



Al-Balqa' Applied University

## Curriculum for the Bachelor degree in Physics

The curriculum for the B.S.c. degree in Physics consists of (132) credit hours distributed as follows:-

Course No.	Requirements	Credit Hours (Cr.H)
1	University Requirements <ul style="list-style-type: none"><li>• Compulsory</li><li>• Elective</li></ul>	21 6
2	Faculty Requirements	20
3	Specialization Requirements <ul style="list-style-type: none"><li>• Compulsory</li><li>• Elective</li></ul>	59 12
4	Supportive Specialization Requirements	14
Total		132

## Curriculum for the Bachelor Degree in Physics

**First :** University Requirement (27 Cr .H.)

**A:** Compulsory Requirements (21 Cr.H.):

Course No.	Course Title	Cr.H.	Weekly Hours		Prerequisite
			Lecture	Lab.	
35003101	Arabic (1)	3	3	--	--
35003102	Arabic (2)	3	3	--	35003101
35004101	English (1)	3	3	--	--
35004102	English (2)	3	3	--	35004101
35005101	Computer Skills (1)	3	--	6	--
35001101	Military Sciences	3	3	--	--
35002100	National Education	3	3	--	--

**B:** Elective University Requirements: (6 Cr.H.)

The student is allowed to select (6 Cr. H.) from the university elective courses other than those offered by his/her faculty.

Course No.	Course Title	Cr. H.
36001101	Communication Skills	3
36002102	Educational Psychology	3
36003103	Jordanian society	3
36004104	Sport for All	3
36005105	Islamic Culture	3
36006106	Administration & Economic Concepts	3
36007107	Agriculture in Jordan	3
36008108	Environment and Society	3

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#### Second: Faculty Requirements: ( 20 Cr .H.)

Course No.	Course Title	Cr.H.	Weekly Hours		Prerequisite
			Lecture	Lab.	
30202101	Calculus (1)	3	3	0	--
30202102	Calculus (2)	3	3	0	30202101
30201101	General Physics (1)	3	3	0	--
30201111	General Physics Lab. (1)	1	0	3	30201101*
30201102	General Physics (2)	3	3	0	30201101
30201112	General Physics Lab. (2)	1	0	3	30201102*
30202131	Probability & Statistics	3	3	0	30202102
30801101	Computer Skills (2)	3	2	3	35005101

\* : or parallel

#### Third: Specialization Requirements: ( 71 Cr .H. )

##### A- Compulsory Requirements: ( 59 Cr .H.)

Course No.	Course Title	Cr.H.	Weekly Hours		Perquisites
			Lectures	Lab	
30201201	Mathematical Physics (1)	3	3	0	30202102
30201211	Electronics	3	3	0	30201102
30201212	Electronics lab.	1	0	3	30201211*
30201213	Optics	3	3	0	30201102
30201214	Electricity and Magnetism (1)	3	3	0	30201102 30202203
30201221	Thermodynamics	3	3	0	30201111
30201231	Modern Physics	3	3	0	30201102
30201301	Mathematical Physics (2)	3	3	0	30201201
30201304	Classical Mechanics	3	3	0	30202203 30201201
30201314	Electricity and Magnetism (2)	3	3	0	30201214
30201321	Statistical Physics	3	3	0	30201221
30201322	Computational Physics	3	2	3	30801101 30202203
30201323	Intermediate Physics Lab.	2	0	6	30201213 30201221

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Course No.	Course Title	Cr.H.	Weekly Hours		Perquisites
			Lectures	Lab	
30201331	Quantum Mechanics (1)	3	3	0	30202203 30201231
30201332	Atomic and Molecular Physics	3	3	0	30201331
30201333	Nuclear Physics	3	3	0	30201331
30201335	Radiation Physics (1)	3	3	0	30201231
30201337	Solid State Physics	3	3	0	30201321*
30201431	Quantum Mechanics (2)	3	3	0	30201331
30201433	Advanced Physics Lab.	2	0	6	30201333 30201335
30201499	Graduation Project	3	-	-	90 Cr. H.

\* : or parallel

**B: Elective Specialization Requirements: (12) Cr.H. to be selected from the following list:**

Course No.	Course Title	Cr.H.	Weekly Hours		Perquisites
			Lectures	Lab	
30201232	Materials Physics	3	3	0	30201102
30201336	Non Destructive Testing	3	3	0	30201335*
30201401	Mathematical Physics (3)	3	3	0	30201301
30201411	Instrumentation and Interfacing	3	2	3	30201211, 30201212
30201334	Renewable Energy Physics	3	3	0	30201221 30201231
30201432	Particle Physics	3	3	0	20301333
30201436	Experimental Techniques in Nuclear Physics	3	3	0	30201335 30201333
30201435	Radiation Physics (2)	3	3	0	30201335
30201437	Astrophysics and Cosmology	3	3	0	30201333
30201438	Introduction to Accelerators and Reactors Physics	3	3	0	30201214, 30201333
30202241	Linear Algebra (1)	3	3	0	30202102
30202304	Partial Differential Equations (1)	3	3	0	30202203

\* : or parallel

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**Fourth: Supportive Specialization Requirements : (14 Cr .H. )**

Course No.	Course Title	Cr.H.	Weekly Hours		Prerequisite
			Lecture	Lab.	
30206101	General Chemistry (1)	3	3	0	None
30206102	General Chemistry Lab (1)	1	0	3	30206101*
30206103	General Chemistry (2)	3	3		30206101
30206104	General Chemistry Lab (2)	1	0	3	30206103*
30202201	Intermediate Analysis	3	3	0	30202102
30202203	Ordinary Differential Equations (1)	3	3	0	30202102

\* : or parallel

**Curriculum for the Bachelor Degree in  
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<b>First Year</b>					
<b>First semester</b>			<b>Second Semester</b>		
<b>Course No.</b>	<b>Course title</b>	<b>Cr.H</b>	<b>Course No.</b>	<b>Course title</b>	<b>Cr.H</b>
30202101	Calculus (1)	3	30202102	Calculus (2)	3
30201101	General Physics (1)	3	30201102	General Physics (2)	3
30201111	General Physics Lab. (1)	1	30201112	General Physics Lab. (2)	1
35005101	Computer Skills (1)	3	30801101	Computer Skills (2)	3
30206101	General Chemistry (1)	3	30206103	General Chemistry (2)	3
30206102	General Chemistry Lab (1)	1	30206104	General Chemistry Lab (2)	1
35003101	Arabic (1)	3	35004101	English (1)	3
<b>Total</b>		<b>17</b>	<b>Total</b>		<b>17</b>

<b>Second Year</b>					
<b>First semester</b>			<b>Second Semester</b>		
<b>Course No.</b>	<b>Course title</b>	<b>Cr.H</b>	<b>Course No.</b>	<b>Course title</b>	<b>Cr.H</b>
30201201	Mathematical Physics (1)	3	30201211	Electronics	3
30201231	Modern Physics	3	30201221	Thermodynamics	3
30201213	Optics	3	30201212	Electronics lab.	1
30202203	Ordinary Differential Equations (1)	3	30202131	Probability & Statistics	3
30202201	Intermediate Analysis	3	30201214	Electricity and Magnetism (1)	3
35003102	Arabic (2)	3	35004102	English (2)	3
<b>Total</b>		<b>18</b>	<b>Total</b>		<b>16</b>

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<b>Third Year</b>					
<b>First semester</b>			<b>Second Semester</b>		
<b>Course No.</b>	<b>Course title</b>	<b>Cr.H</b>	<b>Course No.</b>	<b>Course title</b>	<b>Cr.H</b>
30201323	Intermediate Physics Lab.	2	30201335	Radiation Physics (1)	3
30201304	Classical Mechanics	3	30201333	Nuclear Physics	3
30201301	Mathematical Physics (2)	3	30201321	Statistical Physics	3
30201331	Quantum Mechanics (1)	3	30201322	Computational Physics	3
30201314	Electricity and Magnetism (2)	3	--	Elective University Requirement	3
35002100	National Education	3	35001101	Military Sciences	3
<b>Total</b>		<b>17</b>	<b>Total</b>		<b>18</b>

<b>Fourth Year</b>					
<b>First semester</b>			<b>Second Semester</b>		
<b>Course No.</b>	<b>Course title</b>	<b>Cr.H</b>	<b>Course No.</b>	<b>Course title</b>	<b>Cr.H</b>
30201332	Atomic and Molecular Physics	3	30201433	Advanced Physics Lab.	2
30201337	Solid State Physics	3	30201499	Graduation Project	3
30201431	Quantum Mechanics (2)	3	--	Elective specialization requirement	3
--	Elective specialization requirement	3	--	Elective specialization requirement	3
--	Elective specialization requirement	3	--	Elective University Requirement	3
<b>Total</b>		<b>15</b>	<b>Total</b>		<b>14</b>

## Curriculum for the Bachelor Degree in Physics

### Course Description

<b>30202101</b>	<b>Calculus (1)</b>	<b>3(3-0)</b>
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Functions: domain, operations on functions, graphs of functions, trigonometric functions; limits and continuity; the derivative: techniques of differentiation, the chain rule, implicit differentiation; differentials; Roll's theorem; the main value theorem; L'Hôpital's rule; increasing and decreasing functions; concavity; maximum and minimum values of a function, graphs of including rational functions; the indefinite integral; the fundamental theorem of calculus; the area between two curves; inverse functions; logarithmic and exponential functions; hyperbolic functions.

<b>30202102</b>	<b>Calculus (2)</b>	<b>3(3-0)</b>
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Techniques of integration; improper integrals; applications of the definite integrals Polar coordinates; parametric equations; Infinite series: geometric, p-harmonic, simple comparison tests, formal power series for some elementary functions, Taylor series; topics in analytic geometry: circle, parabola, ellipse, hyperbola.

<b>30201101</b>	<b>General Physics (1)</b>	<b>3(3-0)</b>
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Measurements; motion in one dimension; vectors; motion in two dimension; laws of motion; work and energy; potential energy and conservation of energy; linear momentum and collisions; rotation; simple harmonic motion.

<b>30201111</b>	<b>General Physics Lab. (1)</b>	<b>1(0-3)</b>
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Significant figures & errors; measurements and uncertainties; kinematics of rectilinear motion; vectors; conservation of energy; force and motion; friction; simple harmonic motion; simple pendulum; rotational motion; speed of transverse mechanical waves; centripetal force; specific heat.

<b>30201102</b>	<b>General Physics (2)</b>	<b>3(3-0)</b>
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Electric field; Gauss' law; electric potential; capacitance and dielectrics; current and resistance; direct current circuits; magnetic fields; sources of the magnetic fields; Faraday's law; alternating current; electromagnetic waves.

<b>30201112</b>	<b>General Physics Lab. (2)</b>	<b>1(0-3)</b>
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Galvanometer, Ammeter and Voltmeter; electric field mapping; Ohm's law; specific charge of copper ions; electric equivalent of heat; the potentiometer; the bridge method; Kirchhoff's rules; parallel plate capacitor; the RC circuit; power transfer and voltage attenuators; tangent galvanometer.

<b>30202131</b>	<b>Probability and Statistics</b>	<b>3(3-0)</b>
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Introduction to probability; random variables (discrete and continuous); probability and distribution functions; mathematical expectation; descriptive statistics; random sampling; estimation of parameters (one point estimation and confidence intervals); hypothesis testing; regression and correlation.

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### Course Description

#### **30801101 Computer Skills (2) 3(2-3)**

Basics of programming, algorithm development using top-down design with syntax and semantics of the C++ programming language, creating, compiling and executing C++ programs, primitive data types, operations, control structures, procedures and functions, arrays and classes.

#### **30201201 Mathematical Physics (1) 3(3-0)**

Series, vector analysis, matrices, eigen-value problems, complex numbers.

#### **30201211 Electronics 3(3-0)**

Circuit elements, circuit principles, transient response, sinusoidal signals and steady state response, properties of semiconductors, carrier transport phenomena, semiconductor diode, application of semiconductor diode, special diodes and applications, bipolar transistor, field-effect transistor and MESFET, metal semiconductor devices, operational amplifier and applications, power devices and applications.

#### **30201212 Electronics lab 1(0-3)**

RC-circuit applications, RLC series resonance circuit, semiconductor diode characteristics, rectification, Zener diode, Bipolar junction transistor (BJT) and MOSFET characteristics, BJT and MOSFET biasing, transistor amplifier, operational amplifier, electronic oscillators.

#### **30201213 Optics 3(3-0)**

The nature of light, reflection of light, refraction of light, lenses, optical instruments, colors, photometry and radiometry, interference of light, diffraction of light, polarization of light, quantum properties of light, introduction to photons and their energy, basic laser principles, types of lasers, control of the laser output, applications of lasers.

#### **30201214 Electricity and Magnetism (1) 3(3-0)**

Vector analysis, electrostatics, solution of electrostatic problems, the electrostatic field in dielectric media, electrostatic energy, electric current, the magnetic field of steady currents, magnetic properties of matter, magnetic energy.

#### **30201221 Thermodynamics 3(3-0)**

Fundamental concepts, temperature and temperature scales, heat transfer, equilibrium and zeroth law of thermodynamics, thermal expansion, ideal gas, kinetic theory of gases, first law of thermodynamics, second law of thermodynamics, third law of thermodynamics, applications.

#### **30201231 Modern Physics 3(3-0)**

Introduction to special theory of relativity, introduction to quantum physics, introduction to atomic physics, introduction to nuclear and elementary particle physics.

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<b>30201301</b>	<b>Mathematical Physics (2)</b>	<b>3(3-0)</b>
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Functions of complex variables, calculus of residues, calculus of variations, vector analysis in curvilinear coordinates. Partial differential equations.

<b>30201304</b>	<b>Classical Mechanics</b>	<b>3(3-0)</b>
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Newtonian mechanics of a particle in one- two- and three-dimensions, acceleration in polar and spherical coordinates, conservative and non conservative forces, conservation laws, the central force problem, small oscillations, two-body collision, kinematics and dynamics of special relativity, conservation laws for systems of particles, coupled oscillations, rotating coordinate systems, one-dimensional wave motion, gravitation, kinematics and dynamics of rigid body motion, Lagrange's equation.

<b>30201314</b>	<b>Electricity and Magnetism (2)</b>	<b>3(3-0)</b>
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Electrodynamics; Faraday's law of electromagnetic induction, magnetic energy, Maxwell's equations, propagation of the electromagnetic waves in conductors and insulators, polarization, reflection and refraction of the electromagnetic waves, waveguides, electromagnetic radiation; dipole radiation, antennas, electrodynamics and special relativity.

<b>30201321</b>	<b>Statistical Physics</b>	<b>3(3-0)</b>
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Review to thermodynamics concepts, basics of statistical thermodynamics, Boltzmann distribution, Thermal radiation and Plank distribution, Chemical potential and Gibbs distribution, ideal gas: Fermi-Dirac statistics and applications, Bose-Einstein statistics and applications.

<b>20301322</b>	<b>Computational Physics</b>	<b>3(2-3)</b>
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A practical course on modern computational techniques with applications to problems in nuclear science. Topics include data analysis, applications of Fourier analysis, curve fitting and regression analysis, interpolation techniques, numerical techniques for differential and integral problems, using random numbers to simulate radioactivity, the use of Unix-Linux OS and open-source packages such as ROOT for scientific applications. Previous experience with a computer programming language is desirable. Students complete semester projects. Students also develop experience with professional word processing software such as LATEX for writing reports and papers.

<b>30201323</b>	<b>Intermediate Physics Lab</b>	<b>2(0-6)</b>
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Different experiments in optics, sound and thermal physics.

<b>30201331</b>	<b>Quantum Mechanics (1)</b>	<b>3(3-0)</b>
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Wave packets and the uncertainty principle, Schrödinger equation in one dimension, the harmonic oscillator, potential barriers and wells, operators, eigenvalues and eigenvectors, three-dimensional Schrödinger equation, the angular momentum, the ideal hydrogen atom.

## Curriculum for the Bachelor Degree in Physics

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#### **30201332 Atomic and Molecular Physics 3(3-0)**

The photoelectric effect, the Compton effect, matter waves, the atomic nature of matter, Rutherford's and Bohr's models of the atom, wave mechanics, one-electron atoms, magnetic moments, spin, transition rates, the exclusion principle, multielectron atoms, the periodic table, quantum statistics, superfluidity, molecules, ionic and covalent bonds, molecular spectra, rotational and vibrational spectra and the Raman effect.

#### **30201333 Nuclear Physics 3(3-0)**

Nuclear properties, binding energy and nuclear stability, nuclear models, spin and moments, nuclear forces, the structure of the nucleus, nuclear reactions: energetics and general cross-section behavior, neutron moderation, fission, controlled fission and fusion.

#### **30201335 Radiation Physics (1) 3(3-0)**

X-ray production and characteristics, radioactivity, interaction of radiation with matter, absorption of radiation, radiation damage, neutron production, radiation doses, effect of radiation on living organisms, radiation safety, applications (radioactive dating, medical and industrial applications).

#### **30201337 Solid State physics 3(3-0)**

Crystal lattice, lattice vibration and specific heat, electric properties of solids, metals, semiconductors and devices, dielectric media, superconductors and applications, magnetic properties of solids.

#### **30201431 Quantum Mechanics (2) 3(3-0)**

Review of the ideal hydrogen atom, electron interaction with magnetic fields, operators of angular momentum and spin in matrix representation, angular momentum - spin coupling, time independent approximation methods, real hydrogen atom, helium atom, collision and scattering theories, applications in nuclear physics, time dependent approximation methods.

#### **30201433 Advanced Physics Lab 3(3-0)**

Experiments in atomic, nuclear and radiation physics.

#### **30201499 Graduation Project 3(-)**

The student is expected to put into action his knowledge gained from the different courses in this study plan through a graduation project.

#### **30201232 Materials Physics 3(3-0)**

Types of solids, main types of bonding in solids, crystal structure and defects, preparation of materials, practical determination of structure, elastic properties of solids, thermal properties of solids, electrical properties of solids, magnetic properties of solids.

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#### **30201336 Non Destructive Testing 3(3-0)**

Non Destructive Testing (NDT), nuclear structure and radiation, effects of radiation, radioactive dose and dose rate, dose meters, radiation protection, radiographic testing (RT), instruments and settings of radiography, radiation films, carbon steel weldments, Ultrasonic waves and ultrasonic testing, piezoelectric materials, magnetic particles testing (MPT), direct and alternating magnetic fields, the magnetic yoke, eddy current testing (ET), liquid penetrate testing (LPT), visual testing (VT), fields of application of NDT, horizons of NDT industry.

#### **30201401 Mathematical Physics (3) 3(3-0)**

Special functions, Group Theory, Green functions, Dirac delta function, integral equations.

#### **30201411 Instrumentation and Interfacing 3(2-3)**

Instrumentation objectives, thermal sensors, mechanical sensors, optical sensors, acoustic sensors, magnetic sensors, analog signal conditioning, digital signal conditioning, actuators, digital controllers.

#### **30201334 Renewable Energy Physics 3(3-0)**

Global energy need, atmosphere environment and renewable sources, solar energy, wind energy conversion, waste-to-energy combustion, biomass conversion processes for energy recovery, geothermal power generation, hydrogen energy technology, fuel cells, ocean thermal energy convert.

#### **30201432 Particle Physics 3(3-0)**

Particle families and interactions, symmetries, conservation laws, the quark model, colored quarks and gluons, quark dynamics, grand unified theories.

#### **30201436 Experimental Techniques in Nuclear Physics 3(3-0)**

Activation techniques and time-of-flight measurements, RBS, channeling, ion implantation and synthesis of materials, analytical methods and trace element analysis, XRF, Mössbauer, XPS, NAA, nuclear techniques in hydrology, non-destructive testing, and other applications.

#### **30201435 Radiation Physics (2) 3(3-0)**

Radiation sources and interactions (review), counting statistics, general properties of radiation detectors, gamma spectroscopy with scintillation and semiconductor detectors, neutron detectors, detection of charged particles, nuclear electronics, instrumentation and pulse processing, background radiation, passive and active shields and background suppression.

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#### **30201437                      Astrophysics and Cosmology                      3(3-0)**

Celestial mechanics, astronomical objects, astronomical instruments and measurements, the solar system, stars and stellar evolution including p-p chain and CNO cycle, Hertzsprung–Russell diagram, Other astronomical objects, Galaxies, Curvature of space, The expanding universe: redshift and Hubble's law, origin of the universe and the big bang theory.

#### **30201438                      Introduction to Accelerators and Reactors Physics                      3(3-0)**

Accelerators development, particles motion in electric and magnetic fields, Cyclotron, betatron and linear accelerators, electrostatic acceleration and focusing, high energy accelerators and colliders, some applications of accelerators, issues relevant to synchrotron light sources, mass spectrometry and radioactive ion beams, review of nuclear reactions and interactions, cross sections, reaction rate calculations, neutron physics, fission chain reactions, criticality and six-factor formula, introduction to neutron diffusion theory and nuclear reactor theory, nuclear fuel cycle, reactor safety, accelerators – reactors system.

#### **30202241                      Linear Algebra (1)                      3(3-0)**

Systems of linear equations; matrices and matrix operations; homogeneous and nonhomogeneous systems; Gaussian elimination; elementary matrices and a method for finding inverse; determinants; Euclidean vector spaces; linear transformations from  $R^n$  to  $R^m$  and their properties; general vector spaces; subspaces; basis; dimension; row space; column space; null space of a matrix; rank and nullity; inner product spaces; eigenvalues and diagonalization; linear transformations.

#### **30202304                      Partial Differential Equations (1)                      3(3-0)**

Classification of partial differential equations, comparison with ordinary differential equations, Heat equation: Steady state temperatures insulated Bar, convection, Sturm-Liouville problems, Eigenfunction expansion, finite, semi-Infinite and infinite Rod, Error function, Fourier and Laplace transforms. The wave equation: vibrating string, D'Alembert's solutions on finite vibrating string and beam, semi-infinite, infinite Domains; Fourier transforms (sine and cosine transforms). Green's function method. Canonical forms. Potential equation: in a rectangle, a slot and a disk.

#### **30206101                      General Chemistry (1)                      3(3-0)**

Fundamentals of chemical changes, The periodic table and some properties of the elements, Stoichiometry, quantitative chemical relationships, Reactions between ions in aqueous solutions, Oxidation-reduction reactions, Atomic and electronic structure, Chemical Bonding, Chemical bonding and molecular structure.

#### **30206102                      General Chemistry Lab (1)                      1(0-3)**

Laboratory techniques, Chemical observations, Measurements of volume and mass, Limiting reactant in a salt mixture, Empirical formula for magnesium oxide, Standardization of sodium hydroxide solution, Vinegar analysis, metathesis reactions, Separation and identification of common ions. Determination of Na and K by flame photometer.

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<b>30206103</b>	<b>General Chemistry (2)</b>	<b>3(3-0)</b>
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States of matter and intermolecular forces, Properties of solutions, Chemical thermodynamics, Chemical kinetics, Chemical equilibrium in gaseous systems, Electrochemistry, Acid-Base equilibrium, Solubility and complex ion equilibria.

<b>30206104</b>	<b>General Chemistry Lab (2)</b>	<b>1(0-3)</b>
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Molar mass of a volatile liquid and a solid from freezing point depression, Calorimetry, Thermo chemistry and Hess's law, Studies on some factors affecting chemical reaction, Le Chatelier's principle, Equilibrium constant of a chemical reaction using visible spectrophotometer. Oxidation-reduction reactions, Galvanic cells, Electrolytic cells, Faradays laws, Molar solubility and common ion effect.

<b>30202201</b>	<b>Intermediate Analysis</b>	<b>3(3-0)</b>
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Three dimensional space and vectors: rectangular coordinates in 3-space, spheres, cylindrical surfaces, and quadric surfaces; vectors: dot product, projections, cross product, parametric equations of lines; planes in 3-spaces; cylindrical and spherical coordinates. Vector -valued functions: calculus of vector valued functions, change of parameters, arc length; unit tangent, normal, and binomial vectors; curvature. Functions of two or more variable: domain, limits, and continuity; Partial derivatives; differentiability, total differentials, and local linearity; chain rule; gradient; directional derivatives; tangent planes; normal lines; maxima and minima of functions of two variables; Lagrange multipliers. Multiple integrals: double integral, double integrals in polar coordinates; triple integrals; triple integrals in cylindrical and spherical coordinates.

<b>30202203</b>	<b>Ordinary Differential Equations (1)</b>	<b>3(3-0)</b>
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Introduction and classification, solutions of first order differential equations and their applications, (Growth and decay problems and linear motion problems), solutions of second and higher order linear differential equations and their applications (Spring problem and projectile problems), series solutions of differential equations. Laplace transform and its applications.