL MECHANICS I

Code no: **9.3.12.7.2.9,** Semester: **7th,** Teaching hours: 4

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MATHEMATICAL FINANCE (MICROECONOMIC ANALYSIS).

Code no: **9.2.55.7.2.9,** Semester: **7th,** Teaching hours: 4

Commodity space, consumption bundles, price vectors, consumption set.

Preference relations, properties of preferences (monotonicity, convexity, continuity). Utility functions (convexity, continuity), representation of preferences by utility functions. Budget sets, budget line, maximal elements demand functions (existence, continuity). Competitive exchange economies: Allocations, (rational, Pareto optimal, weakly Pareto optimal) Core allocations, Edgeworth box, Walrasian equilibrium, welfare theorems. Existence of equilibrium in competitive economies (Arrow-Debreu theorem). Production economies: production plans and production sets, profit functions and profit maximization, efficient frontier, supply functions (existence and continuity) allocations, equilibrium in production economies.

INTRODUCTION TO OPERATIONAL RESEARCH

Code no: **9.1.15.7.2.9,** Semester: **7th,** Teaching hours: 4

Operational Research approach to modeling. Formulation of OR problems and case studies. Analysis of Linear Programming models. Graphical modeling and solution. Simplex Method. Solution by using computer packages. Slack variables. Duality theory. Interpretation of Duality. Sensitivity Analysis. Transportation Problem. Project evaluation and management with or without limited resources. Integer programming. Decision making under uncertainty. Decision criteria. Decision trees. Inventory control and management. Economic order quantity and reorder point with or without uncertain demand. Queuing Theory. Dynamics of a queuing system with interarrival time and service time coming from any probability distribution, for a single or multiple servers.

NON-DESTRUCTIVE TESTING OF MATERIALS-ULTRASOUNDS

Code no: **9.3.22.7.2.9,** Semester: **7th,** Teaching hours: 4

Introduction – History of Non-Destructive Testing, reminding from Destructive Testing. ◆ Basic meanings and remindings from the destructive testing of materials (strength, fracture, damage, mechanical properties etc). ◆ Short presentation of the basic NDT methods: Acoustic emission testing, Eddy current testing, Leak testing, Magnetic particles testing, Penetrant testing, Radiographic testing, Ultrasonic testing and Visual testing. ◆ Analytical presentation of the method of ultrasounds (physical principles of ultrasonic testing of materials, general testing techniques and special test problems). Applications and measuring methods using ultrasounds for the determination of shape and size of flaws, the wall and layer thickness, the sound waves velocities, the attenuation and damage, the surface hardness, the mechanical properties of materials etc.). ◆ Experiments: Preparation and calibration of experimental set up. Flaw detection. Determination of thickness, sound velocities, attenuation, damage, strength, hardness and mechanical properties of materials. A, B and C-scan presentation and scanning methods. ◆ Standardization, Qualification and Certification of NDT personnel.

STATISTICAL PHYSICS.

Code no: **9.4.11.7.2.9,** Semester: **7th,** Teaching hours: 4

The microcanonical ensemble. The canonical ensemble. Partition function. Connection with thermodynamic quantities. Parmagnetism. The grand canonical ensemble. Fermi-Dirac and Bose-Einstein distributions. Black-body radiation. Real gases. Phase transitions.

PHILOSOPHY OF MATHEMATICS

Code no: **???????,** Semester: **7th,** Teaching hours: 2

Introduction: necessity and a priori nature of mathematics, existence and ontological status of mathematical entities (realism, idealism, nominalism), mathematical truth. Plato and Platonism in mathematics. Aristotle's philosophy of mathematics. The philosophy of mathematics in rationalism and empiricism (Descartes, Leibniz, Locke, Berkeley, Hume). Kant's philosophy of mathematics. Mill's philosophy of mathematics. Elements of formal logic. Set-theoretic and semantic paradoxes. Elements of axiomatic set theory. The main schools in early 20th century philosophy of mathematics: Logicism, Formalism, Intuitionism. Logical Positivism. Structuralism. Other contemporary views.

EDUCATIONAL RESEARCH

Code no: **???????,** Semester: **7th,** Teaching hours: 3

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8 ο ΕΞΑΜΗΝΟ

OPTIMAL CONTROL.

Code no: **9.2.38.8.1.9,** Semester: **8th,** Teaching hours: 4

Introduction to the Calculus of Variations: Necessary and Sufficient conditions for minimization, Euler-Lagrange equations, Minimization with constraints, Lagrange multipliers, Legendre, Jacobi and Weierstrass conditions. Optimal Control: Linear systems, Attainable sets, Controllability, Time-Optimal Control, Regulator problem, Riccati Differential Equation. Nonlinear systems: Topological and Geometric properties of Attainable sets, Tangent Perturbation Cone, Pontryagin's Maximum Principle, Sufficient conditions for existence of optimal control, Hamilton-Jacobi-Bellman equations.

FUNCTIONAL ANALYSIS II

Code no: **9.2.58.8.2.9,** Semester: **8th,** Teaching hours: 4

Banach spaces. Geometric forms of Hahn-Banach theorem. Separation of convex sets. Definition and basic properties of the weak topology $\sigma\left(E,E^{*}\right)$. The weak topology $\sigma\left(E^{*},E\right)$. Reflective spaces. Uniform convex spaces. Definition and basic properties of the compact operators. Riesz-Fredholm theory. Spectrum of compact operators. Spectrum analysis of compact operators. Unbounded operators in Banach spaces and applications. Sobolev spaces and applications in boundary value problems.

LINEAR MODELS AND DESIGNS.

Code no: **9.2.58.8.2.9,** Semester: **8th,** Teaching hours: 4

Regression and anova models. Multiple comparisons. Random effects models. Fests for homogeneity of variances. Orthogonal contrasts. Nonparamentric one-way anova. Latin and Graeco-Latin square designs. Balanced incomplete block (BIB) designs and their statistical analysis. Recovery of interblock information in the BIB designs. Partially BIB designs and their statistical analysis. Youden squares. Lattice designs. 2^k factorial designs. Design projection. The addition of center points to the 2^k design. Yate's algorithm for the 2^k design. Confounding in the 2^k factorial design. Partial confounding. Two level fractional factorial designs. The notion of resolution. 3^k factorial designs. Confounding in the 3^k factorial design. Factorial with mixed levels. Nested and split-plot designs. Applications using statistical packages.

MATHEMATICAL LOGIC

Code no: **9.2.14.8.2.9,** Semester: **8th,** Teaching hours: 4

Propositional Calculus: Language, unique readability, logical connectives, truth valuations, semantics, adequacy of connectives, disjunctive and conjunctive normal form. Compactness theorem of propositional calculus. Applications. *First order predicate calculus:* Language, variables, dependent and independent variables, substitution, the concept of structure, language and interpretation, Tarski's definition of truth. *Axiomatization of first order logic:* Axiomatic systems and algorithmic concepts, Gentzen systems, propositional resolution, tableaux method and completeness.

INTEGRAL EQUATIONS AND APPLICATIONS.

Code no: **9.2.19.8.2.9** Semester: **8th,** Teaching hours: 4

Introduction to Integral Equations. Classification. Fredholm Theory. Linear Operators and Integral Equations. Volterra and Fredholm Integral Equations. Integral Transformation Methods. Symmetric Integral Equations. Singular Integral Equations. Boundary Integral Methods. Applications to Mathematical Physics, Fluid Mechanics, Elasticity, Electrodynamics etc. Nonlinear Integral Equations and Applications.

ANALYSIS OF TIME SERIES

Code no: **9.2.52.8.2.9,** Semester: **8th,** Teaching hours: 4

Stationary stochastic processes. Autoregressive time series. Moving average time series. The ARMA model. The autocorrelation function and the partial autocorrelation function. The autocovariance generating function. Prediction with an ARMA model. Non-stationary and seasonal time series. Box-Jenkins estimation and model selection. Spectral analysis of time series. Spectral density and periodogram. The spectral density of the ARMA model. State-space models. Kalman filter and Bayesian prediction. Econometric time series.

OPERATOR THEORY

Code no: **9.2.23.8.2.9** Semester: **8th,** Teaching hours: 4

Operators on Hilbert spaces. Properties of bounded linear operators. Operator norm. Continuity of a linear operator. The adjoint operator. Normal, self adjoint, unitary operators. Invertible operators. Matrix representation of a bounded linear operator. Orthogonal projections. Invariant subspaces. Finite rank operators, compact operators, compact self adjoint operators. Spectral theory of compact self adjoint operators. Spectral theorem, second form of the spectral theorem. Applications to integral operators and Sturm-Liouville systems. Green's function. Introduction to linear operators on Banach spaces. Fredholm operators, index of an operator. Unbounded operators on Hilbert space.

MATHEMATICAL MODELLING

Code no: **9.2.54.8.2.9** Semester: **8th,** Teaching hours: 4

◆ *General introduction.* Mathematical models. Population dynamics. Models from Ecology and Biology. Dimensional analysis and normalization. ◆ *Perturbation methods:* regular and singular perturbation, boundary layer. ◆ *Calculus of variations***:** Variational problems. Euler-Lagrage equation, Hamilton's principle, isoperimetric problems. Models in traffic flow. ◆ *Elliptic Problems*: Gravitational field. Electromagnetic field. Scatering problems Telegraphic equation. ◆ *Parabolic problems*: Electromagnetic field. Mass and heat transfer. Probabilistic model of heating. An Economical model. ◆ *Ware phenomena in continuous media* : Linear and non-linear waves. Burger and KDV's equations. Models in continuous media.

SPECIAL TOPICS IN DISCRETE MATHEMATICS.

Code no: **9.2.43.8.2.9** Semester: **8th,** Teaching hours: 4

Introduction. Difference sets. Balanced Incomplete block designs (BIBD). The incidence matrix. Existance theorems and construction theorems for BIBD. Symmetric designs (SBIBD) Pairwaise balanced designs. Hadamard matrices, construction methods. Orthogonal designs. Latin squares and their applications. Steiner triple systems and t-designs. Finite geometries, and their relation to designs.

OPTIMIZATION.

Code no: **9.2.17.8.2.9** Semester: **8th,** Teaching hours: 4

Convex sets and convex functions. Fréchet and directional derivatives. Extrema of functions. Existence and uniqueness theorems. Basic necessary and sufficient conditions for optimality. Lagrange and Kuhn-Tucker-Lagrange multiplier theorems. Quadratic functions. Least-squares methods and applications. Golden section, Gradient, Conjugate gradient, Newton, Frank-Wolfe, Gradient projection, Penalty, and Mixed Gradient-penalty methods. Applications to Nonlinear Programming and Optimal Control.

GRAPH THEORY

Code no: **9.2.39.8.2.9** Semester: **4th,** Teaching hours:

Introduction. The connector problem. Cayley's formula and the Prufer code. Eulerian graphs: Euler's criterion. Fleury's algorithm. Hamiltonian graphs: Necessary conditions. Sufficient conditions. Planar graphs. Euler's formula. Kuratowski's theorem. Dual graphs. Vertex colourings. The Welsh Powell algorithm. The five and four colour theorems. Brook's theorem. Edge colourings and Vizing's theorem. Connectivity. Menger's theorem vertex and edge form. Max-flow, min cut. Matchings: Hall's marriage theorem. Matchings in bipartite graphs. The personnel assignement problem. Stable marriages. Matrices. The adjacency and incidence matrix. The matrix tree theorem.

COMPOSITE MATERIALS

Code no: **9.3.21.8.2.9** Semester: **8th,** Teaching hours: 4

◆ **1.** Introduction. Classification of materials. Isotropic and non-isotropic materials. Classification of composite materials. (Particulate composites, fibrous comp., Laminated comp.)Advantages of composite materials. Uses of composites. ◆ **2.** Reminding of some elements of the mechanics of isotropic materials. Stress-strain relationships. Plane – stress, plane – strain. ◆ **3.** Particulate composites. Mechanical properties of particulate composites. Theoretical expressions for strength, stiffness and thermal expansion coefficient. Particle distribution. ◆ **4.** Macromechanical behaviour of a lamina. Stress-strain relations for non-isotropic materials. Engineering constants for orthotropic materials. Stress – strain relations for a lamina of arbitrary orientation. Elastic constants in arbitrary orientation. ◆ **5.** Fibre reinforced composites. Theoretical evaluation of elastic constants through mechanics of materials and elasticity approach. Mechanics of material approach to strength. Experimental determination of strength and stiffness of fibrous composites. ◆ **6.** Biaxial strength theories for an orthotropic lamina. Failure criteria of fibre reinforced composites. Comparison of various criteria. ◆ **7.** Macromechanical behaviour of laminates. Classical lamination theory. Stress and strain variation in a laminate. Resultant laminate forces and moments. Stiffness tensors. ◆ **8.** Influence of temperature and water absorption (humidity) on mechanical properties of laminates.

MODELS OF COMPUTATION

Code no: **9.2.53.8.2.9** Semester: **8th,** Teaching hours: 4

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AUTOMATIC CONTROL II AND LABORATORY

Code no: **3.3.32.8.2.9** Semester: **8th,** Teaching hours: 4

Description and analysis of discrete time systems. Analysis of continuous and discrete signals. Graphic and algebraic stability criteria. Analysis in state space, inspectability, observability, Kalman decomposition. Classical designing methods (geometrical locus of roots, Bode and Nyquist, PID controllers). Controller design for arbitrary pole positioning. Vector observers. Optimal control of discrete time systems. System recognition, principle of least squares. Adaptable control (self-adjusting control, reference to the prototype control). Controller materialization (circuit materialization, microprocessor materialization). Practical applications. ◆ Laboratory exercises on PLC, PID controllers, CIM systems, on control of electromechanical systems, on process control, recognition and simulation of systems, on designing optimal, adaptive and other controllers (e.g. by using packages like MATLAB) etc.

***Note**: The course includes laboratory exercises*.

MATHEMATICAL MODELLING IN MECHANICS

Code no: **9.3.38.8.2.9** Semester: **8th,** Teaching hours: 4

- *A. Mathematical Modeling in Mechanics and Perturbation Methods.* Function expansions, order symbols, asymptotic series and expansions. Equation solutions. Algebraic equations, cubic and higher order equations. Transcendental equations. Conservative systems with odd non-linearities. Direct solution expansions. The *Lindstedt-Poincare* techique, the renormalization method. The method of multiple scales. The method of averaging. Problems of boundary layer. The idea of boundary layer, outer and inner limits, the matching of solutions the composite expansions. Applications in Nonlinear systems.

- *B. Mathematical modeling of mechanical phenomena and calculus of variations.* Mathematical models and natural phenomena. Examples of construction of mathematical models – Boundary value problems – Strong formulations. Calculus of variations. Definition of the first (1^{st}) variation (*Gateaux*) of a real functional. Saddle points of real functionals. *Euler-Lagrange* equations. Essential and natural boundary conditions. Weak formulations. Approximate methods.The Virtual Work principle in the Continuum Mechanics. The theorem of minimum Potential Energy. General *Hamilton* Principle for dynamical systems – Discrete systems – Continuous systems. The *Hamilton* Principle in the Continuum Mechanics. Applications on axial tension of straight bars and bending of *Euler-Bernouilli* beams.

COUPLED FIELD MECHANICS.

Code no: **9.3.13.9.2.9** Semester: **8th,** Teaching hours: 3

Basic Relations and Constitutive Equations of Nonlinear Thermoelasticity and Poroelasticity. Nonlinear Equations of Electroelasticity. Fundamentals of Crystallography. Introduction to the Theory of Piezoelectricity. Interaction of Fields. Fracture Mechanics in Piezoelectric Materials. Basic Relations and Constitutive Equations of Magneto-Thermoelasticity.

THEORETICAL PHYSICS.

Code no: **9.4.35.8.2.9** Semester: **8th,** Teaching hours: 4

Principle of least action, Euler – Lagrange equations. Lagrangian and Hamiltonian. Poisson brackets. Canonical transformations. Symmetries and conservation laws. Noether's theore. The momentum – energy tensor. Poisson bracket algebra. Continuous dynamical systems as examples of classical field theories: Klein – Gordon and Dirac equations. Lorentz transformation of solutions. Mass and spin. Plane wave solutions. Klein's paradox. Coupling with external electromagnetic fields. Hydrogen – like atoms, spin and fine structure. Discrete symmetries (C, P, T). The neutrino equation.

ALGORITHMIC GEOMETRY

Code no: **9.3.13.9.2.9** Semester: **8th,** Teaching hours:

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NEW TECHNOLOGIES IN EDUCATION

Code no: **?** Semester: **8th**
Teaching hours: 3

The main purpose of the course is to provide the student (and teacher-to-be) with the basic skills necessary to exploit the advantages of the internet and, at the same time, make him/her capable of delivering -in an attractive way- a high school course using links, images and even interactivity through web pages. The outline of the lectures is:1) Basic introduction to HTML. 2) Using a text processor. 3) Head and Title. 4)Text formatting (indentation, fonts, size, decoration, color etc). 5) Ordered and Unordered lists. 6) Introducing images. Images and text. 7) Links (to another page, to the same page, to a file etc). 8) Tables (borders, color, background image, caption etc). 9) Frames. 10) Forms. 11) Some special effects. 12) Introducing Freeware HTML editors.

EDUCATION AND EMPLOYMENT

Code no: **?** Semester: **8th,** Teaching hours: 3

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9 ο ΕΞΑΜΗΝΟ

NON LINEAR ANALYSIS.

Code no: **9.2.20.9.2.9** Semester: **9th,** Teaching hours: 4

Non linear operators. Compact operators and applications in the existence of solutions of integral equations. Monotonic operators. Basic properties. Nemitsky operators. Fixed point theorems of Brower and Shaudar. Applications. Ekeland variational principle. Differentiability in Banach spaces. Gateaux and Frechet derivative. Critical point theory. Applications

FLUID MECHANICS.

Code no: **9.3.11.9.2.9,** Semester: **9th,** Teaching hours: 4

Introduction to Fluid Mechanics. Fluids and Flows. The Continuum Concept. Characteristics and Properties of Fluids. Types of Flow. System and Control Volume. Fundamental Laws of Fluid Mechanics. Fluid Motion: Fluid Particle and Kinematics. The Velocity Field. Material and Space coordinates. Methods of Description. Flow rates of mass and volume. Timelines, Streaklines and Streamlines. Forces and Stresses. Body Forces and Surface Forces. Deformation of Fluids. Macroscopic-Integral Analysis. Reynold's Transport Theorem. Basic Equations in Integral Form: Conservation of Mass, Momentum and Energy. ◆ Basic Equations in Differential Form. The Navier-Stokes Equation. Equations for single and multicomponent Fluids. Initial and Boundary Conditions. Chemical Kinetics. Dimensional Analysis.

RELIABILITY MODELS (AND QUALITY CONTROL)

Code no: **9.2.46.9.2.9** Semester: **9th,** Teaching hours: 4

Basic concepts. Censoring. Reliability or survival function, hazard function. Lifetime distributions (Gamma, Weibull, Gumbel, Log-logistic and others). Non-parametric estimation. Kaplan-Meier estimator, Nelson-Aalen estimator. Log-rank test. Graphical tests. Maximum likelihood model fitting. Goodness-of-fit tests. Regression models for lifetime data: proportional hazards models, Cox's semi-parametric model, accelerated life models. Model building and diagnostic methods, Cox-Snell residuals, Schoenfeld residuals. System reliability. Repairable systems. Applications using statistical packages.

CRYPTOGRAPHY AND COMPLEXITY

Code no: **9.2.68.9.2.9** Semester: **9th,** Teaching hours: 4

Divisibility, Chinese remainder theorem, modular exponentiation, primitive roots. Carmichael functions, Euler's "phi" function, Legendre and Jacobi symbols, square root computation, prime number theorem. Primality test and factoring. The sieve of Eratosthenes. Lucas, Pratt, and Lucas-Lehmer tests. Extended Riemann hypothesis. Solovay-Strassen test, Miller test, probabilistic tests, Rabin test. Public-Key Cryptosystems. Binomial residues in Cryptography. The Discrete Logarithm Problem. RSA and Rabin systems.

NUMBER THEORY AND CRYPTOGRAPHY

Code no: **9.2.40.9.2.9.** Semester: **9th,** Teaching hours: 4

◆ **Number Theory.** Finite Fields: modular arithmetic. The sieve of Eratosthenes and other factoring methods. The extended Eulidean algorithm. The Euler function. Linear Diophantine equations and congruences. The fundamental theorems: The fundamental theorem of Arithmetic, Euler, Fermat, Wilson, the Chinese remainder theorem the prime number theorem. Quadratic congruences, Legendre and Jacobi symbols. The Quadratic reciprocity law. Numbers: perfect, Mersenne, Fermat and amicable numbers. ◆ **Cryptology.** Historical overview. Classical cryptosystems: encryption, decryption and cryptanalysis of the cryptosystems: additive, multiplicative, affine, Vigenere, Playfair and Hill. The Discrete logarithm problem (D.L.P.). Public Key cryptosystems: The R.S.A., Merkle, Hellman- the Diffie-Hellman problem, Elgamal, Massey – Omura. Digital Signatures. Elliptic Curves. Combinatorial Designs and Cryptography.

WAVE THEORY AND APPLICATIONS TO SEISMOLOGY

Code no: 9.3.20.9.2.9 Semester: 9th, Teaching hours: 4

Introduction. Basic Concepts and Relations in the Continuum. Fundamentals of Fracture Mechanics. Representation and Mathematical Modelling of Explosions and Sources. Oscillations and Waves. Seismic Waves. Seismological Problems in Mechanics. Physico-Mathematical Foundation of Characteristics and Geometry of Seismic Waves and Events.

NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS

Code no: **9.2.29.9.2.9** Semester: **9th**, Teaching hours: 4

◆ *Introductory example:* Dirichlet problem. Weak form. Arithmetic solution with Finite Elements Method. ◆ *Boundary Value Problems and Galerkin method:* General week form. Lax-Milgram theorem. Galerkin method. Errors. Rayleigh-Ritz-Galerkin method. General derivatives and Sobolev spaces. Green formulas. Elliptic boundary value problems. Existence and uniqueness. Applications. ◆ *Finite Elements Methods for Elliptic Boundary Value Problems:* Piecewise polynomial, Hermite and spline interpolation. Error estimates. Applications. ◆ *Finite Elements Methods for Evolutionary Boundary Value Problems:* Parabolic and hyperbolic problems. Euler and Crank-Nicholson methods. Stability. Error estimate. Applications. ◆ *Finite Difference Methods:* Sturm-Liouville and Dirichlet problems. Heat equation. Wave equation. Stability and Convergence. ◆ *Workshop Exercises:* Use of software (FORTRAN - IMSL, Matlab, Mathematica, Programming Libraries etc.) for programming.

APPLICATIONS OF LOGIC IN COMPUTER SCIENCE

Code no: **9.2.47.9.2.9** Semester: **9th**, Teaching hours: 4

Theorem proving. First order predicate calculus, models, Herbrand clauses, normal form, prenex, Skolem resolution, correctness and completeness of Robinson resolution. Logical programming, Horn clauses, negation as failure and its semantics, non-monotonic reasoning, three valued logic. Functional programming (with types, with no types), proofs as programs, Curry-Howard isomorphism, second order logic, polymorphism. Semantics of programming languages, fixed points.

STOCHASTIC DIFFERENTIAL EQUATIONS AND APPLICATIONS

Code no: **9.2.51.9.2.9** Semester: **9th**, Teaching hours: 4

Continuous time stochastic processes. Brownian motion. Ito stochastic integral. Ito processes, Ito formula, martingales with respect to Brownian motion, Girsanov theorem. Stochastic differential equations, Ito diffusions, Feynman-Kac formula. Applications: Continuous time market models and Black-Scholes model; Optimal stopping.

ALGORITHMIC GEOMETRY

Code no: **9.2.30.9.2.9** Semester: **9th**, Teaching hours: 4

Introduction: Data structures. Computing machines ex. Pascal machine. Definition of complexity of algorithms. *Problems of convex closure* of the set A of E^n (= n-dim Euclidean space). *Distance problems*: Voronoi diagram. *Separation problems* of a set e.g. into triangles or polygons or according to Delaunay. *Separation problem* of a set with the help of a hyper plane. *Curves* according to Bezier and B-spline. Geometric interpretation of coefficients. Change of base in the space of polynomials. *Nurbs curves* with a short introduction to homogeneous coefficients. Intersections of curves. *Surfaces* according to Bezier and B-spline. Geometric interpretation of coefficients. *Nurbs surfaces***.** Intersection of surfaces. Methods for visibility, shadow and reflection.

ADVANCED DYNAMICS

Code no: **9.3.26.9.2.9** Semester: **9th**, Teaching hours: 4

◆ Basic concepts on the theory of dynamical systems: Types of dynamical systems (linear and non-linear, deterministic and stochastic, chaotic behavior). A process for the study of dynamical systems. Mathematical formalisms. Normalization of physical quantities. Integrals of motion. Zero-velocity curves and surfaces and their properties. Equilibrium states and their stability. Equations of motion. Periodic solutions. Variational equations. The monodromy matrix and its properties. Numerical methods for the determination of periodic solutions. Characteristic curves. Poincare surfaces of section. Stability (Poincaré, Liapunov, Hill). Bifurcations. Inverse motion. Applications. ◆ Rigid body Dynamics: Introduction to the theory of displacement operators. Parametrization of the body's orientation. Dynamical quantities. Equations of motion of a rigid body and applications (reactions, stability, top, gyroscop). Introduction to multibody systems and structures (open and closed chains, trees, composite forms). Kinds of connections and reactions. Equations of motion of a multi-body system. Special kinds of motion. Special topics and applications (gyrostat, multibody systems with co-axial rotations, robotic systems).

ANALYSIS OF MECHANICAL SYSTEMS (DISKS, SHELLS, PLATES)

Code no: **9.3.17.9.2.9** Semester: **9th**, Teaching hours: 4

Elements of the differential geometry of three dimensional surfaces in oblique and orthogonal systems.The general bending theory of elastic shells (Applications). The bending theory of thin elastic shells (Applications).Methods of decoupling of partial linear differential systems of high order. The membrane theory of elastic shells (Applications).Analysis of cylindrical shells and of shells of revolution under bending and membrane loading.

SYSTEM THEORY

Code no: **9.2.35.9.2.9** Semester: **9th,** Teaching hours:

An introduction to the Qualitative Theory of Differential Equations: Stability, Instability, Asymptotic Stability, Lyapunov, La Salle and Chetaev theorems. Controllability and Observability of Linear Control Systems. Equivalence, Feedback-Equivalence, Canonical Forms, Feedback Stabilization, Observer Design, Routh and Hurwitz theorems for stability. Some extensions to Nonlinear Control Systems. An introduction to Stochastic Control (Kalman-Bucy filtering).

SEISMOLOGY MECHANICS

Code no: 9.3.20.9.2.9 Semester: 9th, Teaching hours:

Introduction. Basic Concepts and Relations in the Continuum. Fundamentals of Fracture Mechanics. Representation and Mathematical Modelling of Explosions and Sources. Oscillations and Waves. Seismic Waves. Seismological Problems in Mechanics. Physico-Mathematical Foundation of Characteristics and Geometry of Seismic Waves and Events.

TOPICS IN ANALYSIS

Code no: 9.2.59.9.2.9 Semester: 9th, Teaching hours:

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HISTORY OF MATHEMATICS.

Code no: **9.2.58.9.2.9** Semester: **9th,** Teaching hours:

Introduction. Euclid's *Elements*. The Background. The first four Books and the non-Euclidean Geometry (Arabs, Saccheri, Lambert, Legendre, Lobatchevskii , Einstein's theory of relativity. Book V, Eudoxus theory of proportions and the theories of real numbers during the 19th century. Quadratures. Eudoxus' theory of exhaustion. The quadrature of circle. The nature of number π. The proof of π as transcendental number. Infinitesimal methods of integration and differentiation in Archimedes' work. The development of these methods in Middle Ages and Renaissance. The creation of Calculus by Newton and Leibniz. The Reform of Analysis : Bolzano-Cauchy - Weierstrass. The problem of the foundations of Mathematics. The *Conics* of Apollonius. Kepler-Newton. Apollonius and analytic geometry Fermat-Descartes. Diophantus and Diophantine equations.

RELATIVITY

Code no: **9.4.28.9.2.9** Semester: **9th,** Teaching hours:

Lorentz transformations. Four – vectors. Relativistic dynamics. Transformations of electromagnetic fields. Relativistic kinematics. The equivalence principle. Geometry of curved space. Curvature tensor. Einstein equation. Spherically symmetric solutions.

LAW

Code no: **9.1.09.9.2.9** Semester: **9th,** Teaching hours:

The aim of this course is to provide students lacking a legal background with both a general overview of Greek legal system and the operation of legal rules. Thus, the course focuses on essential legal issues arising in fields such as Public law (Constitutional Law and Administrative Law), Civil Law (contracts, torts and Law of Property), Commercial law (commercial transactions, Company Law, Industrial Property rights etc.), Labour Law (work accidents, constructor liability etc.), Environmental Law (national and European legislation) and European Law (European institutions, Freedoms and rights, Free Trade, Statutory Law etc.). Lectures are followed by practical sessions, where are examined solutions to practical legal issues and court decisions. Assessment is by a mixture of examination (Multiple Choice Questions and practical cases) and coursework.

APPLIED PHYSICS

5TH SEMESTER

PARTIAL DIFFERENTIAL EQUATIONS

Code no: **9.2.12.5.1.9** Semester: **5th,** Teaching hours:

Fourier Series & Transform: Trigometric series. Convergence Theorem. Sine & cosine Fourier series. Generalized Fourier series. Fourier integral and transform. *Boundary value Problems :* Linear boundary value problems. Eigenvalue Problem. Sturm-Liouville: Properties, Regular, periodic and singular problems Nonhomogeneaur problems. *Partial Differential Equation :* Second order. Classification. Equation of elliptic type: Boundary value problems. Uniqueness of solutions of Direchlet - Newmann problem. Compatibility condition. Separation of variables in Cartesian, polar cylindrical and spherical coordinates. Use of Fourier transform and integral. Dirac Functional. Fundamental Solutions. Integral representations. Green's Function and images method. Equation of Parabolic type: Initial and boundary value problems. Separation of variables. Nonhomogeneour problems. Use of Fourier and Laplace transform. *Equations of Hyperbolic type :* Finite and infinite cord. Separation of variables in Cartesian. Use of mathematica to solve Problems.

QUANTUM MECHANICS II

Code no: **9.4.09.5.1.9** Semester: **5th,** Teaching hours:

Mathematical foundation of Quantum mechanics. Schroedinger's equation. Application to stationary states. Transition from Classical to Quantum Mechanics. The harmonic oscillator. Three dimensional potentials. Charged particles in electromagnetic fields. Theory of angular momentum. Introduction to spin. Time – independent perturbation theory. The WKB approximation. Calculus of variations.

CONDENSED MATTER PHYSICS

Code no: **9.4.10.5.1.9** Semester: **5th,** Teaching hours:

Free electron model (Thermal equilibrium and transport properties). Crystal lattices. Diffraction of radiation from crystals. The reciprocal lattice. Crystal bonding (Classification of crystal lattices). Motion of electrons in a periodic potential. Energy bands. Semiconductors. Lattice vibrations. Thermal properties. Surfaces. Amorphous solids. *The course includes laboratory exercises*

THERMODYNAMICS

Code no: **9.4.07.5.1.9** Semester: **5th,** Teaching hours:

Temperature. Heat. Work. Internal energy. Dilute gas. Dilute gas laws. Isothermal and adiabatic processes.Kinetic theory of gases. Maxwell – Boltzmann distribution. Applications. Real gases. The first law of thermodynamics. Reversible and irreversible processes. Carnot engine. Entropy. Second and third law of thermodynamics. Specific heat. Coefficient of compressibility. Chemical potential. Enthalpy. Free energy. Phase transitions. Applications.

ELECTRONICS – LABORATORY

Code no: **9.4.16.5.1.9** Semester: **5th,** Teaching hours:

Instruments and measurements of DC signals; Oscilloscope and measurements of AC signals; Review of basic behavior of R, L, C; Analysis of basic circuit theorems, Thevenin, Norton, Miller, Kirchhoff; Frequency response of R, L, C circuits; Fourier analysis of signals; Low-pass, high-pass Filters; Operational Amplifiers as filters, ideal OpAm; Transistors, common base, common emitter, common collector; Digital Electronics, Boolean algebra, Flip-Flops. *The course includes laboratory exercises*

PHYSICS LABORATORY III

Code no: **9.4.20.5.1.9** Semester: **5th,** Teaching hours:

Eight laboratory exercises: ◆ **1**. The Franck – Hertz experiment. ◆ **2**. The photoelectric effect. ◆ **3**. Electron diffraction. ◆ **4**. Optical spectroscopy. ◆ **5**. Black body radiation. ◆ **6**. Thermionic transmission. ◆ **7**. Study of the Wiedemann – Franz law. ◆ **8**. The Hall effect.

GENERAL CHEMISTRY

Code no: **5.-.---.5.1.9** Semester: **5th,** Teaching hours:

Atomic theory. The periodic system. Chemical bonds. Chemistry of complex and organometallic compounds. Chemical equilibrium. Chemical kinetics. Electro-chemistry. Photochemistry. Nuclear Chemistry. *Special subjects:* Water Chemistry, Chemistry of the atmosphere, Materials and properties.

Laboratory exercises: Preparation of aqueous solutions. Chemistry of anions and cations in aqueous solutions (qualitative and quantitative analysis). Acid-base chemistry. Water hardness. Corrosion. Chemical kinetics.

The course includes laboratory exercises

TECHNOLOGY AND ITS HISTORY.

Code no: **.?.??.** Semester: **5th,** Teaching hours:

This middle level course aims towards the understanding of the notion of technology through its historical genealogy but also the exposition of diachronic questions. More specifically we examine the relation between technique ,technology and applied science, and their relation to the society. We mention the notion of progress, the problem of technological determinism related to the appearance of modernity, and also contemporary political and ethical problems related to technology.

PRINCIPLES OF TEACHING

Code no: **.?.??.** Semester: **5th,** Teaching hours:

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HISTORY OF EDUCATION

Code no: **.?.??.** Semester: **5th,** Teaching hours:

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6th semester

ELECTROMAGNETISM II

Code no: **. 9.4.12.6.1.9.** Semester: **6th,** Teaching hours:

Electric fields in nature. Dielectric materials. Magnetic materials in matter. Magnetic materials. Maxwell's equations in vacuum and in matter. Electromagnetic waves. Propagation of electromagnetic waves in vacuum. The Poynting vector. Propagation of electromagnetic waves in conducting materials. Reflection and transmission of electromagnetic waves. Polarization. Fresnel coefficients. Dispersion.

ATOMIC AND MOLECULAR PHYSICS

Code no: **. 9.4.13.6.1.9.** Semester: **6th**, Teaching hours:
Note: *The course includes laboratory exercises*

Elements of Quantum Mechanics. Introduction to the structure of atoms and molecules: (a) One-electron atoms, atomic orbitals, analytical and numerical solutions, (b) the one - electron molecule H_2^+, molecular orbitals, chemical bond (I), (c) Many-electron atoms, central field, Hartree – Fock theory, open shells, momentum coupling. Perturbation theory, calculus of variations and elementary applications. Interaction with external fields – lasers. Elements of atomic and molecular spectroscopy. Introduction to scattering theory – resonance states.

The course includes laboratory exercises

OPTICS & OPTICS LABORATORY

Code no: **. 9.4.15.6.1.9.** Semester: **6th**, Teaching hours:

Introduction to wave optics. Polarization of light. Reflection, refraction through flat and curved surfaces. Mirrors, lenses, prorerties and errors. Optical instruments (the eye, magnifyinng lens, microscope and telescope).Space and time coherence. Interference and diffraction. Optical Fourier transformations, space filters, holography. ◆ **Laboratory:** Five laboratory exercises: **1.** Interference and diffraction, slits – diffraction gratings, delay plates. **2.** Optical Fourier transformations. **3.** Interferometry (Michelson, Fabry – Perot). **4.** Optical information traqnsfer. **5.** Holography.

EXPERIMENTAL PHYSICS TECHNIQUES

Code no: **. 9.4.21.6.2.9.** Semester: **6th**, Teaching hours:
Note: *The course includes laboratory exercises*

Standards of Physical quantities Characteriscs of instruments. Instruments and measurement methods of fundamental physical quantities. Noise and measurement limits. Elements of electric signal processing. Protection from electronic, electromagnetic, acoustical and particle noise. Signal measurement and recording techniques. Optical systems. Vacuum systems. Cryogenics. Safety rules, experimental practice and operational rules for the research and educational laboratory.

The course includes laboratory exercises

DIELECTRIC, OPTICAL AND MAGNETIC PROPERTIES OF MATERIALS

Code no: **. 9.4.29.6.2.9.** Semester: **6th**, Teaching hours:
Note: *The course includes laboratory exercises*

Dielectric and Optical Properties of Insulators: Static fields: Local electric field. Polarizability. Dielectric constant. Alternating fields: Optical absorption. Polariton. Piezoelectricity. Ferroelectricity. ◆ *Magnetic Properties of Matter:* Diamagnetism. Paramagnetism. Ferromagnetism. Antiferromagnetism and Ferrimagnetism. ◆ *Magnetic Resonance Phenomena:* Electronic magnetic resonance. Relaxation mechanisms. Bloch equations for the steady state. Nuclear magnetic resonance. ◆ *Superconductivity.*

The course includes laboratory exercises

GROUP THEORY IN PHYSICS (SYMMETRIES IN PHYSICS)

Code no: **. 9.4.23.6.2.9.** Semester: **6th**, Teaching hours:

Definition of groups and group algebra. Rotation group. Group representations and characters. Direct group product, Clebsch – Gordan coefficients, the Wigner – Eckart theorem. The Schroedinger equation group. Crystallographic point groups and space groups. Macroscopic properties and crystal symmetry, the Neumann principle. Tensor properties of materials and connection with symmetry groups. Predictions of properties and the effects of symmetry in the Physics of materials. Time inversion and magnetic groups. Lie algebra of the SU(n) group. Exponential matrices, applications to SU(2) and SU(3). Representations and products of SU(n). Other Lie algebras. Introduction to the symmetries of elementary particles.

PRINCIPLES OF MICROWAVE TRANSMISSION AND OPTICAL SIGNALS

Code no: **. 3.??? 6.2.9 .** Semester: **6th**, Teaching hours:
Note: *The course includes laboratory exercises*

Wave propagation in free space. Plane waves, dispersion and polarization effects. Transmission lines, travelling and stationary waves, matching of charge in transmission lines. Parallel plate and perpendicular cross sectional waveguides. Flat geometry dielectric waveguides. Dispersion and damping phenomena in transmission lines, waveguides and optical waveguides. Practical consequences of wave guiding properties in the technology of microwave and optical transmission lines. Elements of microwave circuit theory. Signal characteristics and processing in microwave receivers.

The course includes laboratory exercises

SOLID STATE CHEMISTRY

Code no: **. 5. ??? .6.2.9.** Semester: **6th**, Teaching hours:
Note: *The course includes laboratory exercises*

Bonding and energetics in solids. Ionic model and lattice energy. Born-Haber cycle. Introduction to crystallography and descriptive crystal chemistry: point and space symmetry, lattices and unit cells, close packing, space-filling polyhedra, Pauling's rules. Important structure types (césium chloride, rock salt, zinc blende & diamond, fluorite, wurtzite, nickel arsenide, silicate structures). Crystal defects and non-stoichiometry. Thermodynamics of Schottky and Frenkel defect formation. Solid solutions. Theory and application of X-ray diffraction. Diffusion in crystalline solids. Ionic conductivity. Solid electrolytes. Phase equilibrium and phase transformations. Interpretation of phase diagrams (one and two-component systems). Polymorphic transitions. Chemical reactivity of solids (solid-gas and solid-solid reactions). Preparative and synthetic methods.

Laboratory exercises: X-ray powder diffraction and electronic spectroscopy techniques (X-ray fluorescence, Scanning electron microcopy). Construction of phase diagrams.

The course includes laboratory exercises

AUTOMATIC CONTROL I

Code no: **. 3.3.10.6.2.9.,** Semester: **6th**, Teaching hours:

Introduction and historical review of automatic control systems. Description of automatic control systems with integral-differential equations, transport function, impulse response and state equations. Equivalence of descriptions. Systems analysis in the time field. Errors in the steady state. Noise cut-off.. Study of systems in state space. Contollability and observability. Normal forms. System stability. Algebraic stability criteria of Routh, Hurwitz and continuous fractions. Nyquist and Lyapunov stability criteria. Geometrical locus of roots. Harmonic analysis of systems. Bode and Nichols diagrams. Practical applications.

HISTORY OF PHYSICS IN THE 19TH AND 20TH CENTURY

Code no: **.????** Semester: **6th**, Teaching hours:

This upper level course has aim to describe the basic episodes in the history of physics from the 19th c to 1945 , to show the dramatic change of ideas that occurred this period related to the social and institutional settings. ◆ Emphasis is given to the emergence of the electromagnetic theory the undermining of the mechanical picture of the world and the construction of the quantum mechanics. The use of primary sources is an integral part of the obligatory student works.

7TH SEMESTER

STATISTICAL PHYSICS

Code no: **. 9.4.11.7.1.9** Semester: **7th**, Teaching hours:

The microcanonical ensemble. The canonical ensemble. Partition function. Connection with thermodynamic quantities. Parmagnetism. The grand canonical ensemble. Fermi – Dirac and Bose – Einstein distributions. Black – body radiation. Real gases. Phase transitions.

NUCLEAR PHYSICS AND ELEMENTARY PARTICLES

Code no: **. 9.4.14.7.1.9** Semester: **7th**, Teaching hours:
Note: *The course includes laboratory exercises*

Introduction to the nucleus: radius, mass, charge, binding energy. Stability of the nucleus. Shell model, magical numbers. Angular momentum, spin, coupling, electric and magnetic moments. α, β, γ decay. Dosimetry. Fission, fusion, nucleosynthesis. ◆ Introduction to elementary particles. Properties and classification. Conservation laws. Hadron interactions at high energies. Fundamental quark model. Fundamental interactions: elecromagnetic, weak and strong. Unification of fundamental interactions. Nuclear and particle astrophysics.

COMPUTATIONAL PHYSICS I

Code no: **. 9.4.36.7.2.9** Semester: **7th**, Teaching hours:

Graphing potentials and equipotential curves for systems of point charges and simple charge distributions. ◆ Limits of motion from the potential function. Trajectory, *x*(*t*), of a moving body in terms of the potential energy. Solution of the van der Waals equation for non-perfect gases. Quantum mechanical energy states of a particle in a finite potential well. Derivation of trajectory, *x*(*t*), and velocity, *u*(*t*), of a particle moving in one dimension from Newton's equation, with the use of the smoothly accelerating motion approximation and of Fourier analysis. Derivation of trajectory, *x*(*t*), and velocity, *u*(*t*), of a particle moving in two dimensions. Planet orbits, Rutherford scattering. ◆ Simple electric circuits calculations using Kirchhoff's rules.

INTRODUCTION TO ASTROPHYSICS

Code no: **. 9.4.28.7.2.9** Semester: **7th**, Teaching hours:

Newtonian Mechanics and Kepler's laws. The nature of stars, stellar atmosphere, interior of stars. The Sun, natural processes in the solar system, the planets of the solar system. Galaxies, the nature of galaxies. Structure of the Universe. Black holes. Cosmology, the first stages of the creation of the Universe.

APPLICATIONS OF IONIZING RADIATION IN MEDICINE AND BIOLOGY

Code no: **. 9.4.27.7.2.9** Semester: **7th**, Teaching hours:

Principles of the Physics of ionizing radiation. Ionizing radiation characteristics as properties of the atomic nucleus. Theory of the interaction of ionizing radiation with matter.Nuclear reactions and isotope production. Clinical application of radioisotopes and radiopharmaceuticals. Detector instrumentation for the three fundamental types of radiation, α, β, and γ. Ionizing radiation effects on biological organisms. Biological effect of neutrons and their use in clinical medicine. Advanced techniques for clinical applications and the use of accelerating devices. Introduction to dosimetry and radiation protection.

The course includes laboratory exercises and visits to hospitals and to NRC "Demokritos"

OPTOELECTRONICS

Code no: **. 9.4.25.7.2.9** Semester: **7th**, Teaching hours:
Note: *The course includes laboratory exercises*

Physical optics, photons, optical absorption mechanisms, photoconductivity mechanisms, optical and optoelectronic materials, spontaneous and stimulated emission, absorption, fluorescence, phosphorescence, luminescence, coherent and incoherent sources, displays, radiation detectors, noise and electronics of detectors, image intensifiers, I^2 devices, thermal imagers, couplers, modulators, liquid crystals, integrated optics, photonic logic, introduction to optical fibers – optical communications, introduction to lasers and their applications.

The course includes laboratory exercises

SEMICONDUCTORS AND SEMICONDUCTING DEVICES

Code no: **. 9.4.24.7.2.9** Semester: **7th**, Teaching hours:

INTRODUCTION. STRUCTURE AND PROPERTIES, ENERGY BANDS: (Conductivity Zone and electrons, Valence Zone and Holes, Direct-Indirect energy Gap, Effective mass (mt, ml, mlh, mhh, msoh), Density of States, DoS Effective Mass, Optical Properties – Excitons. HOMOGENEOUS SEMICONDUCTORS. Intrinsic: (Fermi level, Carrier concentrations, n-, p-type). Extrinsic: (Donors – Acceptors, Dopants energy states, Fermi level, carrier concentrations). TRANSPORT PROPERTIES: Drift of carriers (conductivity current), Hall effect, Diffusion of carriers, (diffusion current), Carrier injection, Carrier Generation-Recombination, Einstein relation, Continuity equation. CARRIER SCATTERING MEACHANISMS: Lattice Vibrations ($T \neq 0$), Ionized Doping-atoms. INHOMOGENEOUS SEMICONDUCTORS: In thermal equilibrium (Fermi level, Band-bending, Space-charge electric-field). p-n JUNCTION: Equilibrium state (Fermi level, Contact Potential), Biased p-n junction (Forward – Reverse, I=I(V) characteristic). ◆ Low-dimensional semiconductor structures, Quantum Wells, Quantum Wires, Quantum Dots: Electronic properties. 2-dimensional Hall effect, 2-Dimensional Magnetoresistance

The course includes laboratory exercises

CHARACTERIZATION METHODS OF MATERIALS

Code no: **. 9.4.37.7.2.9** Semester: **7th**, Teaching hours:

Structural characterization: X ray diffraction, electron diffraction, Auger electron diffraction, Nuclear spectroscopy, Microscopy (electron, tunnel effect and atomic force) ◆ *Thermal characterization*: Differential thermal analysis, differential scanning calorimetry, Dynamic mechanical analysis, Thermo-gravitational analysis. ◆ Dielectric spectroscopy, Nuclear magnetic resonance, electronic paramagnetic resonance, Mössbauer spectroscopy. ◆ *Optical characterization*: Infrared spectroscopy, Raman spectroscopy, Ellipsometry, modulated reflectivity spectroscopy, Photoluminescence and electroluminescence spectroscopy. ◆ Non-destructive testing, choice of optimal material, design and development of new materials. ◆ *Laboratory exercises*: X ray diffraction, X ray fluorescence, differential scanning calorimetry, Dynamic mechanical analysis, Dielectric spectroscopy, Nuclear magnetic resonance, luminescence of compact conducting and semiconducting structures, modulated photo-reflectivity of complex semiconductors, production of thin films in a sublimation system with an electron beam, optical measurements of thin film thickness (ellipsometry).

The course includes laboratory exercises

NON-DESTRUCTIVE TESTING OF MATERIALS-ULTRASOUNDS

Code no: **. 9.3.22.7.2.9** Semester: **7th**, Teaching hours:

Introduction – History of Non-Destructive Testing, reminding from Destructive Testing. ◆ Basic meanings and remindings from the destructive testing of materials (strength, fracture, damage, mechanical properties etc). ◆ Short presentation of the basic NDT methods: Acoustic emission testing, Eddy current testing, Leak testing, Magnetic particles testing, Penetrant testing, Radiographic testing, Ultrasonic testing and Visual testing. ◆ Analytical presentation of the method of ultrasounds (physical principles of ultrasonic testing of materials, general testing techniques and special test problems). Applications and measuring methods using ultrasounds for the determination of shape and size of flaws, the wall and layer thickness, the sound waves velocities, the attenuation and damage, the surface hardness, the mechanical properties of materials etc.). ◆ **Experiments**: Preparation and calibration of experimental set up. Flaw detection. Determination of thickness, sound velocities, attenuation, damage, strength, hardness and mechanical properties of materials. A, B and C-scan presentation and scanning methods. ◆ Standardization, Qualification and Certification of NDT personnel.

INTRODUCTION TO COMMUNICATION NETWORKS

Code no: **. 3.3.17.7.2.9** Semester: **7th**, Teaching hours:

Introduction: Part A: Transmission. Introductory concepts. Frequency field, band width. Transmitters, receivers, transmission media, connection with information theory. Types of signals and their characteristics. Data, voice, television signal. Transmission media. Wires, wave guides, optical fibers, wireless transmission, microwave coupling, satellites, subscriber loop. Transmission methods in the basic band and in other frequency band. Multiplexity. FDM, RDM and SDH hierarchies. Deformations, noise, specifications.

Part B: Transfer, basic operations. Control, signaling, management and upkeep. Node technology in FDM, TDM and package transfer networks.

Part C: Networks: Telephone, computer, ISDN and B-ISDN networks. Introduction to communication networks. Communication networks development. Design principles of communication networks. Network architecture. Accessibility to communication networks. Network management.

Part D: Services. Intelligent networks, teleservices, carrier services, service characterization, QOS. Mobility and personal service. Service creation environments. Setting up and completion of services. Multimedia services. Management services control by the user. Security and personal confidentiality in communications.

Part E: Standardization – specification languages.

Part F: Theories, methods, tools.

INTRODUCTION TO ANELASTIC BEHAVIOUR OF MATERIALS

Code no: **. 9.3.05.7.2.9** Semester: **7th**, Teaching hours:

Macroscopic description of anelastic response of materials (metals, polymers), and its physical interpretation. Effect of strain rate. Linear viscoelasticity: simple viscoelastic models, standard loading in viscoelasticity.Complex unidirectional viscoelastic models, Relaxation and compliance modulus. Constitutive equations of viscoelasticity in differential and integral form. Non isothermal viscoleastic response. Dynamic mechanical analysis, storage and loss modulus, examples. ◆ Introduction to plasticity, yield criteria Tresca and von Mises. Simple examples. Prandl-Reuss equations, associated flow rule, Mises flow rule. Constitutive equations in plasticity. Isotropic and kinematic hardening, examples.

PHILOSOPHY OF PHYSICS

Code no: **. ??** Semester: **7th**, Teaching hours:

Foundations of spacetime theories, symmetry principles and covariance (Newtonian physics, special and general relativity). Conventionality of geometry. Conventionality of simultaneity. Causal theories. Substantivalism and relationism (the Newton-Leibniz debate, the hole argument). Foundations of quantum theories. Uncertainty principles and early attempts at interpreting quantum mechanics (Einstein, Heisenberg, Bohr). The EPR argument. Bell inequalities, locality and separability. The problem of quantum measurement. The doctrine of determinism. Determinism in physics (Newtonian mechanics and gravitation, classical field theories, special and general relativity, quantum mechanics).

BUSINESS ECONOMICS

Code no: **. 9.1.11.7.2.9.** Semester: **7th**, Teaching hours:

The subject of business economics. Types of firms. The basic operations of firm. Basic elements of accounting. Managerial accounting. Financial statements. Financial statement analysis and financial ratios. Costing - pricing - planning. Investment evaluation. Developmental incentives. Site selection. Uncertainty analysis.

INTRODUCTION TO SOCIOLOGY OF INDUSTRIAL RESEARCH

Code no: **. 9.1.15.7.2.9** Semester: **7th**, Teaching hours:

The study of work relations in modern societies. What sociology can tell us about industrial societies and relations in the work place? What is the impact of technology in work and industry? Hierarchical stratification of vocations. Gender relations in industrialized societies. Bureaucracy, taylorism and fordism. Sociological theories of work.

8th semester

PHYSICS SEMINAR.

Code no: **. 9.4.50.8.2.9** Semester: **8th**, Teaching hours:

The students attend seminars given by their classmates. Each student presents to the class a topic related to the Physics courses that are taught in the Applied Physics concentration.

THEORETICAL PHYSICS

Code no: **. 9.4.35.8.2.9** Semester: **8th**, Teaching hours:

Principle of least action, Euler – Lagrange equations. Lagrangian and Hamiltonian. Poisson brackets. Canonical transformations. Symmetries and conservation laws. Noether's theore. The momentum – energy tensor. Poisson bracket algebra. Continuous dynamical systems as examples of classical field theories: Klein – Gordon and Dirac equations. Lorentz transformation of solutions. Mass and spin. Plane wave solutions. Klein's paradox. Coupling with external electromagnetic fields. Hydrogen – like atoms, spin and fine structure. Discrete symmetries (C, P, T). The neutrino equation.

NUCLEAR PHYSICS AND APPLICATIONS

Code no: **. 9.4.33.7.2.9** Semester: **7th**, Teaching hours:

Nuclear reactions – cross section. Nuclear decay law. Bound states of nucleons – deuterium – nucleon exchange forces. Nuclear models (liquid drop, shell, collective). Nuclear deformation Electric and magnetic multipoles. γ ray emission. Nuclear magnetic resonance. Rutherford scattering. Nuclear reactions. Applications of Nuclear Physics in the study of materials (RBS, ERDA, PIXE, etc.), in medicine (diagnosis – therapy), to the environment, in archaeometry, in industry

The course includes laboratory exercises

SIGNAL ANALYSIS

Code no: **. 9.4.45.8.2.9** Semester: **8th**, Teaching hours:

Introduction to signals & systems, special types of signals; Analog and discrete signals; Fourier Transform, Laplace for analog signals; Transfer function; Z transform; Difference Equations, Discrete time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), FIR & IIR Digital Filters; Design of Digital Filters; Applications of Digital Signal Processing.

DETECTING AND ACCELERATING SYSTEMS

Code no: **. 9.4.26.8.2.9** Semester: **8th**, Teaching hours:

Interaction of radiation with matter: Interaction of x and γ ray radiation with matter. Interaction of charged particles with matter. ◆ Detectors: Gas – scintillation - solid state and other detectors. Detection of x and γ ray radiation. Detection of charged particles. Neutron detection. Detecting devices in high energy experiments: trajectory detectors, energy detectors (calorimeters), muon detectors, magnets, Cerenkov detectors, gas detectors. ◆ Accelerators: Electrostatic accelerator. Beam transfer. Linear detectors. Cyclotron . Sychnotron. Colliding beam detectors. ◆ Data acquisition: Triggering and data recording conditions. Data analysis techniques and simulation methods. ◆ Experiments: Description of typical experiments.

The course includes laboratory exercises

PHYSICS AND TECHNOLOGY OF LASERS

Code no: **. 9.4.31.8.2.9** Semester: **8th**, Teaching hours:

Introductory concepts, spontaneous and stimulated emission, interaction of radiation with matter, pumping processes, passive optical resonators. Behavior of continuous wave and transient types of lasers, laser beam properties, laser beam transformations, special topics on the Physics and Technology of lasers, selected laser applications, laser safety.

The course includes laboratory exercises

PHYSICS OF ELECTRONIC DEVICES

Code no: **. 9.4.30.8.2.9** Semester: **8th**, Teaching hours:

Introduction to basic semiconductor physics and general planar technology concepts. Ohmic and rectifying contacts to semiconductors. Metal-semiconductor contacts(Shottky). Current-Voltage characteristics. Bipolar devices: (a) Junction p-n, thermal equilibrium conditions, depletion region, current-voltage characteristics, transient behavior, breakdown conditions (b) bipolar transistor, transistor action, static characteristics, switching behavior, frequency response, equivalent circuit. MOS (Metal-Oxide-Semiconductor) devices (a) MOS capacitor, band bending, surface states, Capacitance-Voltage characteristics, influence of frequency on C-V characteristics (b) MOSFET (MOS Field-Effect Transistor): Static and dynamic behavior, surface mobility, MOSFET scaling, type of devices and simple circuits (P-MOS, N-MOS, C-MOS, inverter). Nanoelectronic devices.

The course includes laboratory exercises

POLYMERS AND COMPOSITES

Code no: **. 9.3.30.8.2.9** Semester: **8th,y** Teaching hours:

Introduction, classification of polymers, molecular weight, examples, synthesis of polymers (briefly), molecular configuration of polymers, physical states and transitions of polymeric structures. Hookes law, rubber elasticity theory, examples, viscoelasticity, creep, stress-relaxation, dynamic mechanical analysis of polymers, examples. Yielding and failure of polymers. Introduction to polymer rheology. Polymer melt processing, extrusion, blending molding of polymers. ◆ Introduction to composite materials, particulate and fiber composites.

***Note**: The course includes laboratory exercises*

BIOPHYSICS

Forces – interactions between biomolecules. Water and its role in the structure of living matter. Biopolymers (structure, function and physical properties). Physical methods for the study of macromolecules and cells. Membranes and transport properties of biological membranes. Generation and propagation of the nerve pulse. Bioelectric potential recording techniques. Muscle contraction, bio-thermodynamics, bioenergetics. Biophysics of vision and hearing. Effects of physical factors in living matter.

Laboratory exercises: Spectrometry: absorption spectra of biopolymers, correlation of optical properties with the structure and behavior of macromolecules under various conditions (radiation, active substances). Amplification – recording of bioelectric signals.

The course includes laboratory exercises

CONTINUOUS GROUPS

Code no: **. 9.4.49.8.2.9** Semester: **8th**, Teaching hours:

Introduction to Lie groups and to the Cartan classification scheme. Application to Physics: ◆ *Classical Physics:* Rotation groups in Classical Mechanics. Solution of central potential problems by group theoretical methods (Kepler's problem). Special theory of relativity and the Lorentz and Poincare groups. ◆ *Quantum Mechanics:* Eigenstate calculations for simple quantum systems by group theoretical methods. The harmonic oscillator, the hydrogen atom, particle – spin interaction in magnetic fields. ◆ *Nuclear Physics:* Isospin. Wigner multiplicity (L-S coupling). The SU(3) and SU(6) groups in Nuclear Physics.. ◆ *Elementary particle theory:* Gauge theories and the Standard Model.

INTRODUCTION TO MEDICAL IMAGING

Code no: **. ??** Semester: **8th**, Teaching hours:

Introduction to Medical Imaging Systems: Computed Tomography (CT), Magnetic Resonance Imaging (MRI), endoscopy systems, ultrasound imaging (US).
Medical image reconstruction methods: Image reconstruction algorithms (simple back projection, filtered back projection, iterative reconstruction algorithms), artefacts in the reconstructed images, three dimensional tomography.
Computed Tomography: Physical principles of operation, X-ray Computed Tomography instrumentation, data acquisition geometries, tomographic image reconstruction, helical CT.
Nuclear Medicine and Single Photon Emission Computed Tomography (SPECT): Radiopharmaceuticals, Auger Camera, operation principles, SPECT instrumentation and image reconstruction.
Positron Emission Tomography (P.E.T.): Physical principles, radiopharmaceuticals, instrumentation, image reconstruction, clinical applications.
Nuclear Magnetic Resonance (NMR): Principles, Bloch equation solutions, detecting systems, pulse sequences, relaxation processes and their measurement, NMR imaging equation.
Ultrasound Imaging Methods: Physical principles, production and detection, pulse – echo US imaging, Real time ultrasound tomography imaging, ultrasonic Doppler imaging, ultrasound tomography, evaluation of ultrasonic imaging methods.
Diffraction Tomography: Projections to diffraction tomography, approximate solutions of the wave equation, Fourier's diffraction theorem, reconstruction algorithms.
Interaction of RF electromagnetic waves with Biological Tissue: Electrical properties of biological tissue, biological effects of electromagnetic waves, dosimetry magnitudes and safe exposure limits to electromagnetic waves.

NEW TECHNOLOGIES IN EDUCATION.

Code no: **. ??** Semester: **8th**
Status: **compulsory** Teaching hours:

The main purpose of the course is to provide the student (and teacher-to-be) with the basic skills necessary to exploit the advantages of the internet and, at the same time, make him/her capable of delivering -in an attractive way- a high school course using links, images and even interactivity through web pages. The outline of the lectures is:1) Basic introduction to HTML. 2) Using a text processor. 3) Head and Title. 4)Text formatting (indentation, fonts, size, decoration, color etc). 5) Ordered and Unordered lists. 6) Introducing images. Images and text. 7) Links (to another page, to the same page, to a file etc). 8) Tables (borders, color, background image, caption etc). 9) Frames. 10) Forms. 11) Some special effects. 12) Introducing Freeware HTML editors.

HISTORY OF PHYSICS, 19TH AND 20TH CENTURY

Code no: 9.1.???.8.2.9, Semester: **8th**, Teaching hours:

Has been moved to the 6th semester.

9th semester

Computational Physics II, Modeling

Code no: **. 9.4.47.9.2.9.** Semester: **9th**, Teaching hours:

Random processes: Monte – Carlo methods, diffusion, entropy and the arrow of time. *Statistical Mechanics:* Phase transitions. The Ising Model. *Molecular dynamics:* melting. *Quantum Mechanics:* bound states and scattering problems, the Kronig Penney model. *Statistical Methods of Physics:* data processing, curve fitting to experimental data.

Elementary Particles

Code no: **. 9.4.41.9.2.9.** Semester: **9th**, Teaching hours:

The course includes laboratory exercises

Introduction and historical review. Group theory and the quark model. Chiral symmetry. The parton model. Gauge theories and spontaneous symmetry breaking. Phase space: effective cross section calculations. Elements of Quantum Chromodynamics. The standard model of electroweak interactions. Grand unification theories.

Pattern Recognition and Neural Networks

Code no: **. 9.4.48.9.2.9.** Semester: **9th**, Teaching hours:

Review of linear algebra, linera transformation & probability theory, conditional probability and Bayes rule; Introduction to statistical pattern recognition, feature detection, classification; Bayesian decision theory of pattern recognition; Linear and quadratic discriminant functions; Parametric estimation and supervised learning; Theory of Perceptron; Parzen, K-Near Neighbor (K-NN) classification methods ; Dimensionality reduction, Fisher & entropy techniques; Unsupervised learning, clustering K-means; Neural networks for pattern recognition; Learning

Application of Lasers in Biomedicine and the Environment

Code no: **. 9.4.40.9.2.9** Semester: **9th**,Teaching hours:

Basic principles of the interaction of laser radiation with living matter. Biophysical action mechanisms. Diagnostic applications of lasers. Surgical applications of lasers. Photodynamic therapy. Medical lasers and dosimetry. Laser safety. Basic principles of the propagation of laser radiation in the atmosphere. Mie and Rayleigh scattering. Raman scattering. LIF technique. LIDAR technique (radiation propagation equation, set-up geometry, signal recording techniques). DIAL technique. Measurement of pollutants in the atmosphere and the hydrosphere.

Ceramics and Dielectric Materials

Code no: **. 9.4.38.9.2.9.** Semester: **9th**, Teaching hours:

Ceramics: Structure and physico-chemical properties of ceramics. Production and processing of ceramics, characterization techniques for ceramics. Insulating, semiconducting and superconducting ceramics. Ionic conductivity in ceramics. Ceramic glasses, glass transition. Nanoceramics and porous ceramics. ◆ *Dielectric materials:* Dielectric properties of materials. Experimental methods for the study of dielectric properties. Electro-insulating materials. Dielectric materials for capacitors, dielectric materials for microelectronics. Active dielectrics (ferroelectrics, piezoelectrics, pyroelectrics and electrites).

Microsystems Technology

Code no: **. 9.4.46.9.2.9.** Semester: **9th**, Teaching hours:

Microsystems and nanosystems: Definitions and examples. Relationship between microelectronic, micro-optical and micro-electro-mechanical technology. Basic microelectronic technology processes and modeling: Thermal oxidation, dopant diffusion, ion implantation, physical and chemical deposition, lithography, etching. Examples of microelectronic device fabrication. ◆ Special processes for micromechanics and microsensor fabrication. Surface and bulk micromachining. Physical principles of sensors operation. Examples on fabrication and operation of physical and biochemical microsensors. ◆ From microtechnology to nanotechnology: Methods of fabrication at the nanoscale. Fabrication of nanoparticles and naowires, their interaction with the macro-world. Applications to nanoelectronics and microsensors

Relativity

Code no: . **9.4.44.9.2.9.** Semester: **9th**, Teaching hours:

Lorentz transformations. Four – vectors. Relativistic dynamics. Transformations of electromagnetic fields. Relativistic kinematics. The equivalence principle. Geometry of curved space. Curvature tensor. Einstein equation. Spherically symmetric solution.

Environmental Physics

Code no: . **9.4.18.9.1.9.** Semester: **9th**, Teaching hours:

Atmosphere and biosphere structure and composition . Propagation of radiation and euuations of motion in the atmosphere. The ozone layer. Stability conditions in the atmosphere. Atmospheric pollution. Hydrosphere structure and composition. Propagation of radiation and equations of motion in the hydrosphere. Water pollution. Energy exchange mechanisms between the atmosphere and the hydrosphere. Worldwide climatic change.

Introduction to Medical Physics

Code no: . **9.4.42.9.2.9.** Semester: **9th**, Teaching hours:

Terminology and modeling. Energy, heat, work and power of the human body. Biomechanics, Muscle and forces. Physics of the skeleton. Pressure in the body. Osmosis and the kidneys. Physics of the lungs and breathing. Physics of the cardiovascular system and electric signals. Sound, speech and hearing. Interaction of ultrasound with living matter and applications. Physics of the eyes and vision, artificial vision.

Introduction to Wide World Web Technologies

Code no: . **???.** Semester: **9th**,Teaching hours:

Web principles. OSI architecture in the web. IEEE 802.x transmission media for local webs, IP protocol, Addressing (Διευθυνσιοδότητηση) (ARP, ICMP), TCP and UDP protocol. Internal (OSPF, RIP) and external (BGP) routing protocols. Jamming control, sliding window mechanism, slow start, fast retransmission and fast healing. Web security, SKC secret key algorithms, PKI public key algorithms, authenticity certification protocols and digital signatures. Applications and services, electronic mail, WWW applications, the side of the customer, the side of the server, creation of a web page in HTML, Java, finding information in the web, telephony in the web and multimedia (image and sound information flow).

Fluid Mechanics

Code no: . **9.3.11.9.1.9.** Semester: **9th**, Teaching hours:

Introduction to Fluid Mechanics. Fluids and Flows. The Continuum Concept. Characteristics and Properties of Fluids. Types of Flow. System and Control Volume. Fundamental Laws of Fluid Mechanics. Fluid Motion: Fluid Particle and Kinematics. The Velocity Field. Material and Space coordinates. Methods of Description. Flow rates of mass and volume. Timelines, Streaklines and Streamlines. Forces and Stresses. Body Forces and Surface Forces. Deformation of Fluids. Macroscopic-Integral Analysis. Reynold's Transport Theorem. Basic Equations in Integral Form: Conservation of Mass, Momentum and Energy. Basic Equations in Differential Form. The Navier-Stokes Equation. Equations for single and multicomponent Fluids. Initial and Boundary Conditions. Chemical Kinetics. Dimensional Analysis.

Nuclear Engineering

Code no: . **??.** Semester: **9th**, Teaching hours:

Nuclear reactions with neutrons. Fission. Scattering, diffusion, absorption, thermalization of neutrons. Criticality analysis for bare homogeneous thermal neutron systems. Nuclear Power Reactors. Nuclear Power Plants. Nuclear fuel. Steady-state heat removal from the nuclear power reactor core. Thermodynamic cycles and energy production. Nuclear installations safety, nuclear accidents. Fission products dispersion in the environment. Industrial applications of nuclear engineering. Principles of radiation protection and radioenvironmental analysis.

The course includes laboratory exercises

LAW

Code no: **. 9.1.09.9.2.9.** Semester: **9th**, Teaching hours:

The aim of this course is to provide students lacking a legal background with both a general overview of Greek legal system and the operation of legal rules. Thus, the course focuses on essential legal issues arising in fields such as Public law (Constitutional Law and Administrative Law), Civil Law (contracts, torts and Law of Property), Commercial law (commercial transactions, Company Law, Industrial Property rights etc.), Labour Law (work accidents, constructor liability etc.), Environmental Law (national and European legislation) and European Law (European institutions, Freedoms and rights, Free Trade, Statutory Law etc.). Lectures are followed by practical sessions, where are examined solutions to practical legal issues and court decisions. Assessment is by a mixture of examination (Multiple Choice Questions and practical cases) and coursework.

ENVIRONMENTAL POLICY

Code no: **. 9.1.C.9.2.9.** Semester: **9th**, Teaching hours:

Traditional views for the relations between man and nature: Man and nature in Greek philosophy and Jewish religion. Christianity and nature. The scientific revolution and the concept of nature. Modern philosophy and nature. ◆ *Elements of environmental philosophy:* Ecology: what it is and what it is not. Profound and shallow ecology. Metaphysical and epistemological problems. Moral, political and aesthetic problems. Animal rights. Eco-feminism. Technology, economy and environment. Environmental politics and environmental law in Greece and in European Union.