Competence coverage matrix

GHENT UNIVERSITY

Master of Science in Chemical Engineering

Academic year 2021-2022

Legend:
T=teaching methods
E=evaluation methods

			General Courses														Master's Dissertation
			E071200 Unit Operations in Chemical Industry	E072110 Chemical Reactors: Fundamentals and Applications	E007920 Computer Control of Industrial Processes	E072302 Safety, Health and Environmental Management	E073720 Industrial Project	E071181 Chemistry of Industrial Processes	E071131 Sustainable Chemical Production Processes	E068900 Structure and Dynamics of Polymers	E064950 Polymer Reaction Engineering	E073760 Chemical Process Design	E074200 Kinetic Modelling and Simulation	E040533 Computational Fluid Dynamics in Chemical Technology	E028700 Thermal installations	E091103 Master's Dissertation
Competences in one/more scientific discipline(s)	Master and apply advanced knowledge in the own engineering discipline in solving complex problems.	T 13 E 13	T E	T E	T E		T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E
	Apply Computer Aided Engineering (CAE) tools and advanced communication instruments in a creative and purposeful way.	T 9 E 9		T E	T E		T E		T E	T E	T E	T E	T E	T E			
	Innovative use of expert-knowledge in all parts of chemical installations and the processes taking place in them.	T 9 E 8	T	T E			T E		T E		T E	T E	T E			T E	T E
	Creative use of expert-knowledge for design and optimisation of chemical installations.	T 8 E 7	T E	T E	T E		T E		T		T E	T E					T E
	Original, constructive and innovative use of different and supporting engineering-disciplines during design and research.	T 8 E 8		T E	T E		T E		T E	T E	T E	T E					T E
	Apply knowledge of basic chemistry to chemical installations, especially during development of chemical-analytical ways of thinking.	T 5 E 5		T E			T E	T E	T E		T E						
	Apply knowledge of basic mathematics to chemical installations, especially during the development of mathematical-analytical ways of thinking.	T 5 E 5		T E	T E				T E		T E	T E					
	Apply knowledge of chemistry and process technology to arrive at a solution-focused approach of reactor design and choice of materials.	T 4 E 4		T E			T E		T E		T E						
	Apply knowledge of physics and process technology to arrive at a solution-focused choice of apparatus.	T 5 E 5		T E			T E		T E		T E	T E					
Scientific competences	Analyse complex problems and translate them into concrete research questions.	T 9 E 9	T E	T E	T E		T E		T E	T E	T E		T E				T E
	Consult the scientific literature as part of the own research.	T 6 E 6			T E		T E		T E	T E		T E					T E
	Select and apply the appropriate models, methods and techniques.	T 11 E 11	T E	T E	T E		T E			T E	T E	T E	T E	T E	T E		T E
	Develop and validate mathematical models and methods.	T 4 E 4		T E	T E						T E		T E				
	Interpret research findings in an objective and critical manner.	T 4 E 4			T E		T E						T E				T E
	Be able to handle lack of data for multidisciplinary formulations of problems.	T 7 E 7		T E			T E		T E		T E	T E	T E				T E
	Compose experimental schemata in view of design and optimisation of models.	T 3 E 3			T E								T E				T E
	Perform result-focused scientific research and design.	T 2 E 2			T E												T E
	Be prepared to identify, evaluate and eliminate shortcomings in own research and design.	T 3 E 3					T E						T E				T E
Intellectual competences	Independently form an opinion on complex situations and problems, and defend this point of view.	T 10 E 10	T E	T E	T E		T E		T E	T E	T E	T E	T E				T E
	Apply knowledge in a creative, purposeful and innovative way to research, conceptual design and production.	T 12 E 12	T E	T E	T E		T E		T E	T E	T E	T E	T E	T E	T E		T E
	Critically reflect on one's own way of thinking and acting, and understand the limits of one's competences.	T 5 E 5			T E		T E			T E		T E					T E
	Stay uptodate with the evolutions in the discipline to elevate the own competences to expert level.	T 2 E 1														T	T E
	Readily adapt to changing professional circumstances.	T 3 E 3					T E		T E								T E
	Problem-avoiding, problem-solving and system-oriented scientific thinking.	T 8 E 8		T E	T E		T E		T E	T E	T E	T E					T E
	Critically analyse scientific and industrial problems in the domain of chemical technology and compare own analysis to that of others.	T 8 E 7		T E			T E		T	T E	T E	T E	T E				T E
	Independently extend the own area of research, taking into account the constant evolution of the area of expertise.	T 1 E 1															T E
Competences in cooperation and communication	Have the ability to communicate in English about the own field of specialisation.	T 9 E 8			T E		T E		T E	T E	T E	T E	T E		T		T E
	Project management: have the ability to formulate objectives, report efficiently, keep track of targets, follow the progress of the project,...	T 9 E 9	T E	T E	T E		T E		T E	T E	T E		T E				T E
	Have the ability to work as a member of a team in a multi disciplinary workingenvironment, as well as being capable of taking on supervisory responsibilities.	T 5 E 5		T E	T E		T E		T E		T E						
	Report on technical or scientific subjects verbally, in writing and using graphics.	T 11 E 11	T E	T E	T E		T E		T E	T E	T E	T E	T E	T E			T E
Societal competences	Act in an ethical, professional and social way.	T 5 E 4			T E		T E		T E							T	T E
	Recognize the most important business and legal aspects of the own engineering discipline.	T 3 E 3				T E	T E		T E								
	Understand the historical evolution of the own engineering discipline and its social relevance.	T 3 E 3				T E			T E								T E
Profession-specific competence	Master the complexity of technical systems by using system and process models.	T 12 E 12	T E	T E	T E		T E		T E	T E	T E	T E	T E	T E	T E		T E

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Profession-specific competence	Reconcile conflicting specifications and prior conditions in a high quality and innovative concept or process.	T 6 E 6		T E			T E			T E	T E	T E				T E
	Synthesize incomplete, contradictory or redundant data into useful information.	T 7 E 7		T E			T E		T E		T E	T E	T E			T E
	Possess sufficient ready knowledge and understanding to evaluate the results of complex calculations, or make approximate estimates.	T 10 E 10	T E	T E	T E		T E		T E	T E	T E	T E	T E			T E
	Pay attention to entire life cycles of systems, machines, and processes.	T 2 E 1							T			T E				
	Pay attention to sustainability, energyefficiency, environmental cost, use of raw materials and labour costs.	T 4 E 3					T E		T E			T E			T	
	Pay attention to all aspects of reliability, safety, and ergonomics.	T 4 E 3					T E		T		T E	T E				
	Have insight into and understanding of the importance of entrepreneurship.															
	Show perseverance, innovativeness, and an aptitude for creating added value.	T 6 E 6	T E				T E			T E	T E	T E				T E
			W 12 E 11	W 24 E 24	W 23 E 23	W 2 E 2	W 33 E 33	W 2 E 2	W 30 E 26	W 18 E 18	W 27 E 27	W 25 E 25	W 19 E 19	W 6 E 6	W 9 E 5	W 30 E 30

<< EMingwALG1.1 Master and apply advanced knowledge in the own engineering discipline in solving complex problems.

Competences in one/more scientific discipline(s)

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	group work lecture	report	To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions.

E073720	Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071181	Chemistry of Industrial Processes	guided self-study seminar lecture	oral examination	Application of molecular level insights for catalyst design and process optimization
E071131	Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900	Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E064950	Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760	Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200	Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E040533	Computational Fluid Dynamics in Chemical Technology	guided self-study seminar lecture	oral examination report	To use CFD models in chemical industry To use CFD models in optimization of chemical reactors To implement CFD models To validate CFD models To use CFD models in design of chemical reactors To design CFD models
E028700	Thermal Installations	lecture seminar: practical PC room classes seminar: coached exercises self-reliant study activities	open book examination	Designing heat exchangers Understanding the physics of two phase gas liquid flow Pointing out heat exchanger types and their properties
E091103	Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	group work lecture	report	To evaluate when model-based and non-model based control should/can be applied. To be able to develop a mathematical model formulation through signal processing techniques (identification methods).
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis

E074200	Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E040533	Computational Fluid Dynamics in Chemical Technology	guided self-study seminar lecture	oral examination report	To use CFD models in chemical industry To use CFD models in optimization of chemical reactors To implement CFD models To validate CFD models To use CFD models in design of chemical reactors To design CFD models

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture		To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis

E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E028700 Thermal Installations	seminar: coached exercises seminar: practical PC room classes	open book examination report	Designing heat exchangers
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	guided self-study lecture group work	report	To possess insight into the choice between model based control strategies and to apply them in practice. To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions. To be able to develop a mathematical model formulation through signal processing techniques (identification methods). To critically assess the choice for trade-off between performance of closed loop and robustness to disturbances and process model variations. To evaluate when model-based and non-model based control should/can be applied. To understand the effect of analog-to-digital and digital-to-analog converters on system dynamics. To identify the interactions between sub-processes and to understand the effect of this interaction on the global performance of the total process.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion		Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.

E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	group work lecture	report	To identify the interactions between sub-processes and to understand the effect of this interaction on the global performance of the total process. To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.

E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071181 Chemistry of Industrial Processes	guided self-study seminar lecture	oral examination	Application of molecular level insights for catalyst design and process optimization
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	group work lecture	written examination report open book examination	To understand the effect of analog-to-digital and digital-to-analog converters on system dynamics. To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions. To be able to develop a mathematical model formulation through signal processing techniques (identification methods). To critically assess the choice for trade-off between performance of closed loop and robustness to disturbances and process model variations.
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	group work	report	To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules

E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E007920 Computer Control of Industrial Processes	guided self-study	report	To possess insight into the choice between model based control strategies and to apply them in practice.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	group work lecture	report	To be able to develop a mathematical model formulation through signal processing techniques (identification methods).
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis

E074200	Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E040533	Computational Fluid Dynamics in Chemical Technology	guided self-study seminar lecture	oral examination report	To use CFD models in chemical industry To use CFD models in optimization of chemical reactors To implement CFD models To validate CFD models To use CFD models in design of chemical reactors To design CFD models
E028700	Thermal Installations	self-reliant study activities seminar: practical PC room classes	report	Using software for energy calculations
E091103	Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	group work lecture	report	To critically assess the choice for trade-off between performance of closed loop and robustness to disturbances and process model variations. To be able to develop a mathematical model formulation through signal processing techniques (identification methods).
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E007920 Computer Control of Industrial Processes	group work	report	To possess insight into the choice between model based control strategies and to apply them in practice. To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions. To be able to develop a mathematical model formulation through signal processing techniques (identification methods). To critically assess the choice for trade-off between performance of closed loop and robustness to disturbances and process model variations. To evaluate when model-based and non-model based control should/can be applied. To understand the effect of analog-to-digital and digital-to-analog converters on system dynamics. To identify the interactions between sub-processes and to understand the effect of this interaction on the global performance of the total process.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained

E091103	Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E007920 Computer Control of Industrial Processes	group work lecture	report	To identify the interactions between sub-processes and to understand the effect of this interaction on the global performance of the total process. To be able to develop a mathematical model formulation through signal processing techniques (identification methods). To understand the effect of analog-to-digital and digital-to-analog converters on system dynamics.
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E007920 Computer Control of Industrial Processes	group work online lecture lecture	written examination report open book examination	To identify the interactions between sub-processes and to understand the effect of this interaction on the global performance of the total process. To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions.
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	guided self-study lecture group work	report	To possess insight into the choice between model based control strategies and to apply them in practice. To critically assess the choice for trade-off between performance of closed loop and robustness to disturbances and process model variations.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules

E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	guided self-study lecture group work	report	To possess insight into the choice between model based control strategies and to apply them in practice. To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions. To be able to develop a mathematical model formulation through signal processing techniques (identification methods). To critically assess the choice for trade-off between performance of closed loop and robustness to disturbances and process model variations. To evaluate when model-based and non-model based control should/can be applied. To understand the effect of analog-to-digital and digital-to-analog converters on system dynamics. To identify the interactions between sub-processes and to understand the effect of this interaction on the global performance of the total process.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules

E064950	Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760	Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200	Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E040533	Computational Fluid Dynamics in Chemical Technology	guided self-study seminar lecture	oral examination report	To use CFD models in chemical industry To use CFD models in optimization of chemical reactors To implement CFD models To validate CFD models To use CFD models in design of chemical reactors To design CFD models
E028700	Thermal Installations	seminar: coached exercises seminar: practical PC room classes	open book examination report	Analysing complex thermal processes and cycles Designing heat exchangers
E091103	Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E007920 Computer Control of Industrial Processes	group work	report	To critically assess the choice for trade-off between performance of closed loop and robustness to disturbances and process model variations.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
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E028700 Thermal Installations	excursion self-reliant study activities lecture		Pointing out heat exchanger types and their properties Approaching energy use in an industrial context in a critical way both in a company and in society
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	guided self-study lecture group work	report	To possess insight into the choice between model based control strategies and to apply them in practice. To evaluate when model-based and non-model based control should/can be applied.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.

E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course		Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*				
E072110	Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E073720	Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131	Sustainable Chemical Production Processes	guided self-study lecture group work excursion		Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900	Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E064950	Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760	Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis

E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E007920 Computer Control of Industrial Processes	group work	report	To be able to communicate and cooperate within a team, to manage a project towards the end-objectives and to report the obtained results in a critical objective assessment.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E028700 Thermal Installations	lecture		Pointing out heat exchanger types and their properties
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	group work	report	To be able to communicate and cooperate within a team, to manage a project towards the end-objectives and to report the obtained results in a critical objective assessment.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules

E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

<< **EMingwALG4.3 Have the ability to work as a member of a team in a multidisciplinary workingenvironment, as well as being capable of taking on supervisory responsibilities.** *Competences in cooperation and communication*

Course		Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*				
E072110	Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920	Computer Control of Industrial Processes	group work	report	To be able to communicate and cooperate within a team, to manage a project towards the end-objectives and to report the obtained results in a critical objective assessment.
E073720	Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131	Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950	Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	group work	report	To be able to communicate and cooperate within a team, to manage a project towards the end-objectives and to report the obtained results in a critical objective assessment.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules

E064950	Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760	Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200	Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E040533	Computational Fluid Dynamics in Chemical Technology	guided self-study seminar lecture	oral examination report	To use CFD models in chemical industry To use CFD models in optimization of chemical reactors To implement CFD models To validate CFD models To use CFD models in design of chemical reactors To design CFD models
E091103	Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E007920 Computer Control of Industrial Processes	group work	report	To possess insight into the choice between model based control strategies and to apply them in practice. To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions. To be able to develop a mathematical model formulation through signal processing techniques (identification methods). To critically assess the choice for trade-off between performance of closed loop and robustness to disturbances and process model variations. To evaluate when model-based and non-model based control should/can be applied. To understand the effect of analog-to-digital and digital-to-analog converters on system dynamics. To identify the interactions between sub-processes and to understand the effect of this interaction on the global performance of the total process.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E028700 Thermal Installations	excursion lecture		Approaching energy use in an industrial context in a critical way both in a company and in society
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072302 Safety, Health and Environmental Management	guided self-study online lecture: response lecture online demonstration lecture: response lecture self-reliant study activities lecture demonstration	written examination with open questions participation	Identifying hazards, defining risks, evaluating risks for chemical reactor safety. Knowing and understanding process safety concepts for industrial storage of liquid chemicals in tanks. Understanding contemporary issues around Energy and Climate Identifying and characterizing gas and dust explosion hazards. Understanding and anticipating safety risks in industrial catalytic fixed-bed reactor processes. Permanent creative and scientific thinking, judging and acting; applying scientific / technical disciplinary insights on complex engineering problems. Executing a concise safety study of industrial-scale distillation towers. Integration of sustainability in management and acting. Describing the foundations of a quantitative risk assessment. Developing guidelines for safe execution of turnarounds and contractor management. Responsible use of health, safety and environmental aspects in laboratories and workplaces; integrate and implement these via a management-oriented approach.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072302 Safety, Health and Environmental Management	guided self-study online lecture: response lecture online demonstration lecture: response lecture self-reliant study activities lecture demonstration	written examination with open questions participation	Identifying hazards, defining risks, evaluating risks for chemical reactor safety. Knowing and understanding process safety concepts for industrial storage of liquid chemicals in tanks. Understanding contemporary issues around Energy and Climate Identifying and characterizing gas and dust explosion hazards. Understanding and anticipating safety risks in industrial catalytic fixed-bed reactor processes. Permanent creative and scientific thinking, judging and acting; applying scientific / technical disciplinary insights on complex engineering problems. Executing a concise safety study of industrial-scale distillation towers. Integration of sustainability in management and acting. Describing the foundations of a quantitative risk assessment. Developing guidelines for safe execution of turnarounds and contractor management. Responsible use of health, safety and environmental aspects in laboratories and workplaces; integrate and implement these via a management-oriented approach.
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	guided self-study lecture group work	report	To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions.
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules

E064950	Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760	Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200	Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E040533	Computational Fluid Dynamics in Chemical Technology	guided self-study seminar lecture	oral examination report	To use CFD models in chemical industry To use CFD models in optimization of chemical reactors To implement CFD models To validate CFD models To use CFD models in design of chemical reactors To design CFD models
E028700	Thermal Installations	seminar: coached exercises seminar: practical PC room classes	report	Designing heat exchangers Using software for energy calculations
E091103	Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained

E091103	Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	**KNOWLEDGE: INSIGHTS:** Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations **SKILLS: HEURISTICS:** • Estimating orders of magnitude of quantities important for reactor design • Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration • Scaling up reactors **KNOWLEDGE: MODELS:** Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors **SKILLS: METHODS:** • Determining the number of global reactions to convert a given feed to desired products • Acquiring bench scale data leading to rate equations suitable for reactor design • Assessing the importance of transport and transfer of mass and energy • Deriving design equations and estimating the related transport parameters • Deriving the reactor design equations starting from the conservation laws of mass and energy • Solving the most common and most simple design equations • Defining a window of operation and designing a reactor accounting for thermodynamic equilibrium • Assessing and accounting for deviations from ideal flow patterns **KNOWLEDGE: CONCEPTS** Defining: conversion, selectivity, yield, batch reactor, plug flow reactor, continuous stirred tank reactor (CSTR), residence time distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maximal isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree of segregation **SKILLS: PROCEDURES:** Deriving rate equations based on reaction mechanisms suitable for reactor design **KNOWLEDGE: RELATIONS:** Deriving, calculating, explaining and predicting: the effect of non-ideal flow patterns on reactor behavior, temperature dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun pressure drop equation
E007920 Computer Control of Industrial Processes	guided self-study lecture group work	report	To evaluate when model-based and non-model based control should/can be applied. To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions. To be able to develop a mathematical model formulation through signal processing techniques (identification methods).
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules

E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200 Kinetic Modelling and Simulation	guided self-study seminar project lecture	oral examination report	Use the acquired expertise and apply the interdisciplinary knowledge to solve ill-defined chemical kinetics problems Critically evaluate typical complex problems in kinetic modelling and subsequently select a suitable, yet manageable technique which is to be implemented in the relevant software Design a set of experiments which enables the construction of kinetic models Present the techniques, results and conclusion from kinetic modelling activities in a scientific appropriate and concise, yet complete manner, both orally and written Apply interdisciplinary knowledge, e.g., physical chemistry, kinetics, catalysis, reactor engineering, statistics…, when critically evaluating chemical kinetics problems and proposing suitable solutions Recognize the strengths and weaknesses of the implemented techniques and critically evaluate the solutions obtained
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion		Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion	oral examination report	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E028700 Thermal Installations	excursion lecture		Approaching energy use in an industrial context in a critical way both in a company and in society

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	guided self-study lecture group work excursion		Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass, process simulation, CO2 emissions Process economics. Process simulation. Identification of the most important streams in a refinery and treatment processes. Evaluation of process efficiency and sustainability. Obtain insight in implementation of large-scale processes. Obtain insight in production of selected second generation chemicals. Obtain insight in production methods of important chemicals. Obtain insight in the structure of a refinery. Obtain insight in the structure of chemical industry.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis

<< **EMingwALG6.8 Have insight into and understanding of the importance of entrepreneurship.** *Profession-specific competence*

Course	Teaching methods	Evaluation methods	Course learning outcome

*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E071200 Unit Operations in Chemical Industry	guided self-study seminar: coached exercises practicum lecture	oral examination report skills test	To gain insight in the evaporation process To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operations in chemical industry To gain insight in the boiling process To gain insight in the centrifugation process To gain insight in the extraction process To understand and to determine phase equilibria To gain insight in the filtration process To gain insight in the destillation process To gain insight in the drying process To gain insight in the condensation process
E073720 Industrial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flory-Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing, being capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of different length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of polymers Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline state/melting behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical polymerization; controlled radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution polymerization; bulk polymerization; method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics, the importance of molecular diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and reactor configuration on the polymerization rate and polymer properties Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws for mass and energy for polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length and time scales, and assessing typical order of magnitudes related to the design of polymerization reactors. Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E091103 Master's Dissertation	master's dissertation	oral examination assignment	Define, study and analyse the research problem in a specific domain. Give proof of independency, motivation, dedication, drive to innovation and creativity, initiative and perseverance. Self-assessment with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both to colleagues as to laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of research (literature search, topical study, research and the reflection on the research, experiments, experimentations, designs, simulations, results, conclusions,…). Find an appropriate methodology, in accordance with the applicable scientific norms of the specific field of study.