# Master of Science Program in "Green Process Engineering"

## Joint degree between Cairo University and Universitat Rovira i Virgili - Tarragona - Spain

# Academic and Study Regulations of the Program

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### Definition of the program:

It is a joint master's program to obtain a master of science in green process engineering from Cairo university and a professional master's degree in Sustainable Energy from Universitat Rovira i Virgil, in cooperation between Cairo University in the Arab Republic of Egypt (CU) and the Universitat Rovira i Virgili (URV).

The program attracts graduates of engineering faculties who aim to develop engineering expertise and gain knowledge in the direction of green process engineering. It is an important tool to develop expertise toward making more sustainable processes. These experiences help graduates in both current and future jobs for the benefit of the economy, environment and society. The courses and research of the proposed graduate program are designed in such a way that no introductory courses or qualifying courses are required for the rest of the courses. In this regard, some of the proposed courses will be presented at the beginning of a number of basic introductory lectures to understand the other contents during the study of these courses.

### General Terms: **All items of the regulations of graduate studies at the Faculty of Engineering - Cairo University issued in 2020 shall apply unless otherwise stated.**

### Registration Conditions:

The conditions of enrollment in the general rules of the regulations of graduate studies at the Faculty of Engineering, Cairo University, shall apply with the replacement of item 5-A with the following condition:

The student must have a bachelor's degree with a grade of at least good or $B^-$ in various practical university engineering disciplines from one of the colleges recognized by the Supreme Council of Universities

## 1- Master of Science in Green Process Engineering

**Credit Hour (Egypt) = 2.5 Credit Hours (Spain)**

**Table (219) Master of Science in Green Process Engineering**

| Thesis supervisors | | University | | | | Total Credit Hours | Grade Type |
|---|---|---|---|---|---|---|---|
| | Mission | Fourth Semester | Third Semester | Second Semester | First Semester | | |
| **From Cairo University and from the Universitat Rovira i Virgili** | 18 **URV** credits **(in Spain)** 7 **credit hours** + **At least 5 credits** (CUs) | 30 **URV** credits **(in Spain)** 12 **credit hours** | 30 **URV** credits **(in Spain)** 12 **credit hours** | CU 9 **Credit Hours** | CU 11 **Credit Hours** | 44 + **12 (per message)** | **Joint Degree** |
| **Cairo University – Egypt** | CU 12 **At least one credit hour for the thesis** | | CU 6 **Credit Hours** | CU 9 **Credit Hours** | CU 11 **Credit Hours** | 38 | **Cairo University Degree – Egypt** |

Cairo University (Egypt): CU Universitat Rovira i Virgili (Spain): URV

**Table (220): Compulsory Courses during the First Semester**

**(Total Credit Hours = 11)**

| First Semester Courses (11 credit hours) | | | |
|---|---|---|---|
| Place of study | Number of Credit Hours | Course | Code |
| Cairo University | 3 | **Process Integration of Green Engineering** | CHE 62D |

| | | | |
|---|---|---|---|
| Cairo University | 1 | Environmental Laws and Waste Management | CHE63B |
| Cairo University | 2 | Environmentally conscious product and process design | CHE 63D |
| Cairo University | 2 | Elective Course (1) for the first semester | CHE6xx |
| Cairo University – Egypt | 2 | Elective Course (2) for the first semester | CHE 6xx |

**Table (221): Compulsory Courses during the Second Semester**

**(Total credit hours = 9)**

| Second Semester Courses (9 credit hours) | | | |
|---|---|---|---|
| Place of study | Number of Credit Hours | Course | Code |
| **Cairo University** | 3 | Foundations of Technical Writing | GEN 600 |
| **Cairo University** | 2 | Risk & Project Management | CHE62E |
| **Cairo University** | 2 | Elective Course (3) for the second semester | CHE6xx |
| **Cairo University** | 2 | Elective Course (4) for the second semester | CHE 6xx |

**Table (222): Elective Courses during the First and Third Semesters**

| Place of study | Number of Credit Hours | Course | Code |
|---|---|---|---|
| Cairo University | 2 | Spanish language | GEN 321 |
| Cairo University | 2 | Introduction to Renewable Energy | CHE62A |
| Cairo University | 2 | Programming, modeling and simulation of industrial processes | CHE 62B |
| Cairo University | 2 | Green Energy Engineering | CHE 62C |

| Place of study | Number of Credit Hours | Course | Code |
|---|---|---|---|
| Cairo University | 2 | Laboratory Experiment Design and Data Analysis | CHE 62F |
| Cairo University | 2 | Chemical Reactions and Catalysts Engineering | CHE62G |
| Cairo University | 1 | Seminars and industrial topics | CHE63A |
| Cairo University | 2 | Fundamentals of Chemical Engineering | CHE 63C |
| Cairo Universit | 2 | Process Environmental Control Introduction | CHE 63E |
| Cairo University | 2 | High Temperature Chemical Industry | CHE 63F |
| Cairo University | 2 | Environmental impact assessment of projects | CHE 64E |
| Cairo University | 2 | Risk assessment in Practical life | CHE 63G |

**Table (223): Compulsory Courses during the Third Semester of the Single Degree (Total Credit Hours = 6)**

| Third Semester Courses (6 credit hours) | | | |
|---|---|---|---|
| Place of study | Number of Credit Hours | Course | Code |
| Cairo University | 2 | Water Treatment & Desalination | CHE 64D |
| Cairo University | 2 | Elective Course 5 for the third semester | CHE 6xx |

| | | | |
|---|---|---|---|
| Cairo University | 2 | Elective Course (6) for the third semester | CHE 6xx |

**Table (224): Compulsory Courses – Joint Degree in Spain**

**Third semester in Spain**

**(Total credit points = 30 which is equivalent to 12 credits)**

| Place of study | Number of Credit Points | Course | Code |
|---|---|---|---|
| University of Rovira i Virgili | 3 | Environmental and Energy Management | CHE 64F |
| Universitat Rovira i Virgili | 4.5 | Sustainability Tools | CHE 65A |
| Universitat Rovira i Virgili | 3 | Environment and Energy Legislation | CHE 65B |
| Universitat Rovira i Virgili | 4.5 | Renewable Energy Technology | CHE 65C |
| Universitat Rovira i Virgili | 4.5 | Energy efficiency in industry | CHE 65D |
| Universitat Rovira i Virgili | 4.5 | Waste Assessment and Management | CHE 65E |
| Universitat Rovira i Virgili | 3 | Efficient Environmental Design (1) | CHE 65F |
| Universitat Rovira i Virgili | 3 | 1 elective course for the third semester | CHE 6xx |

**Table (225): Compulsory Courses – Joint Degree in Spain**

**Fourth semester in Spain**

**(Total credit points = 30 which is equivalent to 12 credits)**

| Place of study | Number of Credit Points | Course | Code |
|---|---|---|---|
| Universitat Rovira i Virgili | 4.5 | Advanced Water Treatment | CHE 66A |
| Universitat Rovira i Virgili | 3 | Environmental and Energy Economics | CHE 66B |

| | | | |
|---|---|---|---|
| Universitat Rovira i Virgili | 4.5 | Thermal & Hydraulic Machinery | CHE 66C |
| Universitat Rovira i Virgili | 4.5 | Energy efficiency in buildings | CHE 66D |
| Universitat Rovira i Virgili | 4.5 | Air pollution | CHE 66E |
| Universitat Rovira i Virgili | 3 | Eco-Design Efficient (2) | CHE 66F |
| Universitat Rovira i Virgili | 3 | Elective Course (1) for the Fourth Semester | CHE 6xx |
| University of Rovira i Virgili | 3 | Elective Course (2) for the Fourth Semester | CHE 6xx |

**Table (226): Elective Courses – Joint Degree in Spain**

1 elective course with 3 credit points in the third semester

2 elective courses of 6 credit points in the fourth semester

| Place of study | Number of Credit Points | Elective Courses | Code |
|---|---|---|---|
| Universitat Rovira i Virgili | 3 | Digital Simulation for Environmental and Energy Engineering | CHE 67C |
| Universitat Rovira i Virgili | 3 | Analytical methods and their applications in environmental engineering | CHE 67D |
| Universitat Rovira i Virgili | 4.5 | Management & Corporate Management | CHE 67E |
| Universitat Rovira i Virgili | 3 | Industrial Leadership | CHE 67F |
| Universitat Rovira i Virgili | 3 | Principles of Chemical Engineering | CHE 68A |
| Universitat Rovira i Virgili | 3 | Joint Operations | CHE 68B |
| Universitat Rovira i Virgili | 6 | Advanced thermodynamics and fluid mechanics | CHE 68C |
| Universitat Rovira i Virgili | 3 | Reactor Design | CHE 68D |

| | | | |
|---|---|---|---|
| Universitat Rovira i Virgili | 3 | Contaminant Dispersal Model | CHE 68E |
| Universitat Rovira i Virgili | 3 | Modeling of wastewater treatment units | CHE 68F |
| Universitat Rovira i Virgili | 3 | Renewable Energy Integration | CHE 69A |
| Universitat Rovira i Virgili | 3 | Change of management | CHE 69B |
| Universitat Rovira i Virgili | 3 | Emerging Energy Technology | CHE 69C |

**After the fourth semester in Spain**

| Place of study | Number of Credit Points | Course | Code |
|---|---|---|---|
| Universitat Rovira i Virgili | 18 | Collect scientific material for the thesis | CHE 67A |
| Universitat Rovira i Virgili | 12 | Externship (optional) | CHE 67B |

# Course Description

**Master of Science in Green Process Engineering**

## Compulsory Courses (Cairo University)

**CHE 62D: Process Integration of Green Engineering ( 3 credit hours )**

The nature of chemical industry design and integration, an introduction to the progressive scheme in design – the hierarchy of the design process: design stages, operational integration, targeting the design and integration process, sorting design and integration alternatives, composite curves for energy targeting, heat recovery pinch, algorithmic method of calculations, selection of cooling and heating means, design of heat exchanger networks to achieve the lowest energy, mass integration comprehensive targeting, direct recycling strategies, source/sink mapping, drawing pinch shapes for re- Rotation, mass integration pinch, design of a resource-intensive mass exchanger network, applications and case studies to reduce waste.

**CHE63B: Environmental Law and Waste Management (1 credit hour)**

Introduction, environmental laws and regulations, general concept of pollution, sources of pollution and regulations for wastewater, regulations for gas emissions, executive regulations of the workplace, regulations and laws for solid and hazardous waste, auditing, characterization of waste and waste reduction, waste treatment and safe disposal of waste .

**CHE63D: : Product and Process Conscious Environmental Design (2 credit hours)**

Clean production, risk concepts, product life cycle, occupational hazards, dispersion models of pollutants, water body recovery, green chemistry, environmental audits, environmental cost accounting, industrial ecology, simultaneous energy and mass integration, environmental acceptance of the chemical reaction pathway, membrane separation systems, environmental performance assessment during process design

**GEN600 : Foundations of Technical Writing (3 credit hours)**

**CHE62E: Project and Risk Management ( 2 credit hours)**

Introduction, project development, observation concept, team formation of supporters, advanced forward studies, establishment of companies and major agreements, detailed feasibility studies (bankable), joint venture and partner selection, financing, project schedule, project implementation

and engineering phase management, project implementation stages: construction, commissioning, start-up etc.

Economics: supply and demand, the concept of marginality and improvement, formulas of benefits and equivalence, economic analysis of alternatives.

Evaluation and project criteria: payback period, decision making between alternatives, depreciation and depletion accounting, risk and decision making, simulation techniques, project feasibility study

Risk Management: Introduction. Definition of risk. Postulates and terms of risk. The probabilistic nature of the risks. From the five-step risk assessment approach. Risk management and assessment. Control and control of risks. Control hierarchy. Preliminary Risk Analysis (PRA)

**CHE 64D: Water Treatment and Desalination (2 credit hours)**

Introduction, characterization of water quality and important contaminants in wastewater, industrial wastewater/wastewater, pipe end water treatment, common types of treatment methods, primary/secondary methods, secondary waste management, design and evaluation of sewage and industrial water treatment plants, disinfection methods, laboratory and experimental measurements

**Electives at Cairo University**

**GEN 321: Spanish (Level I) ( 2 credit hours)**

Basic knowledge of the Spanish language, the first level of Spanish, practical exercises.

**CHE 62A: Introduction to Renewable Energy (2 credit hours)**

Energy use and global trends, solar thermal energy for heating, solar photovoltaic systems for electricity production, wind energy and simple theory of wind turbines, power, hydropower and hydropower systems, fuel cells, biomass, fuel and alcohol, geothermal energy and source heat pumps, ocean energy: wave and wave systems, tides.

**CHE 62B: Programming, Modeling and Simulation of Industrial Processes (2 credit hours)**

Introduction to separation processes in chemical industries, introduction to chemical process modeling, basics of simulation principles, commercial simulation software, model selection for

thermodynamic and thermal property calculations, simulation of fixed frame industrial processes, equipment sizing, distillation simulation, simulation of systems with chemical reactions, simulation of pressure changes, simulation of heat transfer equipment, optimization in the simulation process, simulation of oil characterization, dynamic process simulation, case studies of crude oil separation and fractionation systems and processing Natural gas, interactive systems, data and sensitivity analysis.

**CHE 62C: Green Energy Engineering (2 credit hours)**

Resources / Introduction – Biomass to Energy – Gas-to-Liquids – Fischer Tropsch reactions and simulations – Waste valorization – Liquid and solid waste – Green hydrogen – Waste-to-energy – Green diesel – Green energy economics.

**CHE62F: Laboratory Experiment Design and Data Analysis (2 credit hours)**

Introduction to laboratory instrument analysis, chromatographic techniques, high-performance chromatography analyzers in the liquid state, spectroscopy techniques, Fourier transform using infrared, atomic absorption (AA), induction plasma (ICP), visible ultraviolet (UV) rays, an overview of ISO/IEC 17025 requirements , data analysis and interpretation.

**CHE62G :Engineering of Chemical Reactions and Catalysts (2 credit hours)**

Particle Kinetic Theory – Arrhenius Equation – Effect of temperature on reaction rate – Effect of activation energy on reaction rate – Equilibrium vs. catalysis – Homogeneous catalysis – Heterogeneous catalysis – Effect of adsorption on heterogeneous catalysis – Effect of surface reaction on heterogeneous catalysis – Effect of adsorption on heterogeneous catalysis – Mechanism of adsorption process – Mechanism of adsorption process

**CHE63A: Seminars and Industry Topics (2 credit hours)**

Selected topics from industries cover chemical and petrochemical industries, refining industries, cement, fertilizers, etc. Selected topics include start-up, decommissioning, maintenance, commissioning, control and waste control, etc.

**CHE63C :Fundamentals of Chemical Engineering (2 credit hours)**

Introduction, – Types of processes used in chemical engineering: dimensions and units – Unit systems commonly used in chemical engineering (universal system and English system) – The

importance of measurement systems. Dynamic and dimensional consistency and units of the mentioned equations. Balance of matter: Law of conservation of mass – equations used for material balance in a constant state. Degrees of freedom – solving the balances of materials using linear and nonlinear equations. Systems with multiple subsystems – rotating, overtaking and disposing of certain quantities. Chemical reactions – the physical balance in processes involving chemical reactions. The physical balance of processes involving different phases. Energy balance: forms of energy – energy conservation – energy balance in systems involving a chemical reaction.

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**CHE63E: Introduction to Environmental Control for Operations (2 credit hours)**

Computer control of industrial processes (introduction, limited purpose computers, integrated systems), intermittent control systems and their conversions, analysis of nonlinear systems, control of combustion processes, separation of dust and gaseous pollutants, evaporator systems, drying processes, chemical reactors.

**CHE63F: High Temperature Chemical Industry (2 credit hours)**

Ceramic industry: a brief introduction to the classification of ceramic products, raw materials and general production methods, types of pollutants and emissions and methods of reducing pollution, and energy conservation in the ceramic industry .

Cement industry: raw materials, industrial production, technical problems, gas and solid emissions and ways to reduce them, energy considerations and savings methods. Fuels: environmental and practical considerations.

Glass industry: raw materials, manufacturing methods, solid and gaseous emissions and mitigation methods, energy saving in the glass industry.

**CHE 63G: Risk Assessment in Practical Life (2 credit hours)**

Decision making under uncertainty – Special applications: indoor hazards, fire calculations The status of explosive mixtures BLEVE. Can risk be a management technique? Risk-based decision-making. ISO systems. Cost-benefit analysis. Engineering representation of results. Accident investigation and reporting

Concepts of crisis and emergency management and preparedness for emergencies and crises. The concept of resilience

**CHE64E: Environmental Impact Assessment of Water Projects (2 credit hours)**

Introduction – Purpose and Objective of Environmental Impact Assessment, EIA Management and Practice, and the concept of associated assessments, Key elements of the EIA process, Operationalization of EIA, The role of popular participation, which follows the stages of EIA, The costs and benefits of conducting an Environmental Impact Assessment, Understanding the strengths and weaknesses of EIA

**Compulsory Courses – Joint Degree in Spain**

**CHE64F: Environmental and Energy Management (3 credits)**

Environmental and Energy Management Systems: / ISO 14001:2015 – system EMAS ISO 50001:2011 – –Environmental Impact Assessment، IPPC Routing ، Environment and energy assessments.

**CHE 65A: Sustainability Tools (4.5 credits)**

Introduction to sustainability tools, life cycle assessment, life cycle inventory, characterization factors, life cycle impact assessment, environmental burden distribution, uncertainty, software, environmental risk assessment and decision-making: Introduction to environmental risks: REACH guidance, risk definition, toxicology/epidemiology, dose and response assessment, exposure assessment, risk characterization. Ecological Design and Eco-Tagging: Eco-Design Guides, Tools, Environmental Improvement Assessment, Communications.

**CHE65B: Environmental and Energy Legislation (3 credits)**

Part 1 – Environmental Law and Policy: A Energy Issue. Sustainability, Security and Development – International Energy Law – EU Energy Law – National Energy Law

Part 2 – Emissions Law and Markets: International, European and Domestic Climate Change Law – EU Emissions Trading System Regulation

Part 3 – Environmental Law: Public Administrations and the Scope of the Judiciary in Environmental Law – Public Participation, Access to Environmental Information, and Access to Justice in Environmental Cases – Environmental Impact Assessment of Projects – Environmental Protection and Control of Activities – Environmental Labeling and Environmental Auditing

Part 4 – Environmental Responsibility:

**CHE 65C: Renewable Energy Technology (4,5 credits)**

Energy Resources, Renewable and Non-Renewable Energy Sources, General Introduction, Renewable Energies: Solar Thermal and Geothermal - Biomass and Biofuels - Wind Energy - Solar Photovoltaic - Hydropower. Energy Systems Integration: Distributed Generation - Energy Storage - Smart Grids

**CHE 65D: Energy efficiency in industry (4,5 credits)**

Industry: Energy efficiency in electrical systems - cogeneration of heat and electricity - integration of processes - analysis of processes based on the second law of thermodynamics - modeling of energy processes. Transportation: Propulsion systems - vehicles with internal combustion engines, electric and hybrid vehicles

**CHE65E: Waste Assessment and Management (4,5 credits)**

Fundamentals of waste management and business strategies, waste treatment systems - legal framework - measurements and preventive measures. Treatments and techniques for waste management - best available technologies. Valuation of waste with membrane technologies

**CHE 66F1: Environmental Design Competence (1) (3 credits)**

**CHE 66F2: Environmental Design Competence (2) (3 credits)**

Description of the contents of the course in the first and second chapters as follows:

Overview of vehicle production and process design, process optimization: process constraints and product constraints, assessment of environmental metrics of products and processes Life cycle databases, use of environmental standards and indicators in designing more sustainable chemical processes, assessment of the impact of modifications in operating variables and topological changes in the environmental behavior of the process, energy integration in processes - Bench methodology,

Decision tools support: sequential emulators, equation-based emulators - degrees of freedom design variables, solving issues using licensed programs such as: EES , AspenPlus , Hysys , Superpro.

**CHE 66A: Advanced Water Treatment (4,5 credits)**

Legislation applicable to wastewater treatment, water treatment for industrial uses, urban and industrial wastewater reuse, membrane technologies for effluent treatment, advanced biological processes, advanced oxidation processes, best available technologies in water treatment

**CHE 66B: Environmental and Energy Economics (3 credits)**

Introduction to environmental economics, market and environmental failure, environmental quality economics, environmental policy analysis, environmental assessment, energy intensity in the EU economy, energy taxation.

**CHE 66C: Thermal and hydraulic machines (4,5 credits)**

Thermal machinery: – Gas power cycles – Gas turbines – Steam power cycles – Steam turbines – Cooling cycles and heat pumps. Hydraulic machinery: pumps, turbines, fans – flow in piping systems

**CHE66D: Energy efficiency in buildings (4,5 credits)**

Introduction: Definition of air conditioning, Climate: Impact of climate on energy demand in buildings,Comfort: assessment of comfort in buildings, calculation of thermal loads in buildings: properties of building materials– External conditions for design: Methods for calculating thermal loads in buildings – Calculation of thermal loads in buildings with simulation programs EnergyPlus . Air conditioning systems: selection criterion–Air conditioning system elements– Air systems– Water and air systems– Direct expansion systems– All water systems– Energy review in buildings–Identification of systems that consume heat and energy– Measure energy consumption – Energy flow chart.– Techniques for preparing and submitting an energy audit.– Buildings that achieve energy self–sufficiency– Definition of buildings close to energy self–sufficiency in terms of consumption and net balance.– Type of self–generation: Insulated/interconnected network

**CHE 66E: Air Pollution (4,5 credits)**

Atmosphere: layers of the atmosphere – large–scale movement of the atmosphere – temperature and water vapor – composition of the atmosphere – radiation – energy balance. Atmospheric composition, global cycles, and life times:times of atmospheric residence – sulfur compounds – nitrogenous compounds – carbonaceous compounds – halogen compounds – atmospheric ozone – particulate matter– emission stocks– hazardous air pollutants. Meteorology of air pollution: temperature and pressure at the bottom – atmosphere – atmospheric stability – stability layers – introduction to pollutant dispersion models. Global Trading: Global Trading Model. Atmospheric chemistry and climate: global temperature record and solar change – Potential effects of global

warming – Atmospheric chemistry and climate change – Carbon dioxide. Air Pollution Monitoring and Control: Network Monitoring – Pollution Control. Prevention and treatment: cleaner production strategies to reduce air pollutants – Joint processes to separate gaseous air pollutants.– Joint processes to separate particulate air pollutants– Carbon capture.

**Elective Courses – Joint Degree in Spain**

**CHE 67C: Digital Simulation for Environmental and Energy Engineering (3 credits)**

Part I. Introduction to CFD software. Introduction to ANSYS. Simple calculation of two-dimensional tracks. Network independence test. Solution convergence. Introduction to the models available in the ANSYS program .

**CHE 67D: Analytical Methods and their Applications in Environmental Engineering (3 credits)**

Processing and Statistics Data Analysis in Environmental Engineering – Basic statistical reasoning: confidence intervals and hypothesis testing, accuracy of suitability tests, independence testing for two categories of variables, relationships between variables: ANOVA , ANCOVA , simple and multiple regression, discrimination analysis– Multivariate interdependence techniques: key component analysis and factor analysis. GIS, Introduction: Definition and physical and logical components of any GIS application. Practical activities: Introduction to the GIS environment, map configuration, search and selection operations, overlay operations, proximity operations, numbering, and data export.

**CHE 67E: Management and Corporate Management (4,5 credits)**

Advanced Quality: APQP – Problem Solving – PAP– 5S– 6 SIGMA – ISO/TS

Industrial Regulation: Environmental Enhancement – Environmental Program Management – Environmental Industrialization and TPM – Empowerment

Operations and Supply Chain Management: Supply Chain Management – Business Management Strategy – Operations and Balances – Procurement and Supply – Warehouse Management – IT's– ECR – MRP– International Logistics

Economics and Finance for Engineers: Topics – Cost Factors – Prices – Competitiveness – Market Factor – Finance – Price Scenarios – Pricing

**CHE 67F: Industrial Driving (3 credits)**

Introduction to Entrepreneurship: What the Pioneer Does- The Difference Between Entrepreneurship and Management - Does the Pioneer Generate or Make - Does the Pioneer Really Make a Difference

Behavior-based transformational leadership models: behavior-based transformational leadership models - the relationship to the European Foundation for Quality Management Excellence Model - The model presented by researchers Koss and Posner - The model presented by the researcher Jane Klan - Emotional competence - Alabart Dictionary of Efficiency

Talent Leadership: Talent and Potential – Invest in your talents and those of your colleagues – Strengthen your team

Leadership and integrity: the concept of integrity - integrity behaviors - the ABC model - the use of fear as a brake - the Johari window

Leadership and Guiding Principles: Vision, Mission, and Values

Organization Management System: Organizational Structure - Operations Management System. Continuous improvement - strategy management system - quantitative improvement.

Leadership and Influence: Identifying External Stakeholders - Customer Orientation - Identifying Potential Partners to Form Partnerships - Outreach to External Stakeholders - Corporate Social Responsibility

Leadership and motivation for excellence: continuous improvement and innovation

Leadership and empowerment: looking forward to results - the concept of empowerment - how to provide appreciation - how to provide constructive criticism - how to deal with rowdy employees - conflict management

**CHE 68B: Principles of Chemical Engineering (3 credits)**

Introduction, Chemical Engineering and Production Processes: General Concepts - Types of Processes Used in Chemical Engineering. Variables used in chemical processes: dimensions and units - unit systems commonly used in chemical engineering (universal system and English system) - importance of measurement systems. Dynamic and dimensional consistency and units of the mentioned equations. Balance of matter: Law of conservation of mass - equations used for material balance in a constant state. Degrees of freedom - solving the balances of materials using linear and nonlinear equations. Systems with multiple subsystems - rotating, overtaking

and disposing of certain quantities. Chemical reactions – the physical balance in processes involving chemical reactions. Phase equilibrium: states of aggregation of matter – phase diagrams.equations of description of gases – partial pressure and vapor pressure. Gas and liquid equilibrium – saturation – partial saturation and moisture. Liquid and liquid equilibrium – solubility – partially miscible or immiscible liquids. The physical balance of processes involving different phases. Energy balance: forms of energy – energy conservation – the first law of thermodynamics – enthalpy changes with or without phase change – energy balance in systems involving a chemical reaction.

**CHE 68B: Joint Operations (3 credits)**

Introduction: Characteristics and types of separation unit operations, equilibrium phases: devices – equilibrium phases – material balance – operating lines – calculations with graphical methods. Dual distillation: rapid distillation – fractional distillation – devices – operating lines – calculation of the number of stages using the Makib Tila method – concept and calculation of phase efficiency – Fensky equation for calculating the minimum number of stages – minimum rebound ratio. Basic concepts in the processes of material transitions: Theoretical models and calculation of material transition coefficients using experimental equations. Gas absorption: continuous contact equipment – differential mass balance – number of transport units – equations and experimental models.

**CHE 68C: Advanced Thermodynamics and Fluid Mechanics (6 credits)**

Introduction, fluids, continuity hypothesis. Fluid statics: tangential and perpendicular forces – pressure – balance of forces in a fixed fluid. Fluid dynamics: balance of forces in a fluid element – Navyer Stokes equations – Applications – Law of Mechanical Energy Survival – Applications. Bernoulli equation – flow in pipes – hydraulic machinery.

Thermal engineering: heat transfer by conduction – heat transfer by convection – calculation and design of heat exchange equipment – radiation – hygrometer.

**CHE 68D: Reactor Design (3 credits)**

Thermodynamic problems related to a chemical reaction: reactants – equilibrium – energy changes

Balance of matter: without and with chemical reaction, construction of kinetic models from experimental data: using batch reactors – using flow reactors. Batch reactor design, flow reactor design, power balance and safety matters.

**CHE 68E: Pollutant Dispersal Model (3 credits)**

Introduction. Conservation laws: Fundamentals of pollutant transport – Main processes in the environment – Physicochemical properties – Introduction to mathematical modeling

Environmental Interbalance: Introduction to Multicomponent Models – Mechanism of Transport of Pollutants in the Liquid State – Diffusion Models (Atmospheric Diffusion Models) – Transfer of Pollutants in Surface Water – Transfer of Contaminants in Groundwater – Transfer of Contaminants in Soil

**CHE 68F: Modeling of Wastewater Treatment Units (3 credits)**

Introduction. Current status of wastewater treatment in urban and industrial areas.Outline of the wastewater treatment process: primary treatment and phase II and III. Economic and thermal balances for wastewater treatment plants.

Physicochemical processes: sorting and scrutinizing.–Aeration systems.– Sedimentation, coagulation and flocculation.

Biological treatment of wastewater: speed of movement of microbes – activated sludge systems – biological nitrogen removal – biophosphorus removal – selection and design criteria. Modifications of traditional processes. Other aerobic processes.

Tertiary wastewater treatment: filtration, nutrient removal, disinfection

Biological treatment of industrial water: anaerobic biological digestion – sludge management – reduction and sewage processes – sedimentation.

Wastewater Treatment Plant Controls – Model Applications for the Design and Operation of Urban and Industrial Sewerage Treatment Plants.

**CHE 69A: Renewable Energy Integration (3 credits)**

Renewable energy standards and laws for the electricity grid: Electricity systems connection network– Connection in electrical networks for distribution and transmission in power systems– Internal grid connection – Self–consumption – Electrical grid connection process – Special system

for energy systems – Spanish regulation and renewable energy legislation – Catalan legislation on the regulation of renewable energy

Electrical technology and control systems: parallel connection in low voltage networks – parallel connection in medium voltage networks – measurement of energy produced and exchanged with the electrical network – sequential control systems – measurement and regulation systems – electrical power systems

Electrical protection associated with renewable energy plants: grounding and protection against indirect contacts– transformer stations– stations without transformers– overload protection– DC side protection– AC side protection– device switching and connection selection–Overvoltage protection

Electrical Energy Storage:

Analysis of different energy storage systems: electrochemical systems: hydrogen technology, flow– conventional and advanced batteries and batteries– Other systems: flywheel, supercapacitors, etc. – Virtual storage and energy management: cooling and freezing plants, water desalination, electric vehicles, electrolytes, etc.

Integrating renewable energy into buildings: introduction. Fundamentals of dual and triple cogeneration – production of electricity, heat and cooling technology – solar thermal and photovoltaic energy – solar cooling – multi–generation of power generation. Thermal energy storage

**CH 69B: Change of Management (3 credits)**

Introduction to Entrepreneurship and Change Management: The radical transformation of Tihar prison thanks to Kieran Bedi – highly efficient entrepreneurial behaviors – the era of unexpected radical changes – the relationship to the European Foundation for Quality Management Excellence Model

A Systematic Approach to Leading Change: John B. Cotter's Style: The Top Perspective – Generating a Sense of Urgency – Creating an Entrepreneurial Team – Forming Vision and Strategy – Communicating the Vision of Change – Enabling Large–Scale Activity – Achieving Short–Term Victories – Using Victories to Promote and Consolidate Change – Establishing New Trends in the Organization's Culture

Human and environmental factors: reactions to change – strategies to reduce anxiety and stress

**CHE 69C: Emerging Energy Technology (3 credits)**

Current use of energy: description of primary sources of energy, identification of several types of energy: chemical, solar, nuclear, electrical energy, energy density, comparison of energy contents with some food products, petroleum and other fossil fuels, petroleum specifications, products derived from petroleum: Refinery .Refinery Products from the modern photosynthesis process: Biorefineries

Useful energy statistics: daily energy use, hidden energy uses, potential future renewable energy, individual ways to reduce energy consumption, energy technologies different from fossil fuels. The importance of the future of energy mix waves

Waves, tides and thermal energy from the oceans. Conventional geothermal heat, deep geothermal sugar to ethyl alcohol, energy efficiency. Solar PV – Solar Thermal – Wind – Advanced Biofuels – Manufactured Photosynthesis – Nuclear – Fission and Fusion

Part II. Demonstrate, model and calculate a flow problem of environmental or energy–related concern using numerical simulation and interpretation of results.