FEDERAL UNIVERSITY OF SANTA CATARINA
Pro-Rectory of Undergraduate Education
Academic Administration Department

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

## 1st Semester

| Course | | Type | Hours | Credits | Equivalents | Prerequisite |
|---|---|---|---|---|---|---|
| **EGR5617** | Introduction, Standardization, Freehand Technical Tracing, Systems of Representation in Technical Drawing, Sizing, Cuts and Sections, Equipment Drawing, Lay-Out Design, Flowchart Design, Industrial Piping Design, Introduction to CAD. **Technical Drawing for Chemical and Food Engineering** | Req'd | 72 | 4 | EGR5616 | |
| **EQA5103** | The concept of engineering. Methodology for solving engineering problems. Models and optimization. The chemical engineering. The chemical engineer responsibilities. Legislation and professional regulations. The importance of laboratories in chemical engineering. Curricular Structure. **Introduction to Chemical Engineering** | Req'd | 36 | 2 | ENQ1103 | |
| **FSC5101** | Introduction to the fundamental concepts of kinematics, dynamics and statics as well as conservation laws of energy and linear momentum. **Physics I** | Req'd | 72 | 4 | FSC1101 | |
| **MTM3101** | Calculation of functions of a real variable. Limits; continuity; Derivative; Derivative applications. Defined and indefinite integral. Areas between curves. Integration techniques. Improper integral. **Calculus 1** | Req'd | 72 | 4 | MTM1161<br>MTM5161<br>MTM5801 | |
| **MTM5512** | Matrices. Determinants. Linear systems. Vector algebra. The study of lines and planes. Plane curves. Surfaces. **Analytical Geometry** | Req'd | 72 | 4 | MTM1512 | |
| **QMC5152** | Atomic Structure and Periodic Table. Periodic Properties. Chemical Bonds. Chemical Reactions and Stoichiometry. Acid-Base Theory. Solutions. Coordination Compounds. **Fundamentals of General and Inorganic Chemistry** | Req'd | 72 | 4 | QMC5150 | |
| **MTM3100** | Sets and basic arithmetic. Calculation with algebraic expressions. Equations, inequalities, functions. **Pre-Calculus** | Req'd | 72 | 4 | - | |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

## 2nd Semester

| Course | | Type | Hours | Credits | Equivalents | Prerequisite |
|---|---|---|---|---|---|---|
| **FSC5002** | Study of kinematics and dynamics of rigid body rotation. Oscillations and mechanical waves (sound). Concepts of temperature, heat, the principles of thermodynamics and kinetic theory of gases. **Physics II** | Req'd | 72 | 4 | FSC5132 FSC5112 | FSC5101 |
| **FSC5122** | Complementation of the contents of mechanics, acoustics and thermal physics obtained by setting up and carrying out experiments, in a total of 12 (twelve), concerning the topics above. **Experimental Physics I** | Req'd | 54 | 3 | FSC1122 | FSC5101 |
| **MTM3102** | Methods of integration: applications of the definite integral; improper integrals; multivariable functions; partial derivatives; applications of partial derivatives; multiple integration. **Calculus 2** | Req'd | 72 | 4 | MTM1162 MTM5162 MTM5802 | MTM5161 MTM3101 |
| **MTM5245** | Vector space. Linear transformations. Change of basis. Inner product. Orthogonal transformations. Eigenvalues and eigenvectors of an operator. Diagonalization. Application of linear algebra to science. **Linear Algebra** | Req'd | 72 | 4 | MTM1245 | MTM5512 |
| **QMC5125** | Matter, general concepts. Atomic theory. Atomic structure. Electronic configuration. Atomic Orbital. Chemical bonds: ionic, covalent, metallic. Gas laws. The concept of mole. Chemical functions. Mixtures. Solutions. Concentration of solutions. Chemical equations. Redox reactions. Introduction to Chemical equilibrium, acids and bases and pH. Heat of reaction. Introduction to Thermochemistry. **Experimental General Chemistry A** | Req'd | 36 | 2 | QMC1125 | QMC5152 |
| **QMC5222** | Fundamentals of: structure, bonds, isomerism of organic compounds, stereochemistry. Classification of reagents and reactions. Methods of obtaining, chemical and physical properties of alkanes, alkenes, alkadienes, alkynes and cycloalkanes. Electronic effects. Resonance and aromaticity. Benzene and related aromatic compounds. **Theoretical Organic Chemistry A** | Req'd | 72 | 4 | QMC1222 | QMC5152 |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

## 3rd Semester

| Course | | Type | Hours | Credits | Equivalents | Prerequisite |
|---|---|---|---|---|---|---|
| **EMC5131** | Basic operations with vectors (forces). Defining moment of a force. Equivalence between sets of forces. Equilibrium of material point and rigid body on plane and space. Definition, calculation and graphical representation of internal loads of beams on the plane. Definition of strain and stress. Relationships between strain and stress (Hooke's Law). Analysis of the individual effects of internal loads in beams: axial loads, torque, bending moments and shear force. Superposition of normal stress. Stress transformation (Mohr's Circle). **Statics and Introduction to Solid Mechanics** | Req'd | 72 | 4 | EMC5125<br>FSC5050 | FSC5002 or FSC5112 or FSC5132 and MTM5162 or FSC5132 and MTM5162 |
| **FSC5113** | Analysis of the main electric and magnetic phenomena including the study of electric field, electric potential, capacitor, electric current, electromotive force, magnetic field and electromagnetic induction. **Physics III** | Req'd | 72 | 4 | FSC5133 | FSC5112 or FSC5132 or FSC5002 |
| **INE5201** | Computer systems concepts. Formulation of algorithms and their representation. Concepts of programming languages and programs. Practical implementation of algorithms in a programming language. Description of some typical applications. Computational methods in science and technology. **Introduction to Computer Science** | Req'd | 54 | 3 | CEC1128<br>CEC5201 | MTM5161or MTM3101 |
| **MTM5163** | Vector calculus concepts. Line and surface integrals. Stokes' theorem. Gauss divergence theorem. 1st order differential equations, linear differential equations of nth order. Laplace transform theory. **Calculus C** | Req'd | 90 | 5 | MTM1163<br>MTM5803 | MTM5162<br>MTM3102 |
| **QMC5229** | Alkyl and aryl halides. Organometallic compounds. Oxygenated organic compounds. Organic nitrogen compounds. Organic sulfur compounds. Polyfunctional carbonyl compounds. Heterocyclic compounds. Compounds of biological interest. Organic compounds of technological interest. **Organic Chemistry** | Req'd | 72 | 4 | QMC1229 | QMC5222 |
| **QMC5450** | Chemical kinetics and notions about chemical dynamics. **Fundamentals of Chemical Kinetics** | Req'd | 36 | 2 | QMC5412 | MTM5162 or QMC5152 or MTM3102 and QMC5152 |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

## 4th Semester

| Course | | Type | Hours | Credits | Equivalents | Prerequisite |
|---|---|---|---|---|---|---|
| **EQA5318** | Systems of units and dimensional analysis. Mass balances. Energy balances. Mass and energy balances combined. Balances of unsteady state processes. **Introduction to Chemical Processes** | Req'd | 72 | 4 | ENQ1321 ENQ5318 | FSC5112and QMC5152or FSC5112 and QMC5152 |
| **FSC5114** | Inductance and its applications. The magnetic properties of matter: diamagnetic, paramagnetic and ferromagnetic materials as well as the laws that govern them. Maxwell's equations: physical interpretation and applications. Solution of alternating current circuits in series (RLC) and transformers. Light: nature, propagation and optical phenomena (interference, diffraction and polarization). Modern Physics: introduction to quantum mechanics. **Physics IV** | Req'd | 72 | 4 | | FSC5113 |
| **FSC5123** | Complementation of the contents of electrostatics, electromagnetism and optics obtained by setting up and carrying experiments, in a total of 12 (twelve), concerning the topics above. **Experimental Physics II** | Req'd | 54 | 3 | FSC5125 | FSC5113 |
| **MTM5164** | Complex numbers. Numerical series. Function series. Partial differential equations. **Calculus D** | Req'd | 72 | 4 | MTM5166 MTM5804 | MTM5163 |
| **QMC5230** | Synthesis and purification techniques of liquid organic substances: simple and fractional distillation. Steam distillation. Synthesis and purification techniques of solid organic substances: recrystallization and use of activated carbon. Dean-Stark apparatus: use and reflux techniques. Purity determination of organic compounds by means of physical constants. Purification of solids by sublimation. Techniques for liquid-liquid and Soxhlet extractions. Chromatography: thin layer and column. **Experimental Organic Chemistry I** | Req'd | 72 | 4 | QMC1230 | QMC5222 |
| **QMC5350** | Acid-base chemical equilibrium. Chemical equilibrium in heterogeneous systems. Oxidation-reduction chemical equilibrium. Complexation chemical equilibrium. Gravimetric and volumetric principles. **Fundamentals of Analytical Chemistry** | Req'd | 36 | 2 | QMC5312 | QMC5152 |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

## 5th Semester

| Course | | Type | Hours | Credits | Equivalents | Prerequisite |
|---|---|---|---|---|---|---|
| **DIR5996** | People. Goods. Legal fact. Neighborhood rights. The company. Commercial registration. Trade name. Industrial property. Commercial societies. Securities. Employee. Employer. Work contract of employment. Stability and Brazilian pension fund (FGTS). Work safety. Social security. Legislation for engineering professionals. CONFEA. CREA. Professional practice. Professional responsibility. Copyright law for the registration of plants and designs. Professional income. **General Concepts of Law** | Req'd | 54 | 3 | DPS1140<br>DPS5140 | |
| **EQA5201** | Ferrous and non-ferrous metals. Special non-ferrous metals. Non-metallic mineral products. Polymers. Metallic protective coatings and paints. Selection criteria of materials for the construction of equipment of the chemical industry. Material testing. Corrosion. **Materials and Corrosion** | Req'd | 54 | 3 | ENQ1201<br>ENQ5201 | QMC5412 or QMC5450 |
| **EQA5341** | First law of thermodynamics and energy balance. Entropy and the second law of thermodynamics. Thermal machines. Equations of state. Thermodynamics properties of real substances. Equibilrium. Stability and change of phases of pure substances. Fugacity. **Thermodynamics for Chemical Engineering I** | Req'd | 72 | 4 | ENQ1341<br>ENQ5341 | EQA5318 and MTM5162 or EQA5318 and MTM3102 |
| **EQA5415** | Fluid statics. Global and differential balances of mass, energy and momentum. Dimensional analysis and similarity. **Transport Phenomena I** | Req'd | 72 | 4 | ENQ1415<br>ENQ5415 | EQA5318 and MTM5162 or EQA5318 and MTM3102 |
| **INE5108** | Probability theory. Random variables and probability distribution. Main discrete probability distributions. Normal distribution. Other continuous probability distributions. Estimation of parameters. Hypothesis testing. **Statistics and Probability for Formal Sciences** | Req'd | 54 | 3 | CEC1221<br>CEC5108 | MTM5162 or MTM3102 |
| **INE5202** | Errors and number systems. Solution of algebraic and transcendental equations. Solution of polynomial equations. Systems of linear and non-linear equations. Interpolation. Curve fitting. Numerical integration. Numerical solution of ordinary differential equations and systems of differential equations. **Numerical Calculus in Computers** | Req'd | 72 | 4 | CEC1103<br>CEC5202 | INE5201 and MTM5163 |
| **QMC5351** | Conductometry. Potentiometry. Ultraviolet and visible molecular absorption spectroscopy. Atomic | | | | | |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

| | | | | | | |
|---|---|---|---|---|---|---|
| | absorption spectrometry. Inductively coupled plasma optical emission spectrometry (ICP-OES) and inductively coupled plasma mass spectrometry (ICP-MS). Flame photometry. Gas chromatography. High performance liquid chromatography. Thermal methods of analysis. | | | | | |
| | **Instrumental Analytical Chemistry** | Req'd | 72 | 4 | QMC5314 | QMC5312 or QMC5350 |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

## 6th Semester

| Course | | Type | Hours | Credits | Equivalents | Prerequisite |
|---|---|---|---|---|---|---|
| **BQA5126** | Cellular structure of prokaryotic and eukaryotic organisms. Microbial growth: kinetic, nutritional requirements. General structure and function of proteins, carbohydrates, lipids and nucleic acids. Enzymes: kinetics and regulation. Cellular bioenergetics. Main pathways of carbohydrate and lipids metabolism. Biochemical fundaments of biotechnological processes. Interrelationships and metabolic regulation. Introduction to molecular biology. **Introduction to Biochemical Engineering** | Req'd | 72 | 4 | | QMC5230 |
| **EQA5313** | Unit operations of the chemical and food industry used for fluids transport, agitation and mixing; fragmentation, separation, sorting and transportation of solids, fluidization, gas-solid and liquid-solid separation, filtration, sedimentation, centrifugation. **Unit Operations of Momentum Transfer** | Req'd | 72 | 4 | ENQ5313<br>ENQ1303<br>and<br>ENQ1304 | EQA5415 |
| **EQA5342** | Thermodynamic properties of homogeneous mixtures. Partial molar property. Excess properties. Activity coefficient. Phase equilibrium. Activity coefficients obtained experimentally. Chemical equilibrium. Multiple-reaction equilibrium. **Thermodynamics for Chemical Engineering II** | Req'd | 72 | 4 | ENQ1342<br>ENQ5342 | EQA5341 |
| **EQA5408** | Kinetics of homogeneous reactions. Introduction to reactor design. Basic reactor equations. Comparison between stirred and tubular reactors. Combination of tubular and stirred reactors. Non-isothermal ideal reactors. Non-ideal reactors. **Chemical Reaction Engineering I** | Req'd | 72 | 4 | ENQ1408<br>ENQ5408 | EQA5318 |
| **EQA5416** | Heat transfer by conduction. Heat transfer by convection. Thermal radiation. **Transport Phenomena II** | Req'd | 72 | 4 | ENQ1416<br>ENQ5416 | EQA5415 |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

| 7th Semester | | | | | | |
|---|---|---|---|---|---|---|
| **Course** | | **Type** | **Hours** | **Credits** | **Equivalents** | **Prerequisite** |
| **EPS5211** | Economic System: simple and compound interest, nominal and effective rates; present value method, balance and basic accounting principles. Chart of accounts. Equity. Profit and loss results. Tax system. Inventories. ABC analysis. Introduction to financial management.<br>**Financial and Economic Planning** | Req'd | 54 | 3 | EPS1211 | 2,000 hours |
| **EQA5316** | Biochemical Engineering. Enzyme kinetics. Ideal reactors, real reactors. Stoichiometry and microbial kinetics. Bioreactors. Bioreactor technologies. Immobilized enzymes and cell culture reactors.<br>**Biochemical Engineering** | Req'd | 72 | 4 | ENQ1316<br>ENQ5316 | BQA5126and<br>EQA5318 |
| **EQA5331** | Unit operations of the chemical industry involving heat transfer phenomena (heat exchangers, evaporators).<br>**Unit Operations of Heat Transfer I** | Req'd | 72 | 4 | ENQ1331<br>ENQ5331 | EQA5416 |
| **EQA5345** | Capillarity. Thermodynamics of interfaces; electrical aspects of surface chemistry, solid-liquid-gas interfaces; wettability and detergency; adsorption; friction, lubrication and adhesion, emulsions, foams and aerosols. Chemisorption and catalysis.<br>**Surface Phenomena** | Req'd | 72 | 4 | | EQA5342 |
| **EQA5409** | Multiphase reactors. Heterogeneous catalysis. Heterogeneous catalytic reactors. Fluid-fluid reactors. Solid-fluid reactors. Analysis of reactors.<br>**Chemical Reaction Engineering II** | Req'd | 72 | 4 | ENQ1409<br>ENQ5409 | EQA5408 |
| **EQA5417** | Mass transfer by diffusion. Mass transfer by convection. Correlations for the calculation of mass transfer coefficients.<br>**Transfer Phenomena III** | Req'd | 72 | 4 | ENQ1417<br>ENQ5417 | EQA5415 |
| | -<br>**Elective I** | Req'd | 54 | 3 | | |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

## 8th Semester

| Course | | Type | Hours | Credits | Equivalents | Prerequisite |
|---|---|---|---|---|---|---|
| **EQA5214** | Clay and limestone as raw material. Wood and paper industry. Petroleum refining. Petrochemistry.<br>**Chemical Industries** | Req'd | 72 | 4 | ENQ5214 or ENQ1101and ENQ1102 | EQA5318 |
| **EQA5312** | Mathematical models for systems of chemical engineering. Numerical analysis of lumped parameters models. Numerical analysis of distributed parameters models. Computational mass and energy balance concepts in chemical plants.<br>**Process Simulation and Analysis** | Req'd | 72 | 4 | ENQ1312 ENQ5312 | EQA5416 and INE5202 |
| **EQA5333** | Unit operations of the chemical and food engineering involving simultaneous heat and mass transfer: distillation, absorption, extraction, drying.<br>**Unit Operations of Heat and Mass Transfer** | Req'd | 72 | 4 | ENQ1333 ENQ5333 | EQA5416 |
| **EQA5506** | Guidelines for the implementation and planning of a chemical industry. Symbols used in chemical processes. Types of plants, templates and models. Types of flowcharts. Guidelines about the industrial layout and the process charts. Identification of process and design variables as well as of equipment parameters. Economic analysis of chemical processes. Required number of variables for the calculation of a process. Design equation of a given process and its use for process optimization. The use of computers for solving the design and optimization equations. Conception, analysis and optimization of chemical processes.<br>**Chemical Engineering Design I** | Req'd | 72 | 4 | ENQ1505 ENQ5506 | 2,520 hours |
| **EQA5531** | Lab experiments involving the concepts of transport phenomena and unit operations. Set up, measure and analysis of the results.<br>**Laboratory of Transport Phenomena and Unit Operations I** | Req'd | 72 | 4 | ENQ1531 ENQ5531 | EQA5313 and EQA5416 |
| | -<br>**Elective II** | Req'd | 54 | 3 | | |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

## 9th Semester

| Course | | Type | Hours | Credits | Equivalents | Prerequisite |
|---|---|---|---|---|---|---|
| **EQA5309** | Environmental science. Water treatment for industrial purpose. Wastewater treatment. Air pollutants and their treatment. Instrumentation and analysis in the control of environmental pollution. **Environmental Engineering** | Req'd | 72 | 4 | ENQ1309 ENQ5309 | EQA5313 |
| **EQA5508** | Conception, sizing and optimization of a chemical process project at industrial scale. **Senior Chemical Engineering Design Project** | Req'd | 54 | 3 | EQA5507 | EQA5506 |
| **EQA5517** | Multidisciplinary experiments in the fundamentals and processes of chemical engineering. **Chemical Engineering Laboratory** | Req'd | 54 | 3 | ENQ5517or ENQ1515and ENQ1516 | EQA5342and EQA5409 |
| **EQA5521** | Automatic process control: static and dynamic characteristics of the process, the controller and the final element. Transfer functions. Controller performance. Frequency response analysis. **Process Control I** | Req'd | 72 | 4 | ENQ1521 ENQ5521 | EQA5417and MTM5164 |
| **EQA5532** | Lab experiments involving the concepts of transport phenomena and unit operations. Set up, measurements and analysis of results. **Laboratory of Transport Phenomena and Unit Operations II** | Req'd | 72 | 4 | ENQ1532 ENQ5532 | EQA5331and EQA5417 |
| | **Elective III** | Req'd | 54 | 3 | | |
| | **Elective IV** | Req'd | 54 | 3 | | |

# Descriptions of Required Courses and Prerequisites

Major: **216 – Chemical Engineering**
Curriculum: **19911**
**Habilitation: Chemical Engineering**

| 10th Semester | | | | | | |
|---|---|---|---|---|---|---|
| **Course** | | **Type** | **Hours** | **Credits** | **Equivalents** | **Prerequisite** |
| **EQA5615** | Supervised internship with minimum workload of 600 hours in industry or research institution related to the Chemical Engineering field. Individual practice guided by a department faculty. Report presentation of the activities developed during the internship. **Supervised Internship** | Req'd | 720 | 40 | ENQ1615 ENQ5615 | EQA5333 and 3,474 hours or QMC5412 or QMC5450 and 3,474 hours |

| | |
|---|---|
| Technological Center<br>Chemical and Food Engineering Department | Pro-Rectory of Undergraduate Education<br>Academic Administration Department |