CHEMICAL ENGINEERING BSC

FIRST YEAR

Course: Differential and Integral Calculus I
Class hours: 160
Syllabus: Intervals, inequalities and absolute values. Single variable functions: definition, elementary functions and invertibility. Limit and continuity. Fundamental limits. Derivatives: definition; geometric and kinematic interpretation. Derivative as a rate of change. Differentiation rules, and implicit differentiation. Applications of derivatives. Theorems involving differentiable functions. Analysis of function variation. Optimization problems. L'Hôspital´s rule. Taylor series and approximation error. Antiderivatives. Riemann integrals. Area between curves. Fundamental Theorem of Calculus. Integration techniques. Volumes of solids of revolution. Improper integrals.

Course: Vectors, Curves and Surfaces
Class hours: 80
Syllabus: Vectors in bi and three-dimensional geometric space: definition, addition, scalar multiplication and properties. Dot product, vector projection, cross and triple product. Lines and planes in three-dimensional spaces: equations, relative positions and applications to geometric problems. Definition of curves in two and three-dimensional spaces. Cartesian equations and parameterization of curves in two-dimensional spaces, with an emphasis on lines, circles and conics. Quadric Surfaces. Parameterization of curves in three-dimensional spaces such as intersection of cylindrical, spherical, quadratic and planar surfaces. Vector function ideas. Functions of two real variables: definition, graphical representation and contour lines. Tangent planes and normal lines to surfaces. Partial derivatives: definition and geometric interpretation.

Course: Physics I
Class hours: 160
Syllabus: Theory: physical quantities and their measures. Motion in two or three dimensions. Applied forces. Newton's laws. Equilibrium of particle. Dynamics of particle. Work and kinetic energy. Potencial energy and energy conservation. Power. Momentum, impulse and collisions. Center of mass. Equilibrium of rigid bodies. Laboratory: Physical quantities and their Measures. Measuring instruments. Experiments involving the topics of the subject matter.

Course: Drawing
Class hours: 80 horas
Syllabus: Basic geometric constructions; Projection systems, systems of representation. Reading and interpreting drawings. Technical standards. Sketch orthographic views. Parallel isometric perspective. Auxiliary views and sections, 3D visualization, solid modeling and effects of realism in 3D computer visualization.

Course: Algorithms and Programming
Class hours: 80 horas
Syllabus: Logic. Logic for Engineers. Computer Programming. Algorithm. Flowchart. Data: variables and constants. Numerical, logical, strings and user-defined types of data. Programming structures: sequential, conditional and repetitive. Subroutines. Programming language as a tool for logic development.

Course: General Chemistry
Class hours: 160 horas
Syllabus: Scientific Method; Magnetic Properties; Electronic Distribution; Ionic Bond; Metallic Bond; Molecular Orbitals; Band Theory; Semiconductors; Insulators; Physical-Chemical Properties; Covalent Bond; Lewis Theory; Molecular Geometry (VSEPR); Polarity; Intermolecular

Forces; Ideal Gas Model; Real Gas Model (van der Waals); Compressibility Factor; Thermodynamics; Enthalpy, Entropy; Free Energy; Spontaneity; The Study of Chemical Reactions; Equilibria; Chemical Kinetics; Redox Reactions; Electrolysis; Electrochemical Cells; Corrosion.

Course: Engineering Fundamentals
Class hours: 160 horas
Syllabus: Fundamental dimensions. Significant figures. Dimensional analysis. Homogeneity of equations. Systems of units and conversions. Physical measurements and treatment of experimental data. Electronic spreadsheets. Tables and graphs. Curve fittings, linear and non-linear models. Linearization. Trusses, machines and gantries. Optimization. Making prototypes. Oral, written and graphic communication.

Course: Projects and Special Activities I
Class hours: 160
Syllabus: Development of competencies, skills and attitudes relevant to the formation of future Engineer, through electives and student-centered practical activities. Training of interpretation and analysis skills. Problem solving methodologies. Development of engineering projects. Technical visits, lectures, workshops, seminars and technological competitions. Participation In undergraduate monitoring programs, scientific projects and technological research, as well as participation in social responsibility projects.

SECOND YEAR

Course: Differential and Integral Calculus II
Class hours: 80
Syllabus: Partial derivatives: Tangent plane, normal straight. Differentiability. Chain rule and implicit differentiation. Directional derivative and gradient vector. Maximum and minimum values and Lagrange multipliers. Double integrals: definition, properties, polar coordinates and applications. Triple integrals: definition, cylindrical and spherical coordinates and applications. Variable changes in multiple integrals. Vector calculation: vector fields, conservative fields, line integrals, Green's theorem, rotational and divergent operators, surface integrals, Stokes´ theorem and Gauss´ theorem.

Course: Computational Mathematics
Class hours: 80
Syllabus: Computer arithmetic / Errors: Type and Propagation / Taylor Series; Matrices and Matrix Operations / Introduction to Linear Systems / Direct Method (Gaussian Elimination) / Iterative methods (Jacobi and Gauss-Seidel) / Stopping and Convergence Criteria / Notions on Conditioning; Algebraic and Transcendent equations / Bisection Method / Newton Method; Approximation of functions / Interpolation / Linear and Polynomial Fit / Transformations / Determination Coefficient; Numerical Integration (Trapezoidal Rule, First and Second Simpson Rules); Solution of Ordinary Differential Equations / Numerical Solution (Euler and Runge-Kutta Methods) / Notions of Stability of the Solution / Errors / Solution of Higher Order Ordinary Differential Equations as a System of First Order Ordinary Differential Equations; Notions of Partial Differential Equations.

Course: Mechanics
Class hours: 80
Syllabus: Frenet frame (Moving Trihedron). Rigid Bodies Kinematics: velocity and acceleration fields, moving reference frames. Rigid Bodies Dynamics: mass distribution, center of mass

theorem, angular momentum and angular momentum theorem, kinetic energy and kinetic energy theorem.

Course: Physics II
Class hours: 160
Syllabus: THEORY: Electromagnetic interaction. Electric Field. Gauss´s Law. Electric potential. Eletrostactic energy. Electric current. Magnetic induction. Biot-Savart´s Law. Ampere´s Law. Faraday´s Law. Periodic and oscillatory motions. Simple harmonic motion. Physical concepts of forced oscillations, resonance and damped oscillations. Mechanical waves. Energy propagation. Standing waves. Maxwell´s equations. LABORATORY: D.C. generator. Eletric Field.Filiform conductors. Capacitors. Oscillatory motion. Biot-Savart´s Law. Earth Magnetic Field. Faraday´s Law. Photoelectric effect. Diffraction.

Course: Statistics
Class hours: 80
Syllabus: Descriptive Statistics: tabular and graphical presentations, location, variability and distribution shape measures; Probability: basic concepts, unidimensional random variables and common discrete (binomial and Poisson models) and continuous distributions (exponential, Weibull and Gaussian distribution); Estimation: sampling and estimation concepts, sampling distribution, confidence interval (for a population mean, proportion and variance); Hypothesis Tests: basic concepts, testing a single population mean, proportion and variance; testing multiple population means (ANOVA).

Course: Elementary Principles of Process Engineering and Thermodynamics
Class hours: 160
Syllabus: Basic principles of Thermodynamics: system, surroundings, state, energy and its forms, extensive and intensive properties. PVT relations. Thermodynamic property tables. Mass and energy balances, problems with and without chemical reactions, transient and steady-state processes, open and closed systems. Balance calculations with the use of spreadsheets. Introduction to phase equilibrium: pure substances and multicomponent ideal systems. Water activity.

Course: Applied Chemistry I
Class hours: 240
Syllabus: Organic Chemistry: IUPAC nomenclature of organic compounds, chemical bonding, principles of stereochemistry, isomerism and chirality.
Carbocations, carbanions and free radicals. Acids and bases. Effects of structure on reactivity.
Main organic chemical reactions (nucleophilic aliphatic substitution, elimination, addition, radical reactions, and redox).Physical Chemistry and Inorganic Chemistry: Chemical kinetics (rate law, reaction order, integrated equations, reaction mechanisms,
and parallel and consecutive reactions). Analytical Chemistry: Laboratory safety, sampling, equilibrium (neutralization, precipitation, redox, and complex formation). Volumetric titration (neutralization, precipitation, redox, complex formation, and indicators).

Course: Projects and Special Activities II – QM
Class hours: 160
Syllabus: Development of competencies, skills and attitudes relevant to the formation of future Chemical Engineer, through electives and student-centered practical activities. Training of interpretation and analysis skills. Problem solving methodologies. Development of engineering projects. Technical visits, lectures, workshops, seminars and technological competitions. Participation In undergraduate monitoring programs, scientific projects and technological research, as well as participation in social responsibility projects.

THIRD YEAR

Course: Applied Chemistry II
Class hours: 160
Syllabus: Organic Chemistry: Aliphatic and aromatic substitution (nucleophilic and electrophilic). Free radical substitution reactions.
Addition to carbon-carbon and to carbon-heteroatom multiple bonds. Elimination reactions. Rearrangements. Oxidations and reductions.Instrumental Analysis: Introduction to instrumental analysis, UV-VIS spectrophotometry, paper chromatography, thin-layer chromatography,ion exchange chromatography, column chromatography, gas chromatography, high performance liquid chromatography.Spectrophotometry: UV-VIS and IR.
Laboratory: preparation methods, purification, identification and quantification of organic compounds

Course: Transport Phenomena
Class hours: 160
Syllabus: Transport phenomena: mechanisms, driving force and resistance. Fluid mechanics: behavior of fluids, laminar and turbulent flows, Newton´s law for viscosity, overall momentum balance, pressure loss in the systems. Introduction to heat transfer: mechanisms and basic equations; law of conservation of energy. Conduction: Driving rate equation and the equation of heat diffusion. One-dimensional conduction in steady state. Convection: boundary layer; individual coefficients of heat transfer; analogies between the transfer of momentum and heat transfer. Natural convection. Radiation: processes and properties. Radiation exchange between surfaces. Mass transfer: mass transfer coefficients and diffusion mechanisms. Concentrations, velocities and flows. Differential balance for one component. Steady state diffusion. Transient diffusion. Diffusion with and without chemical reaction. Mass convection. Mass transfer between phases: global coefficients of mass transport.

Course: Chemical Reaction Engineering
Class hours: 160
Syllabus: Motivation to study the engineering of chemical reactions - reactor calculation. Fundamentals of chemistry on thermodynamics, kinetics and stoichiometry applied to reactor design. Application of chemical reactors to kinetic studies. Design of ideal and non-ideal, isothermal and non-isothermal chemical reactors, applied to simple reactions and complex reactions.

Course: Laboratory of Chemical Engineering
Class hours: 160
Syllabus: Programming, implementation and analysis of experiments related to the topics: Transport Phenomena, Thermodynamics for Chemical Engineering, Chemical Reactors Design and Unit Operations in Chemical Industry. Use of computational tools that enable the treatment of experimental results, as well as a greater understanding and optimization of the processes.

Course: Chemical Engineering Thermodynamics
Class hours: 160
Syllabus: Measurable thermodynamic properties and basic principles. First Law of Thermodynamics. Irreversibility, Entropy and Second Law of Thermodynamics. Heat engines and thermodynamic cycles. Equations of state and calculation of thermodynamic properties of pure fluids and mixtures. Phase equilibrium. Chemical equilibrium. Case studies in process simulation software.

Course: Electricity
Class hours: 40
Syllabus: Standards and safety in electrical installations; alternating voltage electrical circuits; AC power; three-phase circuits (applications and examples with motors); three-phase power; power factor correction; consumption measurement and electricity billing systems; electricity bill simulation.

Course: Strength of Materials
Class hours: 40
Syllabus: Statics applied to the equilibrium of structures: external and internal forces. Geometrical properties of an area. Axial load. Thermal stress. Shear stress. Torsion. Bending Stresses. Bending deformation. Pressure Vessels. Buckling of columns.

Course: Projects and Special Activities III - QM
Class hours: 160
Syllabus: Development of competencies, skills and attitudes relevant to the formation of future Chemical Engineer, through electives and student-centered practical activities. Training of interpretation and analysis skills. Problem solving methodologies. Development of engineering projects. Technical visits, lectures, workshops, seminars and technological competitions. Participation In undergraduate monitoring programs, scientific projects and technological research, as well as participation in social responsibility projects.

FOURTH YEAR

Course: Entrepreneurship and Management
Class hours: 80
Syllabus: Brief history of the evolution of the Business Administration in the modern World Systemic vision of a company, through the General Theory of Organizations Conceptualization and practical application of: Strategic Planning, Marketing Planning, Operations Planning and Financial Planning, through the design of a Business Plan of a new company, thus encouraging the entrepreneurial spirit of the students.

Course: Engineering of Biotechnological Processes
Class hours: 160
Syllabus: Motivation to study the engineering of biotechnological processes - biochemical engineering. Biology, Microbiology and Biochemistry applied to industrial biotechnology. Sterilization applied to industrial biological processes. Application of bioreactors to kinetic studies. Design of enzymatic and microbiological bioreactors. Design of agitation and aeration systems in bioreactors. Fundamentals of biological treatment of liquid effluents

Course: Unit Operations of Chemical Engineering I
Class hours: 160
Syllabus: Industrial pipes. Pumps. Agitation and Mixing. Properties of Particulate Solids and Screening. Comminution. Particle dynamics. Cyclones. Sedimentation. Flow in porous media. Fluidization. Pneumatic Conveying. Filtration.

Course: Unit Operations of Chemical Engineering II
Class hours: 160
Syllabus: Separation processes and their fundamentals.
Distillation (Industrial applications. Concept of Liquid-vapor equilibrium. Batch distillation. Continuous distillation. Typical installation. Mass and energy balances. McCabe-Thiele´s Method.

Efficiency and tray performance. Packed columns. Hydrodynamics and operational aspects. Distillation of multicomponent systems. Design of distillation columns using ASPEN Plus simulation)
Gas absorption (concept of Liquid-gas equilibrium. Typical installation and most important variables for the process. Mass balances. Height and hydrodynamics in packed column. Operational aspects. Design of absorption columns using ASPEN Plus simulation)
Liquid extraction (Concept of Liquid-liquid equilibrium. Typical installation and most important variables for the process. Mass balances. Operational aspects. Design of liquid extraction equipment using ASPEN Plus simulation)
Heat exchangers (Energy balances. Operational characteristics. Main process variables to design a heat exchanger. TEMA Standard. Design and Rating of shell and tubes heat exchanger using ASPEN PLUS simulation)

Course: Laboratory of Chemical Engineering II
Class hours: 160
Syllabus: Programming, implementation and analysis of experiments related to the topics: Transport Phenomena, Thermodynamics for Chemical Engineering, Chemical and Biochemical Reactors Design, Unit Operations in Chemical Industry, Modeling and Control of Chemical Processes.

Course: Materials for Chemical Engineering
Class hours: 160
Syllabus:.Most important engineering materials. Important issues in the choice of materials. Metallic materials. Procedures for obtaining ferrous and non-ferrous materials and its conformation. Advanced ceramic, glass (vitreous) and refractory materials. Polymer engineering. Nanomaterials. Stability of materials in the environment and its recycling. Corrosion. Metallography. Mechanical, corrosion and chemical tests.

Course: Special Projects and Activities IV
Class hours: 160
Syllabus: Development of competencies, skills and attitudes relevant to the formation of future Chemical Engineer, through electives and student-centered practical activities. Training of interpretation and analysis skills. Problem solving methodologies. Development of engineering projects. Technical visits, lectures, workshops, seminars and technological competitions. Participation In undergraduate monitoring programs, scientific projects and technological research, as well as participation in social responsibility projects.

FIFITH YEAR

Course: Economics
Class hours: 80
Syllabus: Concepts and economic relations: definition of economics. Object of the economy and basic economic problems. Theory and economic analysis: a new microeconomics. Notions of macroeconomics: concept, measures of economic activity and economic policy instruments. International Economics: Balance of Payments and current economic analysis. Brazilian Economy and Contemporary World.

Course: Industrial Process Management
Class hours: 80
Syllabus: Concept of processes and process indicators (KPIs). Quality Management in organizations (TQM). Quality tools for quality improvement. Method for problems analysis

(MASP). Concept of 5S. Sustainable operations and processes. FMEA and product development. Six sigma strategy and introduction to the concept of lean manufacturing. KAIZEN. Concept of Design of experiments (DOE). Statistical control of processes. Process capability. Fundamentals of people management in organizations.

Course: Business Law
Class hours: 40
Syllabus: Fundamentals of Law. Civil Law. Business Law. Trademarks and patent. Labor Law. Tax Law. Environmental Law. Consumer Law. System CONFEA/CREA.

Course: Hygiene and Work Safety
Class hours: 40
Syllabus: Prevention; Accidents at work; Diseases of work; Notions of occupational hygiene; Specific themes; FOODS: biological agents: assessment and control measures; biosafety; security in cold rooms; AUTOMATION AND CONTROL: ionizing and non-ionizing radiation; dangerousness; ELECTRICAL: low, medium and high voltage, electrical and fire safety. MECHANICS: occupational vibration: evaluation and measures control; safety in machinery and equipment; safety in boilers and pressure vessels; safety in welding; PRODUCTION: transportation safety and handling; warehousing and material handling; safety in layout; risk management; accident investigation. CHEMISTRY: chemical agents: assessment and control measures; safety in laboratories and transportation of hazardous materials; safety signage and labeling; Hazard and Operability Study - HAZOP.

Course: Industrial Projects
Class hours: 160
Syllabus: Project steps: Concept, Basic, Detailed, Comissioning. Design and management of industrial projects. Process diagram (PFD) and Pipping and Instrumentation Diagram (P&ID). Control strategies and ISA Standard for process design. Process safety and tools for risk analysis in processes. Main accidents in chemical industries. Case studies. Concepts of costs in projects. Basic concepts of financial mathematics. Decisions for investments. SCRUM and Agile strategies. Process simulation and dynamics simulation through ASPEN PLUS simulation

Course: Instrumentation, Simulation and Process Control
Class hours: 80
Syllabus: Motivation for the study of modeling and control of chemical processes. Fundamentals and applications of chemical processes instrumentation. Mathematical modeling and numerical techniques applied to chemical processes. Conventional and advanced control systems of chemical processes. Analysis and simulation applied to chemical engineering.

Course: Process Engineering Applied to the Waste Treatment
Class hours: 80
Syllabus Principles of liquid, gaseous and solid wastes treatment.
Waste characteristics and legislation. Treatment levels, processes and systems. Physical, chemical, physical-chemical and biological treatments. Analysis and design of waste treatment systems

Course: Undergraduate Thesis
Class hours: 160
Syllabus: The generation and dissemination of scientific and technological knowledge in society. Information sources. Academic work: its purpose and structure. Elements of Standard NBR 14724 and its construction in electronic media. Oral and graphic presentations: techniques and methodology.

Course: Supervised Internship
Class Hours: 160

ELECTIVE COURSES

Course: Oil and Petrochemicals
Class Hours: 80
Syllabus: Theories about oil formation - biogenetics and abiogenetics. Oil composition. Occurrence and extraction of oil / natural gas. Main and secondary products of an oil refinery. Structure and technologies of oil refineries. Dimension of the oil industry. Alternatives to oil. Concept and characteristics of the first-generation petrochemical industry - petrochemical plants. First generation products: ethylene, propene, butenes, aromatics. Basic technology of a petrochemical plant and its upgrade - processes and process equipment. Sustainability options.

Course: Experimental Design and Process Optimization
Class Hours: 80
Syllabus: Analysis of variance. Characteristics of factorial designs. Experimental designs with a 2k factorial scheme. Fractional factorial design. Central composite rotatable design.

Course: Fermented Food and Beverages Technology
Class Hours: 80
Syllabus: Microorganisms of industrial interest used in the production of beverages and fermented foods. Technology of femented alcoholic beverages: wine and beer. Distillated beverage technology: brandy. Technology of fermented vegetables: pickles and sauerskraut. Vinegar and Kombucha technology. Fermented milk technology. Salami technology

Course: Polymer Science and Technology
Class Hours: 80
Syllabus: Monomers, functionality, degree of polymerization, polymer classification, glass (Tg) and melting (Tm) transitions, polymerization methods: addition and condensation, copolymerization, random, alternating, block and graft copolymers. Techniques for polymerization: bulk, solution, suspension, and emulsion. Commodity and general-purpose thermoplastics: PE, PP, PS, PVC, polyesters, acrylic, and polyurethanes.Engineering plastics: nylon, polycarbonate, poly(phenyleneoxide), acrylonitrile butadiene styrene, and fluoropolymers. Thermosetting polymers: phenolic resin, melamine-formaldehyde resin, urea resin, epoxy, and unsaturated polyesters. Natural and synthetic elastomers: latex, styrene-butadiene rubber, nitrile rubber, isoprene rubber, silicone. Thermoplastic elastomers (TPE). Polymer blends and composites. Crosslinking and vulcanization. Synthesis and properties of some polymers.

Course: Cosmetics Development
Class Hours: 80
Syllabus: Cosmetic Emulsions: definition, features, applications and properties of emulsions. Key inputs and quality control. Shampoo and Conditioner: basic components and physicochemical characteristics of inputs. Definition, characteristics and properties of shampoos and conditioners. Soaps: definition, characteristics and properties of liquid and bar soaps. Standardization of solutions, saponification number, addition of fillers and packaging. Deodorant: definition, characteristics and properties of deodorants. Basic components and physicochemical characteristics of the major inputs and solvents. Gel: definition, characterization and properties of the gels. Basic components and physicochemical characteristics of inputs. Oils: definition, characterization and properties of biphasic and triphasic oils. Basic components and

physicochemical characteristics of inputs. Basic Principles for Good Manufacturing Practices and Manipulation. Quality Control: analysis of cosmetic products developed according to the requirements of ANVISA. Makeup.

Note: The student may apply for enrollment in any course offered by the CEUN-IMT, as an elective to complement the required workload, provided it has the approval of the Course Coordinator.