OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

VST FAKULTÄT FÜR VERFAHRENS- UND SYSTEMTECHNIK

Module Catalogue

Master Program

Process Safety and Environmental Engineering

Date: 2019-06-29

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1 Description of our Process Engineering Program

1.1 The Process Engineering Discipline

Process engineering focuses on developing, operating, and optimizing

- efficient,
- sustainable,
- safe,
- and economic

processes that convert raw materials into valuable products using physical, biological, and chemical processes. Process engineering is used to synthesize pharmaceuticals from fine chemicals, extract advanced materials such as fuels and plastics from oil, forge construction materials and ceramics from stone, purify metal from ore, recover recyclables and energy from waste, obtain silicon and glass from sand, and derive food from agricultural resources. Process engineering is everywhere, even when it is not apparent at first sight—and it is essential for the economy and society. It is especially indispensable in balancing societal demands for prosperity with efficient processes that sustainably preserve life and the environment.

Core topics covered in the process engineering program include:

- environmental analysis
- molecular modeling
- recycling
- material transport and storage
- modeling and analysis of energetic processes
- hazard assessment, risk analysis, and safety technology

1.2 Requirements for Admission

The Process Safety and Environmental Engineering master program is taught in the English language.

Applicants must have obtained a bachelor degree (210 Credit Points, EQF 6) in:

- Chemical engineering,
- Process engineering,
- Energy engineering,
- or a related field.

Adequate English language skills must be demonstrated through:

- TOEFL-test (550 points paper based, 213 points computer based, or 80 points internet based),
- Cambridge Certificate of Proficiency in English (CPE) – minimum score: C,
- Cambridge Certificate of Advanced English (CAE) – minimum score: B,
  or IELTS-test overall band score 6.0.

2 Objectives

2.1 Goals of the Process Safety and Environmental Engineering master program

The economical usage of energy resources, safe production and handling of materials, and the protection of the environment are gaining importance worldwide. Safety and environmental protection are indispensable elements of any industrial activity. In a modern society technical processes will only be accepted if the emerging hazards are identified and kept under control and if the environmental impact is reduced to an acceptable minimum. To achieve these aims, experts are needed which possess both an in-depth understanding of process engineering as well as specific knowledge of safety and environmental technologies. The master program **Process Safety and Environmental Engineering** aims to educate experts for industry as well as for authorities, research organizations, and higher education.

Graduates from the program are versed in the natural scientific fundamentals of technical processes, especially those related to safety and environment and think and act holistically in the assessment of safety and environmental concerns and their prevention and mitigation. They are capable to apply their engineering know-how to safety and environmental problems and appropriate solutions.

Graduates analyze processes based on advanced methods and models and develop new products, methods and system solutions to for safety and environment-related challenges.

They are able to identify gaps of knowledge in their field and plan and conduct theoretical and experimental studies to bridge these gaps, including a critical evaluation of the obtained data. They support and develop further a consciousness for safety and environmental protection in their professional affiliations.

Potential areas of employment include:
chemical and pharmaceutical industry, petro-chemical industry, oil and gas industry, power generation, waste management, animal feed and food industries, materials science, apparatus, machine and plant engineering, research organizations, etc.

2.2 Curriculum

The **Process Safety and Environmental Engineering** master program consists of modules. In addition to the compulsory modules on the topics of process engineering, safety and environmental technology, heat and mass transfer, and legal and management issues related to safety and environment, the students are required to compose their own study program with elective courses from the module catalogue. Completion of the Master thesis demonstrates that the student is qualified to work independently on academic topics.

After a standard study period of 3 semesters, the students can acquire 90 credit points (CP). The **Process Safety and Environmental Engineering** master program provides students with the opportunity to perform further research, particularly in areas such as process technology, environmental technology, energy technology and safety technology. The graduates are able to independently develop products, processes, technologies and, engineering solutions, making them into nationally and internationally respected experts in the field.

3 Program Overview

	1. Semester			2. Semester			3. Semester		
	CP	SWS	PA	CP	SWS	PA	CP	SWS	PA
Required Coursework	Σ = 50 CP								
Module 1 – Thermal Process Engineering	5	2-2-0	K120						
Module 2 –Advanced Heat and Mass Transfer				5	2-2-0	K120			
Module 3 – Chemical Reaction Engineering				5	2-2-0	K120			
Module 4 - Hazardous Properties of Materials			K240						
Hazardous Materials and Safety Characteristics	3	2-0-0							
Dispersion of Hazardous Materials	4	2-1-0							
Industrial Explosion Protection	3	2-0-0							
Module 5 - Technical Risks and Risk Assessment						K240			
Methods of Risk Analysis				4	2-1-0				
Fire Safety in Industrial Facilities				4	2-1-0				
Simulation Lab	2	0-0-2	P/F						
Module 6 - Environmental Engineering						K240			
Air Pollution Control				4	2-1-0				
Waste Water and Sludge Treatment	4	2-1-0							
Environmental Science Research Project	2	0-0-2	P/F						
Module 7 – Process Safety									
Legal Issues in Plant Operation and Process Safety				3	2-0-0	G			
Excursion				2	0-0-2	G			
Elective Coursework	∑ = 10 CP								
Module 8 - Elective Courses	7	5		3	2				
Module 9 - Master Thesis							30		KO
Sum	30			30			30		

CP – Credit points
G – Graded assessment
K – Final examination (duration given in minutes)
KO – Colloquium
PA – Final examination
P/F – Pass-Fail
SWS – Semester week hourly workload (Lecture-Tutorial-Lab)

4 Compulsory Modules

4.1 Module 1: Thermal Process Engineering

Compulsory Module for the **Process Safety and Environmental Engineering** Master Program
Module 1: Thermal Process Engineering
Module Objectives (Competences): At the end of this course, students will be able to: • recall the fundamentals of thermal separation processes, • apply these principles to selected unit operations (distillation/rectification, absorption, extraction, convective drying), • transfer these principles to the numerous further existing thermal separation processes, • generate solutions for problems of practical relevance.
Contents: Equilibrium separation processes: ▪ Thermodynamics of vapor-liquid equilibrium ▪ Batch and continuous distillation ▪ Theory of separation cascades, rectification in try and packed columns ▪ Separation of azeotropic mixtures ▪ Practical design and hydraulic dimensioning of tray and packed columns ▪ Gas-liquid equilibrium ▪ Absorption in tray and packed columns ▪ Practical design of absorption apparatuses ▪ Thermodynamics of liquid-liquid equilibrium ▪ Separation of liquid mixtures by extraction ▪ Practical design of extraction equipment Kinetically controlled separation processes: ▪ Fundamentals of convective drying ▪ Adsorption equilibrium and standardized drying curve of the single particle ▪ Dimensioning of convective dryers ▪ Evaporations of liquid mixtures in inert gas ▪ Diffusion distillation and pseudo-azeotropic points
Forms of Instruction / Course Language: Lecture with tutorial / English
Duration and Semester: 1 semester, winter semester
Prerequisites:
Workload: 2-2-0, classroom = 56 hours and self-studies = 94 hours
Assessments/Exams/Credits: K120 (written exam 120 min)/ 5 CP
Responsible/Lecturer: Prof. Dr.-Ing. Evangelos Tsotsas, IVT-TVT/FVST
Text/References: - Own notes for download - Seader, J.D., Henley, E.J.: Separation process principles, Wiley, New York, 1998 - Thurner, F., Schlünder, E.-U.: Destillation, Absorption, Extraktion, Thieme, Stuttgart, 1986

4.2 Module 2: Advanced Heat and Mass Transfer

Compulsory Module for the **Process Safety and Environmental Engineering** Master Program
Module 2: Advanced Heat and Mass Transfer
Module Objectives (Competences): At the end of this course, participants will be able to: · outline radiation heat transfer mechanism, radiation shields, secondary radiation heat transfer effects, · determine the heat radiation from flames, · apply the methods of intensive cooling with liquids and calculate important parameters of the heating and cooling processes for different solid bodies i.e. building walls, doors and windows, · analyze the coupled heat and mass transport processes using equilibrium relationships, · judge the criteria for ignition, extinguishing system and other safety related issues during a process plant design.
Contents: ▪ Fourier's differential equation with boundary conditions and temperature gradients ▪ Simplified analytical solution for one-dimensional and dimensionless heat conduction in different conditions i.e. multi-dimensional heat conduction, heat transfer in semi-infinite bodies and short times, contact temperature, critical heat flux densities for pain sensing ▪ Heat transfer by radiation - mechanism, intensity, emissivity for solid, liquid and gaseous substances as well as dust and soot. ▪ View factors, radiative exchange, radiation shielding, greenhouse effect ▪ Secondary radiation effect of emergency blankets ▪ Solidification and melting processes ▪ Intensive cooling operations, diving, film and spray cooling influence of fluids, critical heat flux densities, Leidenfrost Effect. ▪ Coupled heat and mass transport processes, equilibrium conditions at phase boundaries, coal combustion
Forms of Instruction / Course Language: Lecture with tutorial / English
Duration and Semester: 1 semester, summer semester
Prerequisites:
Workload: 2-2-0, classroom = 56 hours and self-studies = 94 hours
Assessments/Exams/Credits: K120 (written exam 120 min)/ 5 CP
Responsible/Lecturer: Prof. Dr.-Ing. Eckehard Specht, ISUT/FVST
Text/References: - A.F. Mills: Basic Heat and Mass Transfer, Prentice Hall - Handouts can be downloaded. Downloading link will be provided during lecture.

4.3 Module 3: Chemical Reaction Engineering

Compulsory Module for the **Process Safety and Environmental Engineering** Master Program
Module 3: Chemical Reaction Engineering
Module Objectives (Competences): At the end of the course Chemical Reaction Engineering, students will be able to: · identify reaction pathways and reaction conditions based on mass and energy balances · calculate conversion rates of chemical reactions, · compare existing reactor concepts, · select suitable reactor types for specific given reactions and assess the efficiency of reactor concepts and judge critical design features.
Contents: 1. Stoichiometry of chemical reactions ▪ Key components and key reactions ▪ Extent of reaction, conversion, selectivity, and yield 2. Chemical thermodynamics ▪ Reaction enthalpy ▪ Temperature and pressure dependency ▪ Chemical equilibrium ▪ Free Gibbs enthalpy ▪ Equilibrium constant K_p and temperature dependency ▪ Pressure influence on chemical equilibrium 3. Kinetics ▪ Reaction rate ▪ Rate laws of simple reactions ▪ Decomposition, parallel and series reactions ▪ Equilibrium limited reactions ▪ Estimation of kinetic parameters ▪ Differential method ▪ Integral method ▪ Kinetics of heterogeneously catalyzed reactions ▪ Adsorption and Chemisorption ▪ Langmuir-Hinshelwood kinetics ▪ Temperature dependency of heterogeneously catalyzed reactions 4. Mass transfer in heterogeneous catalysis ▪ Basics ▪ Diffusion in porous systems ▪ Pore diffusion and reaction ▪ Film diffusion und reaction ▪ Thiele module and pore efficiency factor 5. Design of chemical reactors ▪ Reaction engineering principles ▪ General mass balance ▪ Isothermal reactors ▪ Ideal batch reactor (BR) ▪ Ideal plug flow reactor (PFR) ▪ Ideal continuous stirred tank reactor (CSTR)

- Real technical reactors
- Cascade of stirred tanks

6. Heat balance of chemical reactors
    - General heat balance
    - Cooled CSTR
    - Stability problems in chemical reactors
    - Residence time behavior
    - Calculation of conversion in real reactor systems
    - Cascade model, Dispersions model, Segregation model
    - Modeling of conventional fixed-bed reactors
    - Selectivity problems
    - Increase of selectivity in membrane reactors
7. Material aspects in chemical process engineering
    - Importance of the chemical industry and feedstock
    - Steam cracking of hydrocarbons
    - Chemical products

Forms of Instruction / Course Language:
Lecture with tutorial / English

Duration and Semester:
1 semester, summer semester

Prerequisites:

Workload:
2-2-0, classroom = 56 hours and self-studies = 94 hours

Assessments/Exams/Credits:
K120 (written exam 120 min)/ 5 CP

Responsible/Lecturer:
Prof. Dr.-Ing. Andreas Seidel-Morgenstern, IVT-CVT/FVST

Text/References:
O. Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, 1972

4.4 Module 4: Hazardous Properties of Materials

Compulsory Module for the **Process Safety and Environmental Engineering** Master Program	
Module 4:	**Hazardous Properties of Materials** Section I: Hazardous Materials and Safety Characteristics Section II: Dispersion of Hazardous Materials Section III: Industrial Explosion Protection
Module objectives (competences): Section I: Hazardous Materials and Safety Characteristics At the end of this course, students will be able to: ▪ identify important properties of chemicals and recall the analytical methods to determine these properties. ▪ explain reaction behavior in terms of the molecular structure and thermodynamic process conditions. ▪ calculate safety indicators from thermo-chemical properties and categorize the substances according to a reactivity assessment. ▪ assess the hazard potential of materials. ▪ judge industrial scenarios according to their hazards and develop safety concepts. Section II: Dispersion of hazardous materials At the end of this course, participants will be able to: ▪ outline the principles of passive and jet dispersion in gas or particle phase and in relation to the atmospheric stability conditions. ▪ interpret release scenarios and calculate concentration profiles for emissions in the x-y-z space and depending on time. ▪ assess the hazard for organisms present in the radius of action of the release and compare the calculated concentrations with relevant hazard threshold values. ▪ formulate solutions for dealing with the problem of accidental releases of hazardous substances from industrial installations. ▪ design concepts to control accidental releases in an industrial environment. Section III: Industrial explosion protection At the end of this course, students will be able to: ▪ identify the explosion hazards in different branches of industry. ▪ explain the phenomenology of initiation and propagation of explosions and the role of key influencing factors. ▪ calculate explosion safety indicators and apply the concept of safety indicators to process equipment. ▪ categorize explosible substances according to their hazard potential, ▪ choose suitable explosion protection concepts and compare their pro's and con's. ▪ reduce the explosion hazard in industrial situations and derive safe operation conditions for it.	
Content: Section I: Hazardous Materials and Safety Characteristics ▪ Overview of groups of hazardous materials (toxicity, ignition sensitivity, fire and explosion hazards) ▪ safety indicators of hazardous materials ▪ experimental testing procedures for safety data ▪ computational methods for safety data	

- application of safety indicators in protective measures

Section II: Dispersion of hazardous materials

- Emission and passive dispersion of neutral and heavy gases, atmospheric stability conditions,
- Gaussian distribution based dispersion models,
- Particle trajectories-based simulation models,
- Jet dispersion,
- Partitioning and fate of chemicals in the environment
- Toxicity of substances, the Acute Exposure Guideline Level concept,
- Release of liquids and gases from leakages,
- Dispersion of radionuclides

Section III: Industrial explosion protection

- Gas, dust and hybrid mixture explosions, phenomenology
- Ignition sources and processes
- Properties of reactive gases, vapors of flammable liquids, dusts, mists and aerosols and foams
- Assessment of explosion hazards
- Explosion protection measures and concepts, design and application principles

Forms of Instruction / Course Language:
Lecture with tutorial / English

Duration and Semester:
1 semester, winter semester

Prerequisites:

Workload:
Section I: 2-0-0, classroom = 28 hours and self-studies = 62 hours
Section II: 2-1-0, classroom = 42 hours and self-studies = 78 hours
Section III: 2-0-0, classroom = 28 hours and self-studies = 62 hours

Assessments/Exams/Credits:
K240 (written exam 240 min) / 10 CP

Responsible:
Prof. Dr.-Ing. Ulrich Krause, IAUT/FVST
Lecturers:
Section I: Prof. Dr.-Ing. Ulrich Krause, IAUT/FVST
Section II: Dr. rer. Nat. Ronald Zinke, IAUT/FVST
Section III: Prof. Dr.-Ing. Ulrich Krause, IAUT/FVST

Text/References:
- Steinbach: Safety Assessment for Chemical Processes
- Steen/Hattwig: Handbook of Explosion protection
- Eckhoff: Dust explosions in the process industries
- Mannan: Lee's Loss prevention in the Process Industries
- Stoessel: Thermal Safety of Chemical Processes
- UN Handbook for Tranportation of Dangerous Goods ("Orange Book")
- Visscher: Air Dispersion Modeling: Foundations and Applications
- TNO Coloured Books Series

4.5 Module 5: Technical Risks and Risk Assessment

Required Module for the **Process Safety and Environmental Engineering** Master Program	
Module 5:	**Technical Risks and Risk Assessment** Section I: Methods of Risk Analysis Section II: Fire Safety in Industrial Facilities Section III: Simulation Lab

Module Objectives:

Section I: Methods of Risk Analysis

At the end of this course, students will be able to:

- summarize knowledge in the field of probabilistic safety analysis and quantitative risk assessment for technical systems and processes.
- discuss several qualitative, semi-quantitative and quantitative risk analysis methods including Hazard and Operability Studies (HAZOP), Layer of Protection Analysis (LOPA), Failure Mode and Effect Analysis (FMEA), Fault and Event Tree analysis.
- perform a risk analysis and calculate the reliability of technical systems.
- analyze the outcome of different methods of risk analysis and judge these methods.
- evaluate an example scenario by a complete quantitative risk assessment including event tree and fault tree analysis, consequence assessment and risk integration techniques and create safety concepts to minimize the risk from industrial situations.

Section II: Fire Safety in Industrial Facilities

At the end of this course, students will be able to:

- identify major fire hazards in the process industries.
- describe fire-related properties of materials produced or handled and summarize ignition sources.
- apply mathematical tools and simulation methods to calculate fire effects like flame radius and height, radiative heat and smoke dispersion.
- analyze fire and smoke propagation through industrial installations including computational fluid dynamics methods and judge fire effects.
- compare the effects of fire protection measures and principles and generate fire prevention and protection concepts.

Section III: Simulation Lab

At the end of this course, students will be able to:

- recognize simulation tools for process engineering including safety analysis tools.
- calculate process scenarios, structure simulation problems including process design studies and hazard assessment.
- evaluate the plausibility of computed results and assess uncertainties in simulations.
- generate preferable process designs and develop safety concepts.

Contents:

Section I:

- Probability distributions and functions (Kolmogorov Axioms), conditional probability, Bayes theorem, maximum likelihood function.
- Risk analysis terminology.
- In detail HAZOP study (content, structure and implementation).
- Quantitative Risk Analysis consisiting of Master Logic Diagram preparation, selection of the analysis area, development of Event Trees for technical incidents and Fault Trees for failure of safety barriers.

- Methods to determine the magnitude of damage for industrial accidents, damage effects on individuals, and Probit function distributions.
- Calculation methods for individual and group risk and development of risk graph.
- Reliability models, failure rates, availability of technical systems.
- Safety Integrity levels (SIL).

Section II:
- Behavior of materials in fire, thermal and chemical stability, physical and chemical properties of combustible materials,
- calculation of fire loads, determination of combustion efficiency
- Fire and smoke propagation, simulation models
- Fires of solids and liquid materials, pool fires, jet fires
- Radiation heat transfer from fires between process installations
- Fire detection in industrial facilities
- Firefighting in industrial facilities

Section III:
- Process engineering software tools (e.g. ASPEN), handling, range and limits of application
- Modelling chemical synthesis and process design with safety considerations
- Assignment paper for process design and plant layout
- Process safety study for selected process and plant design

Forms of Instruction / Course Language:
Lecture, tutorial, and lab / English

Duration and Semester:
2 semesters, summer semester (Sections I and II) and winter semester (Section III)

Prerequisites:

Workload:
Section I: 2-1-0, classroom = 42 hours and self-studies = 78 hours
Section II: 2-1-0, classroom = 42 hours and self-studies = 78 hours
Section III: 0-0-2, computer lab = 28 hours and self-studies = 32 hours

Assessments/Exams/Credits:
K240 (written exam 240 min) / 10 CP

Responsible:
Prof. Dr.-Ing. Ulrich Krause, IAUT/FVST

Lecturers:
Section I: Prof. Dr.-Ing. Ulrich Krause, IAUT/FVST
Section II: Dr.-Ing. Andrea Klippel, IAUT/FVST
Section III: M.Sc. Elizabeth Richter, IAUT/FVST

Text/References:
- Steinbach: Safety Assessment for Chemical Processes
- Bedford/Cooke: Probabilistic Risk Analysis - Foundations and Methods
- Mannan: Lee’s Loss prevention in the Process Industries
- SFPE Handbook Fire protection Engineering
- Drysdale: An introduction to fire dynamics

4.6 Module 6: Environmental Engineering

<table>
<tr><td colspan="2">Required Module for the Process Safety and Environmental Engineering Master Program</td></tr>
<tr><td>Module 6:</td><td>Environmental Engineering
Section I: Air Pollution Control
Section II: Waste Water and Sludge Treatment
Section III: Environmental Science Research Project</td></tr>
<tr><td colspan="2">Module Objectives (technical, methodological, key skills):
Section I: Air Pollution Control
At the end of this course, participants will be able to:
▪ outline the framework of environmental engineering.
▪ explain and summarize the sources and consequences of air pollution.
▪ select strategies for the prevention of air pollution through the efficient combination of mechanical, thermal, chemical, and biological processes and justify their solutions in the context of environmental protection and economy.
▪ design air pollution control processes and equipment using the principles of mechanical, thermal, chemical, and biological processes for the treatment of exhaust gases.

Section II: Waste Water and Sludge Treatment
At the end of this course, students will be able to:
▪ identify the relevant physical, chemical and biological properties of wastewater and recognize the fundamentals of wastewater treatment technologies.
▪ explain the relevant physical, chemical and biological properties of bio-solids from wastewater treatment and classify them according to hazard criteria.
▪ predict emissions to surface water and analyze methods for their control.
▪ develop creative solutions for the treatment of wastewater.

Section III: Environmental Science Research Project
At the end of this course, students will be able to:
▪ report their own scientific achievements while citing references appropriately.
▪ analyze processes according to their environmental impact.
▪ evaluate the published work of other authors and formulate the scientific motivation for their own efforts.
▪ derive and express meaningful conclusions from experimentally or theoretically obtained results.
▪ compose scientific articles on selected topics of safety or environmental technology.</td></tr>
<tr><td colspan="2">Contents:
Section I: Air Pollution Control
▪ Sources of air pollution
▪ Basic meteorological processes
▪ Health risks of air pollution exposure
▪ Environmental impact of air pollution
▪ Gas-phase chemistry and measurements
▪ Pollution emission controls and regulations
▪ Technologies for air pollution control

Section II: Waste Water and Sludge Treatment
▪ Constituents and analysis of waste water
▪ Principles of mechanical treatment processes</td></tr>
</table>

- Principles of biological treatment processes
- Principles of chemical treatment processes
- Activated sludge processes
- Biofilm processes
- Process selection
- Wastewater sludge treatment processes
- Disinfection processes
- Water reuse

Section III: Environmental Science Research Project
- Selection of a (small-scale, preferably theoretical) research topic, identifying the gap of knowledge,
- Literature review on the topic,
- Structuring of a scientific article
- Drafting a scientific paper on the topic selected
- Preparing a group presentation on the paper

Forms of Instruction / Course Language:
Section I: Lecture and tutorial / English
Section II: Lecture and tutorial / English
Section III: Group project, scientific essay, oral presentation / English

Duration and Semester:
2 semesters, summer semester (Section I) and winter semester (Sections II and III)

Prerequisites:

Workload:
Section I: 2-1-0, classroom = 42 hours and self-studies = 78 hours
Section II: 2-1-0, classroom = 42 hours and self-studies = 78 hours
Section III: 0-0-2, classroom = 28 hours and self-studies = 32 hours

Assessments/Exams/Credits:
K240 (written exam 240 min) / 10 CP

Responsible:
Prof. Dr.-Ing. Ulrich Krause, IAUT/FVST
Lecturers:
Section I: Dr.-Ing. Kristin Hecht, IAUT/FVST
Section II: Prof. Dr.-Ing. Heinz Köser, IAUT/FVST
Section III: Dr.-Ing. Kristin Hecht, IAUT/FVST

Text/References:
- Jacob: Introduction to Atmospheric Chemistry
- Baumbach: Air Quality Control
- Tan: Air Pollution and Greenhouse Gases
- N.F. Gray "Water Technology", Elsevier 2005;
- Metcalf a. Eddy "Wastewater Engineering" MacGraw Hill 2003,
- P. A. Vesilind "Wastewater treatment plant design"
- "Student Workbook" IWA Publishing, 2003
- Handouts will be given during lecture

4.7 Module 7: Process Safety

Required Module for the **Process Safety and Environmental Engineering** Master Program

Module 7: **Process Safety**
Section I: Legal Issues in Plant Operation and Process Safety
Section II: Excursion

Module Objectives:

Section I: Legal issues in plant operation and process safety

At the end of this course, students will be able to:

- Recognize legal requirements regarding safety of an operating industrial facility according to different national and international directives.
- discuss the important ethical and legal responsibilities of a Safety Engineer in a process plant and the social rammifications of process safety.
- interpret the classification systems for hazardous substances (REACH) and hazardous materials (GHS).
- classify hazards from the operation of technical facilities and systems according to relevant regulations and analyze different materials with respect to associated hazards, which also meet the requirements of Dangerous Substances Regulation.
- develop solutions for the safe handling and transportation of materials within the framework of regulations.

Section II:

At the end of this course, students will be able to:

- recognize typical problems and approaches for dealing with them based upon theoretical knowledge supplemented with hearing the perspectives of process safety professionals and viewing first-hand an operating plant or a hazard testing and research lab.
- restate practical experience about industrial realities.
- judge solutions and develop processes in adherence to safety principles and with respect to practical application.

Contents:

Section I:

- The content and purpose of the Federal Pollution Control Act and subordinate legal regulations, in particular the Major accident regulations. Also content of the SEVESO European Union directive (Chemical Accidents - Prevention, Preparedness and Response)
- Characteristics and sequence hazardous incidents in process plants, case studies (Seveso, Flixborough) including their social consequences and resulting legislation
- Responsibilities for the operation of process plants, basic duties, extended duties, threshold quantities, safety clearances, safety report, ethics
- Content and purpose of Hazardous Substances Ordinance, Technical rules for Hazardous Substances
- Systems and methods for classifying hazardous substances, REACH system, and Material Safety Data Sheet (MSDS)
- Labeling systems for hazardous substances
- Legal obligations of operators for the safe operation of machinery, equipment and technical systems
- Systematic analysis of hazards in operating areas

- Structure and content of risk assessment according to EC ATEX Directives

Section II:
- Excursion to an industrial operation
- Discussion of industrial safety protocols and requirements
- Exposure to industrial fittings and equipment
- Professional perspectives on dealing with working hazards

Forms of Instruction / Course Language:
Lecture with tutorial, excursion/ English

Duration and Semester:
1 semester, summer semester

Prerequisites:

Workload:
Section I: 2-0-0 classroom = 28 hours and self-studies = 62 hours
Section II: 0-0-2 classroom = 28 hours and self-studies = 32 hours

Assessments/Exams/Credits:
Section I: graded assessment of performance/ 3 CP
Section II: graded assessment of performance/ 2 CP
The module grade is the CP-weighted average of the section grades.

Responsible:
Prof. Dr.-Ing. Ulrich Krause, IAUT/FVST

Lecturers:
Section I: Prof. Dr. Thomas Schendler (BAM), IAUT/FVST
Section II: Prof. Dr.-Ing. Ulrich Krause, IAUT/FVST

Text/References:
- Series of European Commission Seveso Directives
- Mannan: Lee’s Loss prevention in the Process Industries
- UN Handbook for Transportation of Dangerous Goods (Orange Book)
- UN manuals for the handling of hazardous materials and dangerous goods (Yellow Book, Purple Book)
- European Directives on Explosive Atmosphere
- More will be given during lecture

4.8 Module 8: Elective Courses

Required Module for the **Process Safety and Environmental Engineering** Master Program
Module 8: Elective Courses
Module Objectives: The elective courses enable to students to customize their educational experience while still getting a broad education foundation in environmental engineering and process safety. Students deepen their understanding of process engineering in the subjects of their choice. Students can develop sub-specialties in their area of interest or develop skills that they wish to use in their future careers.
Contents: A minimum of three and maximum of five elective courses are chosen from the list of elective courses published by the examination office: http://www.fvst.ovgu.de/en/Examination+Office/Courses+of+Study.html The courses cover a wide range of topics. Students may choose related courses to specialize in a certain area or may choose different topics to gain a broader perspective.
Forms of Instruction / Course Language: Course dependent, see list of elective courses
Duration and Semester: 2 semesters, summer semester and winter semester
Prerequisites: Course dependent, see list of elective courses
Workload: Course dependent, see list of elective courses At least 10 CP in sum
Assessments/Exams/Credits: Each elective course has its own final examination, detailed in the list of elective courses. The module grade is the average grade with equal weight given to each course. The module is worth a maximum of 10 CP.
Responsible: Prof. Dr.-Ing. Ulrich Krause, IAUT/FVST **Lecturers:** Course dependent, see list of elective courses
Text/References: Course dependent, see list of elective courses

4.9 Module 9: Master Thesis

Required Module for the **Process Safety and Environmental Engineering** Master Program
Module 9: Master Thesis
Objectives: The Master thesis serves to prove that the student is qualified to work independently on a given academic problem with scientific methods within a specific period of time. After completing a master thesis, students will be able to: ▪ recognize and interpret the state-of-the-art in a selected field and present the gap of knowledge. ▪ analyze and assess potential solutions critically. ▪ situate their work within the context of current research and justify their own approaches. ▪ create new knowledge and develop innovative solutions in the field of the thesis.
Contents: Subjects related to current research projects are published by the professors of the faculty. The students can chose a subject of their choice. The setting of the topic and the name of the examiner has to be documented at the examination office. In the colloquium the students have to prove, that they are able to defend the results of their independent scientific processing. Therefore the results have to be presented in a 15 minutes talk with subsequent questions.
Forms of Instruction / Course Language: Independent problem-solving with concluding assignment
Duration and Semester: 1 semester, summer or winter semester
Prerequisites: 50 CP
Workload: 20 weeks
Assessments/Exams/Credits: Master thesis with colloquium / 30 CP
Responsible: Chairman of the board of examiners
Text/References: