Competence coverage	matrix							Gene	eral Co	urses						Maste r's Disse
GHENT UNIVERSITY			dustry	itals and	Processes	ıtal Management		ses	on Processes	mers			uc	in Chemical		tation
Master of Science in Ch	nemical Engineering		E071200 Unit Operations in Chemical Industry	E072110 Chemical Reactors: Fundamentals and Applications	E007920 Computer Control of Industrial Processes	E072302 Safety, Health and Environmental Management	Project	E071181 Chemistry of Industrial Processes	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	stallations	issertation
Academic year 2021-20 Legend:	22		00 Unit Opera	10 Chemical F ttions	20 Computer	32 Safety, He	E073720 Industrial Project	31 Chemistry		00 Structure a	50 Polymer R	30 Chemical F	00 Kinetic Mo	33 Computati ology	E028700 Thermal Installations	E091103 Master's Dissertation
T=teaching methods			:0712	0721	6200	:0723	0737	07118	E071131	06890	0649	0737	0742	:0405; echno	0287	0911
E=evaluation methods Competences in	Master and apply advanced knowledge in the own engineering	T 13	Т	Т	Т	ш	Т	Т	Т	Т	Т	Т	Т	Т	Т	Т
one/more scientific	discipline in solving complex problems.	E 13	Е	E	E		E	E	E	E	E	E	E	E	Е	Е
discipline(s)	Apply Computer Aided Engineering (CAE) tools and advanced communication instruments in a creative and purposeful way.	T 9 E 9		E	E		E		E	E	E	E	E	E		
	Innovative use of expert-knowledge in all parts of chemical installations and the processes taking place in them.	T 9 E 8	Т	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	T 8	Т	Т	Т		Т		Т		Т	Т	_		_	Т
	chemical installations. Original, constructive and innovative use of different and	E 7	Е	E T	E T		E		Т	Т	E	E T				E
	supporting engineering-disciplines during design and research.	E 8		E	E		E		E	Е	E	E				E
	Apply knowledge of basic chemistry to chemical installations, especially during development of chemical-analytical ways of thinking.	T 5 E 5		E			E	E	E		E					
	Apply knowledge of basic mathematics to chemical installations, especially during the development of mathematical-analytical ways of thinking.			E	E				E		E	E				
	Apply knowledge of chemistry and process technology to arrive at a solution-focused approach of reactor design and choice of materials.	E 4		E			E		E		E					
	Apply knowledge of physics and process technology to arrive at a solution-focused choice of apparatus.	T 5 E 5		T E			E		E		E	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			Т		Т		Т	Т	_	Т	_			Т
	Select and apply the appropriate models, methods and	E 6 T 11	Т	Т	E T		E T		E	E T	Т	E T	Т	Т	Т	T
	techniques. Develop and validate mathematical models and methods.	E 11	Е	E	E T		Е			Е	E	Е	E	E	Е	Е
		E 4		Ė	E T		Т				Ē		E T			Т
	Interpret research findings in an objective and critical manner.	E 4			E		E						E			E
	Be able to handle lack of data for multidisciplinary formulations of problems.	T 7 E 7		E			E		E		E	E	E			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			Т								_			Т
	Be prepared to identify, evaluate and eliminate shortcomings in	E 2 T 3			Е		Т						Т			T
Intellectual	own research and design. Independently form an opinion on complex situations and	E 3 T 10	Т	Т	Т		E		Т	Т	Т	Т	E			E
competences	problems, and defend this point of view.	E 10	Е	E	Е		E		E	E	E	Е	E	<u>_</u>		E
	Apply knowledge in a creative, purposeful and innovative way to research, conceptual design and production.	T 12 E 12	E	E	E		E		E	E	E	E	E	E	E	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			_										Т	Т
	Readily adapt to changing professional circumstances.	E 1					Т		Т							E
	Problem-avoiding, problem-solving and system-oriented scientific	E 3		Т	т		E		E T	Т	Т	т				E
	thinking.	E 8		E	E		E		Е	Е	E	Е				E
	Critically analyse scientific and industrial problems in the domain or chemical technology and compare own analysis to that of others.	fT 8 E 7		T E			T E		Т	E	E	E	T E			E
	Independently extend the own area of research, taking into account the constant evolution of the area of expertise.	T1 E1														T E
Competences in	Have the ability to communicate in English about the own field of	Т9			Т		Т		Т	Т	Т	Т	Т		Т	Т
cooperation and communication	specialisation. Project management: have the ability to formulate objectives,	E 8	Т	Т	E		E		E	E	E	Е	E			E
23	report efficiently, keep track of targets, follow the progress of the project,	E 9	Ė	E	E		E		E	Ė	E		Ė			Ē
	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		E	E		E		E		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			Т		Т		Т						Т	Т
	Recognize the most important business and legal aspects of the own engineering discipline.	E 4 T 3 E 3			Е	T E	T E		T E							Е
	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	Master the complexity of technical systems by using system and	T 12	T	Ţ	T		T		Т	T	T	Ţ	T	T	Ţ	Т
competence	process models.	E 12	E	E	E		E		E	E	E	E	Е	E	E	E

GHENT UNIVERSITY Master of Science in C Academic year 2021-20 Legend: T=teaching methods E=evaluation methods			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
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							Т			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			Т	
	Pay attention to all aspects of reliability, safety, and ergonomics.	T 4 E 3					T E		Т		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
<< EMinaw				W 24 E 24				W 2 E 2			W 27 E 27					W 30 E 30

Competences in one/more scientific discipline(s)

EMingwALG1.1 Master and apply	advanced knowledge in the ov	vn engineering aiscipili	ne in solving complex problems.	Competences in one/more scientific discipline(
Course	Teaching methods	Evaluation methods	Course learning outcome	
oot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	ggevonden 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 process To gain insight in the absorption process To gain insight in physical, thermal and mechanical unit operators 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 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	bed reactors SKILLS: METHODS: Determining the number of global reactions to convert a given Acquiring bench scale data leading to rate equations suitable Assessing the importance of transport and transfer of masses. Deriving design equations and estimating the related transfer Deriving the reactor design equations starting from the consecutive Solving the most common and most simple design equation. Defining a window of operation and designing a reactor access Assessing and accounting for deviations from ideal flow path KNOWLEDGE: CONCEPTS Defining: conversion, selectivity, yield, batch reactor, plug flow distribution, difference between residence time and space time, stoichiometric coefficies baric adiabatic	in model equations eactor design mining the optimal reactor configuration dels, both one-dimensional and two-dimensional models for fixed ten feed to desired products and energy bort parameters servation laws of mass and energy as counting for thermodynamic equilibrium atterns w reactor, continuous stirred tank reactor (CSTR), residence time cients, degree of advancement, key component, affinity, maximal hiele modulus, Hatta number, intrinsic kinetics, axial and radial icromixing, macromixing, earliness of mixing, degree of the for reactor design non-ideal flow patterns on reactor behavior, temperature
			pressure drop equation	nalyze the effects of these simplifying assumptions.

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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 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.

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Course Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	Teaching methods gevonden in de studiefiche	Evaluation methods	Course learning outcome
		written 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
E007920 Computer Control of Industrial Processes	group work	raport	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 To evaluate when model-based and non-model based control should/can be applied.
•	group work lecture	report	To be able to develop a mathematical model formulation through signal processing techniques (identification methods).
073720 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 the structure of a refinery. Obtain insight in the structure of chemical industry.
068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Obtain insight in the structure of chemical industry. 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. Knowledge: describing and defining the following concepts: amorphous and somi-crystalling polymers: crystalling state/melting.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	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 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

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gwCHEM1.1 Innovative use of ex	pert-knowledge in all i	parts of chemical installations and the	processes taking place in them.
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Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	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: Defining: pseudo-homogeneous models, heterogeneous models, both one-dimensional and two-dimensional models for fixed bed reactors SKILLS: METHODS: Deriving 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: PROCEDUR
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.
E073760 Chemical Process Design	guided self-study seminar: practical PC room classes seminar: coached exercises seminar project lecture	open book examination assignment oral examination	Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering. systematic process design, energy integration, safety and economic analysis

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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.

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	Creative use of expe		•		Competences in one/more scientific discipline
Course		eaching methods	Evaluation methods	Course learning outcome	
Noot: leer- en evaluatievormen voorafgegaar					
E071200 Unit Operations in Chemic		ided self-study minar: coached exercises	oral examination report	To gain insight in the evaporation process To calculate and design apparatus for the above m	entioned processes in chemical industry
	•	acticum	skills test	To gain insight in the absorption process	Lunit apprations in chamical industry
	iec	cture		To gain insight in physical, thermal and mechanical To gain insight in the boiling process	runit operations in chemical industry
				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: Funda	amentals and gui	ided self-study	written examination	KNOWLEDGE: INSIGHTS:	
Applications		•	report		inetics of single and global reactions, effects of non-isothermicity on the
		minar: coached exercises oject	participation oral examination	behavior of different reactor types, diffusion vs. reaction, physical meaning of page 1.	arameters in model equations
	mic	croteaching		SKILLS: HEURISTICS:	·
		egration seminar cture		 Estimating orders of magnitude of quantities impo Assessing of criteria for reactor (model) selection 	
		oup work		Scaling up reactors	rana actorniming the optimal reactor configuration
				KNOWLEDGE: MODELS:	
				bed reactors	neous models, both one-dimensional and two-dimensional models for fixed
				SKILLS: METHODS:	
				 Determining the number of global reactions to co Acquiring bench scale data leading to rate equati 	
				Assessing the importance of transport and transfer	
				Deriving design equations and estimating the relations	
				 Deriving the reactor design equations starting fro Solving the most common and most simple design 	
				 Defining a window of operation and designing a r 	eactor accounting for thermodynamic equilibrium
				 Assessing and accounting for deviations from ide KNOWLEDGE: CONCEPTS 	eal flow patterns
					or, plug flow reactor, continuous stirred tank reactor (CSTR), residence time
				distribution, difference	
				between residence time and space time, stoichiome isobaric adiabatic	etric coefficients, degree of advancement, key component, affinity, maximal
				temperature rise, effectiveness factor, enhancemer	nt factor, Thiele modulus, Hatta number, intrinsic kinetics, axial and radial
				mixing, internal and external	iffusion migramiving magramiving carlings of miving dagree of
				segregation	iffusion, micromixing, macromixing, earliness of mixing, degree of
				SKILLS: PROCEDURES:	
				Deriving rate equations based on reaction mechani KNOWLEDGE: RELATIONS:	isms suitable for reactor design
				Deriving, calculating, explaining and predicting: the	effect of non-ideal flow patterns on reactor behavior, temperature
				dependency on the reaction enthalpy	nd mass transfer, minimum fluidization velocity, terminal velocity, Ergun
				pressure drop equation	id mass transier, minimum hudization velocity, terminal velocity, Ergun
E007920 Computer Control of Indus	•	ided self-study	report		based control strategies and to apply them in practice.
		cture oup work			s and to analyze the effects of these simplifying assumptions. lation through signal processing techniques (identification methods).
	9.0	oup work		To critically assess the choice for trade-off between	n performance of closed loop and robustness to disturbances and process
				model variations.	and control should/oan be applied
				To evaluate when model-based and non-model base. To understand the effect of analog-to-digital and dig	
				To identify the interactions between sub-processes	and to understand the effect of this interaction on the global performance of
E073720 Industrial Project	exi	cursion	oral examination	the total process. To produce a conceptual design for a (new) chemic	cal process
,		minar: practical PC room classes oject	report		•
E071131 Sustainable Chemical Pro	oduction Processes gui	ided self-study			stillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass,
		cture oup work		process simulation, CO2 emissions	
		cursion		Process economics.	
				Process simulation. Identification of the most important streams in a refi	inory and treatment processes
				Evaluation of process efficiency and sustainability.	mery and treatment processes.
				Obtain insight in implementation of large-scale prod	
				Obtain insight in production of selected second gen Obtain insight in production methods of important of	
				Obtain insight in the structure of a refinery.	
E064950 Polymer Reaction Enginee	oring	ided self study	oral ovamination	Obtain insight in the structure of chemical industry.	oncepts: molar mass distribution; coordination polymerization; free radical
Loo-Joo i olymbi ixeaciion Enginee		ided self-study minar: coached exercises	oral examination report	polymerization; controlled	onoopia. Moiai maaa alamballon, coordinallon polymenzallon, nee radical
		oject	participation	radical polymerization; suspension polymerization;	emulsion polymerization; condensation polymerization; polymerization
	ied	cture		reactor control; monomer removal; polymerization reactor types; scale-up; nu	cleation; catalysts; drop distributions; phase equilibrium; solution
				polymerization; bulk polymerization;	. , , , , , , , , , , , , , , , , , , ,
				method of moments; population balances Knowledge: discussing the relation between function	onal 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
					merization processes, the effect of the applied polymerization technique an
				reactor configuration on the polymerization rate and polymer properties	
					on reactors with respect to the final application, applying conservation laws
				polymerization processes, evaluating the important	ce of the polymerization kinetics and transport phenomena on various lengt
				and time scales, and	
				assessing typical order of magnitudes related to the	e design of polymerization reactors. I group a design problem within the field of polymer reaction engineering.

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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.

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Course	Teaching methods	Evaluation methods	Course learning outcome
oot: leer- en evaluatievormen voorafgegaan door ** werden niet te	ruggevonden in de studiefiche		
oot: leer- en evaluatievormen voorafgegaan door ** werden niet te 072110 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
007920 Computer Control of Industrial Processes	group work lecture	report	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 To identify the interactions between sub-processes and to understand the effect of this interaction on the global performance of the total process.
073720 Industrial Project	excursion	oral examination	To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions. To produce a conceptual design for a (new) chemical process
	seminar: practical PC room classes		
071131 Sustainable Chemical Production Processes	project 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.
068900 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.

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.

behavior; orientation;

polymerization; controlled

reactor control; monomer

the importance of molecular

reactor configuration on the

for mass and energy for

and time scales, and

the parameters in the

polymerization; bulk polymerization; method of moments; population balances

polymerization rate and polymer properties

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

structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules

Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical

radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization

Knowledge: discussing the relation between functional groups present in polymer molecules and polymerization kinetics,

diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor scale, the physical meaning of

model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique and

Skills: distinguishing and identifying of polymerization reactors with respect to the final application, applying conservation laws

polymerization processes, evaluating the importance of the polymerization kinetics and transport phenomena on various length

removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase equilibrium; solution

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oral examination

participation

report

E064950 Polymer Reaction Engineering

guided self-study

project

lecture

seminar: coached exercises

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.

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EMingwCHEM1.4 Apply knowled thinking.	age of accidentally to offering		cially during development of chemical-analytical ways of Competences in one/more scientific discipline
Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet te	ruggevonden 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, e
E073720 Industrial Project	excursion seminar: practical PC room classes	oral examination report	pressure drop equation To produce a conceptual design for a (new) chemical process
E071181 Chemistry of Industrial Processes	project guided self-study seminar lecture	oral examination	Application of molecular level insights for catalyst design and process optimization
E071131 Sustainable Chemical Production Processes		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.

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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.

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Course	Teaching methods	Evaluation methods	Course learning outcome
oot: leer- en evaluatievormen voorafgegaan door ** werden niet ten	uggevonden in de studiefiche		
072110 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 difference between 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:
			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.
064950 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

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of materials. Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug			-
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	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 the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique an 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.

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Course		Teaching methods	Evaluation methods	Course learning outcome
	valuatievormen voorafgegaan door ** werden niet terug	Teaching methods gevonden in de studiefiche	Evaluation methods	Course learning outcome
	nemical Reactors: Fundamentals and oplications	guided self-study seminar: practical PC room classes seminar: coached exercises	written examination report participation	KNOWLEDGE: INSIGHTS: Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the behavior of different reactor
		project microteaching	oral examination	types, diffusion vs. reaction, physical meaning of parameters in model equations SKILLS: HEURISTICS:
		integration seminar		Estimating orders of magnitude of quantities important for reactor design
		lecture		 Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration
		group work		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 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, maxima
				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
073720 Inc	dustrial Project	excursion	oral examination	To produce a conceptual design for a (new) chemical process
		seminar: practical PC room classes project	report	
71131 Su	stainable Chemical Production Processes	guided self-study	oral examination	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass,
		lecture	report	process simulation, CO2
		group work		emissions
		excursion		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.
64950 Po	olymer Reaction Engineering	guided self-study	oral examination	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical
	.,g	seminar: coached exercises	report	polymerization; controlled
		project	participation	radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization
lecture	lecture		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
				the parameters in the
			model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique a 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.
\ 70 =0=	nemical Process Design	guided self-study	open book examination	systematic process design, energy integration, safety and economic analysis
073760 Ch	G	seminar: practical PC room classes	assignment	
073760 Ch	, and the second	seminar: practical PC room classes seminar: coached exercises	assignment oral examination	
073760 Ch	· ·	•		

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Course		Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evalu	uatievormen voorafgegaan door ** werden niet terugg	gevonden 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 destillation process
	nical Reactors: Fundamentals and cations	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	NOWLEDGE: 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 Detween residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maxima 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 pre
=007920 Com	puter Control of Industrial Processes	group work	report	pressure drop equation To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions.
E073720 Indus		excursion seminar: practical PC room classes	oral examination	To produce a conceptual design for a (new) chemical process
E071131 Susta	ainable 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.
≣068900 Struc	cture 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/meltin behavior; orientation;

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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.

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EMingwALG2.2 Consult the scientific literature as part of the own research.

Scientific competences	
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EMingwALG2.2 Consult the scien	•		Scientific competence
Course	Teaching methods	Evaluation methods	Course learning outcome
loot: leer- en evaluatievormen voorafgegaan door ** werden niet teru	ggevonden 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.
073720 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.

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polymer flow in basic geometries using the conversation low of mass and momentum, recognizing length scales and molecular	the relevance of different
interactions.	
Attitude: being capable to solve independently and in group problems in the field of structure and considerable in the field of structure and considerable in the following concepts: amorphous and semi-crystalline polymeans are supplied to solve independently and in group problems in the field of structure and considerable in	
behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffu	usion of polymer molecules
E064950 Polymer Reaction Engineering guided self-study oral examination Knowlegde: describing and defining the following concepts: molar mass distribution; coordination processes and the following concepts are concepts: molar mass distribution; coordination processes are concepts: molar mass distribution; coordination processes are concepts.	
seminar: coached exercises report polymerization; controlled project participation radical polymerization; suspension polymerization; emulsion polymerization; condensation polyme	rization; polymerization
lecture reactor control; monomer removal; polymerization reactor types; scale-up; nucleation; catalysts; drop distributions; phase eq	
polymerization; bulk polymerization;	amonani, solution
method of moments; population balances Knowledge: discussing the relation between functional groups present in polymer molecules and p	oolvmerization kinetics
the importance of molecular	•
diffusion and mixing phenomena in polymerization processes on laboratory and industrial reactor s the parameters in the	scale, the physical meaning
model equations, the most important industrial polymerization processes, the effect of the applied	polymerization technique ar
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 p	phenomena on various leng
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 poly	mer reaction engineering.
E073760 Chemical Process Design guided self-study open book examination systematic process design, energy integration, safety and economic analysis	
seminar: practical PC room classes assignment seminar: coached exercises oral examination seminar project	

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project lecture

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 classe	report s	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.

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Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet	_		
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 fixe 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 tin

			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; 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

distribution, difference

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EMingwALG2.5 Interpret research findings in an objective and critical manner.

Scientific competences

Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet ter	uggevonden 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.

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Scientific competences

CONTINUE TO HAIR	e lack of data for illultidiscipili	inary romanamono or pro	Scientific competence
Course Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terugg	Teaching methods gevonden in de studiefiche	Evaluation methods	Course learning outcome
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,
E073720 Industrial Project	excursion seminar: practical PC room classes	oral examination	pressure drop equation To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	project 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 E073760 Chemical Process Design	guided self-study seminar: coached exercises project lecture guided self-study seminar: practical PC room classes seminar: coached exercises seminar project	oral examination report participation open book examination assignment oral examination	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 an 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. systematic process design, energy integration, safety and economic analysis
E074200 Kinetic Modelling and Simulation	lecture 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

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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.

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EMingwCHEM2.2 Compose experimental schemata in view of design and optimisation of models.

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Scientific competences

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Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet ter	uggevonden 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.

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EMingwCHEM2.3 Perform result-focused scientific research and design.

Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teru	iggevonden 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.

Scientific competences

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EMingwCHEM2.4 Be prepared to identify, evaluate and eliminate shortcomings in own research and design.

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Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden n	iet teruggevonden in de studiefiche		
E073720 Industrial Project	excursion seminar: practical PC room project	oral examination classes 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 techr 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 critic 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.

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EMingwALG3.1 Independently for Course	Teaching methods	Evaluation methods	nd defend this point of view. Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	_	Lvaluation methods	
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 destillation process To gain insight in the drying 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	To gain insight in the condensation process 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 tim distribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maxim 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 fo
E007920 Computer Control of Industrial Processes	guided self-study lecture group work	report	pressure drop equation 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		assignment	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

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length scales and molecular

behavior; orientation;

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

structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules

interactions.

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.

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<<	EMingwALG3.2 Apply knowledge in a creat	ive, purposeful and	d innovative way to research	, conceptual design and pro	duction.
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Intelle	ectual	competences

Course Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terugg	Teaching methods gevonden in de studiefiche	Evaluation methods	Course learning outcome	
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-isothermici 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 mod 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), residistribution, difference between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affin isobaric adiabatic temperature rise, effectiveness factor, enhancement factor, Thiele modulus, Hatta number, intrinsic kinetics, axial mixing, internal and external gradients, fluidization, bubble formation, effective diffusion, micromixing, macromixing, earliness of mixing, degree 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-idea	els for fixed sidence time sity, maxima and radial of
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 meth To critically assess the choice for trade-off between performance of closed loop and robustness to disturbances as 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 pethe total process.	nd 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 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.	s, biomass,
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 Huggins parameter in describing molecular interactions, understanding the effect of process conditions (such as temperature and press diffusivity of polymers in melt and solution, being able to relate the polymer structure and polymer dynamics to the basic steps of polymer processing capable to describe isothermal polymer flow in basic geometries using the conversation low of mass and momentum, recognizing the relevance of length scales and molecular interactions. Attitude: being capable to solve independently and in group problems in the field of structure and dynamics of poly Knowlegde: describing and defining the following concepts: amorphous and semi-crystalline polymers; crystalline sehavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer	ure) on g, being f different mers state/meltir

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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.

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EMingwALG3.3 Critically reflect on one's own way of thinking and acting, and understand the limits of one's competences.

Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet ter	uggevonden 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.

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EMingwALG3.4 Stay uptodate with the evolutions in the discipline to elevate the own competences to expert level.

Intellectual competences

Course	Teaching methods	Evaluation methods	Course learning outcome		
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche					
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.		

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<< EMingwALG3.5 Readily adapt to changing professional circumstances.

Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	gevonden 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.

Intellectual competences

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Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	_		
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 Detween 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 pre
E007920 Computer Control of Industrial Processes	guided self-study lecture group work	report	pressure drop equation 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.
E068900 Structure and Dynamics of Polymers	guided self-study practicum lecture excursion	written examination assignment oral examination	Obtain insight in the structure of chemical industry. 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.
E064950 Polymer Reaction Engineering	guided self-study seminar: coached exercises project lecture	oral examination report participation	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 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.

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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.

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Intellectual competences

of others. Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terugge	_		
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: De
			dependency on the reaction enthalpy and chemical equilibrium, analogy between heat and mass transfer, minimum fluidization velocity, terminal velocity, Ergun
E073720 Industrial Project	excursion seminar: practical PC room classes	oral examination report	pressure drop equation 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 an 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	Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering. systematic process design, energy integration, safety and economic analysis

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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.

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EMingwCHEM3.3 Independently extend the own area of research, taking into account the constant evolution of the area of expertise.

Intellectual competences

Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** wel	rden 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.

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Course		Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaa.				
E007920 Computer Control of Indu	istrial 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			oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Pro	oduction 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	of Polymers	practicum	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.
E064950 Polymer Reaction Engine	eering	seminar: coached exercises	oral examination report participation	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. 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 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 the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique ar 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 lengt 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	n	seminar: practical PC room classes	open book examination assignment oral examination	systematic process design, energy integration, safety and economic analysis
E074200 Kinetic Modelling and Sin	nulation	guided self-study	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.

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Course	project,	Teaching methods	Evaluation methods	Course learning outcome
oot: leer- en	evaluatievormen voorafgegaan door ** werden niet terug	ggevonden in de studiefiche		
071200 U	nit Operations in Chemical Industry	guided self-study	oral examination	To gain insight in the evaporation process
		seminar: coached exercises practicum	report skills test	To calculate and design apparatus for the above mentioned processes in chemical industry To gain insight in the absorption process
	lecture	Skills test	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
72110 C	hemical Reactors: Fundamentals and	guided self-study	written examination	To gain insight in the condensation process KNOWLEDGE: INSIGHTS:
	pplications	seminar: practical PC room classes		Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the
	•	seminar: coached exercises	participation	behavior of different reactor
		project	oral examination	types, diffusion vs. reaction, physical meaning of parameters in model equations
		microteaching integration seminar		SKILLS: HEURISTICS: Estimating orders of magnitude of quantities important for reactor design
		lecture		 Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration
		group work		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
				 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 tir distribution, difference
				between residence time and space time, stoichiometric coefficients, degree of advancement, key component, affinity, maxin
				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
007920 C	omputer 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
	•	3 1	•	obtained results in a critical
				objective assessment.
ე73720 Ir	dustrial Project	excursion	oral examination	To produce a conceptual design for a (new) chemical process
		seminar: practical PC room classes	report	
071131 S	ustainable Chemical Production Processes	project guided self-study	oral examination	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass
07 1101 0	addinable Chemical Frederich Frederich	lecture	report	process simulation, CO2
		group work	·	emissions
		excursion		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.
068900 S	tructure and Dynamics of Polymers	guided self-study	written examination	Skills: being capable to relate the polymer microstructure to the polymer properties, understanding the relevance of the Flor
		practicum	assignment	Huggins parameter in
		lecture	oral examination	describing molecular interactions, understanding the effect of process conditions (such as temperature and pressure) on
		excursion		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.
				Autitude, being complied a ratio independently and the control of the first of the
				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/mel
				behavior; orientation;
				structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecule

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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.

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:	EMingwALG4.3 Have the ability to work as a member of	a team in a multidisciplinary workingenvironme	ent, as well as being capable of taking on	Competences in cooperation and communication
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supervisory responsibilities.			workingenvironment, as well as being capable of taking on Competences in cooperation and communication
Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet tel	ruggevonden in de studietiche		
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: RetLATIONS: Deriving, calculating, explaining
E007920 Computer Control of Industrial Processes	group work	report	pressure drop equation 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		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.

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Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	gevonden 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 destillation 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	To gain insight in the condensation process 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, maxima 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 KN
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

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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 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	Attitude: being able to solve independently and in a group a design problem within the field of polymer reaction engineering. 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 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.

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EMingwALG5.1 Act in an ethical, professional and social way. <<

EMingwALG5.1 Act in an ethical,	professional and social way.		Societal competences
Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	gevonden 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.

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Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terugge	evonden 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.

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Course	Teaching methods	Evaluation methods	Course learning outcome	
oot: leer- en evaluatievormen voorafgegaan door ** werden niet terugge	evonden 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 tank 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 discipling 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; integral a management-oriented approach.	ary insights on complex
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 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.	e cycle analysis, biomass,
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 possible sees seement with adequate and critical self-correction and objectivity. Communicate adequately on the research, the results and problems, present and found them, both laypeople. Render and synthesise the results concisely. Critically analyse, formulate, study, execute and/or process different aspects in the execution of reset 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 forms.	to colleagues as to earch (literature search, s,).

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Course		Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evalua	tievormen voorafgegaan door ** werden niet terugg			
E071200 Unit Ор	perations 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
E072110 Chemic Applica	cal Reactors: Fundamentals and ations	guided self-study seminar: practical PC room classes seminar: coached exercises project microteaching integration seminar lecture group work	written examination report participation oral examination	To gain insight in the condensation process 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, maxima isobaric adiabatic temperature isse, 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 KN
E007920 Compu	uter Control of Industrial Processes	guided self-study lecture group work	report	pressure drop equation To apply simplifying techniques to complex systems and to analyze the effects of these simplifying assumptions.
E073720 Industr	ial Project	excursion seminar: practical PC room classes project	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustair	nable 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 Structu	ure 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;

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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 To use CFD models 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.

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∍ourse Noot: leer- en evaluatievormen voorafgegaan door ** werden niet t	_	Evaluation methods	Goul Se learning outcome
course loot: leer- en evaluatievormen voorafgegaan door ** werden niet te 1072110 Chemical Reactors: Fundamentals and Applications	Teaching methods Teruggevonden in de studiefiche 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
073720 Industrial Project	excursion	oral examination	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 To produce a conceptual design for a (new) chemical process
068900 Structure and Dynamics of Polymers	seminar: practical PC room classes project 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/meltin behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
064950 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 the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique ar 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 lengt 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.
073760 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.

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Course Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	Teaching methods gevonden in de studiefiche	Evaluation methods	Course learning outcome
E072110 Chemical Reactors: Fundamentals and Applications	guided self-study seminar: practical PC room classes	written examination report	KNOWLEDGE: INSIGHTS: Deriving, calculating, explaining and predicting of kinetics of single and global reactions, effects of non-isothermicity on the
	seminar: coached exercises project	participation oral examination	behavior of different reactor types, diffusion vs. reaction, physical meaning of parameters in model equations
	microteaching integration seminar		SKILLS: HEURISTICS: • Estimating orders of magnitude of quantities important for reactor design
	lecture		Assessing of criteria for reactor (model) selection and determining the optimal reactor configuration
	group work		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 appearance for the read upon its equilibrium.
			 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	oral examination report	To produce a conceptual design for a (new) chemical process
E071131 Sustainable Chemical Production Processes	project guided self-study	oral examination	Understanding the following concepts: crude oil, distillate, residue, bulk chemicals, sustainability, life cycle analysis, biomass,
	lecture	report	process simulation, CO2
	group work excursion		emissions Process economics.
	excursion		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 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.
E064950 Polymer Reaction Engineering	guided self-study	oral examination	Obtain insight in the structure of chemical industry. Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free radical
	seminar: coached exercises	report	polymerization; controlled
	project	participation	radical polymerization; suspension polymerization; emulsion polymerization; condensation polymerization; polymerization
	lecture		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
			the parameters in the
			model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique an 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	open book examination	systematic process design, energy integration, safety and economic analysis
3	seminar: practical PC room classes		
	seminar: coached exercises seminar	oral examination	
	project		
FO74200 Kingtia Madallia a and City Left	lecture	orol oversis stills	Hoo the convired expertise and explictly intendicately and the track of 1911 (2011) 111 (2011)
E074200 Kinetic Modelling and Simulation	guided self-study seminar	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
	project	.opo.t	which is to be implemented
	lecture		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
			evanation chemical kinetics
			problems and proposing suitable solutions

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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. E091103 Master's Dissertation master's dissertation oral examination assignment 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.

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Course	Teaching methods	Evaluation methods	Course learning outcome
ot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	gevonden in de studiefiche		
071200 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
072110 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 ypes, 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: onversion, 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, maxima 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: CERLATIONS: 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
007920 Computer Control of Industrial Processes	guided self-study lecture group work	report	pressure drop equation 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

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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.

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EMingwALG6.5 Pay attention to entire life cycles of systems, machines, and processes.

Profession-specific competence

Course	Teaching methods	Evaluation methods	Course learning outcome
Noot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	gevonden 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 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

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EMingwALG6.6 Pay attention to sustainability, energyefficiency, environmental cost, use of raw materials and labour costs.

<<	EMingwALG6.6 Pay attention to s	ustainability, energyefficiency,	environmental cost, use	of raw materials and labour costs.	Profession-specific competence
Course		Teaching methods	Evaluation methods	Course learning outcome	
Noot: leer- ei	n evaluatievormen voorafgegaan door ** werden niet terug	gevonden 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, sur 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.	stainability, life cycle analysis, biomass,
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 ar	d in society

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Course	Teaching methods	Evaluation methods	Course learning outcome
loot: leer- en evaluatievormen voorafgegaan door ** werden niet terug	¥		•
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

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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

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<<	Livingwaldo.3 Show persever	ance, innovativeness, and an apti		·
Course		Teaching methods	Evaluation methods	Course learning outcome
Voot: leer- ei	n evaluatievormen voorafgegaan door ** werden niet t	eruggevonden 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/meltin behavior; orientation; structure-property relations; polymers in solution; polymer rheology; multicomponent systems; diffusion of polymer molecules
	Polymer Reaction Engineering Chemical Process Design	guided self-study seminar: coached exercises project lecture guided self-study seminar: practical PC room classes seminar: coached exercises	oral examination report participation open book examination assignment oral examination	Knowlegde: describing and defining the following concepts: molar mass distribution; coordination polymerization; free 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 the parameters in the model equations, the most important industrial polymerization processes, the effect of the applied polymerization technique at 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 lengt 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. systematic process design, energy integration, safety and economic analysis
		seminar project lecture		
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.

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