Faculty of Natural Sciences

IMPORTANT NOTES

If for one subject you can find several different types (lecture, practice, laboratory) of courses then please choose one and only one course from each type in order to be able to perform the subject's requirements successfully.Civil Engineering courses are on the website seperately. Courses chosen from the offer of Faculty of Civil Engineering will be checked and arranged individually by the departmental coordinator.

Subject code	Subject name	Requirement	ECTS credit
BMETE11AP58	Mathematical Methods in Physics	Mid-semester mark	5

Course type	**Course code**	**Course language**	**Timetable information**
Lecture	T0	English	WED:08:15-10:00
Practice	T3	English	THU:12:15-14:00
Practice	T2	English	THU:12:15-14:00
Practice	T1	English	THU:12:15-14:00

The aim of the course is to introduce to students mathematical methods and concepts that play an important role in some branches of advanced physics (e.g. electrodynamics, quantum mechanics) in more detail than taught in general mathematics. The focus is not on rigorous proofs of theorems, but on their illustration and applications to practical problems.
Topics (physical applications will be presented for the topics that overlap with the subjects specified in the prerequisites): Cylindrical, spherical coordinate systems, derivatives in them, the Laplace and Poisson equation, wave equation. Special functions and orthogonal functions with physical applications: Legendre polynomials, spherical harmonics, Bessel functions, Chebyshev polynomials. Physical applications of linear operators, similarity transformation. Distributions: their concepts, Dirac delta, their operations (derivation, convolution, Fourier and Laplace transforms), their use in solving differential equations, Green's function. Basics of complex analysis and some basicapplications.
– G. A. Korn and T. M. Korn: Mathematical Handbook for Scientists and Engineers: Definitions, Theorems, and Formulas for Reference and Review (Dover Civil and Mechanical Engineering, 2000, Revised Edition, ISBN 978-0486411477)
– D. Babusci, G. Dattoli, S. Licciardi, E. Sabia: Mathematical Methods for Physicists (World Scientific Publishing Co, 2019, ISBN 978-9811201578)

Subject code	Subject name	Requirement	ECTS credit
BMETE11AP65	Measurement Techniques	Exam	3

Course type	**Course code**	**Course language**	**Timetable information**
Lecture	T0	English	THU:10:15-12:00(F3213)

Voltage and current sources, voltage and current meters. Measurement of resistance, four probe resistance measurement. Operational amplifiers. Voltage amplifier, current amplifier, and comparator circuits. A/D and D/A converters, data acquisition cards. Normal and common mode rejection ratio. Analog and digital oscilloscopes, sampling modes, triggering, waveform measurements, aliasing. Function generators.
Suppression of disturbing signals: electrostatic and inductive coupling, grounding and guarding, twisted pairs, thermoelectric power and offset compensation, stray capacitance. Wave propagation in coaxial lines, telegraph equations, wave impedance, reflections at the cable termination.
Fourier analysis considering finite temporal window. The role of various window functions: spectral leakage, frequency resolution, amplitude accuracy. The role of finite sampling, sampling theorem. Discrete Fourier transform, and its implementation by the fast Fourier transform algorithm. Spectrum analyzers. Phase sensitive measurements: lock-in amplifiers, phase locked loops.
The application of PID control from temperature controllers to scanning probe microscopes.
Electronic noise phenomena. The spectral density of noise, and its relation to the current-current correlation function and the Fourier transform of the signal. Thermal noise, the thermal noise limit of current amplifier circuits. Cross correlation noise measurement. Shot noise and 1/f noise. Antialiasing filter.
Fundamental measurement units (SI) and their definitions. Measurement standards: atomic clocks, voltage to frequency conversion by the Josephson effect, current to voltage conversion by the quantized Hall effect, current to frequency conversion by electron pump, measurement of mass by Watt balance. Temperature standards.
Modern sensors. Magnetic field sensors: inductive, magnetoresitive, spin valve, and Hall sensors, SQUID magnetometers. Distance and position sensors: linear differential transformers, capacitive transducers, LASER and ultrasound-based measurement of distance, LIDAR systems. Temperature sensors: thermocouples, resistance thermometers, thermistors. Light sensors: photo diodes, CCD sensors, CMOS active pixel sensors, bolometers. Measurement of acceleration: MEMS accelerometers and gyroscopes, piezoelectric accelerometers.

Fundamentals of nuclear measurement technologies. Interactions between electromagnetic radiation, charged particles and atoms of matter that provide the basis for detection. Detector efficiency, energy resolution, dead time, escape and pile-up phenomenon, response function. Basic instruments of electronic signal processing and their characteristic technical properties, analogue-digital conversion.

– James A. Blackburn: Modern Instrumentation for Scientists and Engineers, Springer-Verlag New York, Inc. 2001, ISBN: 978-0-387-95056-3, DOI: https://doi.org/10.1007/978-1-4613-0103-5
– Sh. Kogan: Electronic Noise and Fluctuations in Solids, Cambridge University Press (1996), ISBN: 9780511551666, DOI: https://doi.org/10.1017/CBO9780511551666
– G. F. Knoll, Radiation detection and measurement, 4th Edition, Wiley, 2010, ISBN: 978-0-470-13148-0
– Low Level Measurements Handbook - 7th Edition Precision DC Current, Voltage, and Resistance Measurements
– C. Rauscher, Fundamentals of Spectrum Analysis, Rohde&Schwarz GmbH&Co. KG, 2001 Mühldorfstrasse 15 81671 München Germany, ISBN 978-3-939837-01-5

Subject code	Subject name	Requirement	ECTS credit
BMETE11AX21	Physics 1	Exam	4

Course type	**Course code**	**Course language**	**Timetable information**
Lecture	VE0	English	MON:14:15-16:00; MON:16:15-17:00
Practice	VE1	English	MON:17:15-18:00

Mechanics: Measurements, units, models in physics. Space, time, different frames of references. Motion of a particle in 3D. Newton's laws. Work, kinetic energy, potential energy. Work-energy theorem. Conservation laws in mechanics. Motion in accelerated frames, inertial forces. Newton's law of gravitation. Basics of the theory of special relativity. System of particles, conservation laws. Kinematics and dynamics of a rigid body. Oscillatory motion, resonance. Wave propagation, wave equation, dispersion, the Doppler effect.

Thermodynamics: Heat and temperature. Heat propagation. Kinetic theory of gases. Laws of thermodynamics. Reversible and irreversible processes, phase transitions. Entropy, microscopic interpretation of entropy. Elements of statistical physics.

Static electric and magnetic fields: Electric charge. Electric field, electric flux, electric potential. Basic equations of electrostatics. Applications of Gauss's law. Capacitors, energy of the static electric field. Dielectrics, boundary conditions. Electric current. Magnetic field. Current carrying wire in magnetic field. Magnetic field produced by an electric current, the Biot-Savart law.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF26	Physics of Semiconductors	Exam	3

Course type	**Course code**	**Course language**	**Timetable information**
Lecture	T0	English	TUE:12:15-14:00(F3M01)

Introduction: importance of semiconductor physics, modern applications, the limitations of electronics. Charge carriers in semiconductors: band structure, envelope function, lattice distortions, impurities, localized states, shallow and deep levels. Band structure of semiconductors: spin-orbit interaction, kp model. Transport phenomena: quasiclassical dynamics, Boltzmann equation, conductivity, Hall-effect, magnetoresistance, thermoelectric and thermomagnetic phenomena. Diffusive phenomena in semiconductors: inhomogeneous semiconductors, diffusion, diffúzió, Einstein-relation, conduction, Gunn-diode, p-n junction, Zener-diode, tunnel diode, bipolar transistors, JFET. Characterization and engineering of semiconductors: traditional and epitaxial growth, characterization techniques, lattice matching, band-engineering, heterostructures, superlattices, highe electron mobility 2DEG and its high frequency applications, fabrication of semiconductor nanostructures. Field effect and its applications: surface density of states, remote doping, Schottky barrier, Schottky diode, ohmic contacts, MOS-structures, High-k dielectrics, flash memories, solar cells, CCD devices, the fundamentals of CMOS technológy. Optical properties of semiconductors: interaction with light, photoconduction, absorpion of free charge carriers, recombination mechanisms, the principles and applications of light emitting diodes and semiconductor lasers.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF38	Chemistry in Nanotechnology	Exam	3

Course type	**Course code**	**Course language**	**Timetable information**
Lecture	T0	English	MON:14:15-16:00

The course presents recent developments in nanotechnology and nanoscience using chemical methods. We will overview measurement techniques for nanosclae building blocks, namely transmission electron microscopy (TEM), scanning electron microscopy (SEM), dynamic light scattering (DLS). Synthesis of nanoparticles: chemical, physical and biological methods and chemical stabilization of nanoparticles. Purification and size and shape-selective purification of nanoparticles. The stability of nanoparticles and interactions existing at nanoscale and using them for the self-assembly of nanoscopic components: nanostuctured materials. Usage of nanoparticles in chemistry, medicine and chemical robotics. Targeted drug delivery applications.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF45	Superconductivity	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	T0	English	WED:14:15-16:00

Phenomenology of superconductors. Meissner effect, London equations, electrodynamics of superconductors. Bardeen-Cooper-Schrieffer theory: ground state, thermodynamic and transport properties. Ginzburg-Landau theory: free energy, GL equations and their solution, Abrikosov vortices, magnetic properties of Type II superconductors. Josephson effect and its applications. High-temperature superconductors. Prerequisites: Modern Solid State Physics.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF55	Modern Solid State Physics	Exam	7

Course type	Course code	Course language	Timetable information
Lecture	T0	English	THU:09:15-12:00(F3M01)
Practice	T1	English	WED:16:15-18:00

Course designed for the Physicist MSc education. Only those with Physics BSc diploma are allowed to register for this course.
This course describes the behavior of interacting many body systems (mainly electron systems) building on solid state physics and statistical physics knowledge gained while earning a BSC degree in Physics. The following topics are discussed: identical particles, second quantization, interacting electron systems in Bloch and Wannier representation, itinerant ferromagnetism, linear response theory, susceptibility of metals, spin density waves, Bose liquid.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF58	Nanotechnology and Materials Science	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	T0	English	WED:09:15-12:00

This course gives an introduction to the main trends in nanotechnology and material science. We cover advanced fabrication and measurement techniques by giving examples from state-of-the-art research and development results. The course addresses the following topics: Novel concepts and modern material systems in nanotechnology. Advanced imaging methods from electron microscopy to atomic resolution scanning probe techniques. Top-down nanofabrication techniques: photo and electron beam litography, deposition and special patterning techniques. Bottom-up approaches and self-organizing nanostructures. Semiconductor technology and novel concepts in information technologies. Investigation of electronic and vibrational properties by optical spectroscopy. Advanced surface analysis techniques.

Subject code	Subject name	Requirement	ECTS credit
BMETE80MX00	Nuclear and Reactor Physics Fundamentals	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	T0	English	TUE:14:15-17:00(R215); TUE:14:15-17:00(R215)

Subject code	Subject name	Requirement	ECTS credit
BMETE80NE02	Fusion Devices	Mid-semester mark	4

Course type	Course code	Course language	Timetable information
Laboratory	T1	English	MON:16:15-17:00(R214)
Lecture	T0	English	MON:14:15-16:00(R214)

The course starts with two introductory lectures: the first one summarizes the physics basis needed to understand the criteria for fusion energy producing devices, while the second reviews the main elements of fusion technology and their functions. This is followed by two lectures of introduction to stellarator technology through the German stellarator program, and three leactures dealing with the past, present and future of tokamaks. Spherical tokamaks are discussed in a separate lecture followed by lectures introducing the most important milestones of German, US and Japanese fusion programs. The last lecture presents the rapidly expanding Far-East fusion programs in the context of the history of superconducting tokamaks.

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX00	Mathematics A1a - Calculus	Exam	6

Course type	**Course code**	**Course language**	**Timetable information**
Lecture	EN-EMK-0	English	TUE:14:15-16:00(K372); TUE:14:15-16:00(K372); WED:16:15-18:00(K372); WED:16:15-18:00(K372)
Lecture	EN-VIK-0	English	TUE:12:15-14:00; WED:10:15-12:00
Lecture	EN-VBK-0	English	WED:16:15-19:00(CH302); THU:16:15-17:00(CHA11)
Practice	EN-EMK-1	English	MON:16:15-18:00(K373); MON:16:15-18:00(K373)
Practice	EN-VIK-1	English	FRI:10:15-12:00
Practice	EN-VBK-1	English	THU:17:15-19:00(CHA11)

Algebra of vectors in plane and in space. Arithmetic of complex numbers. Infinite sequences. Limit of a function, some important limits. Continuity. Differentiation: rules, derivatives of elementary functions. Mean value theorems, l'Hospital's rule, Taylor theorem. Curve sketching for a function, local and absolute extrema. Integration: properties of the Riemann integral, Newton-Leibniz theorem, antiderivatives, integration by parts, integration by substitution. Integration in special classes of functions. Improper integrals. Applications of the integral.

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX21	Calculus 1 for Informaticians	Exam	6

Course type	**Course code**	**Course language**	**Timetable information**
Lecture	EN0	English	MON:10:15-12:00(QBF09); TUE:10:15-12:00(IB025)
Practice	EN1	English	WED:12:15-14:00

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX33	Mathematics EP1	Exam	4

Course type	**Course code**	**Course language**	**Timetable information**
Lecture	EN0	English	WED:12:15-14:00(K364)
Practice	EN1	English	FRI:08:15-10:00(K221)

This course covers the elements of single variable calculus and linear algebra. Special emphasis is put on the concepts of linear algebra which are later used by architects in structural design. These are the systems of linear equations, matrices and determinants with their properties. From the elements of calculus, the limit of sequences, the differentiation, the integration and applications belong to the course material.

Subject code	Subject name	Requirement	ECTS credit
BMETE91AM38	Algebra 1	Exam	7

Course type	**Course code**	**Course language**	**Timetable information**
Lecture	A0	English	THU:12:15-15:00
Practice	A1	English	MON:14:15-16:00

Groups, semigroups. Basic properties of groups, group homomorphism, subgroups, cosets. Langrange's Theorem. Examples: diherdral groups, quaternion group, symmetric groups, alternating groups. Decomposition of permutations into disjoint cycles, transpositions. Permutation groups, group actions, transitivity, Cayley's Theorem. Cyclic groups, order of a group element. Cauchy's Theorem. Direct product of groups. Normal subgroups, factor group, Homomorphism Theorem, Noether's Isomorphism Theorems. Important subgroups: derived subgroup, centre, class equation. Subgroup chains, Sylow's Theorems, description of the structure of groups of small size. Nilpotent groups. Fundamental Theorem of Finite Abelian Groups. Free groups. Free algebras over rings, ideals, maximal and prime ideals. Description of the polynomial ring R[x]. Principal ideal domains. Noether rings, unique factorization domains (UFD). Factor rings, field extensions, construction of finite fields. Modules over rings, submodules, module homomorphisms. Semisimple modules and rings. The structure of matrix algebras over division rings. Vector space and module constructions: factor module, direct product, direct sum, tensor product. Linear fuction and the dual space.
– P.J. Cameron: Introduction to Algebra, Oxford Science Publications, 1998.– Atiyah-Macdonald: Introduction to commutative algebra, online textbook

Subject code	Subject name	Requirement	ECTS credit
BMETE91AM42	Informatics 1	Mid-semester mark	4

Course type	**Course code**	**Course language**	**Timetable information**
Laboratory	A1	English	WED:14:15-16:00(H601)
Lecture	A0	English	WED:13:15-14:00(H405A)

The aim of the course is to study the basic notions of information technology. Basics of hardware (CPU, memory, mass storage,...), the hardware environment of the Institute. Basics of operating systems: program, process, file, folder, file system of Linux and Windows (bash, mc, Windows Total Commander). Graphic user interface, terminal user interface, bash language. Internet, network, IP address, wifi, Internet security. Data on machine: number representation, character encodings. Computer algebra, symbolic calculation (Sage, Mathematica,...), variable, recursion instead of iterative programming, deepening the secondary school function concept (factorial, Fibonacci sequence, Euclidean algorithm, exponentiation, quick exponentiation...). Programming paradigms in computer algebra languages. HTML, the markup language concept, homepage. CSS, separation of the content and presentation. Editing mathematical text: TeX, LaTeX, mathematics on the web. Presentation of math (beamer). Basic concepts of graphic file formats, graphics in mathematical text (TikZ).

Subject code	Subject name	Requirement	ECTS credit
BMETE91AM52	Mathematical Logic	Exam	2

Course type	Course code	Course language	Timetable information
Lecture	A0	English	

The language of first order logic, an outlook to higher order languages. Formalization. Structure, valuation. The sets of true valuations. Logical consequence and comparing with the operation implication. Deduction theorem, and characterizations of logical consequence. Normal forms: conjuctive, prenex, Skolem. Compactness theorem and its applications. – Proof theory. Deductive and refutation calculi. Analitic tableaux and its semantical background. Completeness theorem and its importance. Examples for semantical and proof theoretical approaches of some logical properties. The model method. Theorems of Löwenheim-Skolem types. Model constructions. Standard and non-standard models, on the concepts on non-standard real numbers, integers, infinitesimals. Categoricity, and completeness. – Discrete and density orderings. On the limits of first order logic, incompleteness and undecidableness, the famous results of Gödel and Church.On the connection of propositonal logic and Boolean algebras.

– H., A Mathematical Introduction to Logic, Academic Press, 2001.– Ben-Ari, M., Mathematical Logic for Computer Science, Springer, 2012– Ferenczi, M., Szőts, M., Mathematical Logic for Applications, Typotex, 2016– Ferenczi, M., Pataricza, A., Rónyai, L., Formal Methods in Computing, Kluwer-Akadémia Kiadó, 2005

Subject code	Subject name	Requirement	ECTS credit
BMETE91AM56	Programming Exercises for Probability Theory	Mid-semester mark	2

Course type	Course code	Course language	Timetable information
Laboratory	A0	English	THU:09:15-10:00(H507)

The aim of the course is to maintain the students' programming skills through programming problems associated with the topics of Probability Theory course helping the understanding of the basic concepts of probability simulations of random events at the same time.

Subject code	Subject name	Requirement	ECTS credit
BMETE91AP62	Vector and Matrix Algebra	Exam	8

Course type	Course code	Course language	Timetable information
Lecture	T0	English	MON:10:15-12:00; TUE:12:15-14:00
Practice	T3	English	MON:12:15-14:00
Practice	T2	English	MON:12:15-14:00
Practice	T1	English	MON:12:15-14:00

Elementary Real Analysis: The Real Number System. Complex Numbers and Their Arithmetics. Algebraic, Trigonometric and Exponential Representations. Euler's Formula. Elementary Functions. Polynomials. The Fundamental Theorem of Algebra.
Vector Spaces: Motivation. Linear Independence and Bases. Direct Sums. Inner Product Spaces. Orthogonal Sets.
Linear Equations and Matrices: Systems of Linear Equations. Elementary Row Operations. Row and Column Spaces. Solutions to Systems of Linear Equations. Matrix Algebra. Invertible Matrices. Elementary Matrices.
Determinants: Permutations. The Levi-Civita Symbol. Definitions and Elementary Properties. Additional Properties of Determinants. Determinants and Linear Equations. Expansion by Cofactors.
Linear Transformations and Matrices: Linear Transformations and Properties. Matrix Representations. Change of Basis. Orthogonal Transformations. Reflexions, Rotations and Projections.
Eigenvalues and Eigenvectors: Eigenvalues and Eigenvectors. Characteristic Polynomials. Block Matrices. Invariant Subspaces. More on Diagonalization. Diagonalizing Normal Matrices. The Singular Value Decomposition.
Numerical and Algorithmic Approach: The LU and QR Factorizations. The Least Square Method. The Jacobi Eigenvalue Algorithm for Symmetric Matrices.
Operators and Diagonalization: The Adjoint Operator. Normal Operators. More on Orthogonal Transformations. Projections. The Spectral Theorem. Positive Operators. The Matrix Exponential Series.
Multilinear Mappings and Tensors: Symmetric and Antisymmetric Bilinear Forms. Diagonalization of Symmetric Bilinear Forms. Volumes in R^3 and in R^n. Linear Transformations and Volumes.
•Joel G. Broida. Essential Linear Algebra. University of Colorado, Boulder. 2009.
•David C. Lay. Linear Algebra and Its Applications, 4th Edition. Addison-Wesley. 2012

•Derek J. S. Robinson A Course in Linear Algebra With Applications, 2nd Edition. World Scientific. 2006.

Subject code	Subject name	Requirement	ECTS credit
BMETE93BG01	Mathematics G1	Exam	6

Course type	Course code	Course language	Timetable information
Lecture	EN0	English	WED:16:15-19:00(KF82); THU:16:15-17:00(KF82)
Practice	EN1	English	THU:17:15-19:00(KF82)

Algebra of vectors in plane and in space. Arithmetic of complex numbers. Infinite sequences. Limit of a function, some important limits. Continuity. Differentiation: rules, derivatives of elementary functions. Mean value theorems, l'Hospital's rule, Taylor theorem. Curve sketching for a function, local and absolute extrema. Integration: properties of the Riemann integral, Newton-Leibniz theorem, antiderivatives, integration by parts, integration by substitution. Integration in special classes of functions. Improper integrals. Applications of the integral.

Subject code	Subject name	Requirement	ECTS credit
BMETE93BG03	Mathematics G3	Mid-semester mark	4

Course type	Course code	Course language	Timetable information
Lecture	EN0	English	TUE:08:15-10:00(R501)
Practice	EN1	English	WED:08:15-10:00(D316B)

Classification of differential equations.Separable ordinary differential equations, linear equations with constant and variable coefficients, systems of linear differential equations with constant coefficients. Some applications of ODEs.Scalar and vector fields.Line and surface integrals. Divergence and curl, theorems of Gauss and Stokes, Green formulae. Conservative vector fields, potentials. Some applications of vector analysis.Software applicationsfor solving some elementary problems.

Subject code	Subject name	Requirement	ECTS credit
BMETEAGBsMMMOD-00	Mathematical Methods	Mid-semester mark	5

Course type	Course code	Course language	Timetable information
Practice	A1	English	TUE:10:15-12:00; THU:12:15-14:00

– Elementary problems in combinatorics: counting and graphs.– Natural language logic. Propositions, negations, reversing, logical operations.– Single quantifier expressions (syllogisms), sets, their Boolean algebra.– Proof methods. Case separation. Conditional statements. Provablity. Proofs by contradiction. Constructive proofs. Existence proofs.– Pigeonhole principle. Invariants and algorithmic proofs. Isomorphism.– Ordering and relations. Equivalence relations.– Well ordering, principle of induction, infinite descent, recursion.– Descartes product of sets. Equivalence of sets, cardinality. Countable and uncountable sets and their existence. Cantor's diagonal method. Russell's paradox and others.
G. Chartrand, A. Polimeni, P. Zhang: Mathematical Proofs - A Transition to Advanced Mathematics. Pearson 2018.

Subject code	Subject name	Requirement	ECTS credit
BMETEAGBsMVMAL-00	Vector and Matrix Algebra for Mathematicians	Exam	8

Course type	Course code	Course language	Timetable information
Lecture	A0	English	MON:10:15-12:00; TUE:12:15-14:00
Practice	A1	English	MON:12:15-14:00; WED:08:15-10:00

Elementary Real Analysis: Complex Numbers and Their Arithmetics. Algebraic, Trigonometric and Exponential Representations. Euler's Formula. The complex plane. Roots and primitive roots of unity. Elementary Functions. Algebra of polynomials. The Fundamental Theorem of Algebra.
Vector Spaces: Motivation. Linear Independence and Bases. Direct Sums. Inner Product Spaces. Orthogonal Sets.
Linear Equations and Matrices: Systems of Linear Equations. Elementary Row Operations. Row and Column Spaces. Solutions to Systems of Linear Equations. Matrix Algebra. Invertible Matrices. Elementary Matrices.
Determinants: Permutations. The Levi-Civita Symbol. Definitions and Elementary Properties. Additional Properties of Determinants. Determinants and Linear Equations. Expansion by Cofactors.
Linear Transformations and Matrices: Linear Transformations and Properties. Matrix Representations.Change of Basis. Orthogonal Transformations. Reflections, Rotations and Projections.
Eigenvalues and Eigenvectors: Eigenvalues and Eigenvectors. Characteristic Polynomials. Block Matrices. Invariant Subspaces. More on Diagonalization. Spectral theorem. Diagonalizing Normal Matrices. The Singular Value Decomposition.
Numerical and Algorithmic Approach: The LU and QR Factorizations. The Least Squares Method. The Jacobi Eigenvalue Algorithm for Symmetric Matrices.
Operators and Diagonalization: The Adjoint Operator. Normal Operators. More on Orthogonal Transformations. Projections. The Spectral Theorem. Positive Operators. The Matrix Exponential Series.

G Strang: Introduction to Linear Algebra. (Fifth Edition) Wellesley-Cambridge 2016.
R. Irving: Integers, Polynomials, and Rings - A Course in Algebra. Springer 2004.